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THE UNIVERSITY
of EDINBURGH

**The Psychological Effects of
Human-Nature Connection and the
Effectiveness of Nature-based Interventions
on Mental Health in Adults**

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**Thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy (Ph.D.) in Clinical Psychology**

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Unknown future beckons, and I will go ahead bravely!

Abstract

Despite growing research on human-nature interaction, there remains a lack of understanding of the impact of physical engagement in nature and whether nature-based intervention is effective in improving mental wellbeing, mindfulness, sleep quality, and mood in adults. The aims of this thesis are to deepen our understanding of the psychological effects of human-nature interactions in relation to gardening and keeping houseplants, and to test the effectiveness and mechanisms of a targeted nature-based intervention on mental health outcomes.

The thesis investigated the psychological effects of human-nature connection from home settings to the community and to wider public nature environments. Firstly, the psychological effects of houseplants care behaviour on health and wellbeing community gardening, and the experience of engaging in community gardening amongst Chinese adults in urban areas were examined. Next, there is an examination of the effectiveness of greenspace-based walking intervention on mental health – a systematic review was carried out, and then a randomised control study of nature-based mindful walking was conducted in the UK with the design based on the findings of the systematic review.

A review of the literature on the impact of nature on mental health indicated that research on this topic has been done mostly in developed countries, especially in the Western world. A few studies regarding the human-nature connection in psychology have been investigated in China, which is now facing growing urbanisation, and environmental problems, and increasing levels of mental health concerns. A research

gap has also been identified regarding the effectiveness of walking in nature (i.e., greenspace) on mental health in the UK, especially for university students' mood disturbance and sleep difficulties during the COVID-19 pandemic.

As many Chinese adults living in urban environments do not have ready access to outdoor gardens, the first empirical work was to investigate the impact of houseplants on mental health. Using a questionnaire-based survey, two empirical studies regarding the care of houseplants ($n = 421$) are reported. The first part of this research revealed that houseplants carers reported significantly higher levels of mental well-being and mindfulness compared with non houseplants carers. Additionally, taking care of houseplants was positively related to greater levels of mental wellbeing and mindfulness, and the *Universalism* value was found to significantly relate to various houseplants care behaviours. The second study highlights the importance of one's attitude, perceived behaviour controls (i.e., self-efficacy), and intentions on behaviours around keeping houseplants. Moving to community settings from the house, a grounded theory study ($n = 21$) of Chinese community gardeners found participants perceived that community gardening activities benefited their physical health, mood, sense of connection with nature, communication, spirituality, and personal growth, but that Chinese gardeners believed they needed more support from the government to construct more gardens. This study bridges the gap of understanding Chinese city residents' experiences of outdoor gardening activities with respect to health and wellbeing. These findings imply that positively interacting with nature through gardening and indoor houseplants leads to a better human-nature relationship and improved mental health

outcomes for adults in urban China.

The subsequent chapters (5–6) of the thesis present an evaluation of the effectiveness of greenspace-based walking interventions on mental health in the UK. A systematic review of the literature reviewed 17 studies to provide new insight on the effects of greenspace-based walking interventions through a narrative synthesis of existing evidence. The findings revealed that nature-based walking was associated with benefits such as positive mood, wellbeing, anxiety-reduction, rumination, and mindfulness. However, only four of the included experimental studies in the systematic review employed a randomised control design. To address this gap, a novel randomised control study was conducted, using a pre-test, intervention, post-test, and delayed post-test design, where participants (N = 104 UK university students) were allocated to nature or urban walking conditions. Self-reported online assessment questionnaires were used as an evaluation tool. Participants were randomly assigned to either a nature or an urban walking environment, and they followed a prescribed route involving walking for around 35 minutes daily for seven consecutive days with instructions on how to engage in the walk mindfully. The results revealed no difference between nature and urban walking conditions but indicated that outdoor mindful walking improved the participants' mindfulness and sleep quality, and decreased mood disturbance. The improvement of sleep quality was linked to the relationship between the mindful walking intervention and the improvement of mood amongst university students, suggesting that mindful outdoor walking enhances mood through improving sleep.

This thesis highlights the importance of human-nature connections, and the mental health benefits of engaging in various nature-based activities and interventions in China and the UK. It also addresses gaps in psychological research on ways to promote human-nature interaction through gardening and planting; and deepens our understanding of how nature-based walking interventions can enhance adults' wellbeing, mood, mindfulness, and sleep quality. The findings of this thesis have implications for practice and policy and will impact public health (e.g., investment in community gardens for urban residents; encouraging people to grow indoor plants), and the impact on clinical practice of encouraging organisations (e.g., university mental health service) to deliver effective interventions to young adults with their sleep and mood problems.

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Lay summary

The relationship between humans and nature has always been widely discussed, and many people find natural environments attractive and fascinating. When we have leisure time, many of us choose to spend time in greenspace and nature. Gardening and nature walking are common ways across cultural contexts by which people connect with nature, and they have the potential to be utilised as nature-based interventions. However, the psychological effects of gardening and the effectiveness of nature walking remain under-investigated. The research reported in this thesis examined the human-nature relationship, and the effectiveness of nature-based interventions in different environmental settings – indoor house, community, and urban public park.

This thesis started by focusing on two empirical studies carried out in urban China to explore the effects on mental health of keeping houseplants and engaging in community gardening. The first study used an online questionnaire to examine the effects of keeping houseplants on mental health. The results showed that keeping houseplants has a positive association with Chinese people's mental health. To examine community gardening, a series of interviews was conducted in four Chinese cities. Findings revealed that community gardeners in China viewed engagement in gardening as positive for their mental health, physical health, personal relationships, parenting style, and personal growth.

From a community setting to broader outdoor natural environments, the thesis then focused on outdoor nature walking. A review of the previous studies indicated that

one's mental wellbeing, positive mood, and mindfulness can be improved, and anxiety and stress can be reduced, by walking in greenspaces. In addition, walking in nature can bring more psychological benefits compared with walking in urban areas. Based on these findings, a nature-walking intervention was designed to improve university students' sleep quality, mood, and mindfulness during the COVID-19 pandemic. University students who self-identified as having sleep difficulties were encouraged to register for this intervention. It was found that, after seven-day mindful walking in both nature and urban environments, participants reported their sleep quality and mindfulness had improved, and mood disturbance had decreased. Outdoor mindful walking improved participants' mood and has been found to improve the quality of sleep.

Overall, this research helped us to understand the significance of nature connection in the lives of adults, and how active engagement in nature through various activities in everyday settings, such as houseplants care, community gardening, and mindful nature walking, may maintain and promote an individual's mental health.

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Chapter 1

Background and Literature Review

1.1 Introduction

All over the world, mental health problems are highly prevalent in both developed and underdeveloped countries (World Health Organization, 2022). For instance, mental and behavioural disorders were reported as the main causes of YLDs (years lived with disability) in 2010 in the UK (Murray et al., 2013), whereas 17.5% of Chinese adults reported having mental disorders during 2001-2005 (Phillips et al., 2009). Mental disorders accounted for 5.1% of the global burden (World Health Organization, 2022) and posed a severe economic threat to all local and national governments (van der Wal et al., 2021), costing 2.5 trillion dollars a year worldwide (Health, 2020). The annual cost of mental illness to the UK economy is considerably high (£70–100 billion, equivalent to 4.5% of GDP) (OECD, 2014). Likewise, the total national annual costs for mental disorders in 2013 (\$88.8 billion) corresponded to 1.1% of GDP in China (J. Xu et al., 2016). Despite the importance of mental health and the high prevalence of mental health problems, most people suffering from mental problems are under-recognised and undertreated (and untreated) because, for instance, of the insufficient provision, the low-quality of mental healthcare services, and the strong social stigma attached to mental illness, which contribute to the low rate of seeking consultant and professional help (D. S. Davies, 2013; Murray et al., 2013; Que et al., 2019; World Health Organization, 2022; J. Xu et al., 2016).

The causes of mental health conditions are complex. Since the proportion of world population living in urban areas has risen from 30% in 1950 to 54% in 2014, and it is

expected to reach 68% in 2050 (Carta & Bhugra, 2019), the urbanisation-derived disadvantages like overcrowding, pollution, work pressures, social deprivation, health inequalities, and lack of contact with nature (Godfrey & Julien, 2005; Mackenbach et al., 2008; Moore et al., 2003; Ventriglio et al., 2021a) are risk factors for physical and mental health, leading to a variety of negative health outcomes such as sedentary habits, diabetes, sleep disturbances, psychological stress, anxiety, and depression (J. Chen et al., 2015; Giles-Corti et al., 2016; Gong et al., 2012; Lecic-Tosevski, 2019; Ramachandran et al., 2008; Robertson, 2019; Sobngwi, 2004; Srivastava, 2009; Sundquist et al., 2004, 2004; Ventriglio et al., 2021b; Weng et al., 2007). Though the benefits of urban life are recognised (better education, job opportunities, ready access to healthcare and preventive programme, secure nutrition, etc.) (Dye, 2008; Huang et al., 2019), the negative consequences of socio-economic and environmental changes in urbanised areas have made cities epicentres for chronic, non-communicable physical and mental health conditions (Shanahan, Bush, et al., 2016).

Considering the prevalence of mental disorders, the economic burden derived from them, and the increasing population demands that outstrip service capacity in rapidly urbanising and intensely urbanised areas in both developed and underdeveloped countries worldwide, there are concerns about finding effective, integrated, low-cost, and ecological measures to promote urban residents' mental health and create a healthy urban society.

It has been proposed that human contact with nature could be used to develop

effective and affordable interventions with the aim of reducing the public health burden of mental disorders (Maller et al., 2006; Sarkar et al., 2018). There is a blossoming of evidence that human exposure to natural environments is positively associated with various benefits to the urban population's physical and mental health, as indicated by several recent reviews conducted to evaluate the existing literature from a variety of disciplines (Bowler et al., 2010; Hartig et al., 2014; James et al., 2015; Martens & Bauer, 2013; Russell et al., 2013; Seymour, 2016; for further discussion, see below). Indeed, even though urban populations maintain some contact with nature (e.g., private gardens, urban parks, etc.; Davies et al., 2009; Natural England, 2017), urbanisation and urban lifestyles (e.g., increase of screen time, decline of outdoor activities, etc.) have arguably reduced the frequency, duration, and intensity of urban residents' exposure to green space and interaction with nature (Cox et al., 2018; Frumkin et al., 2017) and thereby engendered negative impacts on physical and mental health. Moreover, disadvantaged urban residents, especially those in underdeveloped areas (more than 80% of the population with mental health problems worldwide are residents of low- and middle-income countries, Alloh et al., 2018), have relatively limited access to nature and greenspace (Astell-Burt et al., 2014; Cutts et al., 2009; Dahmann et al., 2010; Rigolon, 2016), and this may reinforce the vicious cycle between mental health conditions and poverty (World Health Organization, 2022). In this light, the promotion of urban nature and nature-based health-facilitating interventions may offer considerable promise in addressing a range of public health issues engendered by urbanisation and arguably be prioritised over other options (Hartig et al., 2014).

Along with the growing body of evidence base regarding the health benefits of nature contact, 'Green Care' or 'Nature-Based Interventions' (a broad spectrum of health-promoting interventions that all use both biotic and abiotic elements of nature in their treatments such as care farming, healing garden, green exercise, ecotherapy, etc.) are progressively becoming popular as an effective, widely available, low-cost, and eco-friendly means of maintaining and promoting a person's social, physical, mental, and even educational wellbeing (Coventry et al., 2021; Haubenhofner et al., 2010; Sempik et al., 2003), which has been implemented in many different settings with various populations (Bloomfield, 2017; O'Brien et al., 2010; Robinson & Breed, 2019). For example, community gardening and nature-based walking as health promoting interventions have some positive effects on physical health and mental wellbeing (Barton et al., 2009; Clatworthy et al., 2013; Dewi et al., 2017; Han, 2017; Heilmayr & Friedman, 2020; Kelly et al., 2018a).

Despite the considerable body of evidence and various promising practices, several problems in this field remain unsolved or under-researched. As Frumkin (2013) argued, further research is needed to explore the causal mechanisms between nature and health and assess nature exposure (types and doses) for predicting and optimising its potential benefits. For instance, beside stress reduction and attention restoration (two contemporary theoretical frameworks, see further below), how might sleep quality, mindfulness level, or social connectedness mediate the psychological benefits of nature contact (Maas, 2006; Nisbet et al., 2019; Schutte & Malouff, 2018; J. C. Shin et al., 2020)? In addition, if nature connectedness and/or awareness (for definition, see further below) may be one of the key mediators of

assessing ‘nature dose’ and delivering nature’s beneficial outcomes (Capaldi et al., 2014; Cervinka et al., 2012; Frumkin et al., 2017; Perrin & Benassi, 2009), how might individuals’ actively mental and physical interaction with nature (rather than passively physical exposure to nature, Elsadek & Liu, 2021; Gamble et al., 2014; J. Lee et al., 2009) facilitate it in different settings?

The premise of the research reported in this thesis is that diverse and active nature-experiences or nature-connections (the subjective perception and active involvement of natural features) on a daily basis will maintain and enhance the mental health of urban populations in both developed and underdeveloped countries. The research is part of an endeavour to evidence and develop effective, widely available, inexpensive, eco-friendly health-promoting nature-based interventions in the context of urbanisation.

The following review of theoretical models and hypotheses about the impact of nature on mental health will provide a background for understanding the psychological benefits of human-nature connection and interaction. Based on this, the subsequent review of the literature will highlight the evidence of links between nature connectedness, mental wellbeing, and mindfulness, before giving an overview of the gaps in the evidence base and presenting the conceptual framework and rationale for the thesis.

1.2 Nature and Mental Health

Prior to introducing theories about nature and mental health, key terms used in this

thesis will be defined.

1.2.1 Definitions

Wellbeing. Despite the lack of a universal definition, wellbeing refers to how well things are going in life, including one's social relationships, feelings of happiness, self-interest, self-satisfaction, utility, quality of life, fulfilment, and flourishing (Dodge et al., 2012; Simons & Baldwin, 2021).

Mental wellbeing. As an integral part of wellbeing, mental wellbeing is understood as a concept covering 'the subjective experience of happiness and life-satisfaction (the hedonic perspective)' and 'positive psychological functioning, good relationships with others, and self-realisation (the eudaimonic perspective)', according to the 'Warwick-Edinburgh Mental Wellbeing Scale' (Stewart-Brown & Janmohamed, 2008), which has been used in one of the studies in this thesis (see Chapter 3).

Mental health. According to the World Health Organization (WHO), mental health is 'a state of wellbeing in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community' (WHO, 2018). This definition overlaps with the eudaimonic perspective of mental wellbeing. Indeed, it has been noted that 'mental wellbeing' and 'mental wealth' are often used interchangeably with 'positive mental health' (Weich et al., 2011). This is reflected in the two-way relationship between wellbeing and health, i.e., that health influences wellbeing and

wellbeing itself influences health (Department of Health, 2014). For consistency and convenience, ‘mental health’ in this thesis refers to the full spectrum of mental health states, whereas ‘mental wellbeing’ covers the positive end of the spectrum (NHS Scotland, 2010).

Nature. The working definition of nature used in this thesis is not based on the strict antithesis between nature and culture; rather, it refers to ‘elements of living systems that include plants and non-human animals across a range of scales and degrees of human management, from a small urban park through to a relatively “pristine wilderness”’ (Bratman et al., 2012). In practice, the nature in this study is often situated in urban settings such as indoor plants, community gardens, and urban parks or meadows (Hartig et al., 2014). The concept of nature may vary across cultures, but the debate about this is beyond the scope of this thesis (Glacken, 1967; Macnaghten & Urry, 1998).

Nature connection. This term refers to human contact with a biophysical system, including flora, fauna, and geological landforms (Hartig et al., 2014). There are many forms of nature connection, varying by spatial scale, proximity, and the sensory pathway through which nature is experienced (visual, auditory, etc.), such as viewing nature through windows or pictures, being immersed in a natural environment (e.g., urban park, forest), being around plants indoors, and actively physically interacting with natural elements like gardening (Bragg et al., 2016).

Nature connectedness. In order to assess the human-nature relationship, a number of

relevant concepts and measures have been developed, including commitment to nature (Davis et al., 2009), connectedness to nature (Mayer & Frantz, 2004), connectivity with nature (Dutcher et al., 2007), emotional affinity toward nature (Kals et al., 1999), environmental identity (Clayton, 2003), inclusion of nature in self (Schultz, 2001), and nature relatedness (Nisbet et al., 2009a). According to Tam (2013), there is strong convergence among these concepts, despite a certain variation in addressing or measuring different aspects of the same underlying construct. In this research, nature connectedness will be used as an umbrella term for all (Capaldi et al., 2014), referring to the subjective sense of one's relationship with nature (C. Martin & Czellar, 2016; L. Martin et al., 2020; Mayer et al., 2009a), a multidimensional construct that comprises cognitive, affective, experiential, and behavioural components that represent i) how one integrates his or her feelings about nature, ii) the degree to which one cares about nature, and iii) one's commitment to take pro-environmental actions (Schultz, 2002). Nature connectedness is primarily understood as a trait that is relatively stable across time and situations (Nisbet et al., 2009a), but it can also be measured at the state level (Capaldi et al., 2014; Nisbet & Zelenski, 2013; Schultz, 2002). It is hypothesised that spending time in nature, actively or passively, will help an individual feel connected to nature, be more inclined to care about nature, and ultimately protect it (Schultz, 2001). However, because socio-cultural factors (e.g., values, policies, education, and worldviews) affect the natural experiences and understanding of the human-nature relationship (Glacken, 1967; Macnaghten & Urry, 1998), nature connectedness may vary across different cultures and nations (Capaldi et al., 2014; Fränkel et al., 2019). Indeed, the validity of the concept of nature connectedness has been questioned. For instance,

Beery and Wolf-Watz (2014) proposed replacing the elusive concept of nature with the relational concept of place in environmental connectedness study.

Nature-based interventions. Treatments designed to utilise natural elements and environments to improve the mental health of individuals or the general public are called ‘nature-based interventions’ or ‘green care’ (Sempik & Bragg, 2013). The two terms are sometimes used interchangeably (Bragg & Atkins, 2016; MacIntyre et al., 2019; Stigsdotter et al., 2011). In this thesis, nature-based intervention is understood as a subcategory of green care (Bragg et al., 2016). Nature-based interventions are defined as interventions that integrate nature as part of a wider treatment process (Nebbe, 2006) and as ‘programmes, activities, or strategies that aim to engage people in nature-based experiences with the specific goal of achieving improved health and wellbeing’ (Shanahan et al., 2019). There are many types of nature-based interventions, and their effectiveness for enhancing a sense of wellbeing has been demonstrated (Annerstedt & Wahrborg, 2011).

Mindfulness. According to the most influential definition of mindfulness put forward by Kabat-Zin (Kabat-Zinn, 1990, 1994a), mindfulness is a moment-to-moment, non-judgemental awareness towards the things happening around us, which can be classified into *trait* mindfulness and *state* mindfulness (Tang et al., 2016). However, Kabat-Zin’s definition may be different from its original meanings in Sati or Zen culture (see Brown & Ryan, 2003; Karunamuni & Weerasekera, 2019; Thanissaro, 2007; Weich et al., 2011).

1.2.2 Theories on the Linkages between Nature and Mental Health

Although humans created expansive urban areas through the industrial revolution (Saunders, 1999), our bodies have not fully adapted to life away from nature (van den Bosch et al., 2018). Humans are much more adapted to live in savanna-type environments compared with other types of nature, including rainforests, deciduous forests, and deserts (Falk & Balling, 2010). From a psychological perspective, environmental aesthetics and landscape preferences are highly correlated with human cognitive function and mental health (Bratman et al., 2012). Natural environments tend to encourage humans to explore; the typical shapes of irregular curvilinear lines and edges with intermediate levels of complexity help people reach an optimal level of arousal (Berlyne, 1960; Wohlwill, 1980). Moreover, humans intrinsically prefer wide, open views, and this can have a restorative effect on mental health (Appleton, 1975). A systematic review (Lovell et al., 2014) of 17 studies indicated that biodiverse natural environments can promote human health and wellbeing. Furthermore, a recent systematic review of 29 empirical studies demonstrated that early life nature exposure is related to improvement of mood, subjective wellbeing, cognitive function, decreased incidence of mental disorders, and fewer psychiatric symptoms (D. Li et al., 2021). There are several theories on the links between nature and human mental health.

1.2.2.1 The Biophilia Hypothesis

One of the most influential and long-standing hypotheses about the links between nature and mental health is the biophilia hypothesis (Barbiero & Berto, 2021; Grinde & Patil, 2009; Gullone, 2002; Wilson, 1986). The term ‘biophilia’ was first

introduced by Fromm (1973) to describe ‘the passionate love of life and of all that is alive’. Adopting an evolutionary interpretation, E. O. Wilson (1986) developed the biophilia hypothesis by offering a phylogenetic perspective on our love for life and preference to connect with nature (Barbiero & Berto, 2021; Ulrich, 1993), explaining that humans’ biological and behavioural phenotypes depend on the nature of the environment (Voss, 2010). The biophilia hypothesis asserts ‘a human dependence on nature that extends far beyond the simple issues of material and physical sustenance to encompass as well the human craving for aesthetic, intellectual, cognitive, and even spiritual meaning and satisfaction’ (Wilson, 1993).

Kellert (1993) put forward nine biophilia values with respect to emotion, physical, and intellectual factors: utilitarian, naturalistic, ecologicistic-scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic, negativistic. Each of these nine human valuations of nature is ‘indicative of our species’ dependence on the natural world and represents a potential evolutionary advantage’. The significance and implications of the biophilia hypothesis along with these relevant values lie in the arguable assumption that natural environments and our long-term interactions with nature have been shaping our cognitive and emotional apparatus (Gullone, 2002). Indeed, humans’ brains are biocentric and, having learned from nature over many thousands of years, the rules of nature continue to dominate our behaviour. However, not everyone finds natural environments restorative. The opposite of biophilia is biophobia (Lundberg, 1998), a fear of and reluctance to have contact with animals, plants, or other natural materials. Ulrich (1993) noted that some people may be afraid of certain species, such as snakes or insects, and be averse to nature, while

embracing more artificial environments. A fear of certain animals or characteristics of nature may come from humans' adaptive behaviours, as such things may have been detrimental to humans, or even fatal, in the past (Kellert & Wilson, 1993; Rachman & Seligman, 1976).

Joye and De Block (Joye & Block, 2011) argued that the notion of biophilia is over-used and has conflicting meanings in different contexts. Some empirical studies aiming to support the biophilia theory are also consistent with other relevant theories, meaning that the reasoning behind the biophilia hypothesis is vague and how the natural environment can influence our mental health is not clearly identified (Grinde & Patil, 2009). Nevertheless, the biophilia hypothesis is often used in environmental-based interventions (Heerwagen & Hase, 2001; Yin et al., 2019) and applied broadly to 'elements of nature that people may find or bring into built settings' (Kellert, 2005). In addition, the hypothesis has some merit in explaining the psychological effects of indoor greenery (Bringslimark et al., 2007, 2008, 2009).

1.2.2.2 Stress Reduction Theory

Drawing on psycho-evolutionary theory, Roger Ulrich proposed Stress Reduction Theory (SRT), holding that the restorative effects of nature stem from stress-reduction (Ulrich, 1981, 1984a) and that natural environments initiate affirmative physiological and psychological responses after exposure to natural elements (Ulrich et al., 1991). According to this theory, if humans are evolutionarily equipped to respond quickly to threats in natural settings, then humans are also prepared to have functional responses that were purportedly retained by evolution

because faster recovery from acute stress would have helped proto-humans better prepare for fight-or-flight responses to threatening stimuli and for the next survival challenge in natural environments (Ulrich, 1979, 1983). In addition, landscapes with views of water and/or vegetation and that contain modest depth, complexity, and curvilinearity would have been most beneficial for survival (Ulrich, 1979). Accordingly, nature connection serves as a buffer, reducing the detrimental effects of stress on one's mental health (Wells & Evans, 2003).

As a result, even simply viewing natural scenery leads to an immediate effect on a human's brain and body through a rapid reduction of stress (Bird, 2007), while urban environments tend to hinder the same process (Ulrich et al., 1991). Ulrich tested his theory in a number of exploratory research studies (Ulrich, 1979, 1981, 1984a; Ulrich et al., 1991). The validation of this theory has been further documented by various studies that demonstrate physiological and psychological benefits in reduced stress (Berto, 2014; Hartig et al., 1991, 2003; Herzog & Strevey, 2008; J. Lee et al., 2009; Martyn & Brymer, 2016a; Ward Thompson et al., 2012). Although this thesis does not investigate the physiological effects of exposure to natural environments and nature-based interventions, stress reduction as a positive effect related to nature connection is often found in the studies conducted and referred to in this thesis. To this end, the stress reduction theory may partly explain the links between nature and mental health.

1.2.2.3 Attention Restoration Theory

Based on the concept of the restorative environment (S. Kaplan & Talbot, 1983),

Attention Restoration Theory (ART) is proposed to explain how experiences of nature can restore attention and improve mental health (S. Kaplan, 1995). The premise of ART is that our attention is divided into two types: effort attention (direct attention) and effortless attention (involuntary attention). Effort attention refers to the controlled attentional focus of an individual, which fills their mind and can lead to mental fatigue; effortless attention describes how a human's attention can be automatically captured by soft fascinating stimuli in the natural environment, for example, when walking in nature. The key to obtaining benefits to cognitive function is the way we capture effortless attention. 'Soft fascination' refers to soft attentional capture from natural green spaces, which are not only restorative, but also create space for reflection; by contrast, 'hard fascination' in urban or built-up environments surrounded with noise is believed to weaken cognitive function and increase mental fatigue (R. Kaplan & Kaplan, 1989). For example, watching television can require people to make full use of their effort attention and the hard fascination stimuli can contribute to mental fatigue (Basu et al., 2019). Conversely, human attention capability can be restored simply by viewing images of nature, because of its features of soft fascination (Gamble et al., 2014). While this process promotes neural activities in our brain, it has been argued that the cognitive flexibility under the subconscious will be boosted in order to improve attention (Barton et al., 2016a).

Although these theories and hypotheses have different foci and propose distinct mechanisms for the positive effects of nature on mental health, all of them agree that nature connections contribute to mental health (Barton et al., 2009). However, a number of authors have suggested that they may not sufficiently explain the

mechanisms between nature connection and mental health and should be tested and expanded by further empirical studies (Cleary et al., 2017; Pritchard et al., 2020a; Schweitzer et al., 2018).

1.2.3 Evidence on the Linkages between the Nature Connection and Mental Health

A number of reviews have evaluated the growing body of evidence on the positive effects of nature connection on mental health and wellbeing (e.g., [Bowler et al., 2010](#); [Capaldi et al., 2015](#); [Gascon et al., 2015](#); [Hartig et al., 2014](#); [Health Council Netherlands, 2004](#); [Ohly et al., 2016](#); [Pritchard et al., 2020](#); [Richardson et al., 2017](#); [van den Berg et al., 2015](#); [World Health Organization, 2016](#)). Regardless of the varying levels of validity in evidence and research design, multiple mental health benefits are linked with nature connections (though types, frequency, duration, and intensity vary) both directly and through several pathways.

1.2.3.1 Direct linkages between nature connection and mental health

There is substantial evidence of the direct effects of nature connection on mental health, among which 1) restorative benefits including psychological stress (also depression and anxiety) reduction and attention restoration (also reduction in mental fatigue and improvement in cognitive function) and 2) mental wellbeing improvement are increasingly well researched (Lovell et al., 2018).

Restorative benefits. According to several reviews (e.g., [Berto, 2014](#); [Hartig et al.,](#)

2014; Nieuwenhuijsen et al., 2017; Reyes-Riveros et al., 2021; Shuvo et al., 2020; Yao et al., 2021), published studies over the past few decades have provided strong evidence for the restorative effects of nature. For instance, a field experiment found that walking in a per-urban park fostered blood pressure change and improved performance on an attentional test, while walking along roads in an area of medium density urban development showed the opposite pattern of change (Hartig et al., 2003). Similar findings are also supported by laboratory experiments. For example, Lee et al. (2015) found that attention boosts can occur after a 40-second viewing of a green roof scene from an office window. A systematic review of 43 real-time non-laboratory studies of stress responses to outdoor, often natural, environments also yielded positive evidence for stress reduction (Kondo et al., 2018). In addition, across 24 good-quality studies of randomised controlled trials, Yao et al. (2021) found that nature connection was related to decreased negative feelings, such as fatigue, and increased levels of pleasant emotions, such as vitality, in comparison to non-green space settings. These are encouragingly consistent with other previous research testing the validity of ART and SRT (Bratman et al., 2012). According to two meta-analyses of these research with a variety of study designs (Bowler et al., 2010b; Ohly et al., 2016b), however, the heterogeneity in outcomes regarding the attention restoration potential of natural settings compared to other settings raised questions, not least about the suitability of the measures used to capture restorative effects (Markevyich et al., 2017a). An updated systematic review and meta-analysis (Stevenson et al., 2018), nevertheless, showed that the effect size of benefits from exposure to nature, in terms of working memory, cognitive flexibility, and attentional control, ranges from small to medium, after clarifying the ambiguity surrounding the

details of directed attention and how cognitive restoration was tested. Relatedly, there is also accumulating evidence on the association between nature connection and reduction in depression, according to a number of studies and reviews (e.g., Gascon et al., 2018; Kotera et al., 2021a; I. Lee et al., 2017). Though most of these studies assessed short-term outcomes, the long-term mental health benefits arising from nature connections are to be confirmed by future research (Hartig et al., 2014; Lovell et al., 2018).

Mental wellbeing benefits. There is a growing body of evidence for the beneficial effects of different types of nature connection on psychological wellbeing (Beute et al., 2020; Sandifer et al., 2015). For instance, White et al. (2017) found that frequency of visiting natural environments (including neighbourhood greenery, White et al., 2013) was positively associated with eudaimonic wellbeing (a long-term effect, see also Coldwell & Evans, 2018) and a specific visit with positive (self-reported) hedonic wellbeing (a short-term effect). A meta-analysis (Pritchard et al., 2020a) revealed that the positive relationship between nature connectedness and eudaimonic wellbeing ($r = 0.24$), as well as hedonic wellbeing ($r = 0.20$), showed a moderate effect size. A systematic review (Houlden et al., 2018) found substantial evidence on the association between the amount of local-area greenspace and mental wellbeing (particularly hedonic wellbeing, e.g. life satisfaction). However, a previous systematic review (Gascon et al., 2015) considered the evidence for a causal relationship between long-term exposure to surrounding greenness and mental wellbeing to be limited.

1.2.3.2 Indirect linkages or pathways

Physical activity. There is evidence (despite mixed outcomes) that suggests physical activities encouraged by natural settings play a mediatory role between nature and mental health (Hartig et al., 2014). It is also suggested that there is a synergistic relationship between the benefits of physical exercise and the benefits of nature connection (Shanahan, Franco, et al., 2016). For instance, according to a meta-analysis (Bowler et al., 2010b), a short-term exposure to natural environments during a walk or run could have more positive effects on mental wellbeing (based on self-reported measures of emotions) than similar activities in synthetic environments. However, a systematic review (Thompson Coon et al., 2011) reported similar results but with a more cautious conclusion that the existing evidence was not adequate and further research was needed (see also Twohig-Bennett & Jones, 2018). Likewise, an updated systematic review (Lahart et al., 2019) found largely inconclusive evidence for the benefits of exercise in natural settings over indoor non-green exercise.

Social and community. Social contacts and community cohesion have been found to be a possible mediator between nature connection and mental health in some studies (Dadvand et al., 2016; de Vries et al., 2013; Maas et al., 2009; M. M. van den Berg et al., 2019), but not so much in others (Fan et al., 2011; Francis et al., 2012; Triguero-Mas et al., 2015). The mechanism for this is thus yet to be perfected.

Nature connectedness. As mentioned above, there is some evidence that nature connectedness mediates the relationship between exposure to nature and subjective wellbeing, especially eudaimonic wellbeing (Mayer et al., 2009b; Pamela Pensini et

al., 2016; Pritchard et al., 2020a; Webber et al., 2015). It is also reported that a higher degree of nature connectedness may lead to various considerable benefits for mental health (Nisbet et al., 2011) including anxiety reduction (Lawton et al., 2017; Martyn & Brymer, 2016b) and psychological restoration (Franco et al., 2017; Wyles et al., 2019). Also, individuals with a higher level of nature connectedness is more likely to spend more time in natural settings and engage in pro-environmental behaviours (Mayer & Frantz, 2004; Nisbet et al., 2009a; Tam, 2013; Whitburn et al., 2020). However, it remains inconclusive due to mixed outcomes, a lack of empirical studies, and the unclarity of mechanisms. For instance, an experimental study found that nature connectedness does not moderate the effect of nature exposure on eudaimonic wellbeing (Passmore & Howell, 2014). Also, the directionality of pathways between nature connection, nature connectedness, and mental wellbeing remains uncertain (Y. Liu et al., 2022; Mayer & Frantz, 2004). In addition, there may be other factors mediating the association between nature connectedness and mental wellbeing, such as spirituality (Kamitsis & Francis, 2013; Passmore & Howell, 2014; Trigwell et al., 2014), social connectedness (Howell & Passmore, 2012; Weinstein et al., 2009), and meaning in life (Howell et al., 2013). Also, as mentioned above (1.2.1), it remains unclear how cultural factors may influence nature connectedness (Pritchard et al., 2020a) and whether the concept of nature connectedness is valid across cultures and nations (Beery & Wolf-Watz, 2014).

Sleep quality. A recent systematic review demonstrated the positive influence of nature connection on sleep outcomes (J. C. Shin et al., 2020). Since sleep quality is associated with mental health (e.g., Scott et al., 2021), improved sleep quality may

be a potential linkage between nature connection and mental health (World Health Organization, 2016).

To sum up, as Hartig (2014) and many others (Bowler et al., 2010b; Dzhambov et al., 2019) understood, there is an intertwining of the pathways between nature connection and mental health, which remains an open question and is to be explored in future empirical studies.

1.2.3.3 Other factors which influence the links between nature and mental health

Environmental type and quality and ‘doses’ of nature. The majority of the studies in this field, according to the review of Beute et al. (2020), provided evidence for mental health benefits arising from nature connection, but results of comparison between different types of natural settings and their specific qualities showed mixed outcomes. In addition, several studies have found evidence for the association between the ‘doses’ of nature (e.g., proximity, duration, intensity, and frequency) and mental health outcomes (Barton & Pretty, 2010; Chou & Hung, 2021a; Shanahan, Bush, et al., 2016; Whitelaw, 2012). Much of the evidence found that greater quantity and proximity of the natural environment are positively and consistently related to mental health outcomes (Kuo, 2013; A. E. van den Berg et al., 2010).

Socioeconomic and sociodemographic factors. Many studies found that people of low socioeconomic status may benefit more from nature connection (e.g. Maas, 2006; Mitchell & Popham, 2008), but this may vary in non-Western countries (e.g., Zewdie

et al., 2022). It is also aware that the impacts of nature connection on mental health may vary by sociodemographic factors (e.g., Shanahan et al., 2016), but the differences have not been fully explored. As Kabisch (2019) noted, nevertheless, some positive effect on mental health was found in most age groups, and the effect mostly remained even after controlling for socioeconomic confounders.

Cultural factors. Different cultural perspectives may influence how and why people come to connect to different natural settings and how specific green space types and characteristics may influence mental health (Bell et al., 2014; Beute et al., 2020). For instance, individual, cultural, and social-structural differences may influence environmental concern and nature connectedness (Fränkel et al., 2019). Pritchard et al. (2020a) noted that although the association between nature connectedness and wellbeing persists across non-westernised cultures, our understanding of how people of different cultures perceive and value nature remains limited. Likewise, cultural factors may also influence the other concepts explored in this thesis, such as wellbeing, happiness, and mindfulness (Capaldi et al., 2014; Kabat-Zinn, 1990).

1.2.3.4 Evidence of the effectiveness of Nature-based Interventions (NBIs)

A number of reviews found some evidence for health benefits associated with engaging with nature-based interventions (Annerstedt & Wahrborg, 2011; Garside et al., 2020; Soga et al., 2017). Regarding the relatively poor quality of the studies (e.g., small sample, inadequate research design), three earlier systematic reviews concluded that there was no robust quantitative evidence of the effectiveness of NBIs and environmental enhancement activities on mental health (Annerstedt & Wahrborg,

2011; Husk et al., 2016; Lovell et al., 2015). Nevertheless, a recent systematic review and meta-analysis found that outdoor NBIs (mostly gardening and green exercise) improved mental health, especially reductions in depression and anxiety, across all populations (Coventry et al., 2021). The authors concluded that NBIs may have therapeutic effects on mental health problems and serve as a preventive approach to maintaining mental wellbeing. In addition, an integrative review focused on garden or forest interventions found positive evidence for the effects of NBIs in reducing stress and improving mental wellbeing and nature connectedness, which supported existential reflections (G. Johansson et al., 2022).

1.2.3.5 A critical summary

Although there is substantial evidence for the association between nature connection and mental health, the current evidence base has several limitations.

Inconclusiveness. There is a lack of understanding of the heterogeneity and inconsistency of outcomes and consensus on the pathways underlying the relationship between nature connection and mental health (Hartig et al., 2014; Keniger et al., 2013; Lovell et al., 2018; R. Wang et al., 2019). Although the diversity in outcomes may lead to difficulty drawing solid conclusions, this may be a ‘prerequisite for gaining a better understanding’ of how different nature connections influence mental health (Beute et al., 2020).

Methodological limitations. Many studies lacked adequate controls, sample size, and duration, and the data was often collected from self-reported questionnaires (Keniger

et al., 2013; Pritchard et al., 2020b). Most of the studies assessed short-term outcomes and did not explore the long-term benefits of nature connection (Hartig et al., 2014; Tillmann et al., 2018). In addition, as Frumkin (2013) noted, the assessment of nature exposure at individual and country levels remains a thorny problem in this field. Moreover, there is a lack of robust evidence for the link between mental wellbeing and nature connection, which may be due to the inherent difficulties in quantifying non-physical health benefits (A. C. K. Lee & Maheswaran, 2011).

Geographical bias. Although there are an increasing number of studies in this field conducted in non-European contexts such as China and Japan (Beute et al., 2020), the current evidence base is limited by a Western-world bias, which influences the definitions of mental health, mental wellbeing, and nature, leading to a lack of diversity and pluralism in this field (Gallegos-Riofrío et al., 2022; Keniger et al., 2013). Moreover, it remains unclear how the benefits of nature contact may vary across different countries and areas (Frumkin et al., 2017; Hartig et al., 2014; Markevych et al., 2017b; Shanahan et al., 2019; White et al., 2021). Relatedly, how might the theoretical mechanisms operate differently in various communities regarding the cultural and socioeconomic differences (Jim & Chen, 2006; R. Russell et al., 2013)? Comparison studies in this field have largely been undertaken in Western cultural contexts, looking at the differences in nature benefits between, for example, the UK, US, and Australia (van den Bosch et al., 2018), while there is relatively less research in other ethnic and cultural contexts (Corazon et al., 2019; Kotera et al., 2021b; Mnich et al., 2019).

Despite these weaknesses and limitations in the evidence base (e.g., lack of robust research design and exact mechanisms), mental health is associated with nature connection directly and through various pathways and can be promoted by nature-based practices and interventions (Coventry et al., 2021; Hartig et al., 2014; Lovell et al., 2018).

1.3 Nature-based Activities and Everyday Wellbeing: The Scope and Conceptual Framework of the Thesis

This thesis focuses on three nature-based practices in relation to three different nature-related settings of daily life: houseplants care behaviour, community gardening, and (mindful) green walking (see Figure 1.2). There are multiple reasons for including the three practices.

1.3.1 Overall aims

This study is designed for twofold purposes. The preliminary aim is to explore the effects of the three nature-based practices on mental health. Based on the findings, a set of nature-based interventions for maintaining and promoting the mental health of urban residents will be developed in the future.

1.3.2 Everyday therapeutic settings: maximise nature connection

It has been proposed in the Ottawa Charter for Health Promotion to maximise the health values of everyday settings (World Health Organization, 1986). In a similar

vein, based on the concept of therapeutic landscapes, a person's everyday geography may be used to promote and maintain mental health on a routine basis (Cleary et al., 2017; Gesler, 1992; Williams, 1999). Within an urban context, these potential therapeutic settings may include indoor nature exposures (Mcsweeney et al., 2014), community gardens (Lampert et al., 2021), public urban parks, and coastal settings (Bell et al., 2015; Cleary et al., 2017; Mossabir et al., 2021). According to a recent systematic review (Beute et al., 2020), the researchers suggested that all types and characteristics of greenspace in urban areas 'matter for mental health and wellbeing'. For instance, the study of Chou and Hung (2021b) on forest walking (30 mins a week and consecutive for 8 weeks) found that more frequent contact with nature, even if each duration of exposure is short, results in the accumulation of more doses of restorative benefits and a greater level of nature connectedness. Given that urban residents may have limited nature exposure generally (consider the idea of 'nature deficit', see Louv, 2010), it is reasonable to suppose that the key to using natural elements for maintaining and promoting mental health in urban contexts may be to 'maximise the minutes' of nature contact (Kuo, 2013), and thus maximise the health values of urban residents' everyday settings (Maller et al., 2006).

In this light, we propose to develop an integrated, comprehensive framework composed of several nature-based practices incorporated into a person's everyday settings and routines with the aim of increasing urban residents' contact with nature and promoting their mental health. Based on the 'health map' in Barton and Grant (2006), the spaces or areas of one's daily life are generally listed as house (residential space), community (public and built environment), and physical (natural)

environment. Therefore, this thesis includes three nature-based practices, covering three typical daily settings, i.e., home (houseplants care behaviour), community (community garden close to one's residential place), and public space (e.g., meadows, parks, accessible during one's commute or leisure time). Mental health benefits (e.g., stress reduction, cognitive function) produced from nature connections may vary in different everyday settings and through multiple causal mechanisms and pathways. The cumulative amount of time spent in these therapeutic everyday settings could be considerable, which may yield an increase in nature connection and thereby contribute to positive mental health outcomes.

Residential level: houseplants care behaviour. The first level of everyday mental health takes place in the interior of a house or place of residence. It is reported that the proportion of time spent indoors (residential areas, workplace, etc.), for instance, for the UK and Chinese populations is around 90% (Duan, 2013; Lader et al., 2006). It is therefore desirable to increase one's nature connection in urban contexts. Houseplants (caring) may be recommended as a form of nature-based activity that may increase the time and frequency of nature exposure for urban residents. Like a type of gardening activity, viewing, growing, and taking care of indoor houseplants may serve as a potential nature-based intervention (Han & Ruan, 2019; Jang et al., 2018; Raanaas et al., 2010, 2011). For convenience, in this thesis, the activities related to indoor houseplants will be called 'houseplants care behaviour' (see further in Chapter 2). Indoor green space is more accessible than public green space in some areas and countries with a high level of urbanisation. In addition, private and public gardens are less common in some (developing) countries of specific cultural

characteristics (for further information, see Chapter 4). Furthermore, in some special situations or contexts (e.g., pandemic periods), people may have difficulties of accessing outdoor green spaces (Spano et al., 2021). Therefore, houseplants care behaviour can be the most convenient, affordable, and secure way of accessing nature on a daily basis. There is some evidence that houseplants and relevant horticultural activities are associated with greater mental wellbeing (Hall & Knuth, 2019; Shibata & Suzuki, 2002; van Lier et al., 2017).

Community level: community gardening. The next level of nature-based activity explored within this thesis is community gardening, which involves various multiple activities including gardening, physical activity, food production and consumption, social interaction, and education to support culturally tailored healthy living in the local context (Al-Delaimy & Webb, 2017; Heise et al., 2017). It is desirable for people to have regular participation in community gardens where they can actively engage with nature with low to moderate physical activities and build up interpersonal relationships, both of which may contribute to their mental wellbeing. There is some evidence for the positive effects of community gardening on mental health (Clatworthy et al., 2013; Gregis et al., 2021).

Public-space level: green walking. Moving further from residential space and community, the third level of nature-based activity takes place in public spaces like urban parks and meadows. The thesis focuses on green walking which takes place during one's commute or leisure time and thus may serve as another widely available, accessible, and affordable way of increasing time spent in nature, potentially

promoting nature connectedness while increasing physical exercise. The psychological effects of green walking on individuals' mood, self-esteem, mental health, and wellbeing have been investigated by means of various experimental designs and research methods (see the systematic review in Chapter 5).

The conceptual framework of the thesis serves both as a kind of research agenda for developing a low-cost, widely accessible, and comprehensive scheme of nature-based interventions integrated into everyday settings for the purpose of maintaining and promoting mental health.

1.3.3 *Active interactions with nature: maximise/optimize the effects*

Compared with being passively exposed to natural environments, *active* (physically and cognitively) interactions with nature may be more effective in achieving mental health benefits from nature connection (Duvall, 2011; Macaulay et al., 2022; Triguero-Mas et al., 2017). In addition, although everyday therapeutic settings offer opportunities for nature connections, an urban resident's nature experiences might remain limited, and the derived mental health outcomes may be constrained by other factors such as a lack of public greenspace of relatively high restorative quality, traffic-related exposures, work stress, and individual attitudes (Von Lindern et al., 2016, 2017). Individuals' *more active and higher level of engagement in nature* is worth considering to strengthen, facilitate, and optimise the mental health effects (directly and indirectly) of nature connection in urban contexts where nature experiences are constrained and limited (Macaulay et al., 2022; Pasanen et al., 2018).

Restorative benefits and mindfulness (practice). Drawing on Attention restoration theory and Stress reduction theory, several researchers have proposed to strengthen the restorative benefits of nature connection through various engagement interventions, especially mindfulness practice (Duvall, 2011; S. Kaplan, 2001a; Macaulay et al., 2022; Sianoja et al., 2018). Although a mindful state achieved by practice and focus seems opposite to a restorative environment experience, its goal is a passively accepting frame of mind as well as restoration of the mind's capacity to focus. As S. Kaplan (2001b) proposed, mindfulness practice may enhance the renewal of directed attention, and the restorative process in nature facilitates achieving a mindful state. Several studies have explored and tested this. For instance, researchers found that mindful engagement may support psychological restoration (Lymeus et al., 2018a; Nisbet et al., 2019; Y.-K. Shin et al., 2013). Based on these, Macaulay and colleagues (2022) proposed that cognitive engagement with nature, like mindfulness practice, may be particularly valuable for facilitating attention restoration and thus promoting mental health.

Mental wellbeing benefits, nature connectedness, and mindfulness (practice). As discussed above (1.2.3.2), nature connectedness seems to be as important a contributor as other variables more traditionally associated with subjective mental wellbeing (e.g., Capaldi et al., 2014; Mayer & Frantz, 2004) and psychological restoration (Mayer et al., 2009b; Whitburn et al., 2019, 2020; Wyles et al., 2019). There is some evidence for the association between nature connectedness and mindfulness in a number of studies using adult samples from different cultures (Choe et al., 2020; Howell & Passmore, 2012; Huynh & Torquati, 2019; Sadowski et al.,

2020; Wolsko & Lindberg, 2013). For instance, openness to experience (related to mindfulness, see Brown & Ryan, 2003) is associated with nature affiliation (Nisbet et al., 2009a). Some researchers found that dispositional mindfulness was positively related to nature connectedness (Hanley et al., 2017). Likewise, *trait* mindfulness was positively associated with nature connectedness in a meta-analysis ($r = 0.25$), and the longer the participants were involved in the study, the larger the effect size of these two variables (Schutte & Malouff, 2018). Also, Mayer and colleagues (2009b) found a positive association between the trait nature connectedness and attentional capacity (a facet of mindfulness). A cross-sectional study (Howell et al., 2011) showed that the *state* mindfulness level was significantly correlated with nature connectedness. Stewart & Haaga (2018) found that *state* mindfulness level is a mediator of the relationship between nature connectedness and mental wellbeing (see also Leary et al., 2008). Moreover, several experimental studies showed that mindfulness practice can promote nature connectedness (Aspy & Proeve, 2017; Nisbet et al., 2019). Based on these findings, mindfulness and nature connectedness might be two measurable factors and potential mediators/moderators between nature connection and mental health benefits. More importantly, mindfulness practice may strengthen the mental health benefits of nature exposure by increasing the level of nature connectedness (Nisbet et al., 2019).

Following this, the studies reported in this thesis pay specific attention to mindfulness (practice) and nature connectedness in three nature-based practices. (1) *Houseplants care behaviour*. This study includes measurements of mindfulness level and nature relatedness, testing the potential linkage between mindfulness, nature

connectedness, and nature connection, with the aim of developing a mindfulness-based intervention with houseplants care behaviour. (2) *Community gardening*. The qualitative study on community gardening explored themes related to mindfulness and nature connectedness, with the aim of developing further nature-based interventions with mindful engagement. (3) *Mindful green walking*. While these two studies were conducted for the future development of nature-based interventions integrated with mindfulness practice, the randomised controlled trial study tested the effectiveness of green walking with mindful engagement on nature connectedness. There is some evidence for the psychological effects of mindful walking as a special intervention on mental health (Gotink, Hermans, Geschwind, De Nooij, et al., 2016; Prakhinkit et al., 2014; Robert-McComb et al., 2015; Teut et al., 2013a). It has been noted that the effectiveness of mindful walking is related to the physical activity component of the interventions, while mindfulness practice may in turn enhance engagement and performance in physical activity (Butryn et al., 2011; Jones et al., 2021; Salmon et al., 2010; Ulmer et al., 2010). In addition, this study also explores the intervention's effects on mood (Barton et al., 2009) and sleep quality (Hartescu et al., 2015). As discussed above, sleep quality may be another potential pathway for nature connection and mental health outcomes. There is some evidence for the positive association between nature exposure, walking, and sleep in research on green exercise and therapeutic gardening (Gladwell et al., 2016; Morita et al., 2011; J. C. Shin et al., 2020). It remains unclear, however, whether the mindful walking intervention influences sleep quality or whether sleep quality mediates the effects of mindful walking on mood. This study will also provide valuable evidence for improving and developing further mindful green walking interventions.

To sum up, the three nature-based practices and interventions in this thesis are studied to understand and explore the ways to maximise and optimise the mental health benefits from nature connection, with an aim to develop further nature-based interventions.

1.3.4 Cultural factors and global perspective

There are individual differences in preference for types of nature connection (Barton et al., 2016a) in different cultures owing to different value systems and perceptions of nature (Vining et al., 2008). Relatedly, the mental health benefits derived from nature connections, as well as the underlying mechanisms and pathways, may vary in different cultural and social contexts (Frumkin et al., 2017; Keniger et al., 2013). The nature-based activities studied in this thesis are chosen with these concerns in mind.

Chinese houseplants care behaviour. We focus on the Chinese population for several reasons. First, keeping plants indoors is a common and widely available practice among Chinese urban residents, who have limited or no access to home gardens. This specific focus on houseplants care behaviour is desirable for research on the association between indoor active nature connections and mental health benefits, since it may not be confounded by other home-based horticultural activities (e.g., home gardening). Second, the urbanisation of the Chinese main cities is increasingly rapid, and mental health problems among the urban residents are prevalent. If houseplants care behaviour could serve as a cost-effective nature-based practice for mental health promotion, it may serve as an alternative home-based

green practice (other than home gardening) for other populations suffering from the negative effects on mental health due to (rapid) urbanisation. Lastly, keeping houseplants has been practiced in China with some cultural specialities (e.g., *Fengshui*), which may bring fresh views and distinct nature experiences to the existing literature on human-nature interactions. Relatedly, the study also intended to understand the behavioural mechanism of the Chinese houseplants care behaviour by using the theory of planned behaviour, based on which further interventions may be developed.

Chinese community gardening. For community gardening, we also focus on Chinese experiences with community gardening for several reasons. In comparison with the populations in the West, private gardens are not common in some of the urban populations in the (developing) countries, and the rapid urbanisation makes the situation worse. In addition, research on the mental health effects of gardening has been more extensive in the West (for the current evidence of the psychological benefits of community gardening, see further in Chapter 4) compared to developing countries like China (Zhu et al., 2021). Although there are some studies in China that demonstrate the effectiveness of horticulture therapy (see Chapter 4), early-stage explorations of gardening as a health intervention are missing. Furthermore, like houseplants care behaviour, the community gardening of the Chinese takes place in a collectivist context with cultural background (e.g., Heaven-human Harmony Theory), which may serve as points of comparison for the experiences of community gardening documented in the West.

Mindful greenspace-based walking in the UK. We conducted a randomised controlled trial study on mindful green walking in a UK-based context rather than a China-based context because of its experimental nature. In addition, unlike houseplants care behaviour and community gardening, green walking seems less related to cultural differences and local social and economic conditions.

The purpose of this series of studies on three nature-based activities also responds to a wider concern about the mental health issues of the populations experiencing from urbanisation (J. Chen et al., 2015; Sundquist et al., 2004; Ventriglio et al., 2021b) and health inequalities (Mackenbach et al., 2008; Marmot et al., 1991; Mitchell & Popham, 2008) in a global perspective. A set of these interventions covering most space and routines of one's everyday life may contribute to enhancing mental wellbeing of those populations who live in urban setting and with some difficulties of accessing health care system. As a widely available, cost-effective, sustainable way to promote the mental health, nature-based activities and interventions can be prioritised over other solutions to the adverse effects of urbanisation on mental health (Hartig et al., 2014).

1.3.5 Research questions, designs, and methodological concerns

A variety of methods were used in correspondence with the distinct research aim(s) and question(s) in each study.

Houseplants care behaviour. The overall aim is to 1) understand houseplants care behaviour practice among Chinese urban residents and to 2) explore whether and

how this nature-based practice associate with nature connectedness, mental wellbeing, mindfulness, and values. Since there is a lack of research in this field, we used self-reported survey to gain information and data. It is worth mentioning that the study used the Theory of planned behaviour (TPB), Transtheoretical Model (TTM, or Stages of Change), and Schwartz's 'human-value theory' to understand both the behavioural mechanism and the values and/or intentions of the participants, based on which further qualitative, quantitative, and experimental studies will be conducted for the future development of interventions with houseplants care behaviour.

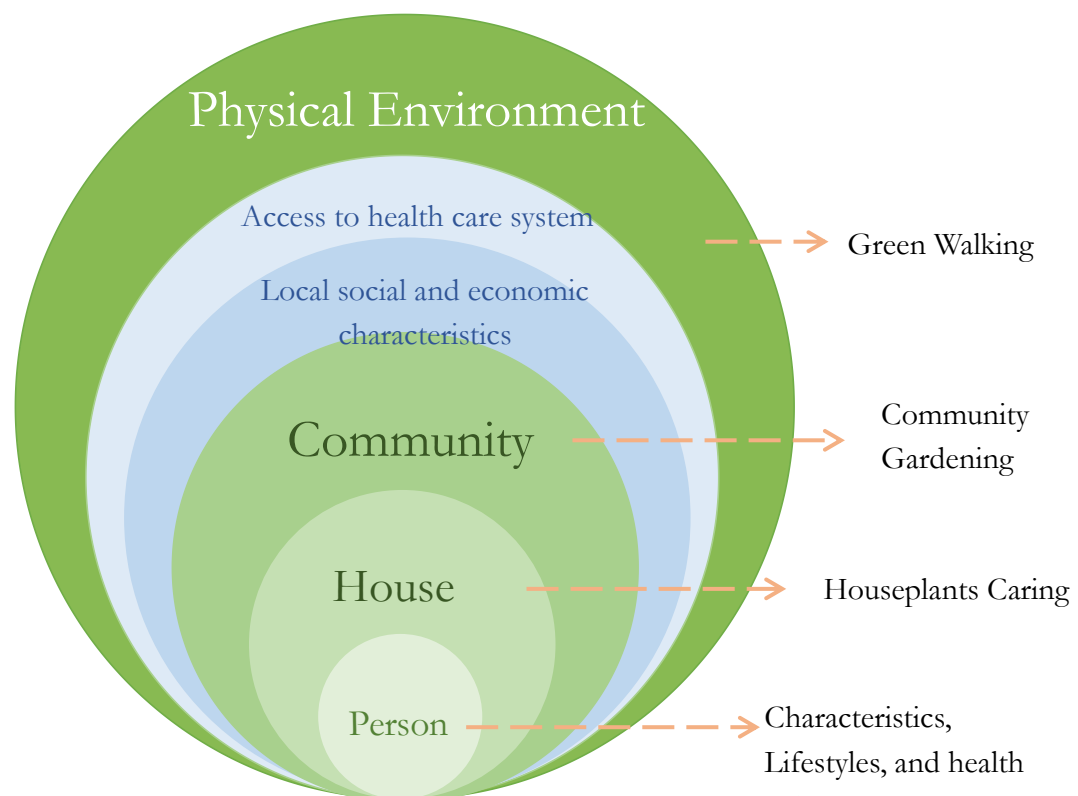
Community gardening. The purpose of this study is to explore the experiences of Chinese community gardeners and understand their perceived benefits and barriers to engaging in community gardening. Given that there is not sufficient research in this field (see further in Chapter 4), a qualitative study was conducted to collect rich data and develop a conceptual framework that may serve as guidance for further research and intervention development. The study design was based on Charmaz's constructive grounded theory (CGT) (Charmaz, 2014), which was chosen for several reasons. The Chinese community garden is a relatively new social practice, that has been mainly led by local governments and influenced by local cultures and social-economic contexts (Qian, 2011; X. Zhang et al., 2022). The participants' experiences in the emergent community gardens in China are being shaped and reshaped by their personal practices and the external changes made to these gardens. In other words, the perceptions of the Chinese community gardens are fundamentally formed, constructed, and transformed in relation to political, cultural, and social

factors in diverse local contexts (of different cities). Therefore, we assumed that any research on the Chinese community garden would inevitably and to some extent engage with its current formation and development. In this view, objectivist grounded theory, which attempts to erase the social context from which data emerge, may be less valid and applicable to this study. Because we intend to understand *how* and *why* the Chinese participants perceive community gardens and construct meanings and actions in such specific situations, we believe that the data and analysis regarding the Chinese community garden, as constructivist grounded theory maintains, will be created from shared experiences and relationships with participants and contextually situated in time, space, culture, and situation (Charmaz, 2014). With this constructivist approach, the conceptual framework derived from the analysis will be an interpretation (Charmaz, 2014). Nevertheless, this may provide valuable data and insights for further research on community gardening in China.

Mindful greenspace-based walking. Unlike the CGT-based study on community garden, we conducted a randomised controlled trial study on green walking with mindful engagement. This integration of these methods and change of epistemological stance (from constructivist to positivist) may raise questions and debates (see, e.g., Catallo et al., 2013). We acknowledge this but have adopted a pragmatic and utilitarian approach, which is not inconsistent with the philosophical grounding of CGT as Charmaz proposed (Charmaz, 2014). This RCT research design was formed to answer the research questions: 1) the effectiveness of mindful walking in nature on the improvement of mental health with respect to mood, mindfulness, sleep quality, and nature relatedness; 2) the role of sleep on the improvement of

mood after outdoor mindful walking. In addition, this study is also a mixed-methods research in which qualitative data (regarding participants' views of the mindful green walking intervention) was also collected for a better understanding of the practice and a richer explanation of results. Furthermore, the effects and experiences of mindful green walking are less related to cultural and social factors compared with those of Chinese community gardens.

Figure 1 *Conceptual Framework of the Thesis*



***Note.** The framework was based on Lovell (2018).

1.4 Summary and Outline of the Thesis

This chapter critically reviews existing theories and evidence on the links and pathways between nature connection and mental health, highlighting limitations and gaps in our knowledge of the mechanisms involved and other factors. It also provides

a comprehensive scheme of everyday therapeutic settings integrated with nature-based practices and/or interventions. The studies reported in this thesis will explore the psychological effects of houseplants care behaviour, community gardening, and mindful green walking on mental health. The three nature-based practices are studied with an aim to explore how to facilitate the direct linkages between nature contact and mental health benefits (*psychological restoration* and *mental wellbeing enhancement*, see 1.2.3.1) by strengthening several potential pathways such as *physical activities*, *social contacts*, *nature connectedness*, and *sleep quality* (see 1.2.3.2), based on which further nature-based interventions will be developed. In physical terms, nature-based practices involve (low to medium) physical activity and social contact, which may contribute to better mental health outcomes. In cognitive or subjective terms, an individual's active, heightened engagement, such as mindfulness practice, may strengthen the restorative benefits and increase the level of nature connectedness, which may contribute to mental wellbeing benefits.

The research findings may make an important contribution to the field of mental healthcare and to the maintenance of wellbeing, by identifying how best to facilitate the inherent potential of nature in various environmental settings and cultural contexts. In addition, it will encourage further development and practical application of nature-based interventions with a global perspective against the adverse effects of worldwide rapid urbanisation.

Chapter 2

Interaction with Nature Indoor: Psychological Impacts of Houseplants Care Behaviour on Mental Wellbeing and Mindfulness in Chinese Adults

2.1 Chapter Overview

This chapter aims to investigate the differences in mental wellbeing and mindfulness levels between houseplants carers and non-houseplants carers. For the houseplants carers, the relationship between hours of taking caring of houseplants, numbers of houseplants, years of keeping houseplants of them, and their levels of mental wellbeing, mindfulness, and degree of nature relatedness were explored. The links between those defined houseplants care behaviours and universalism value will also be explored in this chapter.

A version of this chapter has been published in the *International Journal of Environmental Research and Public Health*: Ma, J. (2022). Interaction with Nature Indoor: Psychological Impacts of Houseplants Care Behaviour on Mental Well-Being and Mindfulness in Chinese Adults. *International Journal of Environmental Research and Public Health*, 19(23), 15810. A copy of the paper is shown in Appendix E.

	Green Walking	Systematic Review: effectiveness of green walking (Chapter 5) Intervention Study: effectiveness of mindful green walking (Chapter 6)
	Community	Qualitative study: perceived benefits and barriers of engaging in community gardening (Chapter 4)
	Houseplants Care	Online Survey - psychological impacts of houseplants care (Chapter 2)

Abstract

The rapid growth of urbanisation and the increased prevalence of mental problems have been concerns in China. ‘Green prescription’ such as keeping houseplants has been found to be an effective means of interacting with nature and improving mental health outcomes. The purpose of this study was to examine the psychological effects of keeping houseplants in the home and how ‘connection to nature’ relates to mental wellbeing and mindfulness among Chinese adults living in urban areas. This study also investigated the association between mindfulness, human values, and houseplants care behaviour. A cross-sectional survey was completed by 421 (66.3% female) participants from 19 representative Chinese cities. Results revealed that the hours spent taking care of houseplants, the number of houseplants, and the years of keeping houseplants were positively associated with greater levels of mental wellbeing and the trait of mindfulness. Participants who self-classified themselves as ‘houseplants carers’ (or houseplanters) reported higher levels of mental wellbeing compared with ‘non-houseplants carers’ (or non-houseplanters). Furthermore, all the above-defined houseplants care behaviours were positively correlated with the universalism value. The findings of the current study show the links between houseplants care behaviour and mental wellbeing for people in China and have implications for use of therapeutic horticulture for people who are seeking to improve their mental wellbeing in urban China.

Keywords: Houseplants Care, Mental Wellbeing, Mindfulness, Nature Relatedness, Schwartz Value Theory

2.2 Introduction

2.2.1 Defining houseplants care behaviour

Houseplants care behaviour in the present study refers to the (regular) practice of keeping, growing, and taking care of (potted) plants indoors in one's residential place(s), during which physical and emotional relationships with plants are developed. The plants (e.g., flowers, vegetables, green plants, and succulent plants) in question may have been cultivated from an early stage (e.g., as seedlings), or they may have been raised entirely from seed. Houseplants care behaviour is distinct from simply appreciating or passively viewing plants since it involves active engagement with, and taking care of, plants indoors, such as watering, feeding, and pruning. It also involves a degree of regular commitment, both temporally and behaviourally, and thus it may be regarded as a habit or hobby. Unlike outdoor planting activities, which may involve intensive physical exercise (e.g., hoeing in the garden), houseplants care behaviour is much less physically intensive. Individuals who regularly take care of houseplants over the course of six months are recognised as 'house planters' in this study. Although the study was designed for future development of intervention, houseplants care behaviour is not explored here as a kind of therapeutic horticulture since it does not involve guidance from trained professionals (Sempik et al., 2003).

2.2.2 Houseplants care behaviour, mental wellbeing, nature connectedness, and mindfulness

According to several reviews (Bringslimark et al., 2009; L. Deng & Deng, 2018; Han et al., 2022; Han & Ruan, 2019; Yeo et al., 2020; Zhao et al., 2023), there is some

evidence suggesting that exposure to plants indoors may contribute to positive mental health outcomes, especially stress reduction, cognitive function enhancement, and subjective wellbeing improvement. For example, two experimental studies found that five minutes in the presence of plants or a brief view of a green roof can reduce one's level of stress and have positive effects on mood (Hassan et al., 2020; K. E. Lee et al., 2015). Several studies in outpatient facilities found improvements in mental wellbeing (Ali Khan et al., 2016; S. H. Park & Mattson, 2009; S.-H. Park & Mattson, 2008) and suggested indoor plants as a wellness feature (Raanaas et al., 2010; Tinner, 2016). However, according to another review (Moya et al., 2019), indoor plants improved people's satisfaction and happiness, but did not have significant effects on task performance or productivity.

The majority of these studies focused on the mental health benefits (especially restorative benefits) from passively viewing or being around indoor plants in workplace or hospital settings rather than houseplants care behaviour in residential homes (Bringslimark et al., 2009; Thatcher et al., 2020). In terms of active engagement with plants, several studies found that indoor gardening programs and structured horticultural therapies may be helpful for cognition and psychological wellbeing for elder people in different cultural contexts (for reviews, see Wang et al., 2023; Yeo et al., 2020).

Although there is a growing body of evidence for the association between indoor nature connection (passive or active) and mental health, it remains inconclusive due to some mixed outcomes and a lack of robust research design (Han et al., 2022; A. E.

van den Berg, 2005; M. Wang et al., 2023; Yeo et al., 2020; Zhao et al., 2023), In addition, while most of the studies followed ART and SRT and thus mainly focused on restorative benefits of indoor nature exposure, the effects of indoor plants on mental wellbeing has not received sufficient academic attention. Relatedly, there is insufficient research exploring other potential pathways between indoor nature connections (passive or active) and mental wellbeing. Furthermore, a wealth of studies in this field focused on elderly people, patients, and employees (e.g., Bringslimark et al., 2007; Park & Mattson, 2008; Yeo et al., 2020) and there is a lack of research on adults in urban settings.

Furthermore, while indoor nature connections may contribute to mental health, it remains unclear how intensity, frequency, and duration of exposure to or engagement with indoor plants relate to mental health benefits. A few studies sought to quantify the number of plants and time spent in the presence of plants that it would take to generate positive results. For instance, two studies demonstrated that employees' stress is mitigated by higher quantities of indoor flora in the workplace (Chang & Chen, 2005; Qin et al., 2014). According to Shibata and Suzuki (2001, 2004), the *total number* of houseplants and the *duration* of exposure to houseplants may be related to several psychological benefits, as a greater number of indoor plants may provide more opportunities for people to interact with and/or view the plants, and a longer duration may allow people to have enough time to register the presence of plants. Further research is needed to quantify other aspects of how people engage with indoor plants, especially in active form.

Despite these limitations, the evidence base reviewed above indicates that keeping plants indoors may have positive effects on mental wellbeing. More importantly, there is some suggestion that active engagement with indoor plants (e.g., via an indoor gardening programme) has greater potential to provide mental health benefits than passive exposure (Yeo et al., 2020). In this light, houseplants care behaviour, which is a habit-like, self-guided, and active engagement with indoor plants, merits consideration for its potential to maintain and promote mental wellbeing for urban adults, especially for those who have no private gardens or limited access to public greenspaces.

Keeping plants indoors is a common practice in China, but most urban residents do not have home gardens. This may be associated with Chinese urbanisation (J. Zhang et al., 2023) and cultural specialties (Cerro, 2022; Hao et al., 2022). For research on the effects of houseplants on mental wellbeing, this typical focus on houseplants may be desirable because it may reduce other confounding variables (from other indoor or home-based horticultural activities like home gardening). In addition, access to green spaces in Chinese cities is unevenly distributed (Du et al., 2020), and urban park accessibility is related to house price and socioeconomic status in the main developed Chinese cities (Y. Chen et al., 2020; Feng et al., 2019; Yu et al., 2020), which leads to health inequality in public green space use. Also, mental health problems are prevalent in China, with around 17.95% of Chinese adults suffering, according to a report from the Lancet (Huang et al., 2019), and the help-sought for mental health is positively related to one's social-economic status (J. Chen & Zhu, 2016). Therefore, it is essential to find an affordable self-help approach for Chinese

people to maintain their mental health. Given that there is some evidence for the psychological benefits of indoor nature connection, houseplants care behaviour may be a solution for Chinese urban residents to access nature elements for better mental health. It is thus desirable to understand the behavioural mechanism of keeping houseplants in urban China, with an aim to further promote this healthy behaviour, reduce inequality of greenspace use, and increase mental health benefits of the residents in urban China.

However, there is a lack of research on houseplants care behaviour among Chinese urban residents. It remains unclear whether houseplants care behaviour is related to mental wellbeing and whether all ‘dosages’ of houseplants care behaviour (e.g., frequency, duration, stages of plant ownership) have positive effects on mental wellbeing for Chinese urban residents. Furthermore, there is a lack of sufficient and reliable information about the preferable characteristics of houseplants among Chinese urban residents.

In order to understand the proposed effects of houseplants care behaviour on mental wellbeing, the study intends to explore the potential pathways. As suggested in the Introduction, mental wellbeing benefits of nature connection may be mediated by nature connectedness (see 1.2.3.2), and nature connectedness may be positively related to (especially trait) mindfulness (see 1.3.3). It is desirable to test this by exploring the relationship between indoor nature connection via houseplants care behaviour, nature connectedness, mindfulness, and mental wellbeing in the Chinese population.

2.2.3 Behavioural mechanism of houseplants care behaviour: universalism value, nature connectedness, and mindfulness

The behavioural mechanism of houseplants care behaviour has not been explored, and thus it remains uncertain with regards to the motivations, reasons, and patterns for houseplants care behaviour. Relatedly, it is unknown whether it is feasible to recommend urban residents keep houseplants care behaviour on an everyday basis for mental health promotion.

According to Schwartz's value theory, 'human values' underpin our beliefs and guide human behaviours (Schwartz, 1992). 'Value' is connected to personal belief but is not synonymous with it. Rather, values support our beliefs and can motivate certain actions and behaviours (Schwartz, 1992). Values may partly be shaped by factors that society perceives as desirable, but there is not necessarily an identity between internal values and outward behaviour (Schwartz, 1992). For example, one can behave obediently at school, but this does not automatically mean that one is dominated by traditional, deferential, or benevolent values. Put simply, a human's certain behaviours and attitudes can be impacted by more than one value (Schwartz, 2012).

Specifically, Schwartz's 'human-value theory' comprises ten human values, namely: self-direction, stimulation, hedonism, achievement, power, security, conformity, tradition, benevolence, and universalism (Schwartz, 1992). It is noteworthy that the universalism value is defined as 'understanding, appreciation, tolerance, and

protection for the welfare of all people and for nature' (Schwartz, 2012). In other words, the value of universalism pertains in part to environmental awareness, a love of nature, and a recognition of the right of other living creatures to exist. There is thus an overlap between universalism value and nature connectedness which is positively related to pro-environmental behaviour (Mayer & Frantz, 2004; Schwartz, 2007). In this light, universalism value might reasonably be expected to be linked with houseplants care behaviour. Given the possible correlation between nature connectedness and mindfulness, universalism value may also be related to trait mindfulness. This study thus explores how universalism value may relate to houseplants care behaviour in order to have a better understanding of its behaviour mechanisms.

There is a practical concern about identifying the target population, i.e., those who engage in houseplants care behaviour (who will be referred to as houseplants carers). People who have houseplants are not always actively and regularly engaged in tending the plants. For the sake of distinguishing houseplants carers from non-houseplants carers and for future promotion of houseplants care behaviour, this study employed the Transtheoretical Model (TTM, or Stages of Change), an integrative model that describes five stages of change for a new healthier behaviour (LaMorte, 2018; Prochaska & DiClemente, 1986):

- (1) Precontemplation: people have no immediate plans to take action in the foreseeable future.
- (2) Contemplation: people are beginning to look at the pros and cons of their

continued actions.

- (3) Preparation: people intend to take action in the immediate future (defined as within the next 6 months), and may begin taking small steps toward behaviour change
- (4) Action: people have recently changed their behaviour (defined as within 6 months) and intend to keep moving forward with that behavioural change.
- (5) Maintenance: people have sustained their behavior change for a while (defined as more than 6 months) and intend to maintain the behavior change going forward. (NB there is the sixth stage, namely, 'termination', which is often not considered in health promotion programs.)

Based on this model, houseplants carers in this study refer to those who identify themselves in the Action and Maintenance stages of houseplants care behaviour, while those in the other three stages fall into the category of non-houseplants carers.

This paradigm has been successfully used in relation to a variety of unhealthy behaviours, such as smoking and drug use (DiClemente et al., 1991; Rios et al., 2019). Using this model in relation to a healthy behaviour might be a novel aspect of the present study, which will test the differences in mental wellbeing between non-houseplants carers (those in the first three stages) and houseplants carers (those in the last two stages).

2.2.4 Research questions and hypotheses

The current study sought to explore the association between houseplants care

behaviour, mental wellbeing, nature connectedness, trait mindfulness, and values.

The research questions were as follows:

- 1 How do engagements of houseplants care behaviours relate to mental wellbeing and mindfulness levels?
- 2 How does the degree of nature relatedness relate to mental wellbeing and mindfulness levels?
- 3 How do mental wellbeing and mindfulness levels differ amongst people at different stages of houseplants care behaviour based on the transtheoretical model?
- 4 What values are related to houseplants care behaviour? Do those individuals who engage in caring for houseplants manifest a stronger *universalism* value?

Considering the ‘dosage’ of houseplants care behaviour, three dimensions related to this behaviour are distinguished as follows:

- (1) behaviour₁: the *hours* spent taking care of plants in one week;
- (2) behaviour₂: the total *number* of houseplants being taken care;
- (3) behaviour₃: the *years spent* planting indoors;

The hypotheses were that a) houseplants carers will report greater levels of mental wellbeing and mindfulness than non-houseplants carers; b) more *hours* spent taking care of plants (behaviour₁) would be associated both with higher levels of wellbeing and with greater mindfulness; c) greater *numbers* of plants kept indoors (behaviour₂)

are associated with higher levels of wellbeing and mindfulness; d) longer *years* of houseplants care behaviour (behaviour₃) are related to greater levels of wellbeing and mindfulness; e) greater levels of nature relatedness would be associated with greater wellbeing and mindfulness; f) behaviours₁₋₃ will be positively associated with universalism values.

2.3 Materials and methods

2.3.1 Design

This is an online questionnaire-based cross-sectional study. Questionnaires are an effective and practical tool for harvesting information and are widely used in psychological research (Lonsdale et al., 2006). Nonetheless, perceptions of social desirability may affect answers to questions in relation to mental-health issues (e.g., stress, anxiety, depression), and this factor may operate differently in online surveys. Thus, the answers to the same survey questions could be statistically different via online, phone-based, and in-person methods, especially when one is targeting ‘desirable’ and ‘undesirable’ factors (X. C. Zhang et al., 2017)

Conversely, the social-desirability effect will be small or negligible if questions pertain to normal, mundane life routines (X. C. Zhang et al., 2017). The present study generated several descriptive questions regarding indoor planting, as well as a few short-version, value-based, and mental-well-being-related questions. Most questions concerned uncontroversial matters of life routine, it may still be more appropriate to deploy online surveys because of their perceived anonymity, as well as

their ease of use.

2.3.2 Participants and Sampling

According to power calculations using G*Power software (Kang, 2021), this study required a minimum of 400 participants to ensure the statistical power of conducting a Pearson's correlation test and a MANOVA test with a medium effect size ($f^2 = .25$). In total, 430 participants initially participated in this study. Nine survey responses were excluded due to a large number (up to 90%) of invalid answers. This study achieved a sample comprised of 421 participants.

This study used a stratified sampling design to recruit participants. With regards to representativeness, the participants were recruited from several Chinese cities that are different in terms of geography, economic development, and culture. For the sake of ensuring representativeness, the sampling design developed by the Chinese General Social Survey (CGSS) (*Sampling Design*, 2003), a widely used and well-established sampling model, was adopted and modified for this study. According to the sampling design of the CGSS, China contains 26 provincial capitals and 4 municipalities, which formed the primary sampling units (PSU, county-level units). Following the stratified sampling design set out by the CGSS, the PSUs were classified into two strata. The first sampling stratum consists of four municipalities, which represent the large and developed cities, whereas the second sampling stratum consists of the provincial capitals in the western, central, and eastern regions, which represent the developing cities. In this study, 19 cities were targeted, which are different in terms of economy, demographics, and geography. The residents of these

cities may reasonably be seen as representative of urban citizens in mainland China (see Appendix A).

The selected cities were divided into four groups, municipalities, western region, central region, and eastern region, according to the stratification categories of the CGSS. Meanwhile, there were five categories for different occupations, namely: student, full-time job, part-time-job, unemployed, and retired. Ideally, at least 20 participants (for a minimum sample size of 400) would be recruited from each layer (i.e., $4 * 5 = 20$).

2.3.3 Inclusion and exclusion criteria

Participants had to be: 1) Chinese residents; 2) fluent in reading written Chinese; 3) aged 18 or over; 4) living in an urban area of the targeted Chinese cities. The participants should not have been involved in community or outdoor gardening on a regular basis.

2.3.4 Measures and Procedure

The Jisc Online Survey was utilised, and the survey was distributed to the targeted nineteen Chinese cities between 30 May 2020 and 30 June 2020, and promoted through social media (e.g., Weibo; Online forums about indoor planting in Baidu; WeChat). Although the data collection was carried out after the outbreak of the Covid-19 pandemic, the study was not designed to address the pandemic situation. The questionnaire consisted of seven parts as follows:

Demographic information: Questions regarding marriage and employment status, age, educational background, gender, and city of residence were asked. The preferable characteristics of plants for keeping as houseplants were also asked using a Likert Scale (from ‘extremely unimportant’ to ‘extremely important’).

Profile of plant ownership and houseplants care behaviour: Descriptive questions about participants’ houseplants care behaviour were included. Firstly, questions were asked to allocate participants into houseplant behaviour groups based on the TTM (or Stages of Change, Prochaska & DiClemente, 1986). The five houseplants care behaviour groups were: *pre-contemplation*, *contemplation*, *preparation*, *action*, and *maintenance*. Participants chose a category that most appropriately described their behaviour (see Appendix A). If participants self-recognised that they have already been a ‘houseplants carers’ (in the stage of action and maintenance), they were also asked to report weekly *hours* spending on taking care of plants, the *number* of plants taking care of at home, and *years* of keeping houseplants. Otherwise, participants who were not houseplants carers were required to report a number zero in each of these questions.

Additionally, to better understand the ownership of houseplants of the participants, preferable characteristics of plants were asked (see Appendix A). This measure comprised six items, which were rated on a five-point Likert scale from “*extremely unimportant*” to “*extremely important*”. Items in this measure included: “*nice scent of plant*”, “*small size of plants*”, and “*green coloured plants*”, and which were items adopted from a previous study (Qin et al., 2014).

Nature Relatedness: The Nature Relatedness Scale (NR-6) was used to examine participants' degree of cognitive and affective connection with nature. The higher scores of relatedness with nature indicated stronger subjective feelings of nature connection (Nisbet & Zelenski, 2013). The scale demonstrated robust internal consistency and contained six short questions regarding one's cognition, affect, and experiences of nature connection. No Chinese-language format of the NR-6 is published; therefore, the present writer contacted the author of the original NR-6 and received permission to conduct a back translation for the scale. Nisbet has confirmed that the translated Chinese-language version maintains continuity in meaning and can appropriately be used in this study. The reliability of the Chinese-language version of NR-6 in the current sample was assessed using Cronbach's alpha, which yielded a value of 0.878, a promising indicator of its reliability.

Human's Values: Participants' values were measured using Schwartz's Portrait Value Questionnaire (PVQ), which contains short verbal portraits of 40 imaginary people, with each portrait describing a value. Consequently, participants can score these portraits from 1 (*not like me at all*) to 5 (*very much like me*). Since the present study addresses a range of Chinese adults with a variety of academic backgrounds, the PVQ is a suitably flexible tool. It enables individuals with lower academic ability and abstract-thinking capacity to participate in the survey (Lindeman & Verkasalo, 2005). Moreover, according to the instructions of use regarding Schwartz's value scale, PVQ is particularly well- suited to insertion into an online-survey format (Schwartz, 2009). As noted above, a version of the PVQ was deployed that had been

translated into Chinese and had also been validated (Cronbach's α : Stimulation = .70, Universalism = .69, Security = .65, Achievement = .64, Benevolence = .63, Hedonism = .60, Conformity = .52, Self-direction = .49, Tradition = .49, Power = .41) (Thøgersen & Zhou, 2012).

Mental Wellbeing: The Chinese version of the Short Warwick-Edinburgh Mental Wellbeing Scale (S-WEMWBS) was adopted. The WEMWBS has shown itself to be a valid and reliable measurement of mental health and wellbeing. Likewise, testing of the Chinese version of the short WEMWBS has led to its validation and the confirmation of its reliability ($\alpha = .89$) (Ng et al., 2014).

Mindfulness: The Five Facets Mindfulness Questionnaire (FFMQ) was used to measure trait mindfulness levels. The measure consists of 39 items and was developed from a variety of mindfulness-based measurements (Baer et al., 2006). The FFMQ can explore an individual's mindfulness in five areas, namely: observing, describing, acting with awareness, 'non-judgemental to inner experience', and 'non-inactivity to inner experience' (Baer et al., 2006). The Chinese version of the FFMQ has demonstrated reliable psychometric properties for all subscales except for the non-reacting (Cronbach's α : Observing = .75, Describing = .84, Actaware = .79, non-judging = .66, non-reacting = .45) (Y.-Q. Deng et al., 2011).

2.3.5 Data Cleaning and analysis

SPSS 24 was utilised for the purpose of statistical analyses. To ensure the accuracy and validity of the data in this study, data cleansing was performed. This online

survey required participants to answer each question before proceeding to the next page, but a system error caused some responses to be missing data. To address this issue, SPSS's expectation-maximization algorithm was used to impute absent data. Using the imputation method, we were able to approximate the missing data based on the observed data. Following data cleansing and imputation, descriptive statistics and inferential analyses were conducted using SPSS. Initially, descriptive statistics, including percentage and mean, provided an overview of each stage of change in relation to age, gender, occupation, city of residence. The Shapiro-Wilk test was also used to check the normality of all the continuous variables.

As not all the continuous variables in the current study were normally distributed ($p < .05$), for the first, second, and fourth research questions, Spearman's correlation was conducted to examine the relationship among scores on houseplants care behaviour, nature relatedness, mental wellbeing, and mindfulness levels. The relationships between the behavioural variables (i.e., behaviours₁₋₃) and the values (i.e., those in the Schwartz's portrait value questionnaire) were also explored by the Spearman's correlation test.

For research question three, the stage of planting behaviour (within five possible categories) provided the independent variable for the final research question, and the dependent variables were mental wellbeing and mindfulness levels. Based on the Shapiro-Wilk test on mental wellbeing and mindfulness levels in five houseplants care behaviour groups, only one group (precontemplation) on overall mindfulness level were not normally distributed ($p < .05$). Furthermore, based on *Levene's*

Statistic test, the results indicated that the assumption of homogeneity of variances was met for mental wellbeing ($F(4, 400) = .09, p = .46$) and mindfulness levels ($F(4, 400) = 3.78, p = .05$). Alternative non-parametric analyses may be less efficient than MANOVA and have limited sensitivity to the underlying data structure. Thus, the utilisation of multivariate analysis of variance (MANOVA) remained suitable for evaluating the discrepancies in the levels of mindfulness and wellbeing among five distinct groups of participants categorised by their respective 'stage of planting'. Nonetheless, it is crucial to exercise caution when interpreting the results of the analysis, as they continue to provide valuable information. The results should be regarded as preliminary evidence requiring additional investigation.

2.3.6 Ethical consideration

Participants voluntarily took part in the study, and their data was anonymised. After reading the participants' information sheet, which was inserted in the online survey, participants consented to their participation. This study gained ethical approval by the Clinical and Health Psychology Ethics Committee, the University of Edinburgh (Reference number: CLIN776).

2.4 Results

2.4.1 Demographics and Exploratory Statistics

This study recruited 421 participants from the targeted cities in mainland China. Because it was designed so that the participants could not submit the online questionnaire if it was not completed, there was no data on non-finishers. The proper handling of missing data resulting from systematic errors in SPSS was dealt with

properly, as indicated in that earlier section.

The engagement of participants with darker colours on the map (Figure 2.1) represents greater numbers of participants. The average number of participants per city was 21. There were variations, however, with the fewest individuals supplied by Jinan ($n = 11$), and a relatively large sample from Guangzhou ($n = 57$). In terms of ideal sampling, the objective was for each city to provide 20 participants. Discrepancies in participant numbers in certain cities may have been due to the nature of the online survey; obtaining an exactly equal number of individuals for each locale was always unrealistic. The researcher conducted the same recruitment method in each city (e.g., finding potential candidates, distributing the survey on social media in each city). The rate of response was stronger in southern and eastern coastal areas than in northern or inland regions.

Figure 2.1 *The distribution of participants in mainland China.*

Note. The number of participants is indicated in the map, the city of the participants' living is marked by orange icon. The darker colour represents the greater numbers of participants.

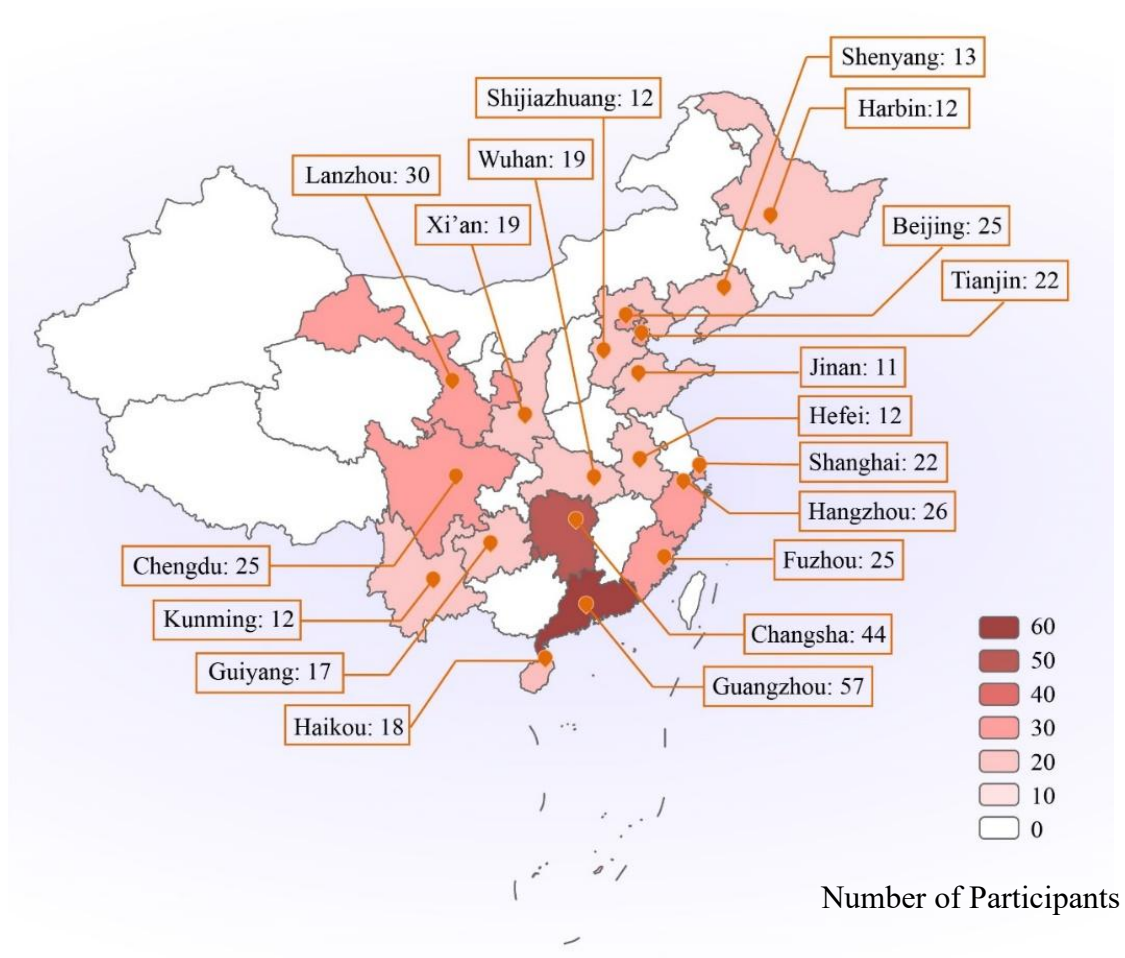


Table 2.1 *Sample demographic information*

Classification of Variables	<i>(N = 421)</i>	
	<i>n</i>	%
Gender		
Male	133	31.6
Female	279	66.3
Prefer not to say	9	2.1
Age Range		
18 -25	144	34.2
26 -34	181	28.7
35 -44	34	8.1
45 -60	51	12.1
>60	11	2.6
Highest Level of Education		
Primary School	1	.2
Middle School and below	10	2.4
High School and below	21	5.0
College & Bachelor's degree	198	47.0
Postgraduate and above	191	45.4
Employment Status		
Student	115	27.3
Full-time job	247	58.3
Part-time job	6	1.4
Unemployed	21	5.0
Retired	32	7.6
Marriage Status		
Single	198	47
Dating	66	15.7
Married	147	34.9
Separated	2	.5
Divorced or Widowed	8	1.9
Stage of Indoor planting		
Precontemplation	136	32.3
Contemplation	25	5.9
Preparation	19	4.8
Action	75	17.8
Maintenance	165	39.2

Demographic information regarding the participants is provided in Table 2.1. Most of the participants were female (66.3%), indicating a bias towards females in recruitment. This is thought to be reflective of gender norms, with females being indicated as more interested in keeping plants at home in China. Furthermore, a large proportion of participants were under 34 years of age; the age bias may be due to the means of recruitment, as recruitment primarily utilised online sources and social media, which are more commonly used by young adults. Regarding educational background, a large proportion of participants were university graduates.

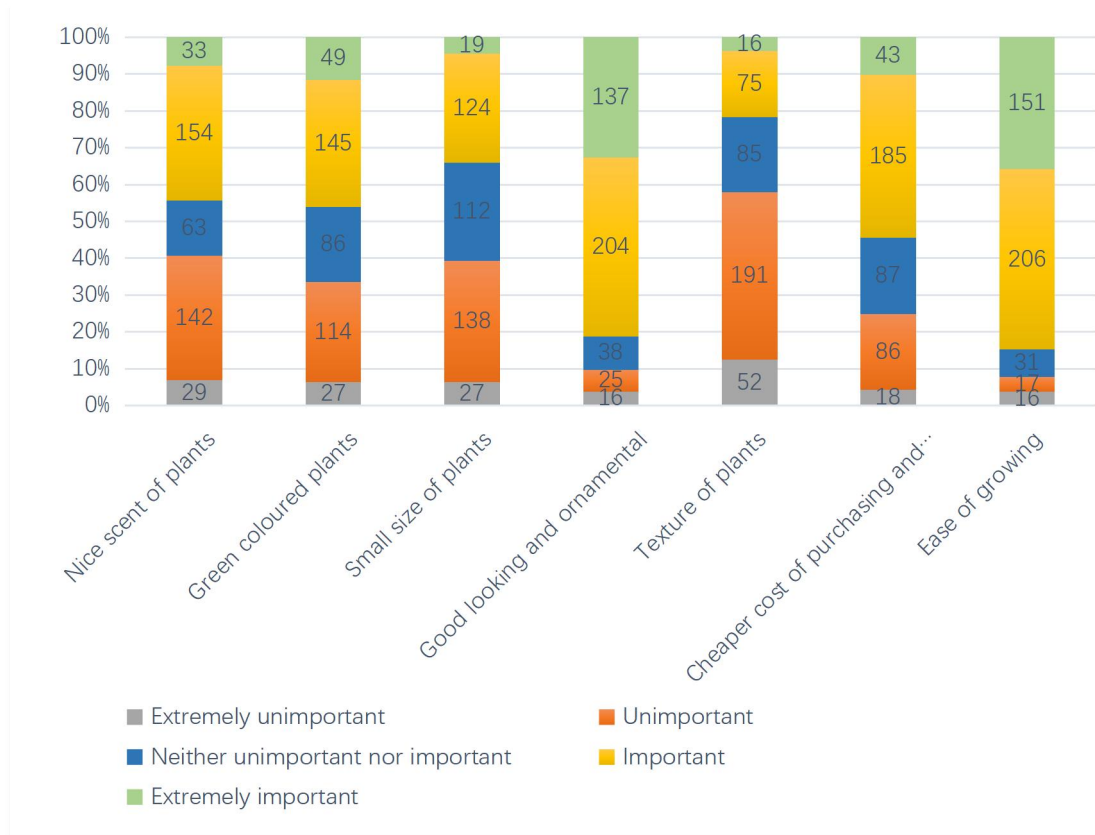
According to an ANOVA test, there was no significant difference in mental wellbeing between residents of the 19 Chinese cities: $F(18, 386) = 1.33, p = .17$. Similarly, there were no statistically significant differences in mindfulness levels between residents of the Chinese cities; $F(18, 402) = .51, p = .96$.

2.4.2 Stages of houseplants care behaviour and plant ownership

Overall, 43 % of individuals who recognised themselves as non-houseplants carers (in the stages of pre-contemplation, contemplation, and preparation) elected to participate, which was surprising. By contrast, over half (57%) of participants self-reported themselves as houseplants carers based on the description of Stages of Change Theory (Prochaska et al., 2008). On average, individuals who engage in the care of houseplants allocate 1.28 hours to this activity ($SD = 2.90$). On average, the participants possessed 5.12 houseplants ($SD = 8.62$) and had maintained them for an average of 4.17 years ($SD = 6.31$).

Figure 2.2 indicates that 44.42% of participants believed that nice-scented plants were important and very important to them; conversely, 40.62% of participants believed that this was unimportant to them. For green coloured plants, 46.08% and 40.62% of the participants believed it was important, or unimportant, respectively, for them to consider keeping them. Additionally, more participants (39.19%) believed the small size of plants was unimportant to them than those who believed it was important (34%). Similarly, more than half (57.72%) of participants believed the texture of the plants was unimportant to them. Notably, participants were concerned about how good the plants looked (81%), the ease of growing (84.80%), and cheaper cost of purchasing and maintaining their plants (54.16%). In conclusion, when keeping houseplants, Chinese adults preferred to take care of plants that were good-looking, easy to grow, and cheap to purchase.

Figure 2.2 *Preferable characteristics of plants*



2.4.3 How do mental wellbeing and mindfulness levels differ amongst people at different stages of houseplants care behaviour?

This section tested the hypothesis a) (see 2.2.4): houseplants carers (those in action and maintenance groups) will report greater levels of mental wellbeing and mindfulness than non-houseplants carers (those in precontemplation, contemplation, and preparation groups). A MANOVA was used to test group differences between house plant behaviour groups (between subject variables) and mental wellbeing and mindfulness levels. The participants were divided into five houseplant behaviour groups, as follows: pre-contemplation, contemplation, preparation, action, and maintenance. The groups were organised by the stage of their current houseplants care behaviour.

Table 2.2 Descriptive statistics of mental wellbeing and mindfulness levels on different Stage of Change groups

Variables	Stage of Change		Mean	SD	N
	Model on Houseplants	Care			
Mental Wellbeing	Total		3.80	.76	405
	Precontemplation		21.11	3.09	130
	Contemplation		21.44	2.28	24
	Preparation		22.00	3.10	19
	Action		22.89	3.24	74
	Maintenance		22.85	3.20	158
Overall Mindfulness Level	Total		22.18	3.21	405
	Precontemplation		3.08	.29	130
	Contemplation		3.21	.28	24
	Preparation		3.28	.21	19
	Action		3.22	.37	74
	Maintenance		3.19	.33	158
F1_Observing	Total		3.16	.32	405
	Precontemplation		3.06	.66	130
	Contemplation		3.32	.61	24
	Preparation		3.25	.61	19
	Action		3.28	.78	74
	Maintenance		3.31	.70	158
F2_Desscribing	Total		3.22	.70	405
	Precontemplation		3.17	.61	130
	Contemplation		3.32	.54	24
	Preparation		3.38	.44	19
	Action		3.36	.71	74
	Maintenance		3.34	.59	158
F3_Acting with Awareness	Total		3.2907	.61461	405
	Precontemplation		3.25	.64	130
	Contemplation		3.52	.68	24
	Preparation		3.48	.68	19
	Action		3.49	.70	74
	Maintenance		3.35	.76	158
F4_Nonjundging	Total		3.36	.71	405
	Precontemplation		2.95	.59	130

F5_Nonreactivity	Contemplation	2.80	.58	24
	Preparation	3.21	.54	19
	Action	2.94	.63	74
	Maintenance	2.89	.65	158
	Total	2.93	.62	405
	Precontemplation	2.94	.61	130
	Contemplation	3.05	.48	24
	Preparation	3.05	.49	19
	Action	2.98	.56	74
	Maintenance	3.03	.53	158
	Total	2.99	.56	405

Table 2.3 *Multivariate tests of differences of mental wellbeing and overall trait mindfulness amongst five stage of change groups*

MANOVA Test						
Stage of Change on	Hypothesis				Partial	
Houseplants Care	Value	<i>f</i>	<i>df</i>	Error <i>df</i>	<i>p</i>	Eta Squared
Pillai's Trace	.119	2.04	24.00	1592.00	.00	.03

A multivariate analysis of variance (MANOVA) was conducted to compare differences in well-being and mindfulness among five groups of participants. The dependent variables were well-being and mindfulness, and the independent variable was the group of houseplants care behaviour. Results of the MANOVA indicated a significant overall effect of group on the combined dependent variables, Pillai's trace = 2.04, $F(24, 1592) = 2.04$, $p < .01$. $\eta^2 = .03$, implying that 3% of the variance in the dependent variable was accounted for by stage of change.

As, Figure 2.3 below shows, participants who identified themselves in the latter stages of houseplants care behaviour evinced a greater level of mental wellbeing. From the stage of pre-contemplation through to the action stage of houseplants

caring, levels of wellbeing rose sharply, and this increase persisted in a stable manner from the stage of action to that of maintenance. Table 2.4 below shows the results from pairwise comparisons using Bonferroni correction, which revealed that the precontemplation group had significantly lower mental well-being scores compared to action group, $p < .01$, maintenance group, $p < .01$. There were no significant differences between the precontemplation group and the other groups after Bonferroni correction was applied.

Overall, the results suggest that participants in the precontemplation group reported significant lower levels of well-being compared to participants who had houseplants care behaviour. No significant differences were found among the other groups.

Figure 2.3 *Houseplants Care Behaviour and Mental Wellbeing*

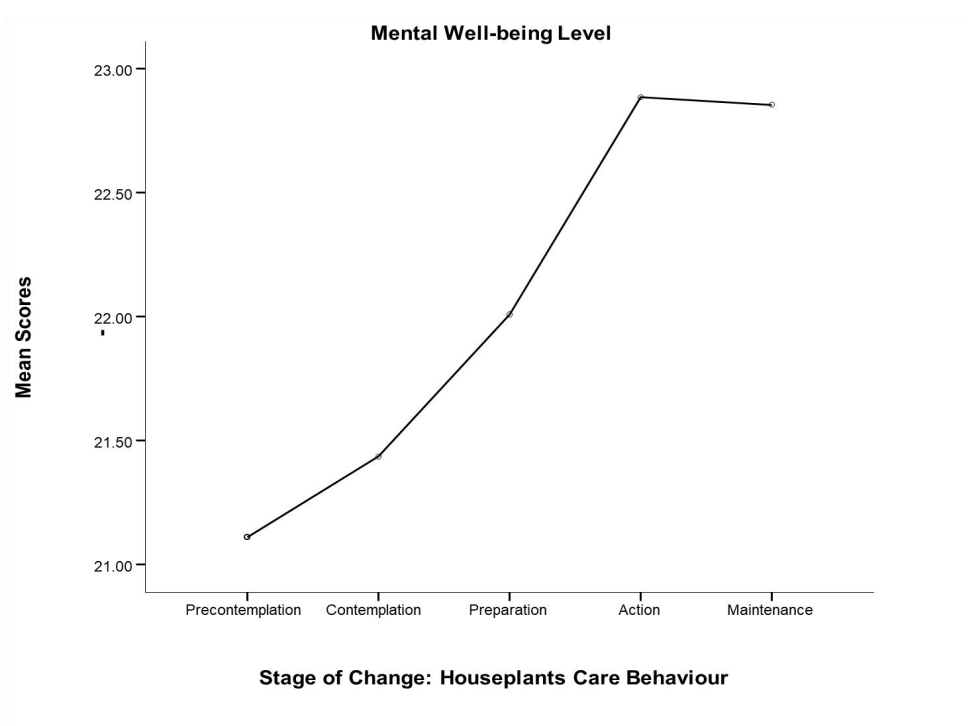


Table 2.4 Pairwise comparisons between 5 groups of stage of change of houseplants care behaviour in mental wellbeing

Dependent Variable	(I) Stage of change of houseplants care behaviour	(J) Stage of change of houseplants care behaviour	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
						Lower Bound	Upper Bound
Mental wellbeing	pre-contemplation	contemplation	-.331	.692	.633	-1.692	1.030
		preparation	-.925	.764	.227	-2.428	.578
		action	-1.737*	.456	.000	-2.634	-.840
	contemplation	maintenance	-1.468*	.390	.000	-2.235	-.701
		precontemplation	.331	.692	.633	-1.030	1.692
		preparation	-.594	.953	.534	-2.467	1.279
	preparation	action	-1.406	.729	.055	-2.839	.027
		maintenance	-1.137	.688	.099	-2.489	.216
		precontemplation	.925	.764	.227	-.578	2.428
	action	contemplation	.594	.953	.534	-1.279	2.467
		action	-.812	.798	.310	-2.381	.757
		maintenance	-.543	.762	.476	-2.041	.955
	maintenance	precontemplation	1.737*	.456	.000	.840	2.634
		contemplation	1.406	.729	.055	-.027	2.839
		preparation	.812	.798	.310	-.757	2.381
		maintenance	.269	.446	.547	-.609	1.146
		precontemplation	1.468*	.390	.000	.701	2.235
		contemplation	1.137	.688	.099	-.216	2.489
		preparation	.543	.762	.476	-.955	2.041
		action	-.269	.446	.547	-1.146	.609

For mindfulness level, as Figure 2.4 shows below, the average scores of overall mindfulness reached a peak value in the preparation stage. Furthermore, Table 2.5 shows the results from a post-hoc test using Bonferroni correction that the overall mindfulness scores in the pre-contemplation group were significantly lower than

those in contemplation ($p = .01$), preparation ($p < .01$), action ($p < .01$) and maintenance ($p < .01$) groups.

Figure 2.4 Houseplants Care Behaviour and Mindfulness

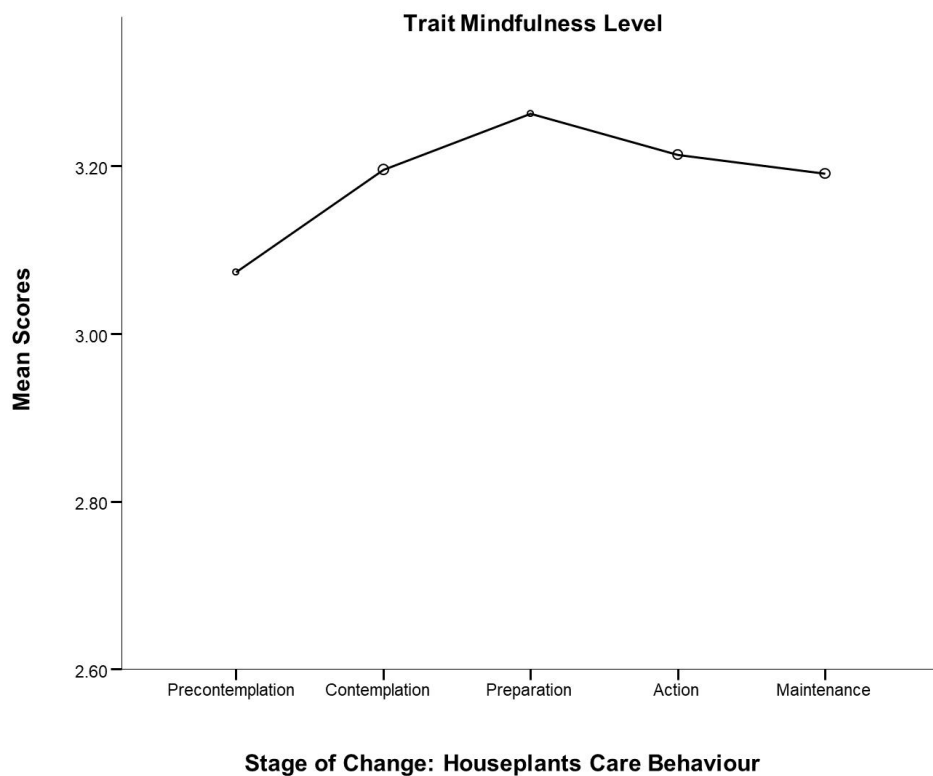


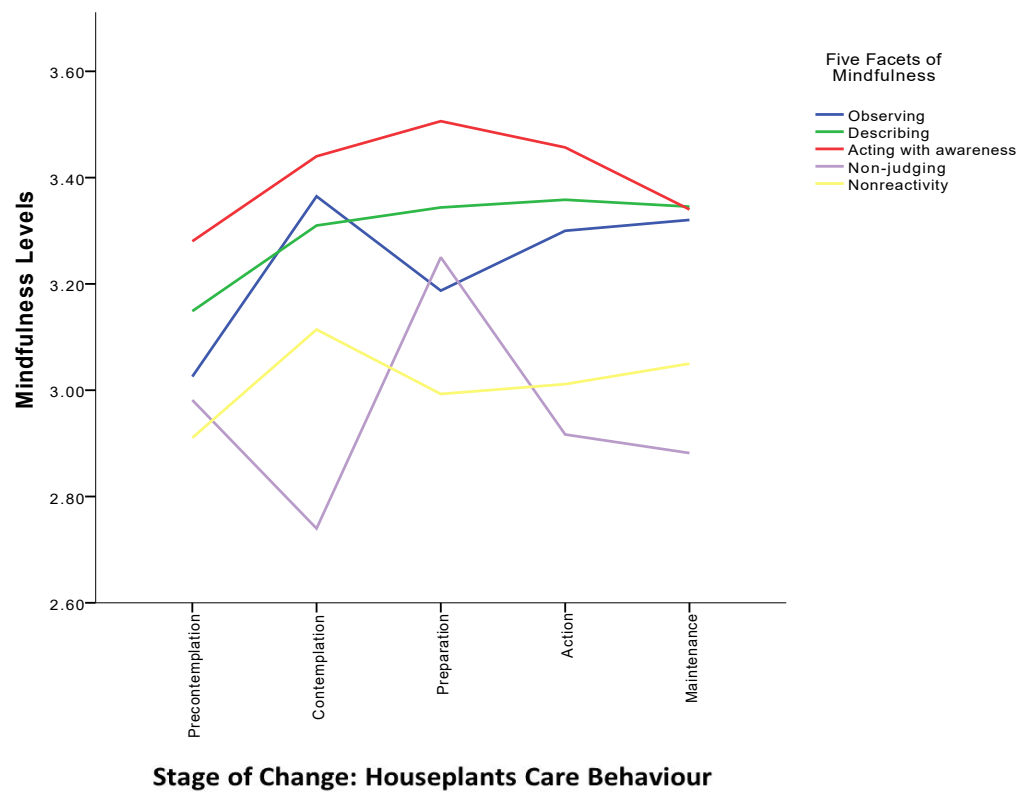
Table 2.5 Pairwise comparisons between 5 groups of stage of change of houseplants care behaviour in mindfulness

<u>Dependent Variable</u>	<u>(I) Stage of change of houseplants care behaviour</u>	<u>(J) Stage of change of houseplants care behaviour</u>	<u>Mean Difference (I-J)</u>	<u>Std. Error</u>	<u>Sig.^b</u>	<u>95% Confidence Interval for Difference^b</u>	
						<u>Lower Bound</u>	<u>Upper Bound</u>
<u>Mindfulness level</u>	<u>pre-contemplation</u>	<u>contemplation</u>	<u>-.121</u>	<u>.071</u>	<u>.088</u>	<u>-.260</u>	<u>.018</u>
		<u>preparation</u>	<u>-.196*</u>	<u>.078</u>	<u>.012</u>	<u>-.349</u>	<u>-.042</u>
		<u>action</u>	<u>-.128*</u>	<u>.047</u>	<u>.006</u>	<u>-.220</u>	<u>-.037</u>
		<u>maintenance</u>	<u>-.079*</u>	<u>.040</u>	<u>.049</u>	<u>-.157</u>	<u>.000</u>
	<u>contemplation</u>	<u>precontemplation</u>	<u>.121</u>	<u>.071</u>	<u>.088</u>	<u>-.018</u>	<u>.260</u>
		<u>preparation</u>	<u>-.075</u>	<u>.097</u>	<u>.440</u>	<u>-.266</u>	<u>.116</u>
		<u>action</u>	<u>-.007</u>	<u>.074</u>	<u>.922</u>	<u>-.154</u>	<u>.139</u>
		<u>maintenance</u>	<u>.042</u>	<u>.070</u>	<u>.548</u>	<u>-.096</u>	<u>.180</u>
	<u>preparation</u>	<u>precontemplation</u>	<u>.196*</u>	<u>.078</u>	<u>.012</u>	<u>.042</u>	<u>.349</u>
		<u>contemplation</u>	<u>.075</u>	<u>.097</u>	<u>.440</u>	<u>-.116</u>	<u>.266</u>
		<u>action</u>	<u>.068</u>	<u>.081</u>	<u>.406</u>	<u>-.092</u>	<u>.228</u>
		<u>maintenance</u>	<u>.117</u>	<u>.078</u>	<u>.132</u>	<u>-.036</u>	<u>.270</u>
	<u>action</u>	<u>precontemplation</u>	<u>.128*</u>	<u>.047</u>	<u>.006</u>	<u>.037</u>	<u>.220</u>
		<u>contemplation</u>	<u>.007</u>	<u>.074</u>	<u>.922</u>	<u>-.139</u>	<u>.154</u>
		<u>preparation</u>	<u>-.068</u>	<u>.081</u>	<u>.406</u>	<u>-.228</u>	<u>.092</u>
		<u>maintenance</u>	<u>.049</u>	<u>.046</u>	<u>.278</u>	<u>-.040</u>	<u>.139</u>
	<u>maintenance</u>	<u>precontemplation</u>	<u>.079*</u>	<u>.040</u>	<u>.049</u>	<u>.000</u>	<u>.157</u>
		<u>contemplation</u>	<u>-.042</u>	<u>.070</u>	<u>.548</u>	<u>-.180</u>	<u>.096</u>
		<u>preparation</u>	<u>-.117</u>	<u>.078</u>	<u>.132</u>	<u>-.270</u>	<u>.036</u>
		<u>action</u>	<u>-.049</u>	<u>.046</u>	<u>.278</u>	<u>-.139</u>	<u>.040</u>

For each subscale of FFMQ, results shown that only for observing ($F = 3.61, p = .01$) and for describing ($F = 2.45, p = .05$) were there statistically significant differences between the five houseplant behaviour groups (see Figure 2.5). Post-hoc tests indicated that levels of observing in the pre-contemplation group were significantly

lower than preparation group ($p = .01$), and action group ($p = .04$) and maintenance ($p < .01$) groups; contemplation and preparation groups were not significantly distinct from other groups on observing scores. Additionally, for describing levels, similarly, the pre-contemplation group was only significantly different from action ($p = .04$) and maintenance ($p = .02$) groups.

Figure 2.5 Subscales Mindfulness and Houseplants Care Behaviour



In summary, the results show that scores of mental wellbeing, overall mindfulness, and its subscales of observing and describing scores, were highest in the preparation to action stages of house planting behaviour, and the group differences between pre-contemplation and action, as well as maintenance groups, were significant on measured outcomes. It suggests that there was a significant difference on levels of mental wellbeing and mindfulness between non houseplants carers and houseplants carers.

Based on the results, the **hypothesis a)** was partly confirmed: 1) houseplants carers showed greater level of mental wellbeing than non-houseplants carers; 2) while houseplants carers showed a greater level of mindfulness level than some of the non-houseplants carers (those at the precontemplation and contemplation stages), the non-houseplants carers at the preparation stage showed the highest level of mindfulness.

2.4.4 Engagement of houseplants care behaviour and mental health

This section tested the hypotheses b-d) and e) (see 2.2.4), that is, 1) greater level of behaviours₁₋₃ (of the participants in action and maintenance groups, n = 240) will be associated with a greater level of mental wellbeing and mindfulness; 2) greater levels of nature relatedness would be associated with greater wellbeing and mindfulness. All of these were confirmed as follows.

Table 2.4 below shows the results of analyses to test associations between levels of engagement in houseplants caring, degrees of mental wellbeing, nature relatedness,

and trait mindfulness. The results indicated that having spent more hours in the last week, owning greater numbers of houseplants, and spending longer years of keeping houseplants, are statistically significant and correlated with greater levels of nature relatedness, mental wellbeing, and trait mindfulness. Furthermore, higher levels of nature relatedness were significantly associated with greater degrees of mental wellbeing and mindfulness. It is notable that the effect magnitude of these associations was sizeable (i.e., $r = .31; .34$; see more details below).

Table 2.6 *Correlations between houseplant behaviour and mindfulness, nature connectedness and wellbeing*

Variable	1	2	3	4	5	6	Mean	SD
1. NR-6		.34**	.28**	.31**	.28**	.32**	3.80	2.90
2. S-WEMWBS			.41**	.24**	.21**	.28**	22.18	3.21
3. CH-FFMQ				.13**	.10*	.17**	3.16	.32
4. Hours of caring houseplants (last week)					.78**	.68**	1.28	2.90
5. Numbers of houseplants						.73**	5.12	8.62
6. Years of keeping houseplants							4.17	6.31

Note. * $p < .05$, ** $p < .01$ (2-tailed). $N = 240$

Abbreviations: Nature Relatedness (NR), hours spent taking care of plants in the preceding week (behaviour1), the total numbers of plants at home (behaviour2) and the total years spent raising plants at home (behaviour3).

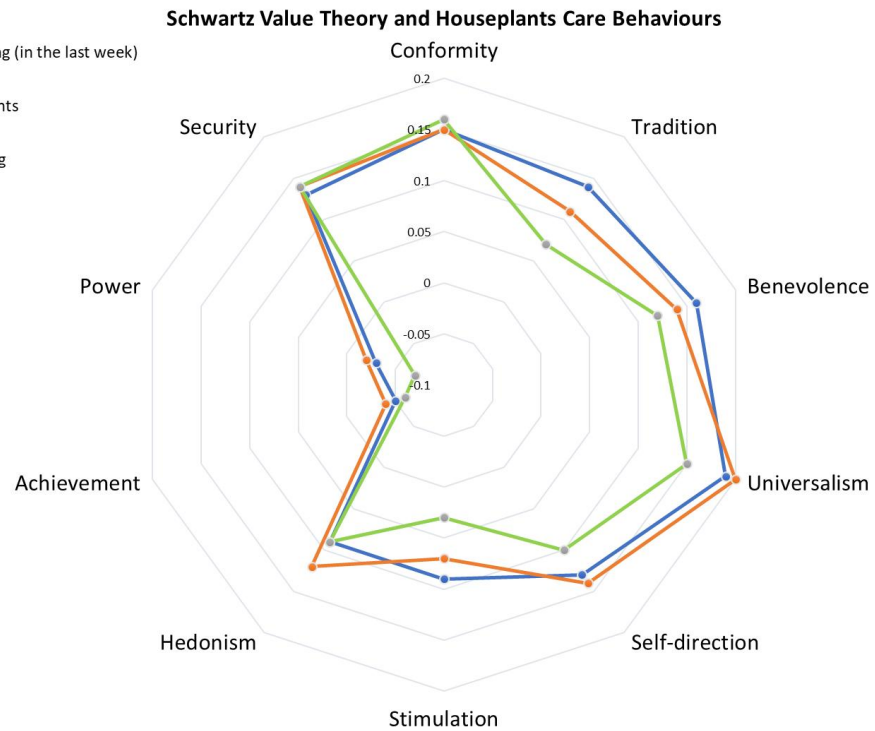
2.4.5 Do those individuals who are more engaged in houseplants care behaviour relate to a stronger universalism value?

This section tested the hypothesis f) (see 2.2.4) that behaviours₁₋₃ (of the participants in action and maintenance groups, $n = 240$) will be positively associated with universalism values, which was confirmed as follows. The radar chart (Figure 2.6) below shows the strength of the relationship between each value and houseplants

care behaviours. There were significant positive relationships between universalism value and behaviour₁ ($r = .19, p < .001$), behaviour₂ ($r = .20, p < .001$), behaviour₃ ($r = .15, p < .001$). This indicates that Chinese urban residents who have stronger universalism values are more likely to own a greater number of plants and to spend more time taking care of them.

Interestingly, apart from the Universalism value, the chart below shows a trend that houseplant ownership and houseplants care behaviour are positively correlated with the values of conformity, benevolence, self-direction, and security, which were found to be significantly and positively correlated behaviours₁₋₃. By contrast, behaviours₁₋₃ were not related to achievement value and power value. It is also worth mentioning that the hedonism value was strongly positively correlated with behaviours₂ ($r = .12, p = .01$), and the tradition value was positively related to behaviours₁ ($r = .14, p < .01$) and behaviours₂ ($r = .11, p = .03$).

Figure 2.6 Relationship between each value and houseplants care behaviours



2.5 Discussion

The present study found a positive relationship between houseplants care behaviour and mental wellbeing, trait mindfulness, nature relatedness, and universalism value amongst Chinese adults living in urban areas.

2.5.1 An overview of the findings

Mental wellbeing, mindfulness, and nature connectedness. Overall, the mental wellbeing and mindfulness of the houseplants carers are better than those of the non-houseplants carers (which may confirm hypothesis a). In addition, nature connectedness was positively correlated with mental wellbeing and trait mindfulness among the houseplants carers (which might prove hypothesis e). Regarding hypotheses b-d, the findings suggest that spending more *time* in houseplants care behaviour in the last week (behaviour₁), keeping greater *numbers* of houseplants

(behaviour₂), taking care of plants for longer *years* (behaviour₃) were positively correlated with greater levels of mental wellbeing and trait mindfulness.

Considering the stages of change, mental wellbeing increased from the precontemplation to action stages, and then slightly decreased at the maintenance stage. This may be because there are individual differences in behaviours₁₋₃ among the houseplants carers. For instance, a houseplants carer who has been keeping houseplants for over 10 years may spend limited time taking of plants on a daily basis.

Surprisingly, mindfulness level increased from the precontemplation to contemplation stages, and reached its highest point at the preparation stage, but then decreased at the action and maintenance stages. The possible reasons for this are as follows. First, a relatively small number of participants identified themselves at some stages, which would likely affect the reliability of the mean scores for those stages. Second, the categories of stage might be ambiguous to the participants, and thus some of them may choose inappropriately. Third, the measurement of mindfulness in this study is commonly used to test mindfulness *changes* before and after a mindfulness-based intervention. The participants at the preparation stage, according to the definition of TTM, began taking small steps toward *changing* to houseplants care behaviour (LaMorte, 2018). In this sense, houseplants care behaviour could be regarded as a new practice or a kind of intervention for the participants at the preparation stage.

Houseplants care behaviour and values. Overall, behaviours₁₋₃ were found to be

positively correlated with the values of universalism, as well as self-direction, conformity, benevolence, and security.

Universalism. The positive association between houseplants care behaviour and universalism value may support the assumed correlation between universalism value and nature connectedness. As Schwartz demonstrated, universalism reflects a concern for nature, but also derives from the historic survival imperatives of groups and individuals (Schwartz, 2012). This indicates that the prevalence of universalism value among the Chinese houseplants carers may be related to Chinese culture and the perception of nature with regard to houseplants.

Universalism, self-direction, conformity, and security. As mentioned, one's values can be either conflicted or compatible (Schwartz, 2012). The conformity and security values are obviously compatible, as they both belong to the 'conservation' type. The self-direction value refers to one's independent thoughts and actions when choosing and creating. The combination of self-direction and universalism values reflects their shared origins in a 'reliance upon one's own judgement and comfort with the diversity of existence' (Schwartz, 2012). Relatedly, the value combination of security and conformity reflects a desire to protect order and harmonious relationships (Schwartz, 2012). It is reasonable that people who are more conservation-driven are also more likely to maintain one form of behaviour for a longer period of time, especially since keeping houseplants is perceived as healthy.

Hedonism. Furthermore, the hedonism value reflects the desire for pleasure and

clearly correlates with the pursuit of happiness. A potential reason for the association between hedonism value and *numbers* of plants may lie with purchasing behaviour; these individuals may buy large numbers of plants because doing so gives them pleasure. Further studies can employ interviews to explore the motivations and values behind houseplants care behaviour in more detail.

Conformity and benevolence. In addition, the values of conformity and benevolence, which represent ‘devotion to one’s group’. Interestingly, the benevolence value can generate intra-group harmony, while conformity (clearly) reflects an individual’s respect for certain customary ideas from his/her culture (Schwartz, 2012). These two values are highly compatible with regular engagement in houseplants care behaviour.

Previous studies have not highlighted the relationships of plant-based or planting behaviour with human values. This is the first study to apply Schwartz’s (2012) value theory to examine how basic human values relate to houseplants care behaviour. Nevertheless, it must be acknowledged that the present study addresses only Chinese urban adults, among whom houseplants care behaviour is a common practice and may be highly associated with Chinese culture. Further studies may investigate whether ‘human values’ still lead people to plant at home when samples comprise more diverse cultural contexts and age groups.

Characteristics of houseplants. This study provides information about the preferred characteristics of plants among Chinese adults. Ease of growing is the most important factor that people, especially beginners, consider when raising plants at

home. The aesthetics of the plants is also an important factor that people consider. Overall, less than half of the participants believed that green coloured, small sized, and soft textured plants were important for them to plant. This study suggests that ease of growing, aesthetics, and affordability are the important aspects Chinese adults consider when keeping houseplants. This finding can be incorporated with further self-guided planting interventions for adults in China.

2.5.2 Strengths

The findings add to the body of literature on the benefits of indoor nature connection on mental wellbeing (Bringslimark et al., 2009; Han et al., 2022; Zhao et al., 2023). The significant effects of houseplants care behaviour on mental wellbeing concur with earlier research on the mental wellbeing benefits derived from indoor plants (e.g., Park & Mattson, 2009; Tse, 2010) as well as some previous studies of the relationship between horticultural activities and mental wellbeing (e.g., Glover-Edge, 2005; Kamioka et al., 2014).

In addition, the mental wellbeing of the houseplants carers is positively related to both trait mindfulness and nature connectedness, while the latter two are also correlated. This may support the argument that the mental wellbeing benefits of nature connection could be mediated by nature connectedness (e.g., Capaldi et al., 2014; Cleary et al., 2017; see also 1.2.3.2). Relatedly, this novel finding may provide some evidence for the proposed linkage between mental wellbeing, nature connectedness, and mindfulness (see 1.3.3).

Moreover, this indicates the potential of integrating mindfulness practice into houseplants care behaviour and thus developing an indoor nature-based intervention. It has been demonstrated by previous research that horticultural activities promote human mental health in various ways. For instance, gardens can be excellent places to practice meditation and become centred on the present moment (Corazon et al., 2012; Lymeus et al., 2018b). Nonetheless, few of these studies examined the relationship between planting-related behaviour and mindfulness, especially in the sense of keeping plants deployed to *cultivate* mindfulness. For instance, one project ('Green Mindfulness') at a Canadian university integrated plants with mindfulness practice, aiming to improve students' wellbeing (Quinlan et al., 2019). Given that many Chinese urban residences do not have private gardens, houseplants care behaviour integrated with mindfulness practice as an inexpensive and easily conducted approach may be prioritised over other options.

2.5.3 Implication for further studies

First, Further studies can test the role of mindfulness in the relationship between houseplants care behaviour and improvement of mental wellbeing by using an experimental research design, to reveal the mechanism of improvement of mental wellbeing via mindfulness. Second, further research may use an experimental design to explore whether nature connectedness is a mediator for the improvement of mental wellbeing and mindfulness through houseplants care behaviour. Third, further studies may use the FFMQ measurement to examine differences in mindfulness before and after engaging in houseplants care behaviour or houseplants-based interventions. In any case, qualitative research is desirable to investigate the effect of houseplants care

behaviour on rumination, meditation and mindfulness in greater detail. Furthermore, as discussed above, the fact that the houseplants carers exhibited a lower level of mindfulness than the participants at the preparation stage may raise questions and merits further research on the relationship between mindfulness and houseplants care behaviour. Further research should address the therapeutic influence of plant cultivation on individuals of different nationalities and cultures.

Based on the psychological benefits produced from houseplants care behaviour, it is reasonable to develop indoor nature-based intervention (integrated with mindfulness practice) for mental health promotion within the general population. Such practices and interventions may also be directed to the management of everyday stress, and not exclusively to mental or emotional pathologies.

2.5.4 Limitations

There are several limitations to the present study. Firstly, as a cross-sectional online survey study, the levels of mental wellbeing, mindfulness, and nature connectedness were assessed via self-reported questionnaires, and thus the reliability of the data may be questionable. Perceptions of social desirability may affect answers to questions in relation to mental-health issues (e.g., stress, anxiety, depression), and this factor may operate differently in online surveys. Thus, the answers to the same survey questions could be statistically different *via* online, phone-based, and in-person methods, especially when one is targeting ‘desirable’ and ‘undesirable’ factors (X. C. Zhang et al., 2017). Nonetheless, the social-desirability effect will be small or negligible if questions pertain to normal, mundane life routines (X. C.

Zhang et al., 2017). The present study included several descriptive questions regarding houseplants, as well as a few short-version, value-based, and mental-wellbeing-related questions.

Secondly, the identification of non-houseplants carer and houseplants carer was also self-reported by participant, who chose the first three (precontemplation, contemplation, and preparation) or the last two stages of change (action and maintenance) respectively. However, one may not perceive himself or herself as a houseplants carer even though he or she meets the requirements. Also, participants may not be able to recall when they started to engage with houseplants. Relatedly, there is some ambiguity between those at the action stage (caring houseplants in the past six months) and those at the maintenance stage (caring houseplants more than six months). For instance, how may the level of mental wellbeing differ between participants who have been taking care of houseplants for seven months and those who have been doing so for six months?

Thirdly, although stratified sampling was used to recruit representative participants among Chinese city residents, the nature of online surveys meant that the participant numbers from each city were unequal. Third, since most participants were young and relatively well-educated, they may not be strongly representative of the wider population. Moreover, there is an apparent bias towards younger adults and females, possibly because domestic plant cultivation is favoured by Chinese women more than men. The age bias may be due to the means of recruitment; the recruitment strategy mainly employed social media, where one finds a higher concentration of

younger adults. In terms of educational background, the participant profile heavily skews towards university graduates, which *may* suggest that the online-survey format is more palatable for people with a higher educational background.

2.6 Conclusion

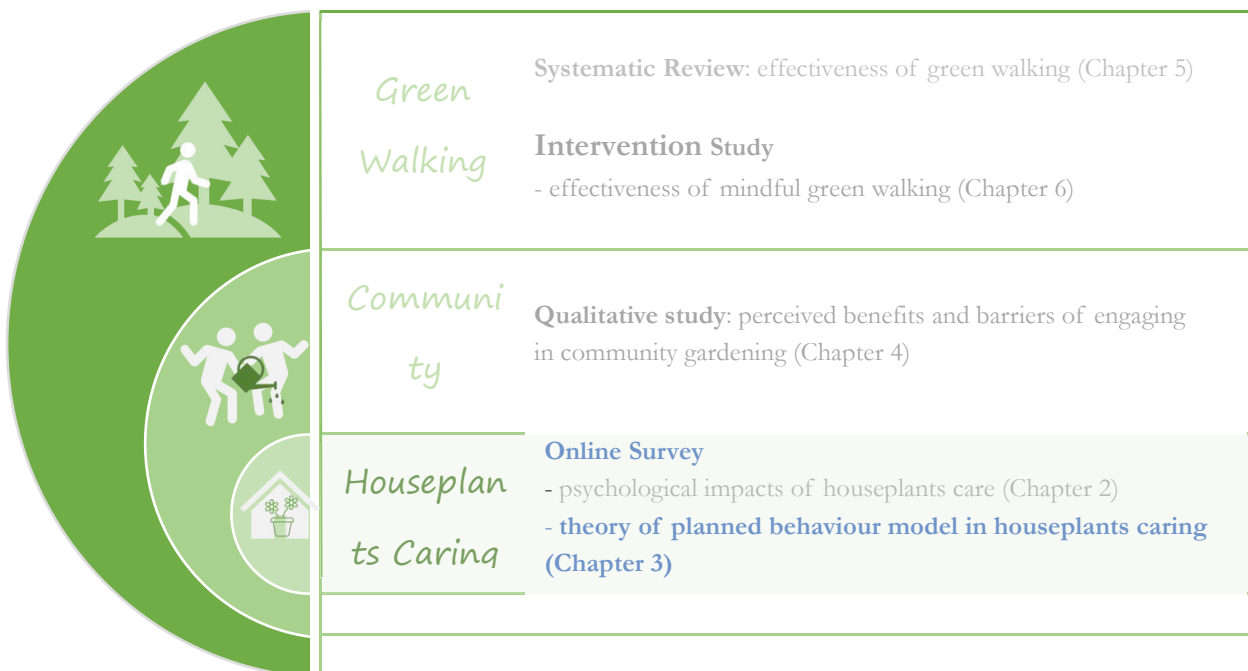
The present cross-sectional study found that some aspects of houseplants care behaviours were associated with greater levels of mental health and trait mindfulness. Taking care of a greater *number* of plants and spending longer time on it were correlated with greater levels of mental wellbeing and mindfulness. Significant group differences between different *stages of change* have been found in mental wellbeing and trait mindfulness. Participants who self-identified as being in the *action* and *preparation* stages reported the highest levels of mental wellbeing and trait mindfulness, respectively. Furthermore, the value of *Universalism* significantly correlated with all defined houseplants care behaviours. The present study provides evidence that may be deployed both to illustrate the mental-health advantages of houseplants care behaviour, and to assist in the formation of mechanisms to promote this healthy behaviour in urban China.

Chapter 3

Creating Indoor Oases in Urban Living Apartments: An Application of Theory of Planned Behaviour to Understand Why Chinese Adults Keep Houseplants

3.1 Chapter Overview

In this chapter, we investigate the behavioural mechanism of why Chinese people keep houseplants and take care of them. An online questionnaire-based survey was used to examine the main constructs of the theory of planned behaviour (TPB) in relation to houseplants care behaviour. The survey included items to measure Chinese adults' attitude, intention, and perceived behaviour control (PBC) towards houseplants care behaviour. In addition, open questions regarding reasons for houseplants care behaviour are also explored in this chapter.



Abstract

A sample of 421 Chinese adults who are living in urban areas completed an online questionnaire-based survey examining the main constructs of the theory of planned behaviour (TPB) in relation to houseplants care behaviour. The survey included items to measure Chinese adults' attitude, intention, and perceived behaviour control (PBC) towards houseplants care behaviour. In addition, reasons for taking care of houseplants were also asked. Results from houseplants carers ($n = 240$) show a significant positive relationship between beliefs, subjective norms, PBC, intentions, and houseplants care behaviours. However, no correlation between *hours* spent on houseplants care in the previous week and the subjective norm was found. Structural equation modelling (SEM) was used to examine whether houseplants care behaviours fit the TPB, and a significant TPB model was found to explain houseplants care behaviours. Conversely, the subjective norm was not a predictor of intention, and PBC predicted houseplants care behaviour more effectively than intention. Open questions about the reasons for keeping houseplants were collected from the participants ($n = 421$). The current research provides a deep insight into the mechanism of houseplants care behaviour.

Keywords: Houseplants Care Behaviour; Nature Connection; Theory of Planned Behaviour; Attention Restoration

3.2 Introduction

Chapter 2 focuses on psychological effects of houseplants care behaviour on mental wellbeing and the relationship between the behaviour and values. Beside universalism and other values identified therein, what factors may influence houseplants care behaviour remain unclear. This chapter serves as a complimentary exploration of the behavioural mechanism, based on which further houseplants-based interventions for mental health promotion may be developed.

3.2.1 Theoretical model for explaining houseplants care behaviour

The present study uses the theory of planned behaviour (TPB) as a framework for understanding houseplants care behaviour among the Chinese urban adults, with the aim of designing a houseplants-based intervention for mental health promotion in the future.

The TPB is one of the most popular and influential models for predicting human behaviour and a modified version of the Theory of Reasoned Action (TRA) (Ajzen, 2011). The central factor of TPB is the individual's intention to perform a given behaviour. Generally, stronger intentions are more likely to predict the performance of the behaviour. The primary factors that influence intentions include personal beliefs (benefits and costs of behaviour), subjective norms, and perceived behavioural controls (PBC) (Hill et al., 1977). Personal beliefs refer to attitudes toward the performance of specific behaviours, and/or perceptions of personal ability. Subjective norms come from the agent's 'significant people', whose approval allows the behaviour to be performed with greater ease and confidence. Perceived

behavioural controls (PBC) refer to the perceived ease and difficulty of performing a behaviour including perceived self-efficacy and perceived controllability to represent internal and external controlled factors (Ajzen, 2002). The theory hypothesises that PBC and favourability of attitudes and subjective norms toward a behaviour predict the behavioural intention, which, in turn, is a strong predictor of the behaviour. In addition, PBC is also proposed to predict behaviour (Ajzen, 2005).

A number of studies have used TPB to explore decision-making behaviour in a range of health-related topics (Lautenschlager & Smith, 2007; Sun et al., 2022). It has been confirmed that the TPB has predictive power in many health behavioural studies (Armitage & Conner, 2001). TPB has been used to predict nature-based behaviours, such as gardening and tree planting, but the previous studies have generated conflicting results. For instance, participation in a local community forest was predicted by personal attitude, subjective norms, and PBC in a study in Thailand (Apipoonyanon et al., 2020). Tree-planting behaviour in Iran and Pakistan was predicted solely by the subjective norms with potential farmers reporting that tree-planting behaviour was both ecologically and economically friendly (Yazdanpanah et al., 2014; Zubair & Garforth, 2006). That may have been because tree planting in those areas was mainly used to increase income rather than being associated solely with a healthy lifestyle. In this case, personal behaviour was more likely to be influenced by social norms. However, another study found that personal attitude was the most significant predictor of gardening behaviour to cultivate and reinforce healthy dietary behaviours (Lautenschlager & Smith, 2007).

Keeping and growing houseplants has a long history (Manaker, 1996). In terms of personal beliefs, people may bring plants into residential areas to improve the living environment and serve as a symbol of nature (Bringslimark et al., 2009; Smardon, 1988). One study found that even a single pot of plants may effectively serve as a symbol of nature, successfully arousing one's feelings of nature connectedness (Pretty, 2004). According to the Biophilia hypothesis, people's placing plants indoors may be an intrinsic desire for nature connection, which may be related to human's 'craving for aesthetic, intellectual, cognitive, and even spiritual meaning and satisfaction' (Wilson, 1986; see also 1.2.2.1). Also, like outdoor nature connection, houseplants may be regarded as desirable due to their potential restorative benefits, as suggested by ART and SRT (Kaplan, 1995; Ulrich, 1984; see also 1.2.2.2-3) and corroborated by recent research (see 2.2.2).

TPB has not been used to predict houseplants care behaviour. This is the first study to employ the TPB to examine the relationships between personal beliefs, subjective norms, PBC, and the behavioural intention of houseplants care behaviour. It is also the first to assess whether houseplants care behaviour among Chinese adults can be predicted by the constructs of the TPB model. In ancient and modern China, houseplants care behaviour is common practice for aesthetic and decorative purposes, which are related to cultural specialties (see, e.g., Cerro, 2022; Hao et al., 2022).

3.2.2 Aim of this study

The study will focus on the following research questions:

- 1 Does the theory of planned behaviour (TPB) predict houseplants care behaviour?

- 1.1 Do personal beliefs and subjective norms correlate with the intention of taking care of houseplants?
- 1.2 Does the intention predict houseplants care behaviour?
- 1.3 Does PBC directly predict houseplants care behaviour?
- 2 What are the reasons why Chinese adults in urban places choose to keep and take care of houseplants?

The following hypotheses will be tested:

Hypothesis 1: TPB can predict the number of hours people spent taking care of plants in the last week.

Hypothesis 2: TPB can predict the numbers of houseplants that people keep at home.

Hypothesis 3: TPB can predict the years that people spend keeping houseplants.

3.3 Methods and Materials

3.3.1 Design, Participants, and Sampling

The research design, sampling procedure, and participants criteria have been reported in 2.3.1, 2.3.2, and 2.3.3. According to the report from G*Power software (Kang, 2021), this study required a minimum of 129 participants for conducting a multiple regression test to ensure a medium effect size ($\rho = .30, f^2 = .15$).

3.3.2 Measures

In addition to demographic measures and descriptive questions about current houseplants care behaviour (which has been reported in 2.3.4), the online survey also

consisted of questions about (1) attitudes, intentions, and perceived behavioural control variables regarding houseplants care behaviour, and (2) reasons for keeping houseplants.

Behavioural intention to keep houseplants was measured using a single question on a 7-point scale “how likely is it that you would raise some plants at home?” (1 = *very unlikely* to 7 = *very likely*) (Ajzen, 1991). This section also sought to obtain attitudinal and intentional data and was constructed based on the TPB. Questions were divided into three parts: personal attitude, subjective norms, and PBC.

Based on a previous study conducted in China (D. Zhang et al., 2015), personal beliefs were measured using two belief-based statements, with each belief scored on a 7-point unipolar scale ranging from 1 (*very unlikely*) to 7 (*very likely*). The two belief statements in this study were adapted as follows: “I believe houseplants care is a beneficial behaviour” and “I believe I will be happy raising some plants at home”.

Subjective norms were measured using a single belief-based statement, which was adapted according to one previous research (D. Zhang et al., 2015): “People who are important to me (e.g. family, friends, classmates, colleagues) would support my home-planting behaviour” (scored 1 ‘*strongly disagree*’ to 7 ‘*strongly agree*’).

To measure PBC, which is comprised of perceived self-efficacy (internal control) and perceived controllability (external control), participants were asked four questions about how easy or difficult they consider it to be to perform given

behaviours. The first two items are adapted from a previous research in China (Zhou et al., 2013), and focus on internal control: “If I want, I’m capable of growing some plants at home and taking care of them well” (*1 = strongly disagree, 7 = strongly agree*). “In general, to grow plants at home for me would be ...” (*1 = very difficult, 7 = very easy*). The final two items focused on self-controllability (external control) and were modified from a study that used PBC to understand gambling behaviour within the Chinese population (Wu & Tang, 2012). These two items were: “Even if someone opposes me, I can find ways to engage in home-planting”; “When I face a problem related to raising my plants, I can usually think of several alternatives”. A 7-point scale was again used for participant responses with *1 = extremely disagree* to *7 = extremely agree*. Participants with higher average scores were considered to demonstrate greater self-control over raising plants at home. The total overall PBC was calculated as the mean of self-efficacy and self-controllability scores.

To obtain insight into the reasons why participants became interested in houseplants care behaviour, a scale to measure reasons for keeping houseplants was created based on previous research (see Appendix A). Six questions were presented on a five-point scale (*1 = “strongly disagree”, 5 = “strongly agree”*). An additional open-ended question was included to identify any further factors that contribute to interest in home-planting that had not been offered in the questionnaire. The items “*to improve human living comfort*” and “*to view them for relaxing*” were derived from literature specifically pertaining to Chinese participants, which recognised their value in terms of comfort, and Taiwanese participants, which focused on the benefits of plants in window displays (Chang & Chen, 2005; Qin et al., 2014). Given that the focus of the

present research is the Chinese population, the cultural factor of *Fengshui* was considered when creating this section, as it is used in landscape, building, and room design (Hong et al., 2007). Therefore, one item asked about *Fengshui*. Items were scored on a five-point Likert scale (from strongly disagree to strongly agree). Open-ended questions were utilized to enable participants to list any other reasons for engaging in the cultivation of plants.

3.3.3 Ethics

The present study was granted ethical approval from the Clinical and Health Psychology Ethics Committee, the University of Edinburgh, prior to commencement (Reference number: CLIN776).

3.3.4 Data analysis

The analyses presented in this chapter focus on the TPB measures. Statistical analyses were carried out using SPSS Version 24 and AMOS. To test the research hypothesis, we used a hypothetical model that was empirically applied to questionnaire data through structural equation modelling (SEM).

3.4 Results

3.4.1 Demographics

Figure 3.1 below depicts the cities in mainland China that the participants came from, and Table 3.1 shows the means, standard deviations, and intercorrelations between the variables explored in the questionnaire.

Figure 3.1 The distribution of participants in China

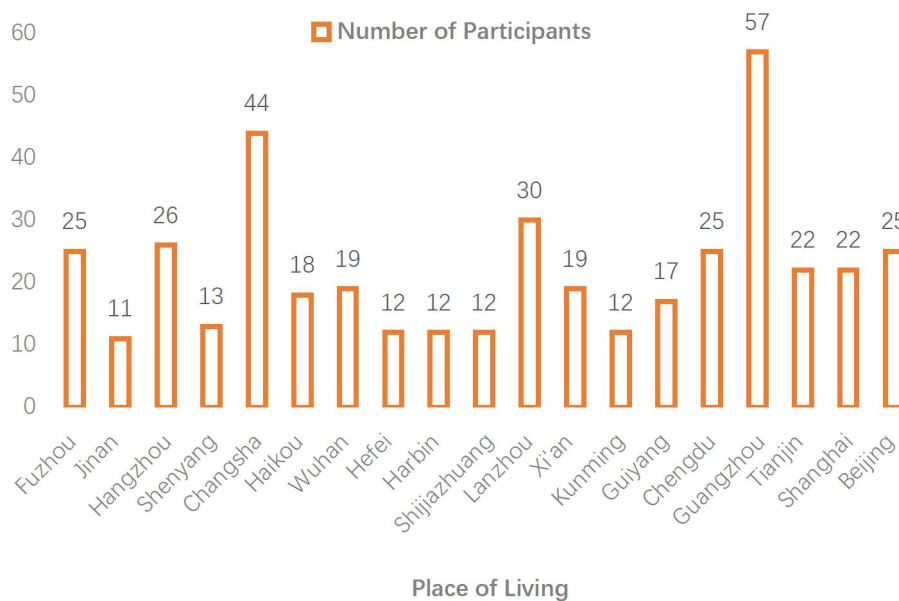


Table 3.1 Demographic variables

Variables Classification	Incidence (N=421)	
	n	%
Gender		
Male	133	31.6
Female	279	66.3
Prefer not to say	9	2.1
Age		
18 -25	144	
26 -34	181	
35 -44	34	
45 -60	51	
>60	11	
Education		
Primary School	1	.2
Middle School and below	10	2.4
High School and below	21	5.0
College & Bachelor's degree	198	47.0
Postgraduate and above	191	45.4
Employment Status		

Student	115	27.3
Full-time job	247	58.3
Part-time job	6	1.4
Unemployed	21	5.0
Retired	32	7.6
Marital Status		
Single	198	47
Dating	66	15.7
Married	147	34.9
Separated	2	.5
Divorced or widowed	8	1.9

3.4.2 Houseplants Care Behaviour and the Theory of Planned Behaviour Model

SPSS and AMOS statistical analysis packages were used to analyse the data. Firstly, a Pearson's correlation was conducted for personal belief ($r = .72, p < .01$), subjective norm ($r = .60, p < .01$), and PBC ($r = .70, p < .01$). All three were significantly correlated with behavioural intention (see Table 3.2).

Table 3.2 Descriptive statistics and intercorrelations between measures

	Belief	SN	INT	PBC	Behaviour ₁	Behaviour ₂	Behaviour ₃	Mean	SD
Belief		.71**	.72**	.69**	.08	.23**	.29**	9.97	3.39
SN			.60**	.63**	-.02	.12*	.11*	5.55	1.67
INT				.70**	.11*	.26**	.27**	5.30	1.83
PBC					.12*	.26**	.35**	9.80	1.83
Behaviour ₁						.29**	.28**	1.28	2.90
Behaviour ₂							.29**	5.12	8.62
Behaviour ₃								4.17	6.31

Note. *p<.05, **p<.01 N = 240

Abbreviations: Subjective norm (SN), Behavioural intention (INT), Perceived behavioural control (PBC), The time spent taking care of plants last week (behaviour₁), the total numbers of houseplants (behaviour₂) and the years of taking care of houseplants (behaviour₃).

A significant positive correlation was identified between intention and houseplants care behaviour. Specifically, planting intention was significantly correlated with behaviour₁ ($r = .11, p = .03$), behaviour₂ ($r = .026, p < .01$), and behaviour₃ ($r = .27, p < .01$). PBC exhibited a strong positive correlation with three aspects of houseplants care behaviour (Behaviour₁, $r = .12, p = .01$; Behaviour₂, $r = .26, p < .01$; Behaviour₃, $r = .34, p < .01$). However, there was no significant correlation between personal beliefs and subjective norms in relation to behaviour₁.

A Structural Equation Model (SEM) was employed using AMOS to assess Hypotheses 1, 2, and 3. Chi-square analysis indicated that the current model is significantly different from the default model ($p < .01$).

Model 1 (see Figure 3.2) illustrates the model path of how personal belief, subjective norms, and PBC predict intention and behaviour₁. It suggests that only belief and PBC can predict behavioural intention, but neither behavioural intention nor PBC was predictive of behaviour₁. Overall, the Chi-square indicated that the model is significant: $X^2 = 9.1 (2), p = .01$. The model was evaluated for goodness-of-fit using the CFI (comparative fit index). A value greater than .95 indicates a very good fit for a model. The CFI was .99, suggesting the present model is a good fit. In addition, the NFI = .99 and RFI = .93, which exceed the cut off value of .90, further indicating that this model is a good fit. The path model was an acceptable fit (RMSEA = .09).

Figure 3.2 SEM model of the relationship between belief, subjective norm, perceived behavioural control, intention and behaviour₁

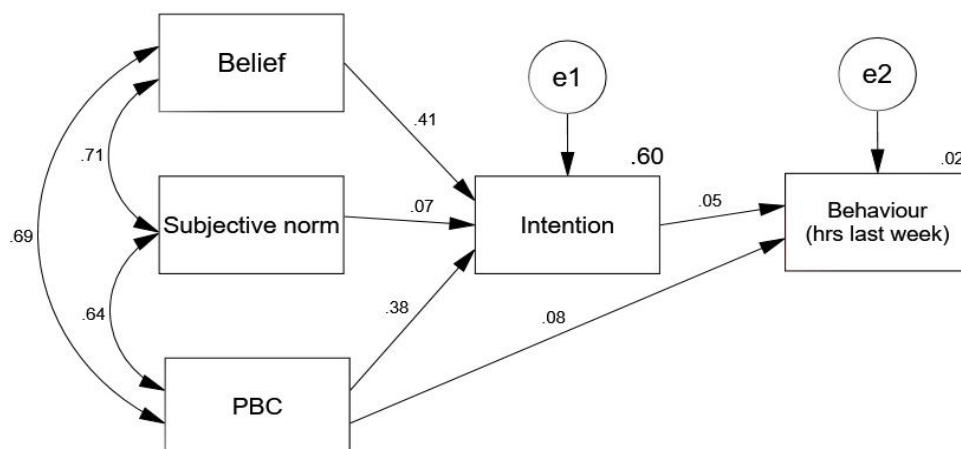


Table 3.3.1 Regression weights in SEM predicting intention and total planting hours in the last week (Behaviour₁)

Outcome variable	Predictor variable	Estimate of regression weight	Standard Error	P value
Intention	Belief	.22	.03	<.001**
	Subjective Norm	.08	.05	.11
	PBC	.23	.03	<.001**
Behaviour ₁	Intention	.08	.11	.45
	PBC	.08	.07	.23

Note. *p<.05, **p<.01

Table 3.3.2 Standardised direct and indirect effects of TPB variables on intention and total planting hours in the last week (Behaviour₁)

		Belief	Subjective norm	PBC	Intention
Standardised direct effect coefficients	Intention	.41	.07	.38	0
	Behaviour ₁	0	0	.08	.05
Standardised indirect effect coefficients	Intention	0	0	0	0
	Behaviour ₁	.02	.004	.02	0

Figure 3.3 shows Model 2, which indicates the relationship between belief, subjective norm, PBC, intention, and behaviour₂. Chi-square analysis indicated the model is significant: $X^2 = 6.13$, $p = .047$. Based on this model, only belief and PBC are predictive of behavioural intention, whilst PBC was the only variable predictive of behaviour₂. The path model was evaluated for goodness-of-fit using CFI. The CFI was .996, indicating that the model is a good fit. This is supported by the NFI = .99 and RFI = .95. The model was an acceptable fit according to the criteria employed ($X^2 = 6.13$ (2), $p = .047$, CFI = .99, NFI = .99, RFI = .95, RMSEA = .07).

Figure 3.3 SEM model of the relationship between belief, subjective norm, perceived behavioural control, intention and home-planting behaviour₂

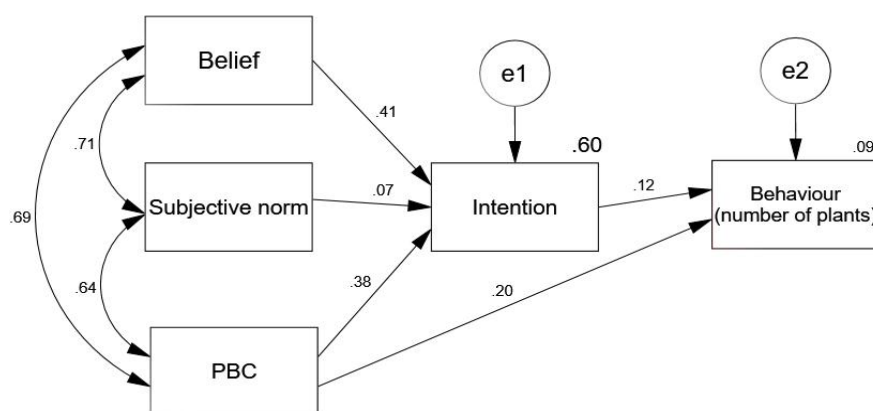


Table 3.4.1 Regression weights in SEM predicting intention and total numbers of plants at home (Behaviour₂)

Outcome variable	Predictor variable	Estimate of regression weight	Standard Error	P value
Intention	Belief	.22	.03	<.001**
	Subjective Norm	.08	.05	.11
	PBC	.23	.03	<.001**
Behaviour ₂	Intention	.57	.31	.07
	PBC	.57	.19	.003*

Note. *p<.05, **p<.01

Table 3.4.2 Standardised direct and indirect effects of TPB variables on intention and total number of plants at home (Behaviour₂)

		Belief	Subjective norm	PBC	Intention
Standardised direct effect coefficients	Intention	.41	.07	.38	0
	Behaviour ₂	0	0	.20	.12
Standardised indirect effect coefficients	Intention	0	0	0	0
	Behaviour ₂	.05	.01	.05	0

Figure 3.4 illustrates the Chi-square analysis, which indicated that the model is significant: $X^2 = 13.53$ (2), $p = .001$. Model 3 indicates that behavioural intention is predicted by belief and PBC, whilst PBC was able to predict behaviour₃. The path model was evaluated for goodness-of-fit using CFI, which was .99, indicating that this model fits well. In addition, the NFI = .99 and the RFI = .90, further meaning that this model is a good fit. The SEM was an acceptable fit according to the criteria that were employed (RMSEA = .12).

Figure 3.4 SEM model of the relationship between belief, subjective norm, perceived behavioural control, intention and behaviour₃

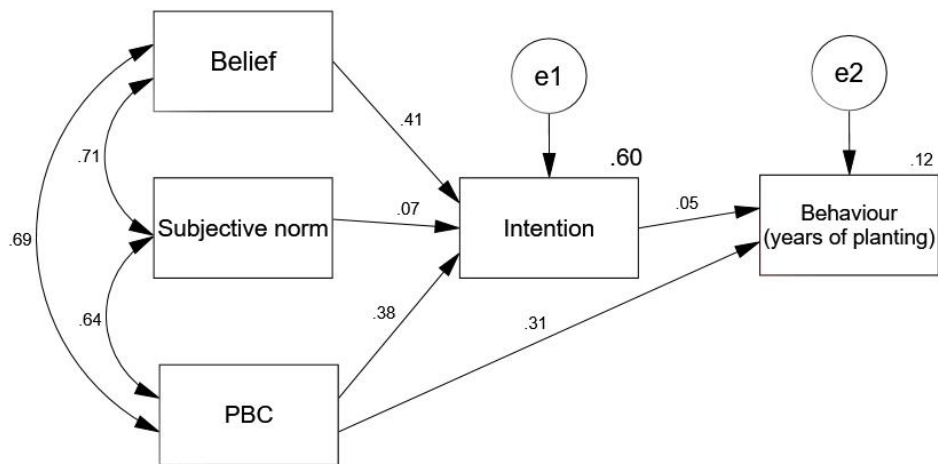


Table 3.5.1 Regression weights in SEM predicting intention and total years of planting (Behaviour₃)

Outcome variable	Predictor variable	Estimate of regression weight	Standard Error	P value
Intention	Belief	.22	.03	<.001**
	Subjective Norm	.08	.05	.11
	PBC	.23	.03	<.001**
Behaviour ₃	Intention	.17	.22	.44
	PBC	.66	.14	<.001**

Note. *p<.05, **p<.01

Table 3.5.2 *Standardised direct and indirect effects of TPB variables on intention and years of planting (Behaviour₃)*

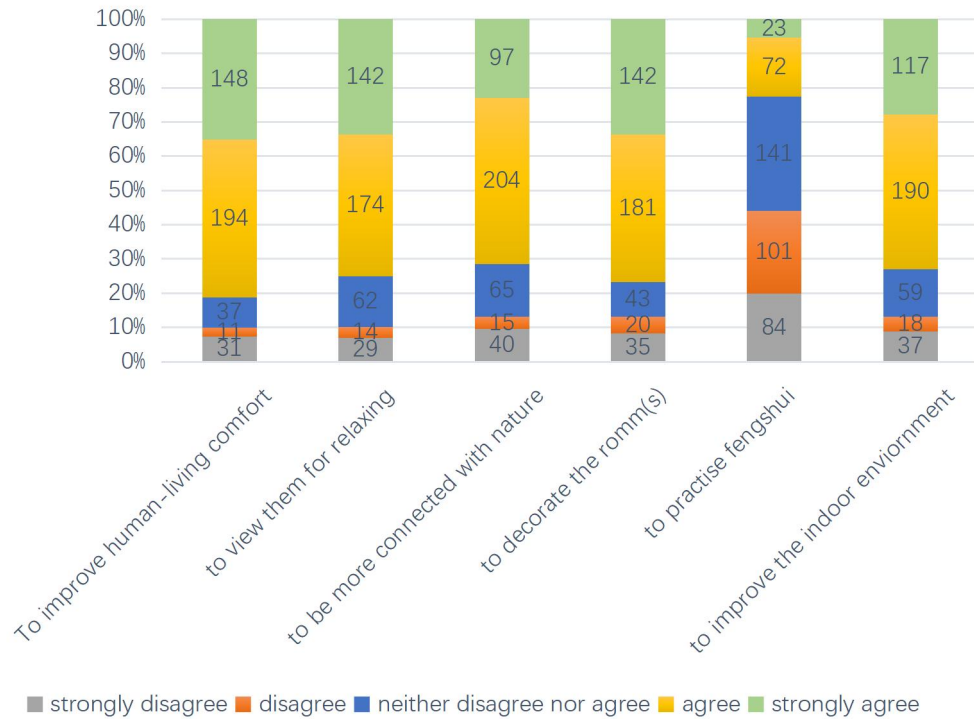
		Belief	Subjective norm	PBC	Intention
Standardised direct effect coefficients	Intention	.41	.07	.38	0
	Behaviour ₃	0	0	.31	.05
Standardised indirect effect coefficients	Intention	0	0	0	0
	Behaviour ₃	.02	.004	.02	0

To summarise, the SEM results show that behavioural intention is solely predicted by personal belief and PBC, whilst subjective norm was unable to predict intention. Furthermore, the results indicate that intention failed to predict behaviours₁₋₃. In contrast, PBC was able to directly predict behaviour₂ and behaviour₃. Neither intention nor PBC were significant in behaviour₁. Nevertheless, the integrated models built by the SEM were all significant, indicating that houseplants care behaviour can be predicted by the TPB model.

3.4.3 Reasons for keeping houseplants

Figure 3.5 shows the proportion of participant responses to each reason. 81.2% of participants indicated that they either agree or strongly agree that they raise plants at home to improve human-living comfort. 75.1% of participants indicated that they either agree or strongly agree that a reason they are involved in home-planting is that they find it relaxing to view their plants. Only 10.2% of participants indicated that they either disagreed or strongly disagreed with this reason. The highest proportion of participants agreed that they own plants for a sense of being more connected with nature, and the lowest proportion of them disagreed with this view.

Figure 3.5 Responses to different reasons for taking care of houseplants



Moreover, 76.7% of participants expressed positive views towards room decoration as a reason for their choosing to raise plants. Interestingly, 33.5% of participants held neutral attitudes towards the practice of *Fengshui* being a valid reason to conduct indoor planting, and nearly half (i.e. 43.9%) of participants disagreed with this point. Furthermore, most participants (i.e. 72.9%) either agreed or strongly agreed with the idea that they had started indoor planting because they felt it would improve the indoor environment. In summary, participants indicated that they became indoor planters because the plants benefit their living comfort, indoor environment, the degree of nature connection, are aesthetically pleasing, and are a form of room decoration.

Furthermore, an additional 66 responses were received for the open-ended question regarding reasons for getting involved in houseplants care (see Appendix A). These

responses were collated into six key themes: *improving mood and reducing stress*; *good looking and pleasing to look at*; *positive feelings of having plants*; *personal hobbies*; *cooking purposes*; and *improvement in quality of life*. Whilst some of these themes are consistent with those explored in the six questions previously indicated, four new themes emerged. These were mood improvement, cooking, positive feelings around having houseplants, and personal hobbies.

In summary, reasons that contribute to people keeping houseplants in China include that they are aesthetically pleasing, support a more positive indoor environment, and strengthen the nature-human relationship. In addition, they reported that raising plants improves their quality of life, mood, wellbeing and can be used to support their cooking.

3.4 Discussion

The present study applied the TPB model to explore relationships between personal beliefs, subjective norms, PBC, behavioural intentions, and houseplants care behaviour among Chinese adults who are living in urban areas. Overall, the correlations between most of the variables under investigation were significant, and three TPB models significantly fit the perfect model, indicating that the three study hypotheses may be confirmed.

However, the correlation between intention and houseplants care behaviour needs further consideration. The SEM analysis results showed that intention failed to independently predict all aspects of the behaviour of interest (behaviours₁₋₃).

Nevertheless, it is noteworthy that PBC had a significant relationship with intention and independently predicted behaviour₂ and behaviour₃ (with 57% and 66% variances, respectively), meaning that the self-controllability and self-efficacy of the participants can determine the number of houseplants and total years of houseplants care behaviour. This indicates that the intention-behaviour correlation is mediated by PBC, suggesting that PBC might be the key determinant of houseplants care behaviour.

Regarding behaviour₁ (time spent taking care of houseplants last week), it cannot be predicted by intention and PBC, though there is a correlation between the three. Also, it was not correlated with personal beliefs or subjective norms. These together suggest that behaviour₁ is not an important aspect of houseplants care behaviour. The probable interpretation of this is that the participants might feel difficult to recall the exact time they spent last week in taking care of houseplants. Further study may consider measuring the *frequency* of houseplants care behaviour last week.

Subjective norm was found to be a non-significant predictor of behavioural intention, which is consistent with a previous meta-analysis that found a normative variable could be a weak predictor of intention probably due to poor measurement (Armitage & Conner, 2001). The normative measurement of this study was designed based on previous published work. The participants were asked to rate how important people such as family members and friends would support their houseplants care behaviour. One possible reason for the low rating is that houseplants care behaviour is viewed as healthy behaviour which is rarely negatively judged and influenced by others.

Additionally, the behaviour of interest is relatively personal, taking place in one's residential areas. Therefore, subjective norm is a poor predictor of intention of houseplants care behaviour. This may also explain the inconsistency with some previous TPB-based studies on gardening and tree-planting. For example, subjective norm was found to be the main predictor of tree planting behaviour (Yazdanpanah et al., 2014; Zubair & Garforth, 2006). Relatedly, although personal belief was a strong predictor of houseplants care behaviour, which is in line with one previous study on gardening behaviour (Lautenschlager & Smith, 2007), personal belief is not the sole behavioural predictor. Such inconsistency between the present study and the previous ones is reasonable because different types of nature connection (farming, tree planting, gardening, and houseplants care behaviour) are inherently different in form and purpose.

This study also reports several potential reasons for houseplants care behaviour among Chinese adults. It is noteworthy that most participants strongly disagreed that *Fengshui* motivates them to engage in houseplants care behaviour. Since *Fengshui* is understood as a kind of philosophy of environment and thus fundamentally related to Chinese culture and history (Hong et al., 2007), it indicates that houseplants care behaviour is less likely to be influenced by cultural factors. For other potential reasons for houseplants care behaviour, the participants exhibited agreement that they engaged with the behaviour for visual relaxation, nature connectedness, room decoration, living comfort, and indoor environment improvement. The findings suggest that personal beliefs may directly determine houseplants care behaviour. Nevertheless, the causal relationships between the perceived benefits and

motivations of houseplants care behaviour remain unclear.

Implications

The findings of this study provide complementary insight into the behavioural mechanisms of houseplants care behaviour. Since personal belief was the strongest predictor of behavioural intention, and PBC was the most predictive of houseplants care behaviour, it indicates that people may maintain this behaviour for a longer time and increase their engagement if they find actively taking care of houseplants more beneficial, available, and accessible. For the promotion of houseplants care behaviour in China, stakeholders and policymakers may consider extolling its benefits, which may strengthen people's positive beliefs and thereby increase their intention of engagement and behaviour maintenance. For the development of houseplants-based interventions, researchers and practitioners may consider improving people's self-controllability and self-efficacy in raising plants at home.

Limitations

Although we used a proper sampling method and the sample size from different Chinese cities was sufficient, the participants of this study were generally young and well-educated, which may reduce the representativeness. Further work is required to recruit participants with more diverse demographic characteristics in China. Nevertheless, because the TPB model, according to a meta-analysis, appears to be most effective among healthy, youthful samples of relatively high socio-economic status people (McEachan et al., 2011), the sample may not influence the results of this study.

Another limitation relates to the TPB. Because of the mixed findings of the TPB-based research (including those on planting and cultivation), the validity of the TBP model has been challenged in recent years (Sniehotta et al., 2014). The critics have argued that the TPB model is too limited and simple to take unconscious factors, habits, and motivational variables into account in explaining behaviour (Gardner et al., 2011; Sheeran et al., 2013). Also, beliefs and PBC can sometimes override intention and directly predict behaviours (Ajzen, 2011). Therefore, the TPB model can only partly explain the houseplants care behaviour among the Chinese urban adults. Further studies need to apply this theory along with other health-related models to explain the behaviour of interest (Sniehotta et al., 2014). For example, in a meta-analysis of 36 studies which integrated TPB and self-determination theory (SDT) to predict health-related behaviours, it was found that the motivation variable of SDT can predict behaviour and this effect was still mediated by TPB variables (Hagger & Chatzisarantis, 2009).

In addition, some previous studies suggested that past behaviour may weaken the prediction of TPB model and the belief-intention, intention-behaviour relationships (Hagger et al., 2001; McEachan et al., 2011; Norman & Smith, 1995). Nevertheless, the aim of this study was to measure the utility and predictive ability of TPB on houseplants care behaviour in the past rather than predict prospective houseplants care behaviour. Therefore, it will be less likely to lead to the study findings being biased.

Furthermore, the measures of personal beliefs, subjective norms, and PBC were adapted from two relevant studies (D. Zhang et al., 2015; Zhou et al., 2013), which were not standardised for houseplants care behaviour. This may weaken the validity of the outcomes. Relatedly, the self-reported measurements of the variables of houseplants care behaviour may enlarge the estimation effect of the TPB model. It has been indicated that self-reported measurements on the TPB model increase 11% of the variance in behaviour compared to objective measurements (Armitage & Conner, 2001). It is possible that an overprediction of variances in houseplants care behaviour occurred in this study. Further studies may seek to conduct experimental based research to compare the differences in prediction on houseplants care behaviours in China using both objective and subjective measurements.

3.5 Conclusions

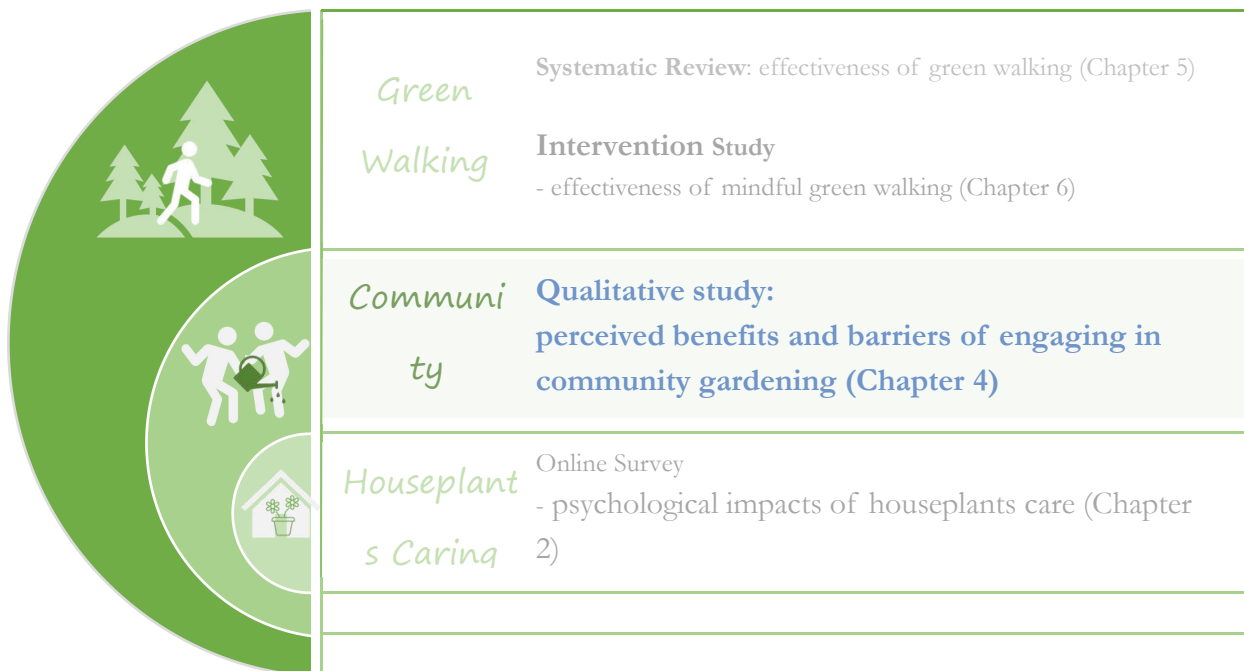
The present study suggests that personal belief and perceived behaviour control (PBC) were predictive of intention to houseplants care behaviour, and in turn, PBC was the strongest predictor of houseplants care behaviours in urban China. In brief, this behaviour can fit the TPB model, but further studies may seek to incorporate other theoretical models into the TPB to reveal how personal belief, motivations, intentions, subjective norms, and PBC predict further houseplants care behaviours. Further studies or planting related interventions are also able to draw on the findings regarding the reasons for planting.

Chapter 4

Gardening for Health: A Qualitative Investigation of the Perception and Experience of Community Gardening in Urban China

4.1 Chapter Overview

From the home setting to community gardening, some Chinese urban residents regularly engage in community gardening activities, which have been found to be highly beneficial to people's overall health. This chapter aims to explore the perceived benefits of, and barriers to, engagement in community gardening amongst Chinese adults. Constructive grounded theory (CGT) was employed to guide the data collection and analysis.



Abstract: Community gardening has been found to be highly beneficial to people's overall health. The studies that have generated these conclusions were largely conducted in the West; there is a marked lack of corresponding research in China. Currently, China is facing increasing urbanisation and environmental problems, which negatively impact its citizens' mental wellbeing. This study aims to explore the perceived benefits of, and barriers to, engagement in community gardening amongst Chinese adults. Constructive grounded theory (CGT) was employed to guide the data collection and analysis. Twenty-one individuals participated in the in-person open-ended interviews, which each lasted about 25–40 minutes. Seven principal themes regarding the benefits of community gardening are generated - 'Mental-Health Improvement', 'Physical Health-Care Benefits', 'Co-operation', 'Nature Connectedness', 'Valuing the Community Garden', 'Parenting', and 'Personal Growth'. A conceptual model was framed, describing the perceived health benefits of community-gardening engagement in China. One theme, with three subthemes pertaining to the barriers of engaging with community gardening, was identified: 'Further Support Needed'. The study confirmed that community gardeners in China perceived benefits from the activity in relation to their health in many respects. In particular, the study adds a Chinese voice to the evidential base, with novel findings around *visual comfort*, *medical herbs*, *collective work*, and *parenting*. Limitations and implications are also discussed.

Key words: Community gardening, grounded theory study, health, nature connection, mental wellbeing

4.2 Introduction

‘Community gardens’ are public areas where people can congregate and cultivate plants, while sharing the benefits of mental health, social coherence, and food nutrition (Glover, 2004). Community gardens have also been recognised as a type of urban green space managed by residents, and have been argued to have a positive therapeutic impact on public health and neighbourhood cohesion (Wolch et al., 2014). Community gardens help people benefit from dynamic interactions with the natural environment, physical activity, and social support, through planting-related activities (Liamputtong & Sanchez, 2018).

Community gardens are common in countries such as the USA, UK, and Australia, but are seldom found in developing nations (Y. Black, 2020; Kingsley et al., 2019). The main purpose of utilising community gardens in developing countries has been to generate improved food-security rather than promote other health-related objectives (Al-Delaimy & Webb, 2017). For example, community gardens in China are limited and the main goal of local gardeners is to ensure food security and maintain the garden itself, rather than achieving positive mental-health outcomes (He & Zhu, 2018).

Recently, community gardening has been viewed as a nature-based intervention or green exercise aimed at improving mental wellbeing (Barton et al., 2016a; Spano et al., 2020), which has been shown to foster a healthier lifestyle for gardeners and alleviate gardeners’ overall anxiety, in turn strengthening physical health, mental health, and familial relationships (P. A. Carney et al., 2012). Community gardening

has been shown to enhance gardeners' mindfulness, mental wellbeing, optimism, resilience, perceived self-worth, spirituality and stress reduction (Y. Black, 2020; Kingsley et al., 2009, 2019; Koay & Dillon, 2020; Michaels, 2013; Okvat & Zautra, 2011; Pitt, 2014), and also to enhance social support, neighbour relationships, conscientiousness, and community connectedness (P. A. Carney et al., 2012; Kingsley et al., 2019; Sanchez & Liamputtong, 2017). In terms of physical health, the prevalence of chronic disease was reduced, and physical exercise increased, through community gardening (Al-Delaimy & Webb, 2017; Sanchez & Liamputtong, 2017; T. L. Scott et al., 2020). Furthermore, during gardening activities, acquisition of skills for growing plants can be cultivated (Armstrong, 2000; Hale et al., 2011; Mehta et al., 2019).

Most studies on community gardens have been conducted in developed, Western countries, possibly because there are fewer community-garden schemes in *developing* countries. Differences in the findings may also reflect differences in approach and methodological quality between research designs (Poulsen et al., 2014; T. L. Scott et al., 2020; Spano et al., 2020). The questions of whether and how mental wellbeing may be enhanced by community gardening, remain unresolved. It is also relevant to examine whether the *types* of plants in the garden are significant (Heilmayr & Friedman, 2020). For studies in developing countries, it is essential to gather participants' expectations, reflections, emotions, and attitudes around the activity.

4.2.1 The present study

As much of the research to date have been conducted in Western countries, it is possible that community gardens provide greater health advantages for gardeners in individualistic societies than in collectivist ones (Spano et al., 2020). Furthermore, previous studies highlight the diverse health benefits of community gardening, but they rarely address the *barriers* to engaging in community gardening. The present study is the first to address the distinct experiences of Chinese urban residents regarding community gardening.

China, the largest developing country evincing a collectivist culture, has so far had few studies investigating the potential benefits of community gardening. In recent years, small numbers of community gardens have gradually been promoted in China (Kou et al., 2019), and it seems an opportune time to explore the experience of community gardening with aspects of health.

Research has been conducted in China using semi-structured interviews and surveys to investigate the impact of the participatory experience of seeding plants, focusing on a community garden in Shanghai during the pandemic (Kou et al., 2019). The results indicated that residents' mental health was indeed positively influenced by gardening activities. However, limited qualitative results were reported and the study exclusively addressed a particular district of Shanghai, so it may not be generalisable to other parts of China.

The present study employs one-to-one in-person qualitative interviews and grounded theory to explore the different perceptions of community gardening in four cities in

China. The research question of this study is thus: what are the perceived benefits and perceived barriers *to*, engaging in community gardening amongst Chinese community gardeners?

4.3 Materials and Methods

4.3.1 Design

The research design, data collection, data analysis and interpretation were guided by Charmaz's handbook of constructivist grounded theory (Charmaz, 2014). As discussed in 1.3.5, CGT was chosen for several reasons. Since community gardening is a new social practice in China, Chinese community gardeners' perceptions of gardening have not been properly explored. CGT may provide a theoretical framework to understand these uncharted experiences. In addition, the perceptions of the Chinese community gardens have been (and continue to be) fundamentally influenced by socio-political and cultural factors in diverse local contexts (in different cities). We assumed that any research on the Chinese community garden may, in one way or another, engage with (and have certain impacts on) its current formation and development. Therefore, as CGT maintained, the data and analysis in this study will be created from shared experiences and relationships with participants and contextually situated in time, space, culture, and situation (Charmaz, 2014).

Relatedly, the previous relevant literature (e.g., the studies on community gardening in Western contexts) is linked to support the findings in this research. However, the design and procedure of this research were not guided by previous readings of literature. We did not disregard the existing knowledge about community gardens but

engaged with it critically. In a CGT study, reflexivity does not mean to eliminate the researcher's viewpoints from the findings and theory, but 'to allow the data to be prioritised over the researcher's assumptions and previously acquired knowledge, including any reviewed literature' (Charmaz, 1990; Ramalho et al., 2015). With a CGT approach, the conceptual framework derived from the analysis will be an interpretation (Charmaz, 2014). Nevertheless, this may provide valuable data and theoretical insights for further research on community gardening both in China and other countries.

4.3.2 Sample, Sampling, and Recruitment

Participants were recruited through all the extant Chinese community gardens with information available online in 2019 in four Chinese cities (Beijing, Shanghai, Guangzhou, and Foshan). These gardens were contacted via email or their official social media accounts. The administrators of those community gardens approved this research to be conducted in their gardens and assisted with recruitment for this project. The researcher visited these community gardens, engaged in the activities in each garden for a few days, and obtained permissions to recruit participants for the interview.

The community gardens in these four cities were: Keyu community garden (in Beijing), Garden of Talent Gathering (in Guangzhou, or Canton), Cure with Flower community gardens (in Foshan), and community gardens established by the Clover Nature School in Shanghai. Only one community garden was found in each of the following cities: Beijing, Foshan, and Guangzhou. However, Shanghai has over 30

community gardens run by Clover Nature School, and the researcher arranged to collaborate with three of these gardens for interviews. All these targeted community gardens are non-profit-making organisations. The details of the gardening activities of each garden involved in this study are listed below in Table 4.1.

Table 4.1 *Descriptions of activities involved in each community garden.*

Location of Garden	Description of Gardening Activities
Beijing	<i>Handicrafts making (using tyres; wasted woods); seeding, watering plants; recycling waste; constructing gardens; picking vegetables.</i>
Guangzhou	<i>Therapeutic horticulture; seeding; constructing gardens; watering plants; picking plants; tasting the herbs for tea; recycling waste.</i>
Foshan	<i>Painting on recycled waste from the garden (glass bottle; leaves; wasted wood); watering plants; picking up vegetables and herbs; learning the use of herbs.</i>
Shanghai	Base 1 <i>Learning value of permaculture; handicrafts making; watching fireflies at night; nature education for children and their parents; picking-up vegetables.</i>
	Base 2 <i>Seeding; watering; learning horticulture knowledge; handicrafts making; picking up vegetables.</i>
	Base 3 <i>Constructing gardens; seeding; chatting activity in garden; tasting herbs and fruits; planting skills competition</i>

The selected photos of the researched community gardens in Beijing, Shanghai, and Guangzhou are shown in Figure 4.1.

The study only included participants who: 1) were adults (over 18 years old); 2) were Chinese citizens; 3) could communicate in Mandarin; 4) had engaged in community gardening regularly (at least once per month). Potential participants registered for the interview through the managers of the community gardens, and the managers

arranged meetings for them with the researcher.

Figure 4.1 *Community gardens that took part in this field work*



Note. 1) Keyu community garden in Beijing; 2) Garden of Talent Gathering in Guangzhou; 3) Clover Nature School in Shanghai, base 1; 4) Clover Nature School in Shanghai, base 2. These photos have been taken by the researcher of the present study; the use of these photos was permitted, and all the copyright reserved. The photo of community garden in Foshan was not shown due to regulations of that garden.

4.3.3 Interview protocol

A degree of researcher-participant interactivity was facilitated by the open-ended interview schedule. The researcher did not encourage participants to give ‘right’ or ‘expected’ answers during the interview; participants had the freedom to use their own voices, in every sense. The design of the questions and interview procedure was based on Charmaz (2014). The researcher had no previous experiences with community gardens in China and, based on Charmaz’ guidance, did not hold any

specific assumptions during the interviews. The questions and sequence of interviews designed and practiced are shown in Table 4.2.

Table 4.2 *Questions and Sequence of Interview*

Sequence	Questions
Initial (General perceptions) (Greater details)	<i>'How long have you been engaging in community gardening?'</i> <i>'What gardening activities do you usually do?'</i> <i>'Tell me your overall experience of engaging in community gardening.'</i> <i>[based on the answers]</i>
Intermediate (Greater details)	<i>Why do you think xxx (something mentioned by participants) is important for you?,' 'Can you describe xxx more specifically?,' 'What are the benefits or barriers you have perceived since you started to be a community gardener?,' 'As you mentioned that you found that xxx had improved since you became a community gardener, can you give more details about xxx?'</i> <i>[based on the answers provided]</i>
Concluding	<i>'Is there anything else that you would like to share?','Do you want to add anything that you have not been asked about?'</i>

4.3.4 Procedure

The researcher, who is a native Mandarin speaker, conducted all the interviews. The hardcopy Participant Information Sheet, and Consent Form, which cover a summary of the study and the participant's rights, were distributed to the participants. The consent forms were understood and signed by all participants. The mean duration of the interviews was 30 minutes (ranging from 25–40 minutes), and they were done in the summer of 2019 over the course of 40 days. All the interviews were recorded on

a Dictaphone and then anonymously transcribed into texts.

In Beijing, the setting for the interviews was a pleasant, quiet office near a community garden. The manager made appointments with potential participants in different time slots. The researcher then travelled to Guangzhou and Foshan. The interviews there took place in the tearoom of the community gardens. Sequentially, the researcher also visited three community gardens in Shanghai, where interviews took place in (a) the garden offices, (b) the counselling room of the senior citizens' activity hub, and (c) the office of the 'community residence'.

4.3.5 Data analysis

Transcription

All audio recordings were deleted once the researcher had finished transcribing the interviews. The transcriptions were written in Chinese, but the researcher translated the final theoretical categories and memos from Chinese to English. To ensure linguistic consistency, an additional native speaker of Mandarin read through the thematic translations.

Memo writing

Memos are crucial, being described as the 'cornerstone of quality' in GT studies (Briks & Mills, 2015). According to Charmaz's memo-writing guidelines, both clustering and freewriting methods can be deployed (Charmaz, 2014) and were used in this study. Appendix B provides an example of the 'clustering memos' employed by the researcher. Appendix B also provides examples of free writing memos.

Coding and Analysis

Nvivo 12 was employed to manage, code, and analyse the data (Robins & Eisen, 2017). Word-by-word and line-by-line coding were deployed for the initial analysis of the transcripts. Initial coding and memo-writing commenced after the first interview. Data collection and analyses were carried out simultaneously. Later, as more interviews were conducted, the researcher began initial open coding and categorising, alongside memo-writing and the development of theoretical ideas. In this early, tentative stage of coding, certain preliminary codes and concepts were recorded for the subsequent stage.

When all the interviews had been completed, focused coding was applied. As coding progressed, the researcher read previous descriptive codes and grouped similar codes into meaningful units for further exploration. During this stage, the coding process itself prompted the researcher to find patterns and indicators through which to sort and define the phenomena, as evinced by the data; the researcher continually made comparisons between codes and themes (Charmaz, 2014). The lead researcher refined all the codes, assigned the prominent patterns to categories, and then compared these emergent categories. With the focused-coding process complete, certain main categories and subcategories were distinguished.

In the last stage, theoretical saturation was attained, and no new codes were generated. To develop relationships among the extant themes, theoretical coding was deployed. The researcher integrated the codes from the focused coding and utilised

abstract phrases, rather than descriptive words, to name the categories/themes for data theorisation (Charmaz, 2014). A few memos were recorded to reflect the following:

- a) the rationale for code refinement
- b) the rationale for final theme conceptualisation
- c) the rationale behind the researcher's creation of a model.

4.3.6 Ethical Considerations

The Clinical and Health Psychology Ethics Committee of the University gave ethical approval for this study (Reference number: CLIN639). To safeguard participants' privacy, the interviews sought to avoid information that would be identifiable. A broad age range was recorded for descriptive purposes. If participants accidentally disclosed any identifying information about themselves during the interviews, the researcher removed this information whilst transcribing the data.

4.4. Results

In total, 21 participants aged 20 to 70 years participated (see Table 4.3 for demographic information). Most participants were female ($n = 14$), and only seven male participants were interviewed. Amongst the four Chinese cities, eight participants were from Beijing (Keyu community garden), whereas only three participants participated in this study in Foshan.

Table 4.3 Demographic characteristics of participants

City	Participant numbers	Gender		Age range
		Female	Male	
Beijing	8	5	3	35 ~ 70
Shanghai	5	2	3	35 ~ 60
Foshan	3	2	1	20 ~ 35
Guangzhou	5	5	0	33 ~ 50
Total	21			

Seven overarching themes were revealed through data analysis regarding the benefits of community gardening engagement, consisting of the following: ‘Mental Health Improvement’, ‘Physical Health Care Benefits’, ‘Co-operation’, ‘Nature Connectedness’, ‘Valuing the Community Garden’, ‘Parenting’, and ‘Personal Growth’. Analysis also revealed one theme regarding the barriers to engaging in community gardening: “Lack of Support”. These categories and subcategories are presented as shown in Tables 4.4 and 4.5. Furthermore, a theoretical model regarding the benefits of community gardening was created (Figure 4.2).

Table 4.4 Themes and subthemes about perceived benefits of community gardening.

Themes	Subthemes	Description
Mental Health Improvement	Positive mental wellbeing	Community gardening improves gardeners’ wellbeing.
	Sense of accomplishment	Gardening activities foster gardener’s sense of accomplishment.
	Restoring attention	Regular gardening activities restore and relax gardeners’ attention.
Physical Health Care Benefits		
	Visual comfort	Staying in the garden and watching the plants help eye relaxation.

“Medical herbs”	The herbs in the garden have medical effects for gardeners’ health.
Physical activities	Gardeners’ physical activities increased when they engaged in various gardening activities.
Co-operation	
Interpersonal relationship	Community gardening enhances gardener’s interpersonal relationship.
Communication	Engaging in community gardening increases opportunity to communicate with others.
Nature connectedness	
Edible plants	Gardeners feel satisfied when they eat the plants that they grew.
Awareness of environmental protection	Connection with nature cultivates gardener’s value of environmental protection.
Spirituality	Nature-human connection inspires the gardeners’ needs of spirituality.
Valuing the community garden	
Collective work	Community gardens are built with gardeners’ collective work.
“No pain, no gain”	Gardeners paid labour and loved to take care of the plants and they got harvest paid back.
Meaningfulness	Gardening activities are believed meaningful by the gardeners.
Parenting	
Nature education	Children can gain knowledge about nature within community gardens.
Nature recreation	Community gardens are a safe and fun place for children to play.
Cultivate responsibility	Gardening activities increase kids’ sense of responsibility.
Personal growth	
Gaining knowledge	Gardeners gained planting knowledge from other experienced members.

Fostering a healthy lifestyleRegular gardening engagement forms healthy lifestyle for gardeners.

Table 4.5 *Categories and subcategories of perceived barriers to community gardening*

Category	Subcategories	Description
Lack of Support	Lack of management	Community gardens lack professional management team(s)
	Lack of professional guidance	Professional tutors are expected to offer relevant knowledge to the gardeners regularly.
	Lack of investment	More community gardens are needed for Chinese residents. Gardeners believed the government should invest more fundings to construct community gardens.

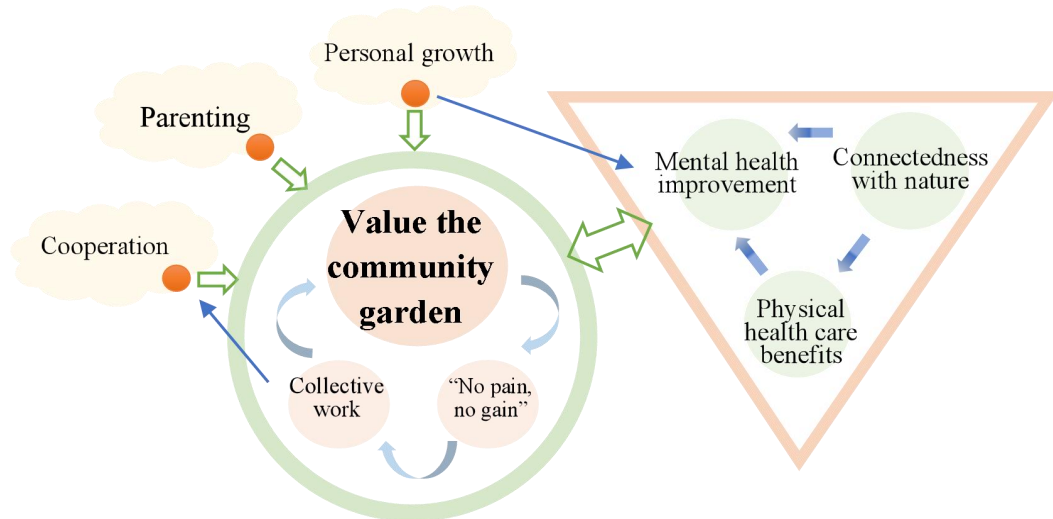
4.4.1 Conceptual model

The conceptual model (see Figure 4.2) reveals the benefits the gardeners perceived throughout community gardening in China and reflects the relationships between these themes. Community gardeners hold positive attitudes towards, and highly value, the community garden because of various perceived benefits derived from different activities therein.

Gardening activities like growing and harvesting foster a sense of accomplishment and meaningfulness (“no pain, no gain”). In relation to gardening, the collective work taking place in community gardens facilitates communication and improves interpersonal relationships among gardeners. Relatedly, community gardens

perceived as ideal places for family (especially parent-child) activities contribute to better parenting and family relationships. Also, the variety of activities encourages participants to learn new skills and thus contribute to their personal growth.

Figure 4.2 *Conceptual model of the benefits of community gardening in China*



Regular community gardening, as an active form of nature contact, leads to several mental health benefits. Relaxation, positive mood, attention restoration, stress reduction, and wellbeing improvement were perceived to be derived from or in relation to community gardening. In addition, the sense of nature connectedness is noticeably improved along with effective attachment with nature, pro-environmental awareness, and insightful reflections on the human-nature relationship. Furthermore, there are various physical health benefits including regular physical exercise and the use of medical herbs. All these contribute to a greater level of mental health and wellbeing.

The psychological, physical, and social benefits derived from regular and active engagement in community gardening lead to a positive evaluation of community

gardens in China. Moreover, the more highly the community gardeners valued community gardens, the more frequently they engaged themselves, and vice versa. More details on each of these themes in the model are reported below.

4.4.2 Benefits of engaging in community gardening

Theme 1: Mental health improvement

Mental health benefits were the main theme expressed by all interviewees, who perceived regular engagement in community gardens as improving their mental health. This theme refers to the positive outcome of the dynamic interaction between the natural environment, gardening activities, and communal work. Three sub-themes were generated: *wellbeing*, *sense of accomplishment* and *attention restoration*. The three sub-themes were interconnected, as beautiful natural environments helped restore the participants' attention, enabling them to feel refreshed, relaxed, and comfortable, which in turn enhanced wellbeing. The sense of accomplishment from being involved in gardening seemed to help enhance wellbeing. Correspondingly, some frequent *vivo* codes that participants reflected regarding this aspect were: "happy", "enjoyable", "stress reduction", "mindful", "relaxing", and "tranquillity".

When I stayed here, and I found myself not being disturbed by the crowdedness of people; I can gaze or look at the plants and pick up the branches myself, or just water them ... I can be very relaxed and calm during this time. I feel like I can let go of things that usually disturb me ..." (Jessica, Beijing)

The garden is perceived as a quiet place free from crowdedness, a typical feature of urbanisation. Jessica's comparison of the urbanised disturbance and the intra-garden relaxation and calmness indicates that gardening helps reduce mental fatigue and stress. Similarly, another participant reflected that "I keep coming here because I have been happy and relaxed here – here is a green oasis in the urban space, a place very different from public parks" (Thompson, Shanghai). Likewise, a female participant expressed the reduction of her anxiety and stress during her time in the garden:

There is only one goal in the garden – do whatever you want and finally you might put things down and take a breath. It makes me happy to stay here as I've been particularly concentrated on "one" point at a time. I won't think about those miscellaneous things that made me anxious". (Amanda, Guangzhou).

The community gardens not only provide a non-urban environment but also offer activities differing from daily work and business (e.g., handcrafts making, seeding, herb-cooking) perceived as causing stress. Amanda highlighted that she felt relaxed because she was not forced to do anything. As Jessica mentioned her 'gazing' at plants and 'relaxing' from urban disturbance, Amanda mentioned that her focus was shifted from the miscellaneous to *herself*—her breathing, mind, and free will. Some female participants felt stressful and disturbed not only because of urban living conditions but also due to their family and occupational responsibilities. The garden provides Amanda a sense of freedom and the opportunity to pursue her favoured activities. Unlike the miscellaneous things of daily work, which might be felt as a

lack of meaning or purpose and thus cause stress and depression, success in gardening allows participants to gain a sense of accomplishment:

When I observed the vegetables I grow, it's really like raising a child - they will gradually grow up and become strong. It brings me a certain sense of self-accomplishment and wellbeing. (Luna, Beijing)

The enjoyable experience derived from horticulture contributed to a sense of self-accomplishment and mental wellbeing. Like Jessica and Amanda, the enhancement of Luna's wellbeing was associated with her concentration on the plants she cultivated. The positive engagement in gardening helped the gardeners realise and perceive their own competence, thus improving their mental health. Moreover, the participants who fully engaged in various activities in community gardens received praise and positive feedback from other gardeners. This helped participants boost their self-confidence and self-satisfaction, thus improving their mental wellbeing.

Theme 2: Physical health care benefits

Community gardens provided significant physical health benefits to participants through *physical activities*, *visual comfort*, and *medical herbs*.

As community gardening involves a series of physical activities, such as watering, picking up vegetables, walking, and constructing wooden boxes, participants reflected that they became physically active during and after gardening and that their

sedentary lifestyles were changed, for instance:

I have always been sitting and staring at screens in my workspaces, I realised sedentary behaviour is not good and my backpain troubles me, but it is hard to change. However, I found I became physically active when I spent my time in community gardens, because I had to walk around to do watering, and to reach out and pick up grapes. These potentially alleviate my muscle pains because I really did exercise here. (Amanda, Guangzhou)

The case of Amanda is typical in that she was suffering from an urbanism-related unhealthy lifestyle and achieved some relief from regular community gardening. Her moderate physical exercises related to gardening led to positive effects on bodily pain and sedentary behaviour. Another male participant also described his experiences with physical activities in the garden in positive terms:

When we made the water tank together, we had to carry various tools from trip to trip in the garden. I've been exercising and sweating heavily, and I enjoyed this experience. (Gabriel, Beijing)

Though Gabriel's physical exercises were more than moderate, he perceived them as enjoyable and thus potentially had positive effects on his mental and physical health. The variety of physical activities in the garden may work the muscles of the body and thus improve physical function. Several participants mentioned the greenness in the gardens that comforted their eyes:

I found one significant effect of direct contact with these plants is the green colour. My eyes feel very comfortable when I watch them. It's definitely better than watching a screen. (Thompson, Shanghai)

In comparison with the visual fatigue engendered by screen watching, the greenness of the garden had soothing and pleasant effects on participants' eyes. The enjoyable experience of contacting with greenness may also serve as motivation for regular attendance in gardens and thus reduce sedentary and screen time. Other short-sighted participants also reported that the green environment of the gardens also helped reduce the visual discomforts related to wearing glasses.

The subtheme *medical herbs* describes participants' practice of using herbs cultivated in the garden to treat colds and other illness based on the Chinese folk medicine approach. In China, natural herbs can be cooked as soup or tea, which serve as complementary medicines, and applied to alleviate certain physical discomforts (e.g., itchy skin). One participant described how herbs grown in the garden helped reduce the symptoms of her daughter's fever:

My daughter got sick very suddenly last week ... I picked mint and thyme from the garden to make a hot tea for her, which is very effective in treating fever. The natural herbs nowadays can be rarely found in the urban supermarket. (Luna, Beijing)

The garden allowed participants like Luna to have convenient access to natural herbs for medical issues. Another participant reported that the herbs were applied to treat sprain and burn:

... we used some herbs from the community garden to treat sprains and burns, we grow these plants, and we know how to use. I'm keen on using these natural plants to solve my problems. (Claire, Foshan)

The herbal remedies made by the participants give a Chinese voice regarding the physical health benefits provided by community gardens.

Theme 3: Nature connectedness

Gardeners described a series of benefits that were perceived through exposure to the natural environment and positively growing plants in the garden. Nature connectedness refers to the subjective connection with nature (see also 1.2.1 & 1.3.3). Subthemes include *edible plants*, *being eco-friendly* and *spirituality*.

Beside *medical herbs* and *visual comfort*, the most commonly mentioned physical connection with nature was the *edible plants* gardeners grow. Whereas the community gardens beyond the Chinese context raised edible plants for culinary purposes and food security, the participants in this study expressed more about their enjoyable experience derived from labour and harvest. For instance, one participant shared, "I eat them only because it's the fruit of my labour but not due to food security issues" (Sarah, Beijing).

As Sarah and other gardeners reflected, ‘partaking’ of the fruits ‘finalises’ the planting-harvest cycle and becomes a way of confirming their ownership and attachment to the plants they grew. They perceived that they were physically connected to nature by literally involving themselves with the cycle of labour and harvest. This forms an interesting comparison: whereas urban residents were mere consumers of the products purchased on the market, community gardeners restored this alienated relationship with nature by growing what they ate. The enjoyable experience derived from physical nature connection was thus also related to mental connection with nature. Indeed, the positive psychological effects were often perceived as associated with the enhanced human-nature connection, for example:

I sometimes felt very depressed because of my work, then I like to come here for fresh air and green environment. I love green spaces, especially here with many flowers, which really changed my mood and made me happy! (Amanda, Guangzhou)

As Amanda mentioned (see also the quote above), her mental wellbeing was improved by being exposed to the natural environment and having an attachment to the flora in the community garden. Again, urban life and work were negatively mentioned in comparison with the positive description of the enjoyable and therapeutic experience in the community garden. The level of nature connectedness increased when gardeners became more actively involved with community gardening: “I like these plants, there is a strong emotion in them ... I get more involved because

I started loving my plants here” (Claire, Foshan). Claire’s expression of affection and attachment with the plants she grew in the garden was interestingly related to her recognition of the ‘strong emotion’ in plants, which indicated that she was physically and mentally connected to, and interacted with, nature. In addition, the emotional connection with nature is also related to a greater level of awareness of eco-friendliness and environmental protection. For instance, one participant shared:

Co-constructing community gardens in the city is good for the ecology. This place is now very clean, and the environment is nicer than before – so much litter and dirt were here. Everyone appreciated and praised it because we realised the importance of environment. (Peter, Beijing)

Likewise, another participant reflected:

After becoming a community gardener, I started thinking about the importance of environmental protection. That's because I connected myself with the garden. I was involved in co-constructing it, and I learned a lot from others. To be close to nature is to love, the mood to stay here is so peaceful, so I don't want this beautiful environment to be destroyed ... I voluntarily cleaned up gardens after workshops in the garden. (Claire, Foshan)

Moreover, community gardeners mentioned that the enhanced human-nature connection led to reflection on life and spirituality. The gardeners perceived a sense of spirituality in this process of communing with nature because, through

horticultural activities, they participated in the natural workings and became part of nature. Some participants referred to the Chinese philosophical notion of the harmonious integration of heaven and man (*tian-ren-he-yi* 天人合一), which claims that heaven and man are inherently and originally united as one, though they are ‘disconnected’ in ordinary life (Grandpierre 2021; Wang 2007). The harmonious connection or union between mankind and nature, nevertheless, is achievable by humans’ active and proper interaction with nature in various ways. Some gardeners perceived such human-nature integration in the sense that each of us was part of nature, for instance:

I was inspired by nature. When noticed I was wet in the rain during planting, I suddenly realised that we are part of nature like all these plants – birds fly without coat, flowers grow in the rain without umbrella, we can also stay in the nature without overprotection, it is like a kind of heaven-man integration.
(Jessica, Beijing)

Through gardening activities, Jessica’s connection with nature was enhanced in both physical and mental terms: like rains falling on her body, self-reflection inspired by nature came to her mind, reminding her that humans are but living creatures and thus re-shaping her identity and relationships with nature and others. The notion of the equality of all living creatures in the presence of nature also led to a further reflection about human-heaven harmony from a larger, cosmic perspective. All these were achieved during Jessica’s gardening and full absorption of her environment in the community garden. Like Jessica, the observation of the natural cycle prompted one

gardener's reflection on the meaning of human life:

I gradually realised the meaning of life. Flower will grow in the most brilliant moment of nurturing, and then it will be withering slowly, and it will be gone. But we can make it reborn by flower pressing ... It's rebirth, like our life. (Mike, Foshan)

Like Jessica's analogy between birds and humans, Mike drew a comparison between the life of flowers *in* a community garden and human life. It is noteworthy that Mike did not describe the rebirth of flowers in botanical terms as usual (e.g., flowers will bloom again on the same plant); rather, he highlighted human endeavours (flower pressing) in achieving a kind of beautiful eternity. The permanent values of nature shine through gardens and the sweat of gardeners.

Theme 4: Co-operation

The co-operation taking place in community gardens helped gardeners know each other better and thus improve *communication* and *interpersonal relationships*. Community gardens provide chances for residents to build communal connections, foster neighbour relationships, and improve family bonding. One participant described her experiences making new friends in the garden:

I brought my friends to be here with me, and others did the same thing, then I could know many new faces and make new friends, which absolutely enhanced my interpersonal relationship! (Catherine, Guangzhou)

Another participant shared experiences of his neighbour relationship:

I met one of my neighbours during the community gardening, and we had something unhappy before... but when we co-operated to do something, then we naturally started to talk, and now we are fine! (Peter, Beijing)

Most participant reflected that their family relationship improved after regularly engaging in community gardening activities, for instance:

I usually don't have much chat with my husband at home because we have few common hobby and topic. However, now we have the same interest in here - we have arranged to water the plants on the weekend. So, we come here together and remind each other about this thing. (Melody, Guangzhou)

Also, community garden serves as an ideal place for communication and social interactions, for instance:

Taking part in community gardening helps us have more communication between people... people are actually very unfamiliar with each other in this big city. We live in reinforced concretes...many people want to change this situation, but we don't have a platform, till we are now joining in community garden and interacting with each other, communicating, and contacting". (Nina, Shanghai)

Nina's reflection was insightful in that the community garden was perceived as an ideal place for communication and social relationship development. The sense of unfamiliarity and the negative description of the living environment ('reinforced concretes') are typical urbanisation features that negatively affect residents' social lives and mental health. Indeed, as indicated by participants (like Nina and Jessica), urbanites are alienated not only from the natural environment but also socially from one another. The urban community gardens could serve as a kind of remedy for the feelings of alienation engendered by rapid urbanisation.

Some participants reflected the interpersonal relationships in the community gardens were very different from in other social settings:

I don't have to consider your so-called work background or your social status to make friends here. Here is so simple, our relationships are pure. Everyone in here is one member of the garden, a parent of children, and a participant of constructing this community garden". (Thompson, Shanghai)

Each participant's identity, derived from urban social activities, was replaced by a new one as a member of the community garden. Community gardens simplified the interrelationships amongst the gardeners from different backgrounds and facilitated a sense of equality. More importantly, the removal of individuals' social background and status corresponds with the mindful gardening experiences of participants (like Jessica and Amanda) who concentrated on themselves *qua* humans in the garden and left the disturbing and stressful urban life behind, as well as the spiritual and

philosophical reflections about the relationship between humans and nature. By returning to nature, gardeners seemed to find a simple and pure way of taking care of themselves and others instead of daily work and the miscellaneous.

Theme 5: Parenting

All ten participants who had at least one child described the benefits of community gardening for children and the parent-child relationship derived from community gardening. First, community gardening was believed to have pedagogic values in the sense that gardeners' children could learn from nature-based activities. For instance:

My child was very excited when the potatoes bear fruits, he can observe the differences of the potatoes during they were growing, which he cannot learn from the books. He can also touch these plants to feel what he has never felt before. (Thompson, Shanghai)

Second, community garden served as an ideal playground for children's recreation and fostered child-nature connectedness:

Children love two things: water and sand. We don't have sand here, but he has always been here to water, water, and water - play with water and water the plants. (Melody, Guangzhou)

As Melody indicated, the gardening activities induced children's love of nature and fostered a better child-nature relationship. Third, some participants reflected that they

found that they could help their children cultivate a sense of responsibility during gardening activities:

Since my daughter came with me to community garden, she may start caring about these plants – whether they are still alive or not. Another aspect is that she can come here and find something to do by herself, it is more like a sense of responsibility. (Donald, Beijing)

This benefit might be related to the *One Child Policy* which was implemented in China until 2016. Parents with only one child are concerned about their child's opportunities to take care of other children at home and thus there is a lack of sense of responsibility. Community gardens may help reduce the negative effects of this policy and improve the quality of parenting as well as the mental wellbeing of the children in these families.

Theme 6: Personal growth

The theme addresses participants' personal growth throughout community gardening activities. The sub-themes are *gaining knowledge*, as well as *fostering a healthy lifestyle*. Firstly, participants reflected that they had learned much pertaining to gardening, they found their practical ability and planting skills greatly enhanced, which left a feeling of satisfaction and meaningfulness:

We learned how to grow different flowers; what tutors taught us is different from what we know from our personal experiences...I can now use these skills in my

house planting as well. (Amy, Shanghai)

Beside gaining knowledge and skills, many participants highlighted that their regular engagements moulded a healthier lifestyle. Participants shared:

Gardening activities here fostered my health lifestyle. I sleep very late and always miss sunrise and fresh air in the morning before. But since I have come here regularly, I get up early and walk to here almost every day...I feel to be healthier than before. (Melody, Guangzhou).

Like Melody, another participant shared, “I treated gardening activities in here as a trajectory of my life, and my life became more fulfilled, pre-planned and regular” (Claire, Foshan). Regular community gardening helped shape the healthier life routines of participants and prompted reflections on nature, life, and interpersonal relationships, which may be positively linked to mental and physical health and wellbeing.

Theme 7: Valuing the Community Garden

Almost every participant expressed their passion for, and positive attitude towards, community gardening. They believe that the community garden and the *collective works* therein, are very *meaningful* and in accordance with the core values of Chinese society. For example, participants described their passion and appreciation:

We voluntarily take part because we have very high enthusiasm. We signed

up for attending and we would come ... I so appreciate the community providing such good place for us. (Amy, Shanghai)

Furthermore, collective work seemed to strengthen relationships, binding members together emotionally and physically through collective labour-focused work. The positive effects on the sense of community were mostly derived from collective work in the community gardens, for instance:

We can go step by step to build up the tube, and everyone discussed ... we were actually solving the problem together, it's a collaborative process and I found I can complete a thing that I can't image before ... when I have completed all tasks in the group, I helped other group members Everyone here can give full play to each person's strengths in here ... I especially love labour works here, it's not heavy and I was honoured during my labour work with others. (Gabriel, Beijing).

Gabriel achieved a sense of self-accomplishment through helping others and realising his potential competence in the collective gardening activities. The cooperation amongst gardeners fostered not only a sense of communal cohesion but also the recognition of one's competence and thus contributed to mental health. Community gardens provide more chances for active and collective communication through various types of work such as watering, designing, and construction. Some participants described their experiences in a dated 'collectivist' slogan, "*Unity is strength, labour is honour*", which, in the context of community gardens, seems to

mean “no pain, no gain”.

In addition, they believed that urban community gardens and the activities therein were *meaningful*. First, all the perceived benefits of the activities in community garden discussed above were found to be valuable and meaningful. For example, one participant reflected:

I love community gardens, the activities here are meaningful. I grow things here, learned new skills here, make new friends, and my daughter can also learn to take care of living-things. (Lucy, Beijing).

Second, community gardens deserve of advocating and promotion across China. One participant shared:

Community gardening is worth being advocating ... sometimes they would hold an event like inauguration ceremony costing hundreds of thousands of yuan and generating a lot of garbage. But if they make use of these money to build more community gardens for us, it would be more meaningful.” (Thompson, Shanghai)

4.4.3 Barriers to being a community gardener

Relatively few participants described barriers to community gardening, with those issues raised being captured within three sub-themes that all identified areas in need of further support, namely lack of *management*, lack of *professional guidance* and

lack of *investment*:

We need to reinforce management of the garden. Some residents steal vegetables and fruit at night, which seems to be unstoppable if there is no security staff. (Irwin, Beijing)

We lack professional tutors to guide us during planting. It is possible that some of us used inappropriate planting method which may destroy the seeds and flowers. (Maggie, Shanghai)

We also need more support from the government. The garden is small, as increased residents come here, we need more and bigger gardens. Now we still paid for the anti-insect products ourselves. (Kobe, Shanghai)

The community gardeners wished to see investment to support management and professional guidance for their gardens and further investment from the government to support existing community gardens and to enable the development of further gardens to meet demand for such gardens from residents.

4.5 Discussion

Community gardens were perceived to provide a healing place that has various therapeutic effects on mental and physical health and thus serves as a remedy for the adverse outcomes derived from urbanisation. The positive values of community gardens perceived by the participants were not merely related to gardening activities

but also associated with fostering a meaningful and healthy lifestyle. Most of the key findings in this study are consistent with the previous literature that community gardening is perceived as benefiting gardeners' health in general (Soga et al., 2017), mental well-being (Koay & Dillon, 2020; Spano et al., 2020), physical health (Zick et al., 2013), nature connectedness (Kingsley et al., 2009), mindfulness level (Okvat & Zautra, 2011), stress reduction (Y. Black, 2020; Spano et al., 2021), inter-personal relationships (Barton et al., 2016b), and self-competence (Cheng & Pegg, 2016).

Regarding mental health improvement, it is noteworthy (in Jessica's case, for instance) that the disturbance and stress relief effects were achieved by simply viewing (Elsadek, Liu, and Xie 2020; Jiang, Chang, and Sullivan 2014; Ulrich 1984; Velarde, Fry, and Tveit 2007) and touching (Koga and Iwasaki 2013) plants and easy gardening (Gonzalez et al. 2011). The attention of the gardeners (see Amanda's quote) seemed to be restored and her mindfulness level was improved to the extent that she was 'happy' to stay in a preferred place and fully concentrated on herself (Barbaro and Pickett 2016; Han 2017). For both Jessica and Amanda, the intensely focused moments of absorption in green space indicate a high level of mindfulness and might be therapeutic (Pitt 2014). Relatedly, the participants often expressed that gardening helps reduce mental fatigue and stress, which is in line with some of the previous studies (Dewi et al., 2017; R. Kaplan & Kaplan, 1989; Koay & Dillon, 2020; White et al., 2021). Also, community gardens were perceived as a place free from some of the unwelcome features related to urbanisation (such as crowdedness), which may buffer the negative effects to one's health (Gong et al., 2012; Jia et al., 2008). More importantly, both mentioned that they retrieved the capacity to cope with life stress

(‘I feel I can let go’; ‘I won’t think about’), indicating that their mental health was improved (WHO 2018). These findings may support the Attention Restoration theory, which posits that exposure to natural environments refreshes our attentiveness and reduces mental fatigue (S. Kaplan 1995; Basu, Duvall, and Kaplan 2019). More importantly, some profound expressions of *nature connectedness* and reflections of the participants about the human-nature relationship and one’s existence often occurred along with *mindful* observation of oneself and simple elements in nature (see Themes 1 & 3 in 4.4.2). This may lend support to the Attention restoration theory according to which soft fascination (such as wind blowing through leaves) offers “a special advantage in terms of providing an opportunity for reflection, which can further enhance the benefits of recovering from directed attention” (Basu et al., 2019; S. Kaplan, 1995).

In terms of physical health benefits, a variety of physical activities during community gardening improve physical function (S.-A. Park et al., 2009). In addition, the *medical herbs* subtheme is noteworthy. The gardeners raised herbal plants for medical use and thus improved their physical health. This forms an interesting comparison with the Western counterparts (Mehta, Lopresti, and Thomas 2019; Kingsley, Foenander, and Bailey 2019) where food security, nutrition and vegetable consumption were cited as the main purposes. China has a long history of using medicinal herbs to treat various types of diseases (Xi and Gong 2017). This tradition is retained in modern China and some of the Chinese prefer these alternative, natural herb-based therapies to modern medical care (Hou and Jin 2012).

This study also reveals positive links between nature connectedness, mental health, and physical healthcare (Pretty 2004). The community gardens accommodated in urban areas increased nature connectedness of the residents and the regular gardeners (Black 2020a; Poulsen et al. 2014). There are various forms of nature connection described by the community gardeners in this study and addressed in both physical and mental terms. The most commonly mentioned physical connection with nature was fruit eating, the mark of completion of the labour-harvest cycle. This connection was also related to the reflection about the human-nature relationship in philosophical terms, i.e., the notion of *tian-ren-he-yi* (harmonious unity of human and heaven), which shows how the gardeners' mental connection with nature was expressed in specific cultural contexts, and indicates a greater level of nature connectedness, which may have positive effects on their mental health. In addition, it is worth noting that a positive human-nature relationship was often achieved by mindfully observing both natural environments and oneself. The mindful state described by the gardeners suggested that a greater level of mindfulness could be achieved by active mental connection with nature. Moreover, participants came to realise the importance of environmental protection and conservation, which is related to mental connection with nature in terms of emotion and cognition (Okvat and Zautra 2011).

The community garden was perceived to play a mediative role in fostering not only human-nature relationships but also interpersonal relationships. It is interesting to note that participants found themselves equal in the presence of nature and some of them believed the harvest from the gardens both reinforced their connection with

nature and fostered a sense of community. Also, the cooperation or collective work in the community garden was perceived to foster the recognition of one's competence and enhance an individual's self-esteem. Community gardening seems to be a beneficial solution against the adverse outcomes of urbanity, where people are alienated from nature and from one another except in most instrumental and functional ways (Clapp, 2005).

Another novel finding concerned the positive link between community gardening and *parenting*. Earlier research found that bringing children to a garden was a hindrance for community gardeners, because children might interrupt them (Kingsley, Townsend, and Henderson-Wilson 2009). The present study, conversely, found the positive values of community gardens in fostering child-parent relationship, helping children cultivate a sense of responsibility, and providing them with a natural playground for recreation and nature-based education. Relatedly, community gardens were perceived as beneficial to children's relationships with nature. Indeed, rapid urbanisation and the burgeoning development of digital entertainment were thought to engender the so-called child-nature disconnectedness, which is often associated with physiological, emotional, and social dysfunctions (Louv, 2010). The promotion of community gardens in China may serve as an effective way to facilitate children's re-connection with nature.

Further novel findings of this study pertain to the reasons why gardeners see their activities as beneficial. One qualitative study previously summarised a theme that it designated as 'love of community gardens' (Kingsley et al., 2009). This is similar to

a main theme of this study - 'valuing' the community garden. These two themes reflect the affective attachment between gardeners and community gardens. Since the earlier Kingsley (2009) study did not create a theoretical model however, it was difficult for that research to deduce the relationships of this theme with others. Conversely, the current study found that participants value community gardening because of *collective work* (sub-theme) and the value of '*no pain, no gain*' (sub-theme) as well as the *meaningfulness* (sub-theme) of community gardening. In turn, the grounded theoretical model provides the relationships between these three subthemes. Although it cannot be determined that the above themes directly lead participants to value community gardening, the model does demonstrate that these themes interact with each other. This finding is notable because a meta-analysis suggested that community gardens generate greater mental-health benefits in individualist societies than collectivist ones (Spano et al., 2020). In the present study, the conceptual model reported reveals collective work is associated with the gardeners' positive attitudes towards community gardening, and positive attitude is interwoven with mental-health advantages. Collectivism is a core value of Chinese society, and participants in this study described how this value positively influenced their perception of collective work. The *communal* aspect of the community garden was a key factor in their engagement. Nevertheless, further studies are needed to examine how the role of culture and societal values within community gardening impacts mental health.

Furthermore, community gardeners themselves enjoyed both the gardening activities *per se* and the opportunity to learn skills from their activities (Mehta et al., 2019).

The current study connects two novel themes, namely *fostering a healthy lifestyle* and *improving personal life quality*, to construct the proposition that community gardeners' 'personal growth' is realised during community gardening.

The conceptual model created in this study reveals positive links between nature connectedness, mental health, and physical healthcare, which have been suggested by one previous study (Pretty, 2004). According to a recent meta-analysis the effectiveness of outdoor nature engagement (e.g. gardening) results in improved depression and mood, but has less effect on physical health (Coventry et al., 2021). The present study adds to the evidence of the benefits of community gardening for physical health, and confirms the potential relationship between gardening activities, nature connection, mental health, and physical health.

4.5.1 Limitations

There are some limitations to this study. First, only a few male participants were interviewed ($n = 7$), which may lead to gender-biased final results. Further research may be desirable to investigate whether gender is associated with the benefits of community gardening. Relatedly, because there are some socio-cultural differences among different areas of China, the mental health benefits perceived by the community gardeners (especially those related to human-nature relationships and spirituality) may be influenced by local socio-cultural factors and thus not be representative.

Secondly, the participants who voluntarily took part in this study were individuals

who regularly engaged in community gardening, they may tend to highlight positive rather than negative aspects. The themes in relation to *barriers* to community-gardening engagement were also limited, and this may have generated incomplete conclusions for the researcher's questions. This is also associated with another sampling limitation: the present study did not target non-gardeners to examine their attitudes (especially the barriers) toward community garden participation. Further quantitative studies should recruit diverse populations including those who have not participated in community gardens.

Thirdly, although this study provided some qualitative insights about the community gardening experience in China, these are limited by the researcher's data analysis and interpretation in a constructive grounded theory. Nevertheless, the findings in this study are likely to be significantly strengthened and further contextualised by quantitative research, that enables a more systematic approach to the examination of community gardening participation in China. More convincing quantitative evidence is desirable and needed to promote community gardens both as individuals' everyday therapeutic activities and as public health interventions in China.

4.5.2 Implications and Research Directions

The findings in this research have several implications for further studies. First, further research is suggested to develop a quantitative survey with more specific questions, which might be deployed based on the findings from this study. Also, future research should conduct experimental research designs (e.g., RCT(s), quasi-experiments, time-series studies, etc.) to examine the psychological

effectiveness of community gardening on the mental health benefits addressed in this study. This could be done, for example, to ascertain the influence of Chinese community gardening on participants' sense of nature connection, cooperation, physical well-being, mental health, and parenting skills.

Second, regarding the positive links between community gardens and parenting, it is desirable to have further research on how Chinese parents and schools may benefit from making use of community gardens to cultivate children's sense of nature-connectedness and environmental responsibility.

Third, the self-esteem improved by cooperation in community gardens may relate to 'collectivism' as a core value in modern Chinese society. Further studies are needed to examine how the role of culture and societal values within community gardening impacts mental health.

Fourth, given that the present study does not provide sufficient male voices about community gardening, further studies may want to determine whether the experiences of community gardening might evince gender differences in Chinese society.

Fifth, this study suggests a potential relationship between Chinese philosophical concepts of *tian-ren-he-yi* and nature connection, which might be valuable to guide future development of theories about human-nature relations.

Lastly, the conceptual model reveals a dynamic process as to why Chinese

community gardeners value community gardening, and how it is perceived as positively affecting their mental health, feeling of nature connectedness, and other physical health care. The theoretical model can also guide other researchers and social workers to frame community and nature-based interventions, to support individuals' mental health. This study provides scientific evidence of the perceptions of the positive impact of community gardens in China for government decision makers to consider the construction of more community gardens to improve Chinese city residents' wellbeing and general health. Relatedly, the barriers indicate that the Chinese community gardens require additional support in terms of investment, management, and professional advice.

4.6. Conclusions

This grounded theory study reveals community gardeners in China perceived gardening-related activities as benefitting their mental health, physical health, nature connectedness, personal growth, parenting, and they fully described why they valued gardening activities. The conceptual model illustrates the relationships between these themes. However, barriers may impede more gardeners' ability or willingness to keep engaging - they need more support and investments from the government to manage the existing community gardens and build up more gardeners for the residents in China. More high-quality quantitative studies are required in the future to test the relationship among the themes and the conceptual model generated in this study.

Chapter 5

Effectiveness of Greenspace-based Walking Interventions in Improving Mental Health in Adults: A Systematic Review

5.1 Chapter Overview

Greenspace-based walking is a low-cost and eco-friendly approach for people to maintain health and improve their mental health status (Du et al., 2020). This chapter reports on a systematic review that aimed to evaluate the evidence regarding green walking's effectiveness in enhancing mental health outcomes in adults. The findings of this chapter were the basis for the design and implementation of the RCT study of mindful nature walking, which is reported in Chapter 6.



Abstract

Aim: Greenspace-based walking is a low-cost and eco-friendly approach for people to maintain health and improve their mental health status. This systematic review aims to evaluate the evidence regarding green walking's effectiveness in enhancing mental health outcomes in adults.

Method: Applied Social Sciences Index & Abstracts (ASSIA), PsycINFO, MEDLINE, EMBASE, the Web of Science Core Collection, Doctoral thesis databases (ProQuest), and manual searches.

Studies met the inclusion criteria, and the quality of these studies was evaluated. This review includes randomised and non-randomised (quasi-experimental design/single case with pre-and-post) studies. Due to the heterogeneity of the eligible studies, a narrative synthesis was employed.

Results: 17 studies were included in this review and 1,209 adult participants (female = 336) were involved. The findings suggest that greenspace-based walking enhanced adults' positive mood, optimistic emotions, mental wellbeing, and nature connection, while decreasing their levels of anxiety, rumination, and stress. In addition, compared with urban walking, greenspace-based walking intervention could bring extra benefits on reduction of anxiety and rumination.

Conclusion: greenspace-based walking interventions linked with various mental health benefits and appear to be an effective approach to foster wellbeing and maintain mental health. Further empirical investigations should address constraints in intervention design, sample representativeness, and methodological robustness that reduced the quality of the evidence.

Keywords: Green Walking; Nature-based Interventions; Mental Health; Review

5.2 Introduction

A variety of risk factors in relation to urbanisation and urban lifestyles such as overcrowding, physical inactivity, and a lack of nature connection have led to negative health outcomes, contributing to the increasing prevalence of mental health disorders (Ventriglio et al., 2021a; World Health Organization, 2022). Specifically, for instance, sedentary habits not only lead to obesity (Martínez-González et al., 1999) and other physical health problems such as coronary heart disease, type 2 diabetes, dementia, cardiovascular, chronic pain, and hypertension (Knight, 2012; Lavie et al., 2019) but are also linked to anxiety and depression (Moselhy et al., 2012). Prevention and amelioration of these alarming health issues are necessary for the sake of reducing health-care demands and treatment costs (Health, 2020).

Physical exercises like walking in natural settings have been proposed as a novel and desirable approach for mental illness prevention and health promotion (Bird, 2007; Frumkin et al., 2017). On the one hand, there is considerable evidence that physical exercise may improve mood and cognitive function (Kelly et al., 2018b) while alleviating anxiety and depression (Carter et al., 2021; Gaia et al., 2021; Kanning & Schlicht, 2010; Lam & Riba, 2016; Xiang et al., 2020). Walking is more accessible and acceptable than other forms of physical activity, which can be incorporated into everyday life (Marselle et al., 2014), conferring benefits to cardiovascular fitness, physical resilience, psychological stress reduction, and positive mood (Kelly et al., 2018a; Sianoja et al., 2018; Song et al., 2015; Sturm et al., 2012). On the other hand, the use of outdoor spaces including natural settings has been recognised as a determinant of public health (Department of Health, 2014). Considering the potential mental health benefits of nature connection and available theories (as summarised in

1.2.2 and 1.2.3), walking in natural environments may confer extra health benefits compared to non-natural settings. There is a growing number of studies regarding the extra health benefits of exercising in nature compared with non-natural spaces. According to a systematic review of 23 published studies (Thompson Coon et al., 2011), some promising effects on self-reported mental wellbeing after taking exercises in nature were not found after the same exercise indoors. Regarding walking in nature, an experimental study found that a 50-min walk in a natural environment may confer greater mental health benefits to affective and cognitive functions than the same exercise in an urban setting (Bratman, Daily, et al., 2015). Another experimental study found that group walks in nature may be associated with a variety of mental health benefits such as lower depression and enhanced mental wellbeing (Marselle et al., 2014). Similarly, Roe & Aspinall (2011) found restorative benefits in rural walking but not in town walking. However, it is far from conclusive owing to the variety of natural settings, poor methodological quality, and heterogeneity of outcome measures in the current studies (Barton et al., 2009; Thompson Coon et al., 2011). For instance, a recent systematic review found that nature walks were shown to be useful for state anxiety but not for generalised anxiety, and the effects on depression were mixed (Kotera et al., 2021b). Also, other mental health outcomes that nature walks might improve have not been addressed in that review.

For a better understanding of the extra benefits conferred by nature-based walking, the paper aims to systematically review and evaluate the evidence of the effectiveness of greenspace-based walking interventions on mental health among

adults. For controlling the characteristics of natural settings, this study has a specific focus on greenspace (while bluespace and other synthetic spaces may need further investigation), which is also associated with the thesis' central concern of finding a widely available and accessible way to increase nature connection for urban adults and thus improve their mental health. Relatedly, urban and non-green space are defined as the same in this thesis for convenience.

The review questions are as follow:

- 1 Do adult people's mental health outcomes improve after greenspace-based walking compared to before the intervention?
- 2 Is there a greater improvement in people's mental health following a greenspace-based walking intervention than those who walked in non-green spaces?

5.3 Methods and Materials

This systematic review has been registered in the PROSPERO systematic review database (ID: CRD42018091431). The first search for this systematic review was in August 2018. The latest update took place in March 2022. The Cochrane database was screened to make sure that there were no similar reviews in this field.

5.3.1 Inclusion and Exclusion Criteria

According to the guidance of PICOS, which was developed from the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2019) and the PRISMA statement (Liberati et al., 2009) studies were included if they were based

on randomised controlled trials, between-subject experimental or quasi-experimental designs, or within-subject designs with control groups/conditions that compared the effects of a greenspace-based walking intervention on mental health to those of a suitable control. The eligible studies must report pre-post differences and/or group comparisons of wellbeing related outcomes and will be analysed to determine within-subject design and between-subject design.

The participants included in the studies must be adults, but there is no restriction on the mental health condition of participants; that is, they can be with or without mental illnesses. Those studies with participants with a diagnosable physical health condition were excluded from this review, because this review mainly focuses on the changes of mental health related outcomes, rather than those of physical ability. Any interventions involving indoor walking and/or virtual experimental settings with pictures or videos of natural green environments were excluded. The eligible studies thus might be concerned with a) mental health improvements in the green space walking intervention and/or b) whether wellbeing improvements in the green space walking intervention are greater than those in the control group. The summarised inclusion and exclusion criteria are shown below.

Table 5.1 Eligibility criteria

Item	Criteria
Population (P)	Adults (aged 18 and above).
Intervention (I)	Greenspace-based walking intervention, walking in urban park, farmland, forest, national parks, hills, landscape fields (including places such as golf courses).
Comparators (C)	Non-green outdoor spaces, such as urban area without significant greenery
Outcomes (O)	Mental wellbeing was defined broadly to include measures such as:

	mood, mindfulness, anxiety, depression, subjective wellbeing, quality of life.
Methods and design	Quantitative research using randomised and non-randomized controlled designs, within-subjects and between subjects with pre-post-tests.
Language	Written in English.
Types of publication	Peer-reviewed publications, grey literature (e.g. dissertation, PhD thesis).

Note. There was no Mandarin research published in this field.

5.3.2 Search strategy and selection process

The following electronic bibliographic databases were then used for the formal search: Applied Social Sciences Index & Abstracts (ASSIA), PsycINFO, MEDLINE, EMBASE, the Web of Science Core Collection, and doctoral thesis databases (ProQuest).

The following keywords were used with commands “AND” and “OR”: “natural green space*” OR “natural green field*” OR “natural green area*” OR “natural surrounding*” OR “green space” OR “green” OR leafy OR grassy OR verdant OR “natural environment*” OR outdoor* OR outside OR country* OR rural OR nature * OR walk* OR ramble* OR stroll* AND “wellbeing” OR wellbeing OR “well being” OR mental health* OR “sleep quality” OR mindfulness OR anxi* OR depress* OR distress* OR stress* AND “adult” NOT “qualitative” NOT “cross-sectional” NOT “review”. To reduce potential limitations related to selection bias, manual searches were also conducted in the reference lists of the screened papers. No additional qualified studies have been found through manual searches. One relevant unpublished dissertation was identified (Goulding et al., 2018).

Rayyan was used to manage references. Citations retrieved were downloaded,

duplicates were removed, and titles and abstracts were independently screened for eligibility. One second reviewer (Peilin Lin) then independently assessed the article for an eligibility check.

5.3.3 Data extraction

The data extraction has been independently completed by the author and the second reviewer, while agreement on the final version has been reached after discussion to ensure consistency and reliability. The following items are pertinent to the review question: study design, participants' characteristics, the intervention and the control, number of walking sessions, measurements, pre-post effect size, main findings, and key limitations.

5.3.4 Quality assessment

The RCTs' risk of bias was assessed using the Revised Cochrane Risk of Bias Tools for Randomised Trials (ROB-2) with result categories of low, some concerns, or high risk of bias (Sterne et al., 2019). For the non-randomised studies observational studies, existing criteria and guidelines were adapted from the SIGN 50 Checklist (Scottish Intercollegiate Guidelines Network, 2019). The applicability of this tool was discussed with the supervisor and a consultant to the professions to ensure the suitability of using it in the present review.

The rating of each quality criterion was classified as: well-covered (3 points); adequately addressed (2 points); poorly addressed (1 point); and not addressed (0 points). The rating "well-covered" was assigned when the evaluation categories were

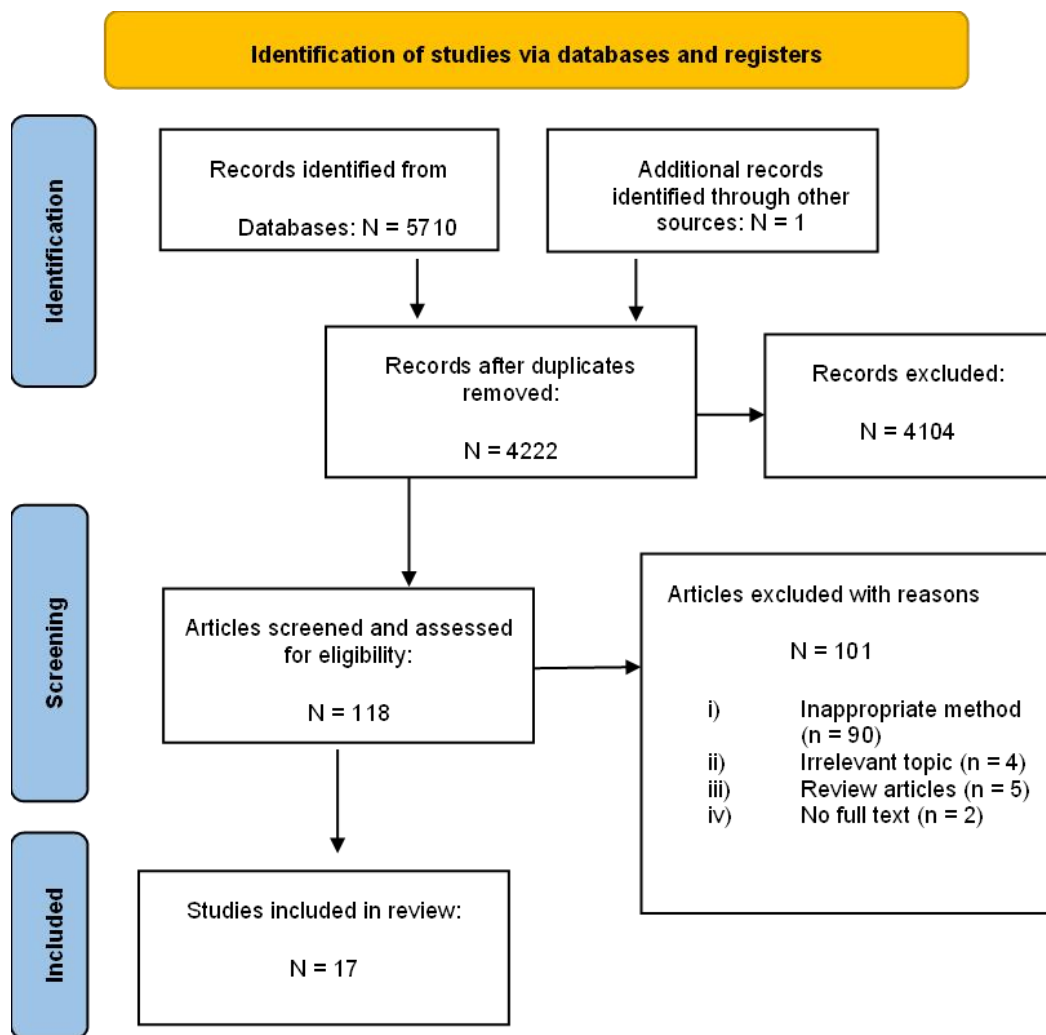
clearly reported and could be identified by the reviewers; “adequately addressed” was assigned when detailed descriptions were missing but could still be identified from the information provided by the article; ‘poorly addressed” was assigned when there was no relevant or only limited information provided in the article. However, because these criteria are not truly of equal importance, the summed numerical scores were not used as a final rating, to avoid misleading conclusions. The ratings were finally stated as “++”, “+”, or “-” to represent high quality (overall rating ranging from 18-24), medium quality (overall rating ranging from 12 to 17), and relative low quality (overall rating ranging from 0 to 11) respectively. The author and the second reviewer independently evaluated all of the included studies. The agreement on quality ratings between these two appraisers reached 75%, and the final rating was decided after discussions.

5.4 Results

5.4.1 Included Studies

There were 5,710 studies identified during the initial search phase, and one dissertation was requested by the author to be included. Studies were excluded during the initial title and abstract screen. After duplication, 4,222 studies were found, and of them 118 with full texts were screened for further eligibility. Overall, 17 studies were eligible to be included in this systematic review. The selection process for the included studies is shown in a PRISMA flow chart (see Figure 5.1). Additional information on exclusions can be found in Appendix C.

Figure 5.1. Flow chart of study selection



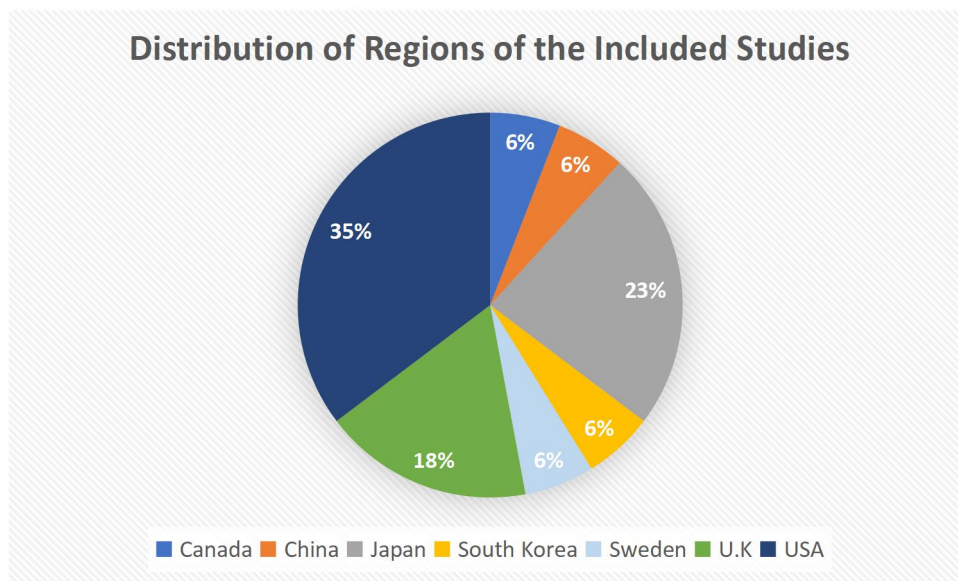
5.4.2 Study characteristics

Key characteristics of the included studies are outlined in Table 5.2, which includes demographic information, research design (treatment, control interventions, or conditions; number of walking session and walking duration), outcome measurements, effect sizes, main findings, and key limitations of the included studies.

These included studies (n = 17) contain 1,209 participants, among whom 336

participants were female. Most of the studies included the general population without a diagnosed mental illness ($n = 15$). Only two studies included participants with a major depressive disorder (MDD; (Berman et al., 2012)) and those who experienced depression or anxiety (Keenan et al., 2021). The mean age of participants ranged from 19.6 to 40.34 years old. Therefore, the number of female participants involved in these included studies is fewer than the male ones. These included studies were mostly conducted in the USA ($n = 6$), Japan ($n = 4$), and the U.K. ($n = 3$). More details regarding this can be found in Figure 5.2.

Figure 5.2 *Regional distribution of the included studies*



Intervention characteristics varied among studies in multiple aspects, including walking locations, duration, and frequency of walking. For the greenspace-based walking intervention, which took place in forests (Hassan, Tao, et al., 2018; Keenan et al., 2021; Koselka et al., 2019; W. S. Shin et al., 2011; Song et al., 2018, 2019), urban parks (Aspinall et al., 2015; Berman et al., 2012; Bratman, Daily, et al., 2015; Goulding et al., 2018; M. Johansson et al., 2011; Song et al., 2014, 2015), landfill

(Geniole et al., 2016), and other natural landscapes with grassland (Bratman, Hamilton, et al., 2015; de Brito et al., 2019a; Mayer et al., 2009a). Whereas the comparator walking took place in downtown (Berman et al., 2012; M. Johansson et al., 2011; W. S. Shin et al., 2011; Song et al., 2019), urban areas (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015; Geniole et al., 2016; Hassan, Tao, et al., 2018; Song et al., 2014, 2015, 2018), busy shopping streets (Aspinall et al., 2015; Goulding et al., 2018; Koselka et al., 2019), residential areas with traffic roads (Koselka et al., 2019), concrete areas with buildings (Keenan et al., 2021; Mayer et al., 2009a). Walking duration varied between 15 to 90 minutes. Except for two studies, which employed multiple walking sessions, (30-minutes sessions for five consecutive days, (Keenan et al., 2021); once-weekly sessions for three weeks, (de Brito et al., 2019a), the rest of the included studies only applied a single walking session.

For the measured mental health outcomes, mood was the most frequently measured outcome, which was mostly measured by the Positive Affect and Negative Affect Schedule (PANAS) (Berman et al., 2012; Bratman, Daily, et al., 2015; de Brito et al., 2019a; Goulding et al., 2018; Keenan et al., 2021; Koselka et al., 2019; Mayer et al., 2009a) and Profile of Mood State (POMS) (W. S. Shin et al., 2011; Song et al., 2014, 2015, 2018, 2019). In addition, anxiety was measured by the State-Trait Anxiety Inventory (STAI) (Bratman, Daily, et al., 2015; de Brito et al., 2019a; Hassan, Tao, et al., 2018; Koselka et al., 2019; Song et al., 2014, 2015, 2018, 2019). Rumination and mindfulness levels were measured by the Reflection Rumination Questionnaire (RRQ) (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015; Goulding et al.,

2018), and the State Mindfulness Scale (SMS) (Goulding et al., 2018), respectively. To measure distress and stress levels, the Bodily Distress Syndrome (BDS) (de Brito et al., 2019a; Koselka et al., 2019) checklist and the Perceived Stress Scale (PSS-10) (Koselka et al., 2019) were used. In addition, the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Goulding et al., 2018; Keenan et al., 2021) and 8-item Flourishing scale (EFI) (M. Johansson et al., 2011) were adopted to measure overall mental wellbeing and optimistic emotion, respectively. Only one included study measured the degree of nature connection by using the Connectedness to Nature Scale (CNS) (Keenan et al., 2021). Other measurements were those that included EEG (Aspinall et al., 2015; Hassan, Tao, et al., 2018), and arterial spin labelling (ASL, a neuroimaging method to record brain activity in prefrontal cortex) (Bratman, Hamilton, et al., 2015), which enable the measurement of mood, meditation, rumination, and attention. A detailed discussion of the pre-to-post effect size will be provided in 5.4.4.

Table 5.2 Key characteristics of the included studies

Author Year Country	Sample Characteristics	N/Age	Design	Treatment /Control Interventions (or conditions)	No. of Session(s) / Walking duration	Outcome Measurements	Pre-Post Effect Size of Green Walking	Group*Time effect size of Green Walking	Main Findings	Key Limitations
Aspinall et al., 2015. UK	General	N = 12 (female = 4). Mean Age = 30.08	Time-series with pre-post-test.	Walking in urban park / Walking in urban shopping street.	Single session. / 25 minutes for both routes.	Mobile EEG to record excitement, frustration, engagement, arousal, and meditation.	R ² = .06 (medium effect size)	[N.A.]	Walking from urban to green spaces reduced participants' arousal, frustration, and engagement, increased mediation.	The EEG recorder was occasionally not streaming data. No Follow-up tests.
Berman et al., 2012. USA	Major Depressive Disorder (MDD)	N = 19 (female = 12) Mean age = 26	Counter-balanced within-subject design.	Walking in a park with tree line / Walking in downtown.	Single session. / 50 – 55 minutes for both groups.	PANAS	Positive affect: d = .23 (small effect size). Negative affect: d = -.58 (medium effect size)	[N.A.]	Mood improved after walking for both groups of participants. Greenspace-based walking brought additional positive affect than urban walking.	Small sample size. Difficult to motivate participants to take nature walks. No follow-up tests.
Bratman et al., 2015 (a). USA	General	N = 60 (female = 33). Mean age = 22.9.	RCT with pre-and-posttest.	Walking in a park with paved path through grassland, scattered shrubs, and oak	Single session. /	STAI; RRQ; PANAS.	STAI: d = .46 (small effect size). RRQ: d = .29 (small effect size). Positive	[N.A.]	Compared to walking in urban, the greenspace-based walking decreased greater levels of anxiety, rumination, and negative affect, as well as maintained the more positive affect.	Participants' characteristics have not been considered as a co-variable. No follow-up tests.

				trees. / Walking in a busy street.				affect: d = .61 (medium effect size). Negative affect: d = .68 (large effect size).		
Bratman et al., 2015 (b). USA	General	N = 38 (female = 18) Mean age = 26.6.	RCT with pre-and-p osttest.	Walking in grassland with scattered oak trees and shrubs. / Walking in an urban area.	Single session. /	RRQ; ASL (measuring sgPFC).	RRQ: d = .34 (small effect size). sgPFC: 1.01	[N.A.]	Nature experience reduced rumination and sgPFC activation. Greenspace-based walking has shown more effective on reducing rumination compared with the urban walking.	Did not reveal the mechanism of how nature experience reduced negative repercussions in urban life.
Brito et al., 2019. USA	General.	N = 23 (female = 19). Mean age = 49.3.	Non-RCT crossover design	Walking in the Minnesota Landscape Arboretum. / Walking in paved sidewalks adjacent to medium traffic roads in a medium-densit y residential development area	3-weeks once-weekly sessions. / Both routes took 50 minutes.	STAI; PANAS; BDS task.	[N.A.]	[N.A.]	Green walking reduced state anxiety and improved positive affect better than suburban walking, with green walking eliciting somewhat greater but not significant reductions in negative affect versus suburban walking. Directed attention did not seem to benefit from either green walking or suburban walking in this sample.	No follow-up tests. No simultaneous random assignment to treatment sequence. Outcomes were all measured using self-reported questionnaires. Mistaken wording in scales that could impact the results. Limited sample generalizability (majority being high-educated women of middle- to

										high-income from a single geographic area).
Goulding et al., 2018. UK.	General.	N = 37 (female = 24). Mean age = 24.67.	RCT with pre-and-posttests, and follow-up test after two weeks.	Walking in a large park containing hills. / Walking in a busy shopping street.	Single session. / Both routes were 2 miles long and took around 45 minutes.	WEMWBS; RRQ; SMS; PANAS.	Positive affect:	Positive affect: $\eta^2 = .046$ (small effect size).		
							d = .66 (medium effect size)	Rumination: $\eta^2 = .001$ (small effect size).	Both walking groups showed significant improvement on positive affect, mindfulness, and on reduction of rumination. Increased mindfulness was only associated with decreased rumination.	RRQ was designed as a trait mindfulness measurement, it may not identify short-term changes.
							Rumination: d = .71 (medium effect size)	Mindfulness: $\eta^2 < .001$ (small effect size).	There was no significant effect of mental wellbeing on time, but significant interaction effect of time and group was found, indicating that walking in greenspaces contributed to greater levels of wellbeing than urban group.	
							Mindfulness: d= 1.18 (large effect size)	Mental wellbeing: Not reported		
							Mental wellbeing: Not reported			

Geniole et al., 2016.	Canada.	General	N = 31 (no female). Mean age = 24.61.	Within-subject design with pre-and posttests.	Walking in naturalized landfill with green spaces. / Walking in an urban area.	Single session. / Both routes took 25 minutes.	The Affect Grid (measure mood and arousal).	Mood: $d = .59$ (medium effect size). Arousal: N. A.	[N.A.]	Participants' positive mood increased after walking in greenspaces and decreased after walking in urban.	Urban area used in the study was not 'urban' enough. Sample bias (only included males). Un-standardised measurements.
Hassan et al., 2018.	China.	General	N = 60 (female = 30). Mean age = 19.6.	Crossover study design with pre-and post-tests.	Walking in a bamboo forest. / Walking in an urbanised area.	Single session. / Both routes took 15 minutes.	EEG; STAI.	$d = .32$ (within-subject); Beta wave: $d = .42$ (within-subject); $d = .72$	[N.A.]	Mean meditation and attention scores were significantly increased after walking in a bamboo forest. Walking in the bamboo forest improves mood and significantly reduces anxiety.	Limited sample representativeness – only young females and males were recruited. Only single nature condition introduced.
Johansson et al., 2011.	Sweden.	General.	N = 20 (female = 10). Mean age = 24.2.	Time series within-subject design.	Walking in a park with hardwood trees and grassland. / Walking in street with moderate traffic.	Single session. / 40 minutes for both routes.	EFI.	Revitalisation: $\eta^2 = .084$. Positive engagement: $\eta^2 = .015$. Anxiety/Depression: $\eta^2 = .067$. Anger: $\eta^2 = .415$	[N.A.]	The intervention increased positive affect and reduced negative affect. Greenspace-based walking was more effective on increasing revitalization compared with urban walking.	Single group. Small sample size. Lack of valid measurements. No follow-up.

Koselka et al., 2019.	General USA.	N = 38 (female = 20). Mean age = 22.9.	Between-subject design with pre- and-posttests.	Walking on a forest path. / Walking along a busy road. / A period of activities of daily living.	Single session. / Both routes take 50 minutes.	PANAS; STAI; PSS-10; BDS;	PA: d = .51. NA: d = .61. Anxiety: d = .57. Stress: d = .55.	[N.A.]	Walking in forest path group experienced significantly increase in participants' positive affect, significantly reduce in negative affect, anxiety, and perceived stress. Walking along a city roadside either provided less improvements (negative affect) or declined participants wellbeing (positive affect, perceived stress).	Small sample size and short duration due to the restriction of a pilot study. Potentially influence from a unintentional and undiscovered wording mistake in the STAI scale used.
Keenan et al., 2021.	Individuals with experiences of depression and/or anxiety	N = 50 (female = 30). Mean age = 40.34.	Between-subject design with pre- and-posttests.	Walking in a forest park in lakeside, beach, mountain, forest, and bog areas. / Walking in urban areas through housing estates, town centres, a town park and main roads	30-minutes sessions for five consecutive days.	WEMWBS; PANAS; CNS;	Nature connection: $\eta^2 = 0.34$. Positive affect: $\eta^2 = 0.42$. Negative affect: $\eta^2 = 0.66$. Wellbeing = $\eta^2 = 0.29$ (large effect size for all above variables)	[N.A.]	Significant effect of time by condition on all Variables. Post-hoc tests indicated a significant increase in nature connectedness and positive affect in the nature versus an urban walk at post and follow-up. Negative affect decreased in nature walk at post intervention, while wellbeing was significantly greater in the nature walk at follow-up.	Small sample size of included clinical patients. Potential bias due to lack of pre-made walking leading instructions. Limited investigation in influence of the severity of depression and/or anxiety.

Mayer et al., 2009. USA.	General	N = 76 (female = 51). Mean age not reported.	Between-subject design with pre-and-posttests.	Walking in an open land with wood and grass. / Walking in a concrete area near a building with an adjacent parking lot.	Single session. / Not reported.	PANAS	Not specified.	[N.A.]	Participants in green space walking group reported significantly greater positive emotions than urban walking. Both groups reported almost equal levels of negative emotions.	Lack of statistics that has been reported. No follow-up.
Shin et al., 2011. South Korea.	General	N = 60 (female = 25). Mean age = 23.27.	Counter balanced RCT	Walking in an urban forest park with pine trees. / Walking in downtown.	Single session. / Both groups walked 50 – 55 minutes.	POMS	Tension-Anxiety: d = -.99. Depression-Dejection: d = .90. Anger-Hostility: d = .57. Vigour-Activity: d = 1.19. Fatigue-inertia: d = -1.05. Confusion: d = -1.53.	[N.A.]	Participants' mood significantly improved after walking in forest. Significant within-subject differences were found for the urban walking across all sub-scales excluding Depression-Dejection and Confusion.	Pre-environmental behaviours have not been investigated. No-follow-up.
Song et al., 2014. Japan.	General	N = 17 (no female). Mean age = 21.2.	Within-subject design with pre-and-posttests.	Walking in an urban park with significant greenery. / Walking in an urban area.	Single session. / 15 minutes walking for	POMS; STAI.	Not specified.	[N.A.]	Walking in both routes can decrease anxiety but walking in greenspace improved greater levels of mood state and decreased anxiety than walking in urban.	Small sample size. Sample biased (only included male). Short walking duration.

					each route.					
Song et al., 2015. Japan.	General	N = 23 (no female). Mean age = 22.3.	Within-subject design with pre-and-posttests.	Walking in an urban park with hardwood trees. / Walking in an urban area.	Single session. / 15 minutes walking for each route.	POMS; STAI.	Not specified.	[N.A.]	Walking in both routes can decrease anxiety but walking in greenspace improved greater levels of mood state and decreased anxiety than walking in urban.	Small sample size. Sample biased (only included male). Short walking duration.
							Not specified.			
Song et al., 2018. Japan.	General	N = 585 (no female). Mean age = 21.7.	Crossover study design with pre-and post-tests.	Walking in forest. / Walking in a city area.	Single session. / 15 minutes for both routes.	POMS; STAI.		[N.A.]	Walking through forest areas decreased the negative moods of “depression-dejection”, “tension-anxiety”, “anger-hostility”, “fatigue”, and “confusion” and improved the participants’ positive mood of “vigor” compared with walking through city areas. Furthermore, a significant correlation was found between participants’ trait anxiety levels and their changes in the subscale of “depression-dejection” of POMS after walking through forest areas.	Differences in sites according to region might introduce confounding factors. Restricted generalizability due to limited sample representativeness. Lack of measuring on other relevant wellbeing outcomes. Limited control on participants’ prior expectations and experience with forests.

Song et al., 2019. Japan.	General	N = 60 (female = 60); Mean age = 21.0.	Crossover study design with pre- and post-tests.	Walking in well-maintained forest areas. / Walking in city areas located either downtown or near a Japan Railway station.	Single session. / 15 minutes for both routes.	POMS; STAI.	Not specified. [N.A.]	Scores for the comfortable, relaxed, and natural parameters and vigor subscale of POMS were significantly higher, whereas scores for negative feelings, such as tension–anxiety, depression–dejection, anger–hostility, fatigue, and confusion, were significantly lower, as were the total mood disturbance of POMS and the anxiety dimension of the STAI.	Limited sample representativeness – only healthy female university students in their 20s were recruited. The only physiological indices used were for autonomic nervous activity.

5.4.3 Quality assessment

Amongst the included studies, four were randomised controlled trials (RCT) with two of them being rated as ‘low risk’ of bias (Bratman, Daily, et al., 2015; Goulding et al., 2018) while the other two were rated as ‘some concerns’ of risk bias (Bratman, Hamilton, et al., 2015; W. S. Shin et al., 2011). See Figure 5.3.

Ten studies used observational repeated measures including within-subject design and time-series design with single group participants. They compared the changes in mental health outcomes over time within the same group of participants. Amongst these, two were rated as having relatively high quality (“++”) (de Brito et al., 2019a; Keenan et al., 2021), whereas four studies were rated as medium quality (“+”) (Berman et al., 2012; Geniole et al., 2016; Koselka et al., 2019; Mayer et al., 2009a) and the rest were rated as having low quality (“-”). More details can be found in Table 5.2.

Overall, the quality of the included studies is modest. Nevertheless, the author will not exclude studies of relatively low and medium quality due to the limited number of studies within this research field. However, the reviewer has taken the quality of each study into account to synthesize the evidence and draw an objective conclusion. A meta-analysis was not applicable due to the lack of homogeneity of outcomes measured and intervention structures, thus the data were synthesised narratively.

Study		D1	D2	D3	D4	D5	Overall		
	Bratman et al., 2015b	!	+	+	+	+	!	+	Low risk
	Bratman et al., 2015a	+	+	+	+	+	+	!	Some concerns
	Goulding et al., 2018	+	+	+	+	+	+	-	High risk
	Shin et al., 2011	!	+	+	+	+	!		
								D1	Randomisation process
								D2	Deviations from the intended interventions
								D3	Missing outcome data
								D4	Measurement of the outcome
								D5	Selection of the reported result

Figure 5.3 Risk of bias for RCT studies

Table 5.3 Quality assessment for non-randomised observational studies

Study		Study design	Recruitment and Inclusion Criteria	Allocation Process	Groups similar at baseline	Addressing missing data	Valid and reliable measurement	Follow-up measure	Appropriate analysis	Total score	Overall rating
1	Aspinall et al., 2015	2	1	0	0	0	3	0	2	8	-
2	Berman et al., 2012	2	3	2	2	3	3	0	2	17	+
3	Brito et al., 2019	3	3	1	3	3	3	0	3	19	++
4	Geniole et al., 2016	3	2	0	2	3	3	0	3	16	+
5	Hassan et al., 2018	3	2	0	0	0	3	0	3	11	-
6	Johansson et al., 2011	3	2	0	2	0	3	0	2	12	+
7	Koselka et al., 2019	3	3	1	3	1	3	0	3	17	+
8	Keenan et al., 2021	3	3	1	3	0	3	2	3	18	++
9	Mayer et al., 2009	3	1	2	1	0	3	0	2	12	+
10	Song et al., 2014	2	1	0	1	0	2	0	1	7	-
11	Song et al., 2015	2	1	0	1	0	1	0	1	6	-
12	Song et al., 2018	2	1	0	0	0	3	0	3	9	-
13	Song et al., 2019	1	1	1	2	0	3	0	3	11	-

Notes. Well-covered = 3, Adequately addressed = 2, Poorly addressed = 1, Not addressed = 0.

5.4.4 The effect of nature-walking on mental health

5.4.4.1 Review question one: Changes in mental health after greenspace-based walking

Mood. Participants' mood has been measured in twelve studies using POMS, PANAS, and the Affect Grid. For those studies that used non-randomised observational studies, four of them reported a significant decrease in negative mood after greenspace-based walking but no changes in positive mood (Song et al., 2014, 2015, 2018, 2019). Two studies reported that positive mood significantly improved after greenspace-based walking but there were no changes in negative mood (de Brito et al., 2019a; Mayer et al., 2009a). However, effect sizes were not reported in the above four studies, and insufficient information was provided for the researcher to calculate effect sizes. The other two included studies which measured mood outcomes reported that greenspace-based walking can significantly improve positive mood and decrease negative mood with medium (Koselka et al., 2019) and large effect sizes (Keenan et al., 2021), respectively. In addition, another included study used the Affect Grid (Geniole et al., 2016) to measure mood and found that the positive mood of the participants rose after walking in green space with medium effect sizes. However, the psychometric properties of the Affect Grid have not been clearly reported (J. A. Russell et al., 1989) reducing the reliability of its results. One study that used EEG to measure emotion reported significant differences in emotion changes between two walking places (Aspinall et al., 2015). This study may yield relatively invalid results because it only used mobile EEG instruments to measure emotion; and the sample size was very small ($n = 12$). Johansson and his colleagues' study (2011) used the eight-item Flourishing scale (EFI) to measure emotion, and

significant changes were found after the greenspaces-based intervention on improvement of positive emotion and decreased negative emotion with a medium effect size.

Additionally, three RCT studies that measured mood, and two of them indicated that positive mood improved, and negative mood reduced after greenspace-based walking with small to medium effect sizes (Bratman, Daily, et al., 2015; Goulding et al., 2018); one RCT (W. S. Shin et al., 2011) found a large effect size of changes in negative mood decrease and positive mood improvement (in vigorous-activity).

Amongst those studies, participants in two included studies experienced depression and anxiety, and both negative and positive mood changes after their greenspace-based walking with small to large effect sizes (Berman et al., 2012; Keenan et al., 2021). Overall, taking the results of quality assessment and participant characteristics into account, the included studies show that changes in positive and negative mood after greenspace-based walking can be effectively detected.

Anxiety. Eight included studies measured participants' anxiety levels using STAI. Seven of them are non-randomised observational studies and only one of them is an RCT study, which found that walking in greenspace led to lower anxiety levels with a medium effect size. However, only one included observational study reported effect size (Koselka et al., 2019), and the rest of them did not appropriately report the effect size of changes in anxiety. In the RCT study (Bratman, Daily, et al., 2015), significant effect of time was found with a small effect size, indicating that

participants' anxiety level decreased after the greenspace-based walking intervention.

Rumination and Mindfulness. Amongst the included studies, three evaluated ruminations using the Rumination and Reflection Questionnaire (RRQ), and all of them employed the RCT experimental design. These studies showed lower rumination after greenspace-based walking than before with small (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015) to medium effect sizes (Goulding et al., 2018). Mindfulness was also measured by the State Mindfulness Scale (SMS), and a large effect on time was found, indicating that walking in greenspaces led to an improvement in state mindfulness (Goulding et al., 2018).

Other mental health outcomes. Firstly, mental wellbeing was measured by WEMWBS in two studies, one study did not find a significant effect of time (Goulding et al., 2018), whereas another indicated a large effect of time on changes in mental wellbeing (Keenan et al., 2021). The latter one involves more subjects ($n = 60$) than the Goulding study ($n = 36$), however, Goulding's study employed RCT, and only single walking sessions had been delivered with green walking taking place in an urban park; and Keenan's study used a non-RCT between group study and they ran a consecutive five-day walking intervention in a forest park. As both studies were rated as either 'low risk' and 'high quality', it is very likely that greenspace-based walking could improve one's mental wellbeing.

Secondly, stress levels were measured in two observational studies. Changes in both perceived stress and body stress among participants were found with a medium effect

size (Koselka et al., 2019). However, one study did not report effect size (de Brito et al., 2019a).

Thirdly, the degree of nature connectedness was only measured in one non-RCT between-group study, and a large effect on time was found (Keenan et al., 2021), meaning that the affective relationship with nature improved after green walking.

Lastly, three included studies used either EEG or a brain imaging tool (ASL) to measure changes in rumination, emotion, and mediation (Aspinall et al., 2015; Bratman, Hamilton, et al., 2015; Hassan, Qibing, et al., 2018). Those studies reported medium to large effect sizes of changes in the reduction of rumination and increased meditation as well as optimistic emotion.

In short, to answer review question one, the synthesised findings indicate that participants' degree of positive mood, optimistic emotion, mental wellbeing, and nature connectedness effectively improved, and their levels of anxiety, rumination and stress effectively decreased after greenspace-based walking.

5.4.4.2 Review question two: The effectiveness of greenspace-based walking intervention on mental health outcomes

Only four RCT studies were included in the present systematic review, which measured participants' mood, anxiety, rumination, mindfulness, and mental wellbeing. First, two of them measured mood using PANAS and POMS and reported an interaction effect in time*group (Bratman, Daily, et al., 2015; Goulding et al.,

2018). The two studies only conducted a single walking session. One of them showed that both walking groups showed statistically significant improvement in positive affect, and no group difference was found (Goulding et al., 2018). The other RCT study found a significant interaction effect in time*group on mood, indicating that greenspace-based walking brought greater levels of positive mood and less negative mood than urban walking (Bratman, Daily, et al., 2015). These two studies were rated as 'low risk' of bias, and the characteristics of participants were similar, though one (Bratman, Daily, et al., 2015) contained more participants (n = 60) than the other (Goulding et al., 2018, n = 37).

Secondly, only one included RCT study compared differences in anxiety reduction between green and urban walking groups (Bratman, Daily, et al., 2015). They found a significant interaction effect in time*group in anxiety, indicating that walking in greenspaces reduced anxiety compared with walking urban areas. However, the effect size was not reported.

Thirdly, three included RCTs compared the differences in rumination changes between two walking groups, two of them reported a significant interaction effect in time*group on rumination, meaning that walking in greenspace contributed more to a reduction in rumination compared with urban walking (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015). However, one RCT study did not find significant group differences in changes in rumination or state mindfulness level between two walking groups (nature versus urban) (Goulding et al., 2018). As the two studies (Bratman, Daily, et al., 2015; Goulding et al., 2018) employed the same instrument

to measure rumination, and their walking settings were similar, the differences in their findings may be a result of sample size and other undetected variables. Only Goulding and her colleagues' study tested all variables in a follow-up, however, no between-group differences were identified on mental wellbeing, mood, and rumination.

In summary, greenspace-based walking interventions can effectively reduce participants' anxiety and rumination, but does not significantly improve mental wellbeing. It is still unclear whether green walking can be more effective in improving mood than urban walking.

5.5 Discussion

The present systematic review aimed to investigate the effectiveness of greenspace-based walking interventions on mental health outcomes in adults. The evidence from 17 studies, 16 of them published in academic journals, is synthesised and gaps in the research evidence are discussed below.

Regarding the two review questions, this evidence suggests that adult participants' positive mood, optimistic emotion, mental wellbeing, and nature connection effectively improved, and their levels of anxiety, rumination and stress effectively decreased after greenspace-based walking. In addition, greenspace-based walking interventions were found to be more effective in reducing participants' anxiety and rumination compared with urban walking, no significant between-group differences were found in mood or wellbeing. These findings are consistent with a recent

systematic review, which indicated that various physical activities (i.e. hiking, jogging, walking, etc.) in nature enabled people to reduce their anxiety, negative affect and improve positive affect (Wicks et al., 2022). The current systematic review also found effects of green walking on mental wellbeing, mindfulness, stress, nature connectedness, and rumination.

Furthermore, while the findings of mood enhancement and restorative benefits such as fatigue reduction after greenspace walking intervention may support the Attention Restoration Theory (which posits that attention restoration underlines or mediates the improvements in mood associated with nature connection; see further in 1.2.2.3), one study found that directed-attention did not improve from pre- to post-walk for either condition (de Brito et al., 2019b) and another study reported that nature exposure was not associated with the improved attentional control (Geniole et al., 2016). Therefore, although there may be some synergistic benefits of walking and nature exposure for mood improvements, the mechanism proposed by ART may need further investigation.

Though the present study confirmed greenspace-based walking's effectiveness on several mental health outcomes, there was either a lack of external validity or an inconsistency between the studies included in this review. Though all the measurements used related to mental health, the experimental designs they employed were heterogeneous, so no definite conclusions could be reached. The assessment instruments used in some studies may lessen the validity of the results. For example, Aspinall and colleagues' study (2015) used a low-cost headworn EEG recorder that

failed to stream data occasionally, resulting in missing data. Moreover, the headwear-based equipment may have negatively impacted the mood of the participants while walking outdoors. Goulding and colleagues (2018) also mentioned that some vocabulary in PANAS may be outdated, which may cause some confusion amongst participants. One study (M. Johansson et al., 2011) reflected that some measurements used were low-internally consistent. More specifically, the reviewed studies conducted experiments to examine whether green walking brings greater psychological benefits than non-green walking due to the effects of connectedness with nature, but only one of them assessed and compared participants' degrees of nature connectedness in the two environments (Keenan et al., 2021). Therefore, it is not possible to assess the extent to which environmental differences (green versus non-green) relate to the different psychological outcomes of walking. Further studies are required to explore whether the degree of connectedness with nature predicts the differences in psychological outcomes between walking in nature and walking in urban environments. Lastly, two studies (Geniole et al., 2016; W. S. Shin et al., 2011) mentioned that the types of environments may bring different results and that we should consider the pro-environmental behaviour of participants before the walking intervention because their environmentally friendly lifestyles might already explain some variables about wellbeing improvement.

Furthermore, the sample sizes were very small in some studies included in this review. Four studies mentioned this weakness as a limitation that may lead to inconclusive results. Relatedly, in the studies of Song and colleagues (2014, 2015), only male participants were involved, which potentially reduced the sample's

representativeness when considering the whole realistic population.

Despite each study employing controlled trials to test the differences between walking in green spaces and non-green spaces, it remains difficult to synthesise the results of these studies by using meta-analysis due to different research designs (e.g., the review included both between-subject and within-subject studies). The reviewer decided not to run a meta-analysis to display the overall effect size of green walking among adults for several reasons. Firstly, there were missing values of mean and SD in Bratman's two RCTs studies, and the analysis cannot be run without those values. Secondly, the included studies used various measurements which could not be combined. Even though the fix-effect model may address some of these issues, there were still a few studies that poorly presented the descriptive data and had some missing values.

Other influential factors such as duration of walking and weather can also influence wellbeing. The included studies in this review were conducted in inherently different countries under significantly distinct weather conditions and natural features. Accordingly, weather conditions should be considered and controlled as an important variable so as to interpret properly the results of these studies.

Further randomised controlled trials are required to test the effectiveness of the greenspace-based walking intervention on mental health. This should be done with a randomisation process, pre/post and follow up test, as well as valid measurements implemented to reduce external variables and experimental biases. Most importantly,

it is necessary to explore the mediators between green walking and the improvement of mood and other measures of mental wellbeing.

RCT of nature-based walking might reveal what types of green spaces are most beneficial for mental wellbeing. The studies included in this review varied in many ways making the mechanisms through which nature walks influence mood difficult to discern. The total time of the walking intervention varied throughout the included studies, and the green spaces were often different. Though it is believed that natural environments are beneficial, one study argued that natural green spaces are not always restorative: densely wooded areas and the natural environment may trigger stress and fear (Gatersleben & Andrews, 2013). Furthermore, most of the studies included in this review provided poor descriptions of the green environments the walking took place in and lacked discussions about this.

Despite these limitations (e.g., small sample size), the highly controlled studies identified in this systematic review provide some valuable data and information for future intervention development and practitioners. However, further research on nature-based walking is needed to give more reliable guidance and advice for clinical practice and policymaking.

5.6 Conclusions

The findings of this review highlight that nature-walking, a low-cost and environmentally friendly intervention, helps people maintain and improve mood and mindfulness, and reduce anxiety and rumination. While there is a need for further

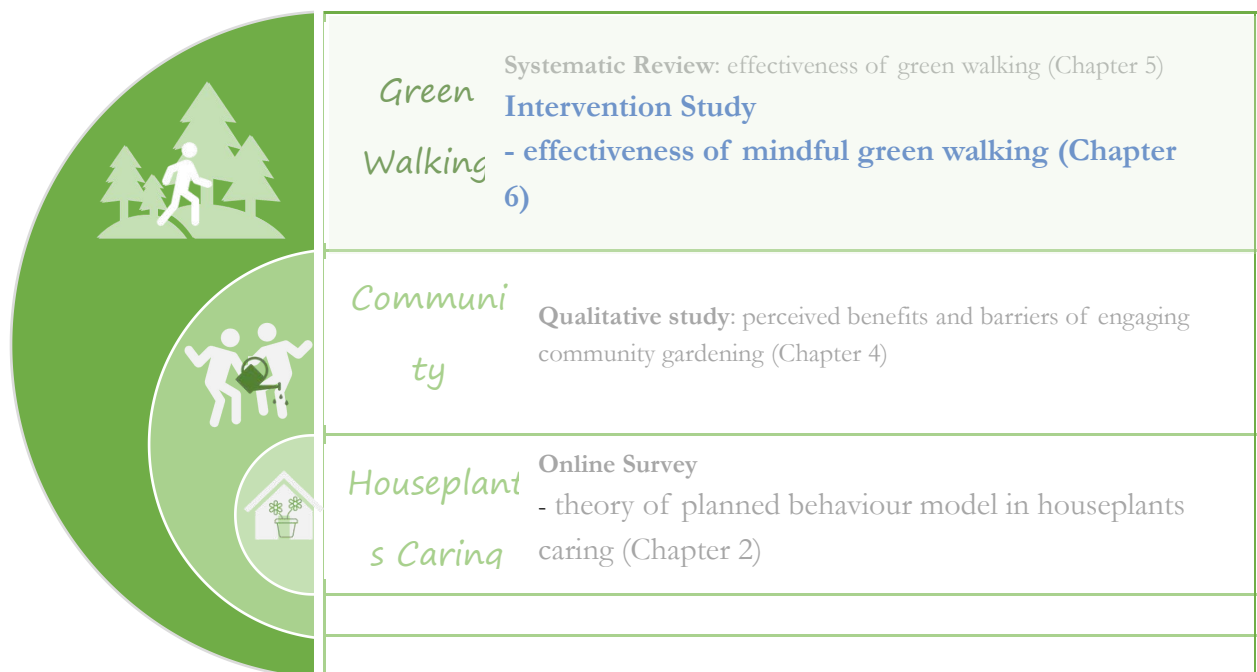
research these findings support policies to plan more urban parks for the purpose of improving people's health and wellbeing. In terms of public health, green space-based walking should not only be viewed as an "intervention"; rather, people should be encouraged to engage in greenspace-based walking and to integrate it into their lifestyle. Further research is required on participants' perspectives on green walking's effectiveness to inform future research and practice.

Chapter 6

Effectiveness of Mindful Walking Intervention in Nature on Sleep Quality and Mood Among University Student during COVID-19: A Randomised Control Study

6.1 Chapter Overview

This chapter reports a randomised control study to test whether outdoor mindful walking in nature can effectively improve university students' sleep quality, mood, and mindfulness during the lockdown of the COVID-19 pandemic in the U.K. It also tested the potential mediating role of sleep quality in the relationship between the intervention and mood.



A version of his chapter has been published: Ma, J., Williams, J., Morris, P. G., & Chan, S. W. (2022). Effectiveness of mindful walking intervention in nature on sleep quality and mood among university student during Covid-19: A randomised control study. Explore (New York, NY). A copy of the paper is shown in Appendix E.

Abstract

Objective: The aim of this project was to conduct a randomised control study to examine whether outdoor mindful walking in nature could effectively improve university students' sleep quality, mood, and mindfulness, and assess the mediating role of sleep quality in the relationship between outdoor mindful walking and decreased mood disturbance, during the lockdown of the COVID-19 pandemic in the U.K.

Methods: Participants were measured at T₀ (pre-study baseline), T₁ (pre-intervention), T₂ (post-intervention), and T₃ (follow-up). A total of 104 participants (female = 94) who were experiencing sleep difficulties were randomly allocated to either an experimental (i.e. nature) or control (i.e. urban) walking environment. Participants in each walking condition independently undertook a daily 35-minute walk for a week (7 days). Subjective sleep quality, total mood disturbance, mindfulness, and degree of nature connectedness, and participants' perspectives and suggestions about the intervention, were collected.

Results: Findings suggest that both groups exhibited significant improvements in participant's trait mindfulness, sleep quality and mood after the intervention. However, mindful walking in nature did not bring additional mental health benefits to participants compared to those who walked in an urban environment. Mediation analyses confirmed that sleep quality was the significant mediator of the relationship between the outdoor mindful walking intervention and mood improvement ($B = .68$; $CI [.49 \text{ to } .88]$). Participants reflected on their perspectives about the intervention, which will assist with further intervention development.

Conclusions: The findings contribute to the evidence base for the effectiveness of

outdoor mindful walking interventions on mental health. These findings add new knowledge of how mindful walking outdoors reduces university students' mood disturbances and improves their sleep quality and mindfulness level during the pandemic. An outdoor mindful walking intervention was associated with a reduction in mood disturbance, which was partially mediated through the improvement of sleep quality.

Keywords: Mindful Walking Intervention, Nature, Sleep Quality, RCT, COVID-19, University Students

6.2 Introduction

College and university students experience a high incidence of mental-health concerns and sleep problems, and these may negatively impact students' mood, stress, and wellbeing levels, and thus impair academic achievement (Schlarb et al., 2017). Up to 60% of university students have experienced sleep difficulties and 20% of students may encounter sleep disorders (Schlarb et al., 2012). A cross-sectional study of 26 countries found that poor sleep quality and other sleep disturbances were experienced by 10.4% of university students (Peltzer & Pengpid, 2014). In the context of the COVID-19 pandemic, university students' lives and studies have been negatively impacted. The mental wellbeing and sleep quality of many students have undoubtedly been harmed by months of enforced quarantine and isolation (Almomani et al., 2021; Kassir et al., 2021; Kutana & Lau, 2021; Quintiliani et al., 2022).

Moreover, mood disturbance is commonly found in university students (Fradelos et al., 2019; Lia et al., 2011), which may negatively contribute to poor academic achievement (Lin et al., 2020) and could be a risk factor for mental illness. According to previous studies, approximately 19.2% of university students experience low mood, which may be due to social isolation, financial stress, and family issues (Demery et al., 2012; Stallman, 2010). The coronavirus disease 2019 (COVID-19) pandemic drastically changed the lifestyle of university students; online educational courses, self-isolation, and frequent lockdown reduced their social and physical activities and increased mood disturbance and sleep difficulties (Charles et al., 2021; Dhar et al., 2020; Ingram et al., 2020; Marelli et al., 2021). Physical

inactivity, which has been defined as achieving less than 30 min of moderately intensive physical activity per week (Pate et al., 1995), was prevalent during the lockdown period (Pinto et al., 2020). This may increase the risk of sleep difficulties and mood disturbance (Knight, 2012).

To encourage physical activity and alleviate sleep and mood disturbance of university students during the lockdown period, outdoor walking in nature might be an effective and accessible solution, which may be effective in reducing anxiety, stress, and rumination, and improving mood, mental wellbeing, and nature connectedness, according to the findings of Chapter 5. However, the evidence is limited and inconclusive. Specifically, it is unclear whether walking in natural environments (e.g., urban park and forest) can be more effective in improving mood than walking in other outdoor settings (e.g., busy urban streets without significant greenery). Relatedly, given that mood and sleep is correlated (Kahn et al., 2013, see 6.2.2 below), it remains unclear whether and how greenspace-based walking improves sleep quality and mood. Also, only one non-RCT study addressed the association between greenspace-based walking and nature connectedness (Keenan et al., 2021).

6.2.1 Nature-based walking, mindfulness (practice), and nature connectedness

According to Attention Restoration Theory (see further in 1.2.2.3), overuse of directed attention may result in mental fatigue and mind-wandering, leading to mood disturbances, while nature connection may reduce concentration fatigue by facilitating people to use effortless attention capturing natural environments,

resulting in attention restoration and mood improvement (R. Kaplan & Kaplan, 1989). The four qualities (fascination, extent, being away, and compatibility) identified by ART that contribute to a restorative experience are regarded as components of human-nature interaction (S. Kaplan, 2001a), instead of external, physical qualities (Pasanen et al., 2018). As proposed by Kaplan (2001a), the role of an individual in need of restoration is an active one. Therefore, *active* engagement with natural environments may enhance the restorative benefits of nature and improve mood (see also 1.3.3).

Drawing on this theoretical framework, several researchers have proposed to strengthen the restorative benefits of nature connection through various engagement interventions, especially mindfulness practice (Duvall, 2011; Kaplan, 2001; Macaulay et al., 2022; Sianoja et al., 2018). When people spend more time in natural environments, greater present-moment awareness (a facet of mindfulness) is experienced (Wolsko & Lindberg, 2013). While mind-wandering was found to be the mediator between mindfulness and negative mood, trait mindfulness is positively associated with positive mood (Y. Wang et al., 2017). In this light, mindfulness practice may strengthen mood-improvement as one of the mental health benefits derived from human-nature interactions.

As mindfulness practice emphasises our present moment awareness of body movements (Longshore et al., 2019a), light physical exercises are incorporated into mindfulness practice, such as basic body stretch, yoga, or walking (Beddoe et al., 2010; Kabat-Zinn, 1994b). Mindful walking can be implemented as a self-guided

practice or as a formal 4-week mindfulness-based intervention for one's health benefits (Teut et al., 2013b). Mindful walking appears to facilitate one's feeling of "being there," wherein the combination of light physical exercise and the practice of meditation can reduce the sedentary behaviour that occurs during routine meditation practice (Sitzman, 1999). There is some evidence for the psychological effects of mindful walking as a special intervention for mental health promotion, especially positive mood improvement and stress reduction (Gotink, Hermans, Geschwind, De Nooij, et al., 2016; Prakhinkit et al., 2014; Robert-McComb et al., 2015; Teut et al., 2013a; Yang & Conroy, 2019). The effectiveness of mindful walking may be related to the physical activity component of the interventions (Barton et al., 2009), while mindfulness practice may in turn enhance engagement and performance in physical activity (Butryn et al., 2011; Jones et al., 2021; Salmon et al., 2010; Ulmer et al., 2010).

Moreover, as discussed above (1.2.3.2 & 1.3.3), nature connectedness may be positively associated with subjective mental wellbeing (e.g., Capaldi et al., 2014; Mayer & Frantz, 2004) and psychological restoration (Mayer et al., 2009b; Whitburn et al., 2019, 2020; Wyles et al., 2019). A meta-analysis suggested that trait mindfulness was positively associated with nature connectedness, and the longer the participants were involved in the study, the larger the effect size of these two variables (Schutte & Malouff, 2018). Also, Nisbet and colleagues (2019) found that mindfulness practice may strengthen the mental health benefits of nature connection by increasing the level of nature connectedness.

In light of these, mindfulness practice may strengthen the effects of improvements in mood, nature connectedness, and mental health accumulatively derived from nature connection (e.g., [Hartig et al., 2014](#)) and walking (e.g., [Barton et al., 2009](#); [Nisbet et al., 2019](#)). Exploring mindfulness practice's role in nature walking interventions, the current study evaluated the effectiveness of a mindfulness-based walking intervention in improving the mental health of university and college students.

6.2.2 Nature-based walking, sleep, and mood

There is some evidence that walking may enhance overall sleep quality at night ([Hartescu et al., 2015](#); [F. Wang & Boros, 2020](#)). Some mixed outcomes, however, were found regarding the relationship between walking and sleep. For instance, one study found that walking interventions improved perceived sleep quality but not objective sleep duration or sleep latency ([Hori et al., 2016](#)). By contrast, a RCT study indicated that walking interventions improve both subjective *and* objective sleep quality among menopausal women ([Najafabadi et al., 2017](#)). The mixed outcomes may reflect demographic variations in the samples that these studies employed and differences in the context of the walking interventions.

Nevertheless, a recent systematic review ($n = 13$) found that sleep quality and quantity may be improved by nature exposure ([J. C. Shin et al., 2020](#)) and a positive association between nature-based walking and sleep quality has been suggested in research on green exercise and therapeutic gardening ([Gladwell et al., 2016](#); [Morita et al., 2011](#); [J. C. Shin et al., 2020](#)). In addition, several studies have found that mindfulness practice or movement-based meditation may improve sleep quality

among older adults (D. S. Black et al., 2015; Irwin et al., 2008; F. Li et al., 2004). Whether mindful walking may improve sleep quality, however, remains under-researched.

Relatedly, it has been identified that sufficient sleep contributes to optimal mood and the ability to regulate emotional (Kahn et al., 2013; Watling et al., 2017). A systematic review and meta-analysis ($n = 74$) showed that short sleep is a universal risk-factor for mood deficits (Short et al., 2020). Another systematic review indicated that self-reported low sleep quality predicts depression or depressive symptoms among college students (Dinis & Bragança, 2018). The current evidence suggests that there is a complex and bidirectional relationship between sleep and emotion (Kahn et al., 2013). Regarding the intimate relationship between sleep and mood (Vandekerckhove & Wang, 2017), the mood improving benefits of the nature-based walking may also be related to sleep quality. It remains unclear, however, whether the mindful walking intervention influences sleep quality or whether sleep quality mediates the effects of nature-based walking on mood.

6.2.3 The present study

As university students were found to struggle with mood and sleep difficulties during the COVID-19 pandemic, it is desirable to encourage them to perform mindful walking which may positively affect their mood and sleep, and good sleep quality could decrease their mood disturbance. For the sake of developing an effective and accessible intervention for improving the mood and sleep quality of university students and addressing some of the gaps in the evidence base, the current RCT study

was designed to investigate whether nature-based mindful walking in nature is an effective intervention to improve university students' levels of nature connectedness, mindfulness, mood, and sleep quality. The research questions and hypotheses were as follows:

- 1 Will mindful walking improve sleep quality and mood, regardless of the walking environment?

Hypothesis 1: mindful walking in both nature and urban environments would improve participants' sleep quality, mood, nature connectedness and mindfulness.

- 2 Compared with walking in urban environments, will 'nature walking' bring additional benefits in terms of mindfulness, nature connectedness, mood, and sleep quality?

Hypothesis 2: green walking would significantly improve greater levels of mood, sleep quality, mindfulness, and nature connectedness than urban walking.

- 3 Does sleep quality mediate the association between the intervention and mood?

Hypothesis 3: sleep quality mediates the relationship between the outdoor mindful walking intervention and mood improvement.

6.3 Materials and methods

6.3.1 Participants

Using G*power software (Faul et al., 2007), a-priori power analyses assumed a small effect size ($f^2 = 0.25$) and 5% α error probability (Lakens, 2022), it was estimated that a sample of 32 participants would be sufficiently powered to carry out the

planned analyses (see below for details).

Leaflets were distributed across university campuses and student accommodation and the study was promoted via social media to recruit potential participants. The researcher contacted various departmental administrators who helped to spread the word (i.e., retweet the Twitter request, email the students) about this study. Interested individuals were invited to contact the principal researcher to obtain an information sheet and consent form. If the participants were willing to take part in the study, the researcher confirmed their eligibility for participation, and a pre-study baseline test with a formal consent form was provided for the participants. Additionally, the participants were given a written “Outdoor Mindful Walking Instruction,” which contained step-by-step guidance on how to walk mindfully (see Appendix D). For example, the participants were trained to walk with present-moment awareness and observe their body sensations and surroundings while walking, take notice of their breathing pattern, and pay attention to their walking footsteps without making judgements about their feelings.

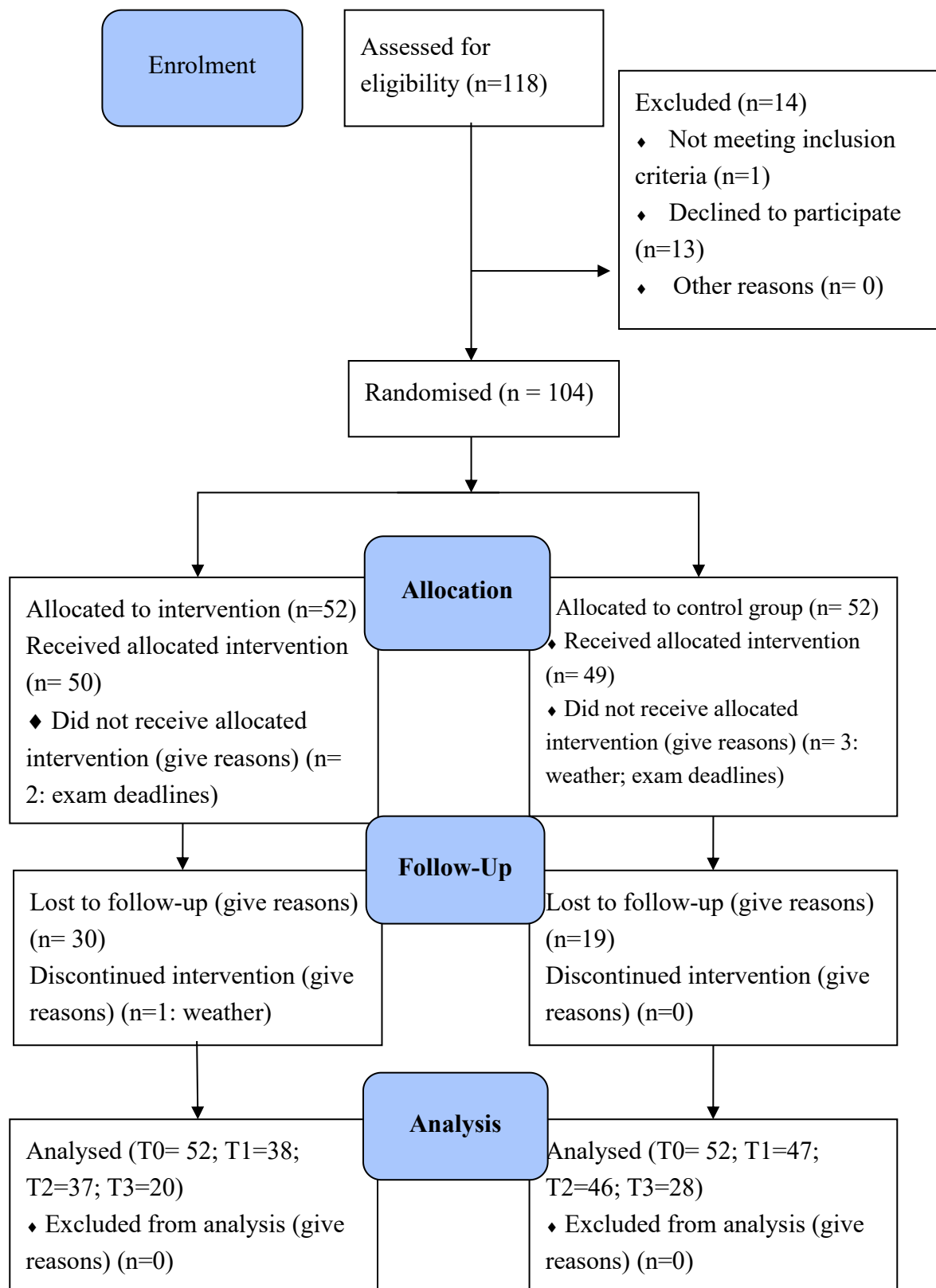
A total of 118 university students registered their interests in this project, and 104 ($m = 23.6$ years, 90.4% female) consented to participate in the intervention between March and June 2021. Each group had been assigned 52 participants, however, only 50 and 49 participants started the intervention in nature and urban groups, respectively. Two participants in the nature group and three participants in the urban group gave reasons for their withdrawal. After the intervention, only 20 and 28 participants from the nature and urban groups were tested in follow-up. For the

online questionnaire, 38 and 47 participants completed the survey in the nature and urban groups at T1, respectively, and each group lost one participant at T2. Additionally, only 61 sleep diaries were returned to the researcher (nature = 28; urban = 33). The Consort Flow Diagram in Figure 6.1 shows more details about the allocation.

6.3.2 Inclusion and exclusion criteria of participants

Participants were eligible for inclusion if they were: 1) adult university or college students (aged 16 and above); 2) self-identified as experiencing some level of sleep difficulties; 3) not in receipt of treatments for sleep problems, formally or informally, within the preceding six months (e.g. using sleep medicines or accepting psychological training for sleep difficulties); 4) self-identified as having sufficient English-language proficiency to fill in the questionnaires. Individuals who perceived themselves to be in high-risk categories regarding COVID-19 were excluded. Individuals with disabilities that might impede their engagement in a daily walking intervention were advised not to participate.

Figure 6.1 CONSORT flow diagram. Randomised allocation to intervention environment (natural/urban) from enrolment to allocation time and to the follow-up test.



6.3.2 Intervention

6.3.2.1 Randomisation

This study employed a randomised controlled trial design. Participants were randomly assigned to either the experimental (i.e., nature) or control (i.e. urban) mindful walking groups.

Participants first completed the baseline measurements online, and they were randomly assigned into groups afterwards. A randomisation strategy was employed to minimise the variability of the evaluation, and to avoid confounding variables from other known and unknown factors (Altman & Doré, 1990). Since the sample size of the current study was relatively small ($n = 104$), merged block randomisation was employed to allocate participants to each group (van der Pas, 2019). A randomised list was generated using Microsoft Excel.

6.3.2.2 Nature versus urban mindful walking

The natural setting was a public park (see Figure 6.2.1), comprising a large area of open grassland crossed by a line of trees; it covers 58.4 acres in total. The urban route was designed by the researcher (see Figure 6.2.2). The latter is the city's busiest commercial street, comprising many shops, tall buildings, crowds of tourists and shoppers, and heavy traffic. However, it does run next to large formal gardens and is overlooked by the historic Edinburgh castle. All aspects of the urban walking intervention were equivalent to those of the nature walking group except for the environment. Both routes were chosen with due consideration for safety (see further in ethics consideration in 6.3.5), and each took roughly 30-35 minutes to walk at a moderate pace.

Figure 6.2.1 Route map and inset photographs of the natural environment walk

The designed route is displayed as a red line. The photo in left hand and right hand were taken in February and May of 2021, respectively, by the researcher of this study. Copyright of these photos is reserved.

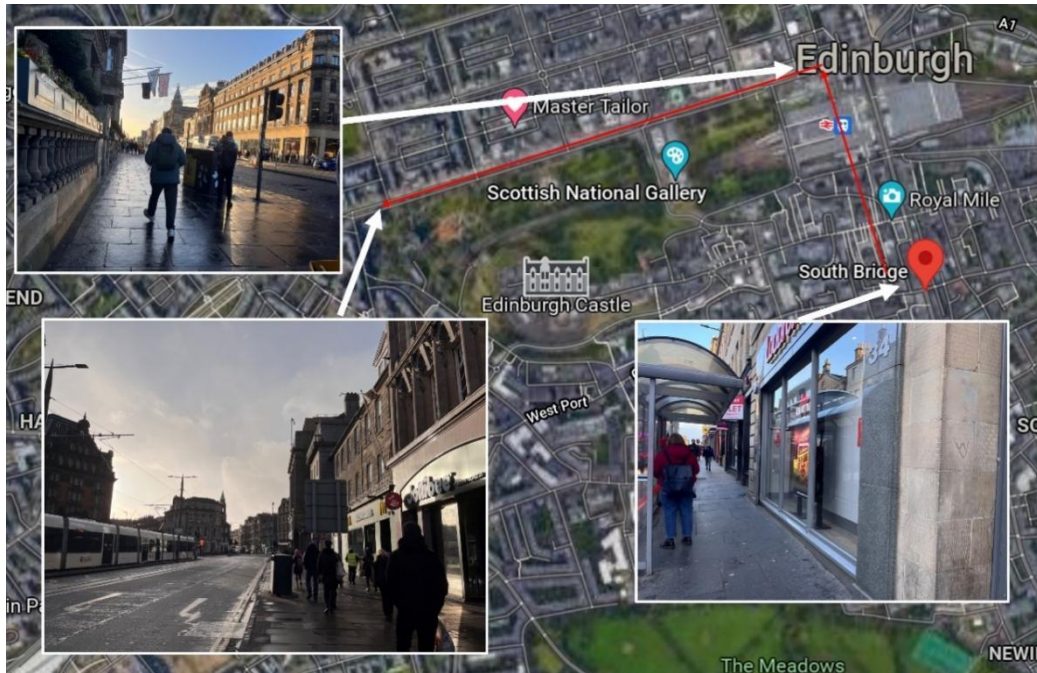
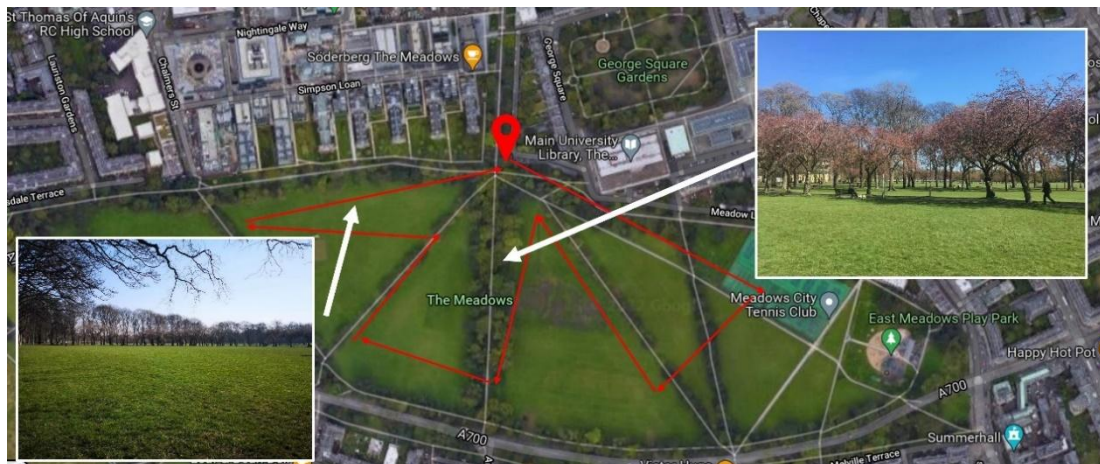


Figure 6.2.2 Route map and inset photographs of the urban environment walk

The designed route is displayed as a red line. The photo in left hand and right hand were taken in February and May of 2021, respectively, by the researcher of this study. Copyright of these photos is reserved.



A guide on mindful walking was developed by the researcher based on previous published guidance for walking meditation (Amaro, 2019; Mantzios & Giannou, 2018; Nisbet et al., 2019) and sent to each participant before they started the walking intervention (see Appendix D). The mindfulness instruction focused on teaching participants to observe their body movements, their breath, and to be “in the present moment”. The researcher gave clear guidance in advance regarding how to be mindful while walking to ensure the participants fully understood how to mindfully walk and be involved in the environment around them.

6.3.3 Evaluation Procedures and Measures

All the standardised questionnaires except the sleep diary were completed digitally via Jisc Online Survey. The outcome measures included participants’ subjective sleep quality, mood states, physical-activity (PA) levels, degrees of nature relatedness, and *state* and *trait* mindfulness. A sleep diary has been inserted into a word document, including questions regarding consumption of sleep-affecting stimulants (e.g., daily caffeine and alcohol, as well as seven repeat questions about participants’ walking time (e.g., what time do you take your walking today? From _ am/pm to _ am/pm?).

Demographics. Questions regarding demographic variables included gender, age, educational level, and status regarding weekly physical activity. Participants’ previous experience of walking in nature and exposure to nature, accessibility to green spaces (e.g., whether they lived near or far away from green spaces), mental-health conditions, and treatment history regarding sleep difficulty (if any), were also recorded.

Sleep quality. Two self-reported measures of sleep were employed: 1) The Pittsburgh Sleep Quality Index (PSQI) is a self-reported questionnaire that contains four open-ended questions regarding an individual's sleep habits. The remaining 'component scores' address a variety of factors, namely: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, daytime dysfunction, and overall rating of sleep quality in the last month (Buysse et al., 1989). A single global score is used to represent the entirety of the responses: the higher the global score, the poorer the sleep quality. The internal consistency ($\alpha > .70$) of PSQI has been found to be adequate (Mollayeva et al., 2015). It has also been widely reported that PSQI is a valid and reliable tool to assess sleep quality among different populations (Beaudreau et al., 2011; Netto et al., 2011; Spira et al., 2012); 2) The Core Consensus Sleep Diary (CCSD) is a standardised and validated tool for assessing subject-perceived sleep quality (C. E. Carney et al., 2012). The sleep diary assesses sleep time, awake time, frequency of awakening, total duration of sleep time, final awakening time, and time of getting out of bed.

Mood. The Short Form of Profile of Mood State (POMS-SF) was used to measure participants' daily mood states before and after their walking sessions. It is also highly flexible in capturing a participant's mood over the course of one week, as it captures his/her mood, in the preceding week, 'today' and 'right now' (McNair et al., 1981). The standard version includes 65 items with a five-point Likert response scale ranging from 'not at all' to 'extremely'. This study used the POMS short version of

37 items (Shacham, 1983). The internal consistency of the short-version POMS is comparable to that of the original version ($.75 < \alpha < .92$) among both clinical and non-clinical samples (Curran et al., 1995; Shacham, 1983).

Physical activity (PA). The short form of International Physical Activity Questionnaire (IPAQ) includes seven questions relating to the duration of vigorous/moderate physical activities, as well as walking and sitting, that participants had engaged in during the preceding week (Booth, 2000). A robust level of stability is reflected in the test-retest reliability data ($\alpha < .80$) (Booth, 2000). The internal reliability is also adequate ($.79 < \alpha < .98$) (Ács et al., 2021).

Caffeine and alcohol consumption. As stimulants, alcohol and caffeine have the potential to disrupt or interrupt sleep, participants' daily caffeine and alcohol intake was recorded using the stimulant section of the Munich Chronotype Questionnaire (MCTQ) (Roenneberg et al., 2003, 2008). The stimulant section contains eight questions regarding all relevant variables that may negatively impact sleep quality, such as cigarette use, alcohol intake, coffee intake, soft-caffeinated-drink intake, tea consumption and use of 'sleep medicine'. Participants were required to report the frequency of taking such stimulants (i.e., per day/week).

Nature Connectedness. The degree of nature connectedness was measured by the Nature-Relatedness Scale, which includes six short questions with a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) to assess the strength of one's connectedness to nature (Nisbet & Zelenski, 2013). The NR-6 scale has proven

robust in terms of both internal consistency and reliability ($\alpha = .83$) (Nisbet & Zelenski, 2013).

Mindfulness. Two measures were used to capture changes in mindfulness levels before and after walking. The Mindful Attention Awareness Scale (MAAS) and the Toronto Mindfulness Scale (TMS) were used to assess *trait* mindfulness and *state* mindfulness, respectively. MAAS was designed to measure changes of an individual's trait-mindfulness level over time and has exhibited good psychometric properties ($\alpha = .83$). It has also been widely used across a range of different samples (Barros et al., 2015; Brown & Ryan, 2003). Additionally, the TMS was designed to evaluate state mindfulness which reflects the instant changes in mindfulness levels before and after each walking session. It has also shown robust levels of internal consistency and validity ($.84 < \alpha < .88$) (Lau et al., 2006).

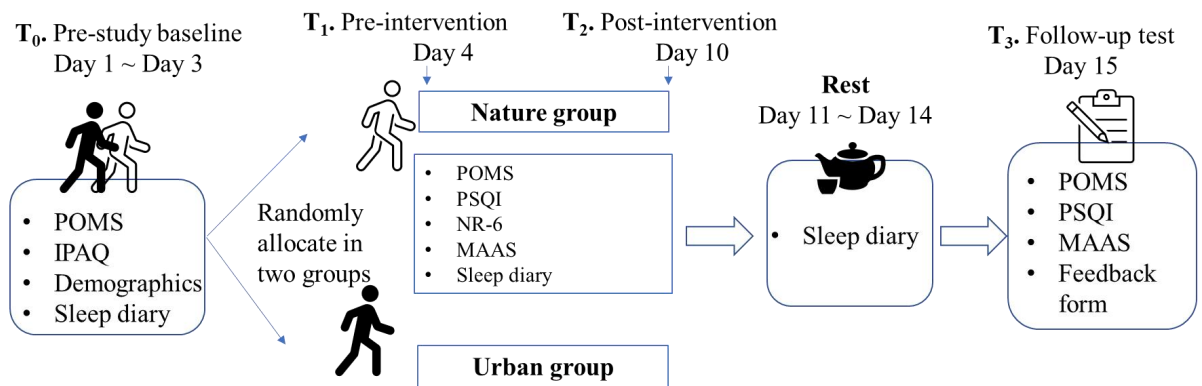
Feedback form. Two open ended questions were asked in the follow-up test, which are: 1) what feedback for the intervention would you like to provide (both positive and negative aspects)? 2) do you have any suggestions for this intervention?

The study took 15 days in total, day one to day three were the baseline period, and participants started a one-week daily walking intervention from day four to day ten. The outcome variables were measured at four time points: pre-study baseline (T_0), pre-intervention (T_1), post intervention (T_2), and follow-up (T_3) five days after the post-intervention. Notably, state mindfulness was tested before and after each daily walk. The sleep diary was completed every day across 15 days from phase one to

phase four. More details of the timing of the measurements are shown in Figure 6.3 below.

Figure 6.3 *Measurements and Procedure of Data Collection.*

Note. The TMS was measured immediately before and after each walking intervention, therefore the participants filled the TMS twice a day during Phase 2.



During Phase one (day 1 - day 3), pre-study baseline data was collected (T₀), including demographic information, sleep quality, mood states, PA, and mood. Except for the sleep diary, all other measures were completed once, even though the phase lasted for three days.

In Phase two (day 4 - day 10), participants undertook their walking interventions every day for a week. Data were collected at T₁ for the pre-intervention test on the first walking day. They were asked to complete POMS, PSQI, MAAS, and NR-6. The T₂ data collection took place on the last walking day using the same measurements as in T₁. TMS was completed before and after each walking session.

In Phase three (day 11 - day 14), participants ceased walking and rested for three

days, but were asked to continue maintaining their sleep diaries. During this phase, participants should do as little physical activity as they can, and the researcher did not monitor this element.

In Phase four (day 15), at the T₃ data collection point, the researcher sent the follow-up assessment (using POMS, MAAS, PSQI and a feedback form) to the participants.

6.3.4 Statistical analysis

IBM's SPSS 25 statistics software was used. Descriptive statistics were explored, and the Shapiro-Wilk test was adopted to test parametric assumptions and the violation of assumptions. For all continuous variables that were measured at the baseline, only scores of the vigorous physical activity level were not normally distributed (see more details in Table 6.1). Therefore, parametric tests were used for the research hypotheses. As the sample size dropped from T₁ (n = 85) to T₃ (n = 48), for the sake of ensuring the power of statistical analysis, two separate ANOVAs were conducted to compare the effects of the intervention from T₁ to T₂, and T₂ to T₃, respectively, instead of 2*3 ANOVAs. A series of independent sample t-tests were employed to explore the differences in variations from baseline on the measured dependent variables. For mediation analysis, the Hayes' Process macro was used to estimate the direct and indirect effects of the predictor variables on the outcome variable. For the open-ended questions regarding the feedback, content analysis was adopted to summarise the key information and generate themes (Drisko, 2015). The following steps were performed to analyse qualitative data in the current study:

familiarise with the contents, initial coding, structuring codes, generating themes, and defining the themes (Bengtsson, 2016).

6.3.5 Ethics consideration

Ethical approval was granted by the Clinical and Health Psychology Ethics Committee (reference number: CLIN813). As this study was conducted after lockdown and during the COVID-19 pandemic, participants in both walking groups were reminded to follow the latest government rules (two metres social distancing). The participants chose their own times for walking, did not meet each other, were not accompanied by the researcher or other friends, and walked alone in either an urban or natural setting. The researcher also reminded participants to wash their hands carefully before and after the walking sessions.

The routes were chosen for safety's sake. Both the meadows and Prince Street were safe and easily available for most of the university and college students (1-10 mins walk). Despite some built or urban features around the meadows, it was safe and accessible as it is adjacent to the Main Library. Likewise, although Prince Street is not completely free from greenery, it is the busiest place in Edinburgh and near most of the study and accommodation areas for the students. The researcher fully understood that for this study, it may be better to choose, for instance, a route around Holyrood Park (which has an array of hills, lochs, glens, and ridges). However, because the researcher and sponsor were responsible for the safety of the participants, any risks that the activity entailed must be low in any case since it was conducted outdoors.

6.4 Results

6.4.1 Sample Characteristics

The descriptive statistics shows the mean and standard deviation of the tested variables at baseline (see Table 6.1). Based on Table 6.1, the mean age of the participants was 23.6 years, and the gender distribution was skewed, with 94 females and 10 males. Most participants were postgraduate students ($n = 87$, 83.7%), and only seven participants were undergraduates. Most participants experienced sedentary behaviour and spent more time sitting than being physically active. In addition, the majority of participants accessed natural environments once a week and lived within 1 mile of natural greenspaces. For the average physical activity level, sedentary behaviour was reported by most participants., implying participants were likely to spend more time sitting than doing exercise in the recent week. Mood was assessed using the Total Mood Disturbance (TMD) scale. Furthermore, 66.3% of the participants had never received treatments regarding sleep difficulties, whereas the rest of them had received various treatments more than six months ago.

Table 6.1 Sample characteristics and outcome variables at pre-study baseline.

Variables N =104	Descriptive Statistics	Mean (SD) /Frequencies (%)	95%CI for mean [Lower Bound, Upper Bound]	Shapiro- Wilk test (<i>p</i>)
Age (mean, SD)	23.6 (2.23)			
Gender (female/male)	94:10			
Level of education	Undergraduate	7 (6.7)		
N (%)	Postgraduate (master)	87 (83.7)		
	Postgraduate (PhD)	10 (9.6)		

Frequency of	Never	3 (2.9)		
Accessing natural	Once a week	51 (49)		
environment N (%)	2 ~3 times a week	35 (33.7)		
	Over 3 times a week	15 (14.4)		
Distance of living	< 1 mile	63 (60.6)		
from natural	1~3 miles	36 (34.6)		
greenspaces N (%)	4~6 miles	3 (1.9)		
	> 10 miles	3 (2.9)		
Treatment history	Pills	7 (6.7)		
of sleep difficulties	Psychotherapy	2 (1.9)		
N (%)	Non-medical	7 (6.7)		
	supplements			
	Deep breathing/ relaxing/meditation	18 (17.3)		
	All above	1 (1)		
	Never	69 (66.3)		
Physical activity	Vigorous	207 (186.27)	-24.28, 438.28	<.001
level (mean/SD)	Moderate	165 (135.83)	-3.66, 333.66	.64
	Walking	204 (138.13)	32.49, 375.51	.26
	Sedentary	420 (120)	271, 569	.44
Mood (mean/SD)	Total mood			
	disturbance (TMD)	28.58 (3.80)	23.87, 33.3	.19
	Depression	083 (1.03)	-.46, 2.11	.04
	Vigour	2 (.66)	1.18, 2.82	.64
	Confusion	1.90 (.96)	.69, 3.09	.06
	Tension	1.57 (.81)	.55, 2.58	.87
	Anger	.54 (.71)	-.34, 1.42	.12
	Fatigue	1.76 (.74)	.84, 2.68	.98

6.4.2 Exploratory Data Analysis

Table 6.2 Summary results table of outcome means and SD from T_1 to T_3

Outcome measures Mean (SD) [95%CI ^a]	Nature			Urban		
	T1 (n = 38)	T2 (n = 37)	T3 (n = 20)	T1 (n = 47)	T2 (n = 46)	T3 (n = 28)
PSQI	5.32 (3.03) [4.31; 6.33]	3.89 (2.42) [3.08; 4.70]	5.0 (2.16) [4.12; 6.18]	5.09 (2.67) [4.27; 5.91]	4.57 (3.14) [3.49; 5.37]	5.71 (2.88) [4.60; 6.83]
MAAS	2.77 (1.14) [2.19; 3.17]	3.0 (.88) [2.72; 3.31]	3.11 (.77) [2.74; 3.47]	2.64 (.92) [2.35; 2.92]	3.02 (.70) [2.80; 3.24]	3.13 (.83) [2.80; 3.45]
NR-6	2.50 (.68) [2.28; 2.73]	2.77 (.73) [2.53; 3.02]	-	2.53 (.84) [2.25; 2.77]	2.58 (.79) [2.33; 2.81]	-
TMD	29.77 (4.27) [28.20; 30.99]	27.34 (3.95) [26.12; 28.76]	26.40 (3.24) [24.89; 27.92]	29.16 (4.37) [27.83; 30.49]	27.77 (3.74) [26.64; 28.91]	26.70 (3.88) [25.17; 28.13]

Note. ^a CI: Confidence Interval. PSQI represents the global score; a higher score indicates poorer sleep quality. POMS-SF represents the total mood disturbance (TMD); a higher score indicates greater levels of mood disturbance.

Table 6.3 Within-subject changes of the measured outcomes from pre-to post-walking

Outcome measures	T ₁ (n = 81)	T ₂ (n = 81)	Overall (n = 166)	Changes from T ₁ to T ₂ (n = 81)	<i>p</i>
Mean (SD) [95% CI ^a]				(df = 80)	
PSQI	5.20 (2.84) [4.59, 5.81]	4.18 (2.81) [3.59, 4.83]	4.72 (2.86) [4.30, 5.14]	-1.01 (3.34) [-1.75, -.26]	2.72 <.01
POMS-SF	29.36 (4.27) [28.43, 30.30]	27.62 (3.81) [26.80, 28.47]	28.50 (4.13) [27.88, 29.14]	-1.74 (5.97) [-3.03, -.48]	2.62 .01

Independent t-tests show that sleep quality (PSQI: $t = .45$, $p = .66$), total mood disturbance (TMD: $t = .81$, $p = .42$), trait mindfulness (MAAS: $t = .63$, $p = .53$), and nature relatedness (NR-6: $t = -.18$, $p = .86$) were not significantly different between the two walking groups at T1, indicating that the two groups were matched at baseline (Table 6.2). The representation of adequate randomisation was observed, and an ANOVA analysis did not incorporate the covariates.

According to Table 6.3, the results indicate that there were improvements in both sleep quality and mood states from T1 to T2. Specifically, the mean PSQI score decreased from 5.20 (SD = 2.84) at T1 to 4.18 (SD = 2.81) at T2, with an overall mean of 4.72 (SD = 2.86). The mean POMS-SF score decreased from 29.36 (SD = 4.27) at T1 to 27.62 (SD = 3.81) at T2, with an overall mean of 28.50 (SD = 4.13). Moreover, statistical analysis revealed that the changes in both sleep quality and mood states from T1 to T2 were significant. The t-test results showed that the changes in PSQI and POMS-SF scores were statistically significant ($t = -1.01$ and -1.74 , respectively) with p-values less than .01 and .05, respectively. These results suggest that mindful walking may have a positive impact on sleep quality and mood states.

Table 6.4 presents the data from the sleep diary, which reflected participants' sleep patterns regarding bed duration, sleep duration, and sleep efficiency from the duration of the pre-study baseline, intervention days, and follow-up duration. Independent t-tests showed no difference between the intervention groups during the pre-study baseline and intervention days. During the follow-up, bed duration and

sleep duration were significantly different between the two groups, with a medium effect size. For sleep efficiency, during the follow-up period, the nature walking group reported a mean sleep efficiency of 0.85 (SD = 0.19) while the urban walking group reported a mean of 0.84 (SD = 0.11), and the difference was not statistically significant ($t = 0.27$, $p = .79$, $d = .06$). Sleep diaries showed that participants' bed duration, sleep duration, and sleep efficiency have not increased from baseline to the intervention days; however, the nature walking group reported greater levels of the above three measured outcomes regarding sleep quality than the urban walking group.

Table 6.4 Descriptive data analysis and Independent T-test of the sleep diary (n = 69)

Note. Three diaries are excluded due to incomplete answers. Mean summary scores of each category regarding the sleep quality were reported.

Outcome measured (Mean/SD)		Group		T-test Statistics			
		Nature (n=36)	Urban (n=33)	<i>t</i>	<i>p</i>	95%CI ^a	Cohen's <i>d</i>
Baseline (Day 1 – 3)	Bed duration	8.58 (1.64)	8.82 (1.21)	.70	.97	[-.94, .46]	.17
	Sleep duration	7.67 (1.46)	7.59 (1.14)	.25	.80	[-.55, .71]	.06
	Sleep efficiency	0.90 (0.10)	0.86 (0.10)	1.66	.19	[-.01, .09]	.40
Intervention (Day 4 – 10)	Bed duration	8.76 (1.24)	8.19 (1.26)	1.89	.12	[-.05, 1.19]	.46
	Sleep duration	7.12 (1.19)	6.90 (0.99)	.84	.80	[-.32, .76]	.20
	Sleep efficiency	0.85 (0.07)	0.82 (0.11)	1.34	.36	[-.02, .08]	.33

Follow-up (Day 11- 15)	Bed duration	8.58 (1.59)	7.58 (1.64)	2.49	.03	[.18, 1.82]	.60
	Sleep duration	7.13 (1.33)	6.37 (1.48)	2.24	.05	[.06, 1.45]	.54
	Sleep efficiency	0.85 (0.19)	0.84 (0.11)	.27	.79	[-.06, .09]	.06

Note. ^aCI: Confidence Interval.

Figure 6.4 Frequency of walking starting time

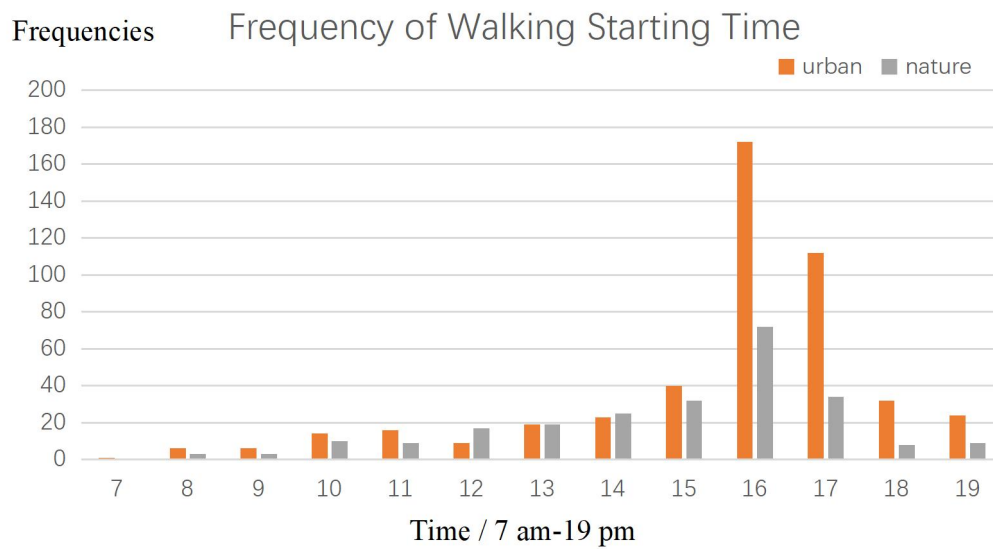


Figure 6.4 shows that participants in both groups frequently started their walks from 16:00 to 17:00 on seven walking days. An independent sample t-test showed that there was no statistically significant difference between two group participants on walking duration in minutes: $t(57) = -1.78, p = .08$. Additionally, the Shapiro-Wilk test indicates that walking duration was not normally distributed ($p < .001$).

Table 6.5 Descriptive statistics of stimulants related to sleep quality.

Note. Mean summary scores were used to represent the overall consumption of stimulants.

Stimulants (per/week)	Nature (n = 28)	Urban (n = 33)
Cigarettes	0	0.1
Beer	0.25	0.65
Wine	0.39	0.1
Liquor	0.22	0.43
Coffee	1.14	2.84
Soft drinks	0.74	1.07
Black tea	2.81	3.55
Sleep medication	0.01	0.13
Overall	0.70	1.11

Table 6.5 shows the number of stimulants that affect sleep that participants have taken per week. The independent sample test showed that the consumption of stimulants for both group participants was not statistically significant: $t(59) = -1.22$, 95%CI [-1.08, .26], $p = .23$. The Shapiro-Wilk test indicated that stimulants were not normally distributed ($p < .001$). A simple linear regression test revealed that stimulants did not statistically impact on participants' sleep quality after the intervention for either group: $F(1, 57) = 1.05$, $R^2 = .02$, $b = .29$, 95%CI [-.28, .85], $p = .31$.

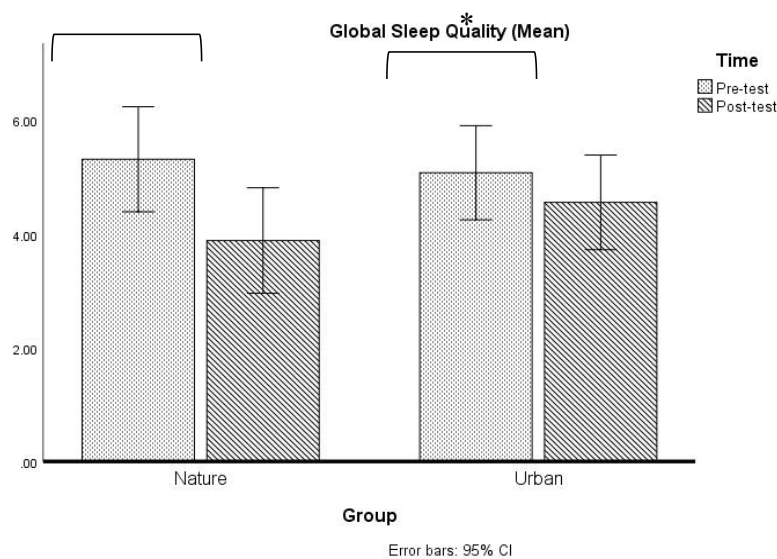
6.4.3 The effectiveness of the intervention

A series of 2 (Group type: Nature, Urban) $\times$ 2 (Time: T₁, T₂) ANOVAs with repeated measurement on the Time were conducted on the sleep quality, mood, nature connectedness, and mindfulness scales. The results revealed significant effects of

time on sleep, mood, and trait mindfulness. However, there was no significant interaction effect on group or time for the measured outcomes.

Sleep quality. There was no significant interaction between group and time on sleep quality, $F(1, 81) = 1.49, p = .23, \eta^2 = 0.02$, or main effect of group, $F(1, 81) = .19, p = .67, \eta^2 < .01$. A significant effect of time was found with a medium effect size, $F(1, 81) = 6.86, p = .01, \eta^2 = .08$, driven by a reduction of sleep quality in both groups from pre-intervention to post-intervention. The mean scores of sleep quality of both intervention groups decreased from the pre-intervention to the post-intervention indicating improvement in sleep quality. Inspection of means indicated that participants in the nature group decreased sleep scores more than the urban group, indicating that after the seven-day intervention, the sleep quality of the nature group improved more than the urban group on average (see Figure 6.5).

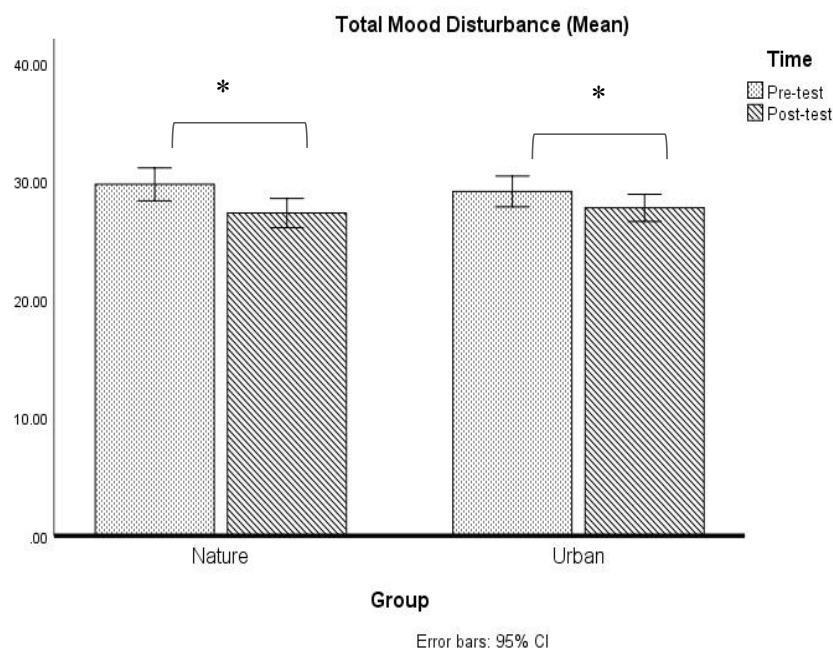
Figure 6.5 *Intervention effectiveness measured by sleep quality*



Mood. There was no significant interaction between group and time on the total

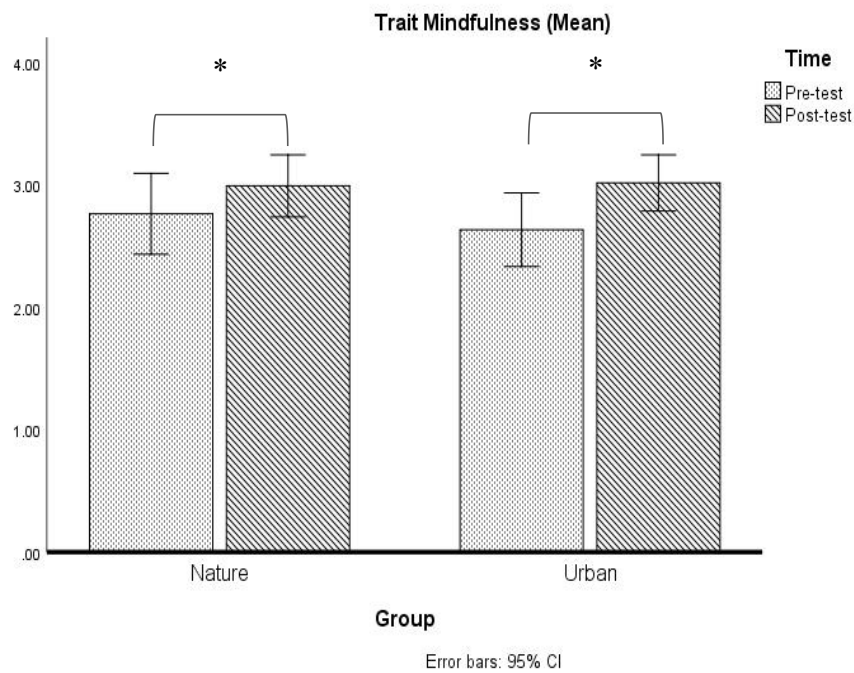
mood disturbance (TMD), $F(1, 80) = .61, p = .44, \eta^2 < .01$, or main effect of group, $F(1, 80) = .02, p = .89, \eta^2 < .01$. There was however a significant main effect of time with medium effect size, $F(1, 80) = 8.09, p < .01, \eta^2 = .09$, suggesting that all participants, regardless of intervention group, reported a reduction in mood disturbance (See Figure 6.6).

Figure 6.6 *Intervention effectiveness measured by TMD*



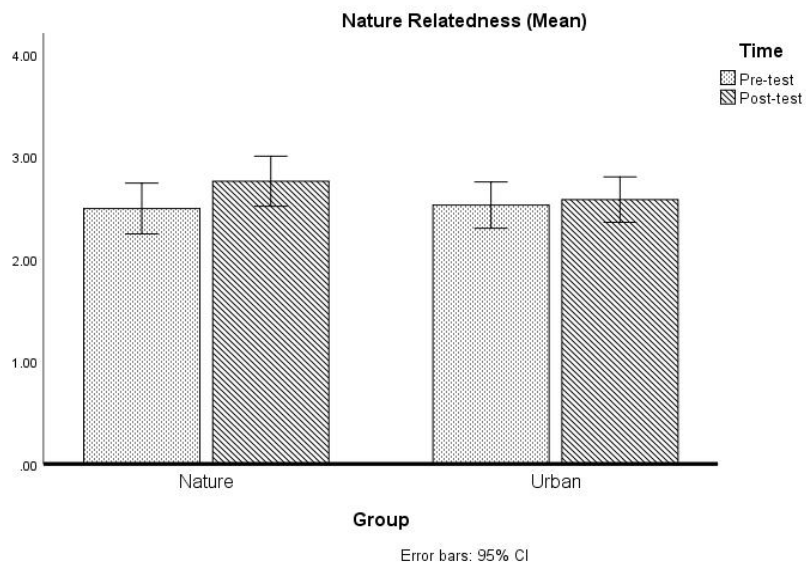
Trait Mindfulness. There was no significant interaction between group and time on trait mindfulness, $F(1, 82) = .33, p = .57, \eta^2 < .01$, or main effect of group, $F(1, 82) = .13, p = .72, \eta^2 < .01$. There was a significant main effect of time with medium effect size, $F(1, 82) = 5.15, p = .03, \eta^2 = .06$ (see Figure 6.7). This showed that for both walking conditions trait mindfulness scores improved following the intervention.

Figure 6.7 Intervention effectiveness measured by trait mindfulness



Nature Relatedness. There was no significant interaction effect ($F(1, 82) = .86, p = .36, \eta^2 = .01$), main effect of group ($F(1, 82) = .36, p = .55, \eta^2 < .01$), or main effect of time ($F(1, 82) = 1.95, p = .17, \eta^2 = .02$) (see Figure 6.8).

Figure 6.8 Intervention effectiveness measured by nature relatedness



State mindfulness. Table 6.6 presents the state mindfulness levels before and after each single walking intervention in two groups of participants - Nature ($n = 52$) and Urban ($n = 49$). The state mindfulness levels were measured using two subscales - Curiosity and Decentring. Mean summary scores were adopted to represent the trait mindfulness level for each subscale. In terms of the subscale curiosity, results suggested no significant interaction between group and time, $F(1,99) = .30, p = .59, \eta^2 < .01$, main effect on group, $F(1, 99) = .29, p = .59, \eta^2 < .01$, or main effect of time, $F(1, 99) = .01, p = .91, \eta^2 < .01$, were found for curiosity. Similarly, no significant interaction effect ($F(1,80) = .10, p = .76, \eta^2 < .01$), main effect of group ($F(1, 80) = 1.78, p = .19, \eta^2 < .01$) or time ($F(1, 80) = .01, p = .94, \eta^2 < .01$) were found for the subscale decentring (see Table 6.6).

Table 6.6 State mindfulness before and after each single walking intervention.

Note. Mean summary scores were adopted to represent the trait mindfulness level for each subscale.

TMS Outcome	Nature ($n = 52$)				Urban ($n = 49$)			
	Curiosity		Decentring		Curiosity		Decentring	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean	13.53	14.04	15.30	15.50	14.11	13.78	14.78	14.57
(SD)	(3.68)	(3.41)	(3.49)	(2.81)	(3.01)	(3.46)	(3.59)	(3.44)
95%CI ^a	[12.38; 14.67]	[12.98; 15.1]	[14.2; 16.39]	[14.62; 16.37]	[13.11; 15.12]	[12.63; 14.94]	[13.58; 15.97]	[13.43; 15.72]

Note. ^a CI: Confidence Interval

Follow-up analysis

Two-way ANOVAs: 2 (Group type: Nature, Urban) $\times$ 2 (Time: T₂, T₃) were conducted to investigate the effectiveness of the mindful walking from the post-intervention to the follow-up timepoints.

Sleep quality. No significant interaction effect between group and time, $F(1, 45) = .04, p = .85, \eta^2 < .01$, nor main effect of group was found, $F(1, 45) = 1.29, p = .26, \eta^2 < .01$. A significant main effect of time was found with large effect size, $F(1, 45) = 18.25, p < .01, \eta^2 = .29$, suggesting that the sleep quality for both groups increased from the post-test to the follow-up.

Mood. There was no interaction effect between group and time ($F(1, 45) = .03, p = .86, \eta^2 < .01$), but main effect of intervention group ($F(1, 45) = .33, p = .57, \eta^2 < .01$), or main effect of time ($F(1, 45) = .19, p = .67, \eta^2 < .01$), indicating that the effects of the intervention on mood were maintained after the post intervention to the follow-up timepoints.

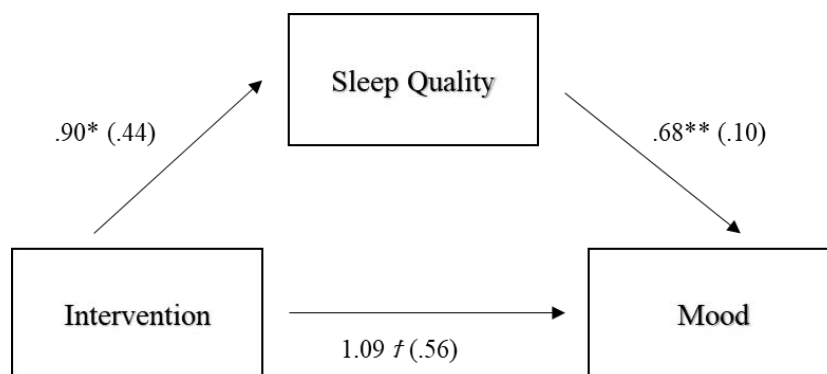
Trait Mindfulness. Similarly, from the post intervention to the follow-up test, there was no significant interaction effect between intervention group and time ($F(1, 46) = .98, p = .33, \eta^2 \leq .02$), no significant main effect of intervention group ($F(1, 46) = .39, p = .53, \eta^2 < .01$) and no main effect of time ($F(1, 46) = .25, p = .62, \eta^2 < .01$). It indicates that the intervention's effects on mood were sustained from the post-intervention to the follow-up timepoints.

6.4.4 Does sleep quality mediate the pre-to-post intervention changes in mood?

The PROCESS macro analysis with 95% CI and 5,000 bootstrapping was used to confirm the significance of the direct and indirect effects of the above model (Hayes, 2013). In this analysis, walking timing was coded as follows: 0 = pre-intervention

and 1 = post-intervention. The overall model was significant ($R^2 = .26$, $F(2, 163) = 28.87$, $p < .001$). The outdoor mindful walking intervention was a statistically significant predictor of sleep quality improvement ($b = .92$, 95% CI [.05, 1.79], $t = 2.10$, $p = .037$) and explained 2.6% of the variance. The outdoor mindful walking intervention became a non-significant predictor for reduction of mood disturbance with a relationship to sleep quality in the model, $b = 1.09$ 95%CI [-.02, 2.20], $t = 1.94$, $p = .054$. Sleep quality was a significant predictor of mood improvement ($b = .68$, 95% CI [.49, .88], $t = 6.94$, $p < .001$). In this model, 26.2% of the variance in mood improvement was explained. For both measurements of sleep quality and mood, lower scores indicated better outcomes. Therefore, the positive value of the coefficients indicated that better sleep quality was positively associated with lower mood disturbance.

Figure 6.9 Path values for the exploratory mediation model.



Note: † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

In the mediation analysis, the total effect represents the association between receiving the outdoor mindful walking intervention and the change in mood without adjusting for the mediating variable. The direct effect represents the effect of

receiving the intervention on changes in mood after adjusting the mediator, whereas the indirect effect represents the effect of attending the intervention on changes in mood that occur through the mediator. The CIs of the effect size output indicated that sleep quality was the mediator of the relationship between the outdoor mindful walking intervention and mood improvement (see Table 6.7). The indirect effect (IE = .63) was statistically significant: 95% CI = (.04, 1.29), where zero falls outside the confidence interval, indicating the indirect effect is inferred to be non-zero.

Table 6.7 *Total, direct, and indirect effects of accepting outdoor mindful walking intervention on total mood disturbance mediated by sleep quality scores*

Pre-intervention to Post-intervention			
Measure	B	SE B	95% CIs
TMD			
Total	1.72	.63	.48, 2.97
Direct	1.09	.56	-.02, 2.20
Indirect	.63	.32	.04, 1.29

Note. N = 81; Timing of intervention was coded as follows: 0 = pre-intervention and 1 = post-intervention; CI = Confidence Interval; if the CI value is greater than zero, the effect is significant; B = mean of non-standardized estimators of 5,000 bootstrapping samples; SE B = standard error of B.

6.4.5 Qualitative data analysis

Feedback forms collected participants' views and suggestions for mindful walking interventions (see Appendix D). Thirty-eight open answers were analysed using content analysis. Several themes (see Table 6.9) were identified regarding the positive and negative perspectives on mindful walking.

A key theme related to sleep, participants perceived their sleep quality improving after the intervention. Positive mood improved and anxiety and stress were perceived

as decreasing following the intervention. Moreover, mindfulness practice during the walk was perceived as cultivating their sense of mindfulness and their concentration. Participants reported that it was enjoyable to be in an outdoor environment, breathe fresh air and be close to nature. In addition, the daily walk, was perceived as regulating their lives and bedtime, and some participants felt they had more routine and were healthier. A few negative feelings regarding mindful walking were described, such as crowded walking places, and time/energy consumed on the walks, and two participants reflected that the mindful walking intervention was not very effective in improving sleep quality. Overall, the positive themes are more prevalent than the negative aspects of the intervention. Example quotes can be found in Table 6.9.

Table 6.8 Description, frequency, and percentage of participants' views of the intervention.

Content	Description	Examples (Quotes)	n	%
Positive aspects				
Sleep quality improvement	Participants feel that were sleeping better and falling asleep more quickly.	<i>"It helps me sleep better at night"</i> <i>"I can fall asleep more quickly than before"</i>	7	18.42
Mood improvement	Participants felt relaxed, calm, and improvement of positive mood; walking interventions reduce negative emotion, stress, pressure, and anxiety.	<i>"The walking was very helpful in terms of relieving me from the pressure of essay writing"</i> <i>"This is a good way to release stress especially during the pandemic period"</i>	25	65.79
Mindfulness cultivation	Mindful walking helped participants be more concentrated/focused to observe inner mind and outdoor environment.	<i>"Feel more mindful and relaxed...than before"</i> <i>"I started to look at the flowers on the road and the expressions of people coming and going"</i> <i>"These walking sessions help me relax my mind and pay more attention to my emotions and feelings"</i>	11	28.95
Healthy lifestyle	Participants' life became more regular than before – regular bedtime and walking exercise; it motivates to go outside and keep regular exercise.	<i>"I can force myself to go outside and feel fresh air"</i> <i>"It really helps me to sleep early and get up early"</i> <i>"It helps me take daily exercise somehow"</i>	15	39.47
Being active	Being more active in mentally and physically	<i>"After that I feel more active than before"</i> <i>"Walking outside helps lift up my</i>	4	10.53

spirit”

Outdoor environment	Stay outdoors for fresh air and nice weather; close to nature.	<i>“I can breathe the fresh air and feel closer to nature”</i>	6	15.79
Negative Aspects				
Walking environment	A little bit far, crowded, busy and noisy sometimes.	<i>“Walking environment are crowded and noisy sometimes”</i>	4	10.53
Time/Energy consuming	Walking interventions were sometimes time-consuming and lead to feeling of tiredness.	<i>“I always feel tired at night, because I spent time walking about 30mins...”</i>	5	13.16
No improvement of sleep	A few of participants felt did not improve their sleep quality.	<i>“I think it only worked a little to help sleep at night”</i>	2	5.3

Participants also suggested improvements to the follow-up timepoint of the intervention. They mainly advised that further research could use mobile apps to track participants’ walking routes and physical exercise data to increase accuracy. Further studies may consider adding objective measurements to track all walking data to control anticipated confounder variables.

6.5 Discussion

6.5.1 General discussion

This RCT study investigated the effectiveness of an outdoor mindful walking in nature intervention for enhancing sleep quality, mood, mindfulness, and a degree of nature relatedness amongst adult university students in the UK. Results suggest that outdoor mindful walking in both nature and urban settings improves university students’ sleep quality, mood, and trait mindfulness levels. However, no significant

interaction effects of group (nature versus urban walking route) and time were found for any measured outcomes, indicating that mindful walking in a natural environment does not bring statistically significant additional psychological benefits to the participants compared with those who walk in an urban environment.

Overall, the findings are in accordance with previous studies on the effectiveness of greenspace-based walking on mental health, especially mood, depression, rumination, and wellbeing, as discussed in the systematic review in Chapter 5. Specifically, the current study was consistent with other studies indicating that outdoor walking can improve mood regardless of environment and that both types (rural and urban environments) of outdoor walking benefit mood improvement and rumination reduction without significant group differences (Berman et al., 2012; M. Johansson et al., 2011; W. S. Shin et al., 2011). However, the current study was not in line with a number of the previous non-RCT studies showing that nature walks were more effective than urban walking on improving mood and rumination (Aspinall et al., 2015; M. Johansson et al., 2011; Keenan et al., 2021; Koselka et al., 2019; Song et al., 2014, 2015, 2018). Also, the present study's finding was inconsistent with previous studies indicating that only nature walking can reduce negative mood, rumination, and anxiety, and improve positive affect (Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015). The discrepancy may be due to different intervention designs. For instance, Bratman and his colleague's two studies used a single walking session, while the present study designed a mindful walking intervention for seven consecutive days over one week. Relatedly, the characteristics of the natural environment in the present study (public meadows park) were not the

same with those (e.g., forest) in other studies, which may lead to different results. Therefore, it remains unclear which types of nature connections and how much of the dose (frequency, duration, and intensity) of nature-based walking (with mindfulness practice) can maximally and optimally boost mental health outcomes. For instance, despite the differences in intervention design, Chou and Hung's study (2021b), which recruited college students to have 30 min of forest walks once a week continuously for eight weeks, reported significant improvements in mental health and nature connectedness after four weeks of intervention and the effects accumulated in the following weeks. The differences between Chou and Hung's study and the present study suggest that further studies are needed to find the optimal dose of nature-based walking or other exercises for maximising mental health outcomes.

Another unexpected finding was that there was no significant improvement in nature relatedness for participants in the nature group after seven consecutive days of walking. This may not support some previous empirical studies and experimental studies that found that mindfulness practice can promote nature connectedness (Aspy & Proeve, 2017; Nisbet et al., 2019). However, the mixed outcomes were largely due to the variation in intervention design and probably socio-cultural contexts, which are associated with the conception and experiences of nature connectedness. For instance, the quarantine experience during the pandemic period may influence how the participants relate to the outdoor environment. Nevertheless, the finding in the present study may be partly consistent with the study of Chou and Hung (2021b), which found that the degree of nature relatedness was not significantly improved

after forest walking for four weeks (30-min a week), but significantly increased after the eighth week.

In addition, the present study found that trait mindfulness level was improved in both mindful walking groups. Unexpectedly, there was no significant group difference (nature versus urban) in this aspect, as in the case of nature connectedness (cf. 1.3.3), which may be due to the mixed features of the routes (see further in 6.5.2 below). Another unexpected outcome was that the *state* mindfulness level was not found to improve after the intervention, which is inconsistent with previous research on mindful walking (Gotink, Hermans, Geschwind, Nooij, et al., 2016) and a systematic review on nature-based mindfulness practice (Djernis et al., 2019). However, the present finding is similar to a pilot study (L. Shi et al., 2019) which found no efficacy on mindfulness after a 4-week mindful walking intervention (30 mins for each section, consecutive for 28 days). The possible reasons for this are that the mindfulness practice in the present study was largely self-guided and that not all the participants followed the guidance during the intervention.

Moreover, the findings suggest that changes in sleep quality improvement during the mindful walking intervention were positively and significantly correlated with total mood disturbance, indicating that the greater the sleep quality, the lower the level of mood disturbance in the university students. Previous studies have documented positive relationships between sleep quality and mood in adult populations (e.g., Triantafyllou et al., 2019), and sleep quality was found to be a predictor of better mental health outcomes (e.g., R. Xu et al., 2021). The present study is consistent

with the previous research on the association between mood and sleep quality. However, there is very limited research on the effects of mindful walking on sleep quality (Ruggiero, 2015; Shi et al., 2019). The study by Shi and her colleagues found no improvement in sleep quality after the intervention. The study by Ruggiero (2015) used the ABAB design with very few participants ($n = 3$), leading to the unreliability of its statistical results. This result was inconsistent with the findings of the present study. A possible explanation is a difference in sample size and methodology between the two studies. The present study used a relatively large sample size ($n = 85$) to overcome the deficiency of previous studies and confirmed a significant relationship between the mindful walking intervention and mood improvement as well as the mediating role of sleep quality. The present study not only contributed to the evidence base but also revealed the mechanism according to which the mindful walking intervention reduces mood disturbance by identifying the mediating role of sleep quality improvement.

6.5.2 Strengths and Limitations

The present study has several strengths. First, repeated walks have been conducted in the intervention compared with previous research most of which only used a single walking session (Aspinall et al., 2015; Berman et al., 2012; Bratman, Daily, et al., 2015; Bratman, Hamilton, et al., 2015; Song et al., 2013, 2015). Secondly, the randomised control study design reduces potential confounder biases which may hamper the effects of the intervention detected. Thirdly, the collected qualitative data, including the perceived positive and negative aspects of the intervention, will assist researchers in framing further mindful walking interventions. Lastly, the current

study incorporated mindful practice with nature walking, which may provide a new insight into designing nature-based interventions.

The main limitation of the present study is the homogeneity between the chosen nature and urban walking routes. First, the social distancing policy regarding COVID-19 has reduced human traffic in the study location, resulting in the urban walking route being less busy and the nature walking route being more crowded than usual. This potentially increased the similarity of the two walking locations. Like one previous related study concluded, if the urban walking route was not urban enough, it may potentially decrease the effect size of group differences on mood improvement (Geniole et al., 2016). Second, due to ethical consideration, the nature walking route was chosen with concern for the safety of the participants. The meadows park is located adjacent to the campus of the university, while Prince Street is not far from the accommodation area for the students. The routes based in these two places, however, have some mixed features of urban and natural elements. For instance, there are traffic roads (though not busy) on the east and south sides of the meadows, while some greenery could be perceived in the Prince Street. park. Third, relatedly, it is hard to control that the university and college students arrive at the chosen routes without passing other natural or urban settings. Further study should select an urban walking route in an inner city area without significant naturalised places, and choose nature walk routes in more naturalised green spaces.

Another limitation pertains to the unbalanced gender distribution of participants, self-guided mindfulness guidance, and the exclusive use of self-report measures.

Owing to the COVID-19 pandemic during the period of this study, participants in both groups were arranged to walk independently without the direct guidance of the researcher, the walking time and duration were not controlled for, which potentially increased the risks of bias in the intervention implementation and thus weakened the validity of the study results. Though the walking durations were not statistically different between the two groups, it would be more standard and valid to have further mindful walking interventions with a restricted equivalent walking time and duration for all the participants. Again, due to the social distance policy of COVID-19, the mindfulness practice was self-guided by the participants, and the researcher cannot provide more detailed instructions or explanations about the practice before or during the intervention, which may influence the results regarding nature connectedness and mindfulness level. Further studies may be concerned about providing a more detailed description and full explanation of the mindfulness practice.

Furthermore, there may be some limitations to using university students as a sample population. First, some students may change the sleep pattern or life routine that is associated with the learning schedule or study projects. This may influence the time spent performing the walking intervention and sleeping during the intervention week. Second, because the ethnic and cultural backgrounds of the students are varied, their conceptions, perceptions, and experiences of nature and their understandings of mindfulness practice may vary accordingly.

6.5.3 Clinical implications and further research directions

Firstly, as sleep difficulties and mood problems are prevalent amongst university

students (Lund et al., 2010), and may compromise their academic ability (Gaultney, 2010), walking interventions may be beneficial as a means of enhancing student mental wellbeing. Additionally, research has suggested that sleep patterns have changed, and that sleep efficiency was poorer than usual during the COVID-19 pandemic among university students (Benham, 2021; Cellini et al., 2020), which was related to increased stress and anxiety levels (Benham, 2021; Köktürk Dalcalı et al., 2021). The current study suggests that outdoor mindful walking could be an effective way to support university students and young adults to cope with their sleep problems and mood disturbances. Outdoor mindful walking is a self-guided and accessible health behaviour and students' welfare services can encourage their students to engage in it as a form of self-help as required.

Moreover, although the present mindful walking was designed for university and college students, the positive results indicate that the intervention is also applicable to other adult populations. Further studies may be desirable to evaluate its effectiveness on other populations across countries. Relatedly, the fact that the intervention is effective for mood and sleep quality improvement regardless of the environmental features indicates that the intervention could be applied to other settings in everyday life for mental health promotion.

The qualitative data presented here about students' views of mindful walking highlighted that most participants perceived outdoor mindful walking as fostering a healthier lifestyle. They report that walking encouraged them to be more active, enhanced subjective sleep quality and improved their mood. Some negative aspects

of the intervention were also mentioned by participants, which are useful for the professionals to shape future interventions to be more acceptable for university students. Based on the feedbacks of the participants, we recommend further mindful walking in nature interventions with multiple walking routes in quiet places. A mindful walking intervention may reduce the session frequency but prolong the period of the whole intervention (e.g., 2 * 30 mins nature-based walking sections per week and consecutive for 4 weeks).

Further studies should examine the effectiveness of nature walking interventions in other types of populations. Non-active groups (i.e. group participants practice mindfulness without walking outdoors; or indoor mindful walking groups without views) should be included in RCT studies to provide clearer evidence of the value of mindful walking in nature. Furthermore, research is required to compare the effectiveness of different types of mindful walking (indoor versus outdoor), as well as various forms of mindful practice (with or without physical activity) in terms of developing helpful interventions for improving adults' mental health outcomes.

6.6 Conclusions

Outdoor mindful walking in either a natural environment or an urban area for one week led to improvements in sleep quality, trait mindfulness, and mood among university students in the U.K. Upon further evaluation and development, walking interventions can be implemented to help university students cope with sleep difficulties and mood disturbance.

Chapter 7

General Discussion

7.1 Chapter Overview

This thesis provides new insights into the psychological effects of nature-based activities (i.e., houseplants caring and community gardening), and nature-based interventions (i.e., mindful walking in nature) on mental wellbeing, mindfulness, and other mental health related outcomes. The research findings from each of the studies presented in this thesis will shed light on the theoretical mechanism(s) underpinning the health benefits of nature connection for mental wellbeing. The core aims of this chapter are to:

- 1 summarise and synthesise the key findings from the various studies and relate them to previous research, highlighting the novel contributions of this thesis;
- 2 assess research limitations and gaps in evidence and provide suggestions for future research;
- 3 derive implications for practice in terms of how we can promote human-nature connection to enhance mental wellbeing.

This chapter will consider applications of the findings presented in this thesis in relation to the mental health benefits of nature-based activities/interventions such as keeping houseplants, gardening, and nature walking. Finally, the overall conclusions of the thesis will be presented.

7.2 Psychological Effects of Nature-Based Activities/Interventions on Mental Health

Based on the findings reported in this thesis, nature-based activities/interventions in various everyday settings may contribute to the maintenance and promotion of mental wellbeing by increasing the level of nature connectedness and mindfulness, reducing stress and anxiety, improving mood and sleep quality, and facilitating physical activities and social connections.

7.2.1 Nature connectedness

According to the houseplant study reported in Chapter 3, most participants agreed that they felt a greater sense of being connected with nature through owning and caring for houseplants. In addition, having spent more hours in the last week, owning greater numbers of houseplants, and having longer years of experience keeping houseplants, are found to be statistically significant correlated with greater levels of nature relatedness (3.4.3).

In Chapter 4, participants of the qualitative community gardening study reported that community gardening activities increase their opportunities to connect with nature, which they perceived as offering a ‘shelter’ from the massive buildings and heavy traffic of urban life. Additionally, community gardens were perceived as providing a natural playground for the residents where they could stay, grow, play, and learn. Like houseplants carers, community gardeners interviewed as part of this thesis perceive a strong sense of nature connectedness (4.4.2).

The cross-sectional houseplant survey reported in Chapter 3 also demonstrated that the nature connectedness of the houseplants carers was positively associated with the universalism values, which are commonly found to be related to pro-environmental behaviour (Dutcher et al., 2007; Schwartz, 2012), and thus pro-environmental awareness. Likewise, as indicated in Chapter 4, community gardeners believed gardening engagement cultivated their awareness of protecting our earth and ecosystem. Remarkably, gardening not only strengthens relationships between people and nature, but this experience in turn promotes gardeners' environmental protection awareness, which could benefit the sustainability of natural environments. Previous research has well-documented that nature relatedness increases humans' eco-friendly behaviour and pro-environmental concern (L. Martin et al., 2020; Nisbet et al., 2009b; Obery & Bangert, 2017). This reciprocal interaction between humans and nature was also reflected in the conceptual model presented in Chapter 4. This process contributed to gardeners' positive attitude towards gardening, and their willingness to keep connecting or reconnecting with nature. These results further support evidence of how humans are intrinsically close to nature and how a positive relationship with nature can benefit our health.

The study on mindful walking intervention in Chapter 6 did not find a significant interaction between intervention group (nature versus urban) and time (pre- to post-intervention change) on nature relatedness, meaning that participants in the nature walking condition did not improve in connectedness with nature more than the urban walking group as predicted (6.4.1). Future studies on nature walking should

use a range of instruments to measure nature connectedness. Furthermore, it may be helpful to use post-intervention interviews to explore participants' affective and cognitive relationships to nature after the mindful walking interventions.

The studies in the thesis are largely in line with previous research showing that various nature-based activities and interventions enhance nature connectedness and thereby have positive effects on mental health (Y. Black, 2020; Coventry et al., 2021; Frumkin et al., 2017; Hartig et al., 2014; Markevych et al., 2017b; Poulsen et al., 2014; Shanahan et al., 2019).

7.2.2 Mindfulness

In the houseplant survey, it was found that houseplants carers had a higher level of mindfulness than the non-house-planters. The more time they spent caring for houseplants, the more houseplants they had, the higher their level of mindfulness (3.4.4 and 3.6). This relationship, however, will need further research to determine whether there is a causal relationship and the direction of such causation.

In line with the enhanced level of mindfulness of the houseplants carers, community gardeners also reported several benefits of gardening related to a sense of mindfulness. For instance, 'mindfulness' was a frequent *vivo* code, which was correlated with other codes such as 'relaxing' and 'tranquil'. The correlation between gardening and mindfulness has been indicated in a previous study (Okvat & Zautra, 2011). Additionally, mindfulness was found in gardeners' self-reflections about their experiences of paying attention to the present moment during their gardening

activities. Such mindful experiences are also related to the sub-theme of ‘spirituality’.

In Chapter 6, the participants of mindful green walking were found to be more centred/focused on observing the inner mind and the outdoor environment. After one week of walking, the mindful outdoor walking intervention was found to be effective in improving trait mindfulness. Findings from Chapter 6 suggest that both groups (nature and urban walking) displayed significant improvements in participants’ trait mindfulness, regardless of walking environment, after the seven-day mindful walking intervention. For the follow-up test, no significant main or interaction effects were found on time (pre- to post-intervention) or group (urban and nature) for mindfulness. These findings imply that after the seven-day mindful walking intervention on both green and urban routes, participants’ trait mindfulness improved and was maintained in follow-up.

The positive relationship among mental health, nature-based activities, and mindfulness has been noted and explored in a variety of research (Choe et al., 2020; Djernis et al., 2019; Gotink, Hermans, Geschwind, De Nooij, et al., 2016; Howell et al., 2011; Huynh & Torquati, 2019; Mayer et al., 2009c; Prakhinkit et al., 2014; Robert-McComb et al., 2015; Sadowski et al., 2020; Z. Shi & MacBeth, 2017; Simpson et al., 2019; Stewart, 2016; Stewart & Haaga, 2018; Teut et al., 2013a; Wolsko & Lindberg, 2013; Zollars et al., 2019) and the findings from this thesis provide further evidence for the knowledge of this field.

7.2.3 Mood

Nature connectedness has been found to improve one's mood and reduce 'negative thoughts' (Nisbet & Zelenski, 2013). The open-ended questions of the houseplant survey reported in Chapter 2 revealed that participants grow houseplants because they find them beneficial for mood improvement, stress reduction, and enhancing positive feelings (2.4). Likewise, the community gardeners reported that they experienced mood change and improvement during gardening activities (4.4.2), which is consistent with some previous studies (e.g., Coventry et al., 2021). Correspondingly, Chapter 4 indicated that an extended time in the community garden could restore their attentive capacities.

In the mindful nature walking RCT study reported in Chapter 6, all participants, regardless of intervention group (urban and nature), reported a significant reduction in mood disturbance following the intervention. In addition, the intervention's effects on mood were sustained from the post-intervention to the follow-up timepoints (6.4.3). According to the qualitative data gathered as part of this walking intervention study, participants felt relaxed, calm, and experienced improvements in positive mood (6.4.5). Furthermore, sophisticated mediation analyses of this data showed that the seven-day outdoor mindful walking intervention significantly predicted a decrease in mood disturbance through improving sleep quality as the mediator (6.4.4). The findings suggest that improvements in sleep quality during the mindful walking intervention were positively significantly correlated with a reduction in mood disturbance, indicating that the greater the sleep quality, the lower the level of mood disturbance in the participating university students (6.5).

This thesis has contributed to knowledge about the positive relationship between nature-based activities/interventions and the improvement of mood, which is consistent with previous studies (Elsadek & Liu, 2021; Hartescu et al., 2015; Rogerson et al., 2020; Thatcher et al., 2020; Y. Wang et al., 2017; Wolsko & Lindberg, 2013).

7.2.4 Other mental health benefits

Restorative benefits. According to the self-report and interviews, the houseplants carers and community gardeners perceived some restorative benefits such as *stress* and *anxiety reduction* from active engagement with nature-based activities (3.4.3 & 4.4.2). Also, the community gardens indicated that human-nature interactions during gardening restored their attention capacity and led to further reflections on human-nature relationships (4.4.2)

Physical health benefits. While *visual comfort* was one of the motivations for the engagement in houseplants care behaviour, the community gardens felt their eyes relaxed and comforted through gardening activities. Also, the community gardens perceive the moderate to vigorous *physical exercises* during gardening as beneficial to their physical health and mental wellbeing. In addition, it is a novel finding that the community gardeners grew *medical herbs* for treatments and perceived it as a great bonus for their physical health (4.4.2).

Social and community. It was found that community gardening facilitated

interpersonal relationships including *parenting*, and a sense of community through *collective work*. As addressed in Chapter 4, the community gardeners had more chance to communicate with others and cooperate with each other through various *collective works* in the community gardens, which not only encouraged social interactions, but also enhanced *self-accomplishment* and *personal growth*, all contributing to mental wellbeing.

7.3 Mechanisms Underpinning the Effects of Green Activities on Mental Health

7.3.1 Nature connectedness, mindfulness, mental health, and attention restoration theory

The significant correlation between nature connectedness, trait mindfulness, and mental wellbeing (see 2.4) found among the houseplants carers may support the idea that nature connectedness is one of the potential pathways between nature connection and mental wellbeing, and that nature connectedness is associated with mindfulness (see 1.2.3.2 and 1.3.3). Relatedly, a number of the participants in the three studies perceived that the nature-based activities were beneficial, in one way or another, to their attentive capacities (see 2.4.5, 4.4.2, and 6.3.4). Specifically, the community gardeners perceived the natural environments of the community gardens as enabling them to feel refreshed, relaxed, and comfortable. More importantly, some profound expressions of *nature connectedness* and reflections of the participants about the human-nature relationships and one's existence often occurred along with *mindful* observation of oneself and simple elements in nature (see Themes 1 & 3 in 4.4.2). This may lend support to the Attention restoration theory according to which soft fascination (such as wind blowing through leaves) offers “a special advantage in

terms of providing an opportunity for reflection, which can further enhance the benefits of recovering from directed attention” (Basu et al., 2019; S. Kaplan, 1995). Taking together, the thesis may validate the assumption that various forms of *active* engagement with nature facilitate the restorative experiences implied by implied by Attention restoration theory (Kaplan, 2001; Pasanen et al., 2018; see also 1.2.2.3 and 1.3.3).

7.3.2 Mindful Walking, Sleep Quality, and Mood

Chapter 6 assessed the causal relationship and mechanisms involved in outdoor mindful walking and mood improvement *via* sleep quality enhancement. As mindful walking *per se* effectively improved people’s mood, sleep quality, and trait mindfulness, Chapter 6 confirmed that sleep quality is the mediator of the causal relationship between the outdoor walking intervention and mood improvement. The mediation analysis showed that sleep quality was a significant predictor of mood improvement and mediated the mood after the intervention. In addition, the findings also indicated that there were significant positive relationships between the improved sleep quality and positive mood following intervention. This finding is supported by previous studies showing that improvement in sleep quality is positively related to positive mood after mindfulness training in college students (Caldwell et al., 2010).

7.3.3 A Potential Hypothesis: Responding to the Biophilia Hypothesis

An important finding from Chapter 4 on community gardening is that some of the participants explained the feeling of nature connectedness in terms of ‘unity of heaven and man’ achieved by humans’ active interactions with nature and

participation in the natural cycle (e.g., by eating the harvested fruits they have grown). The importance of spirituality is also noted in the process of communing with nature. According to the Chinese perception of the universe, heaven, earth, and man are holistically connected and interdependent. On the one hand, this indicates cultural differences in terms of Chinese philosophical thoughts, which may serve as a theoretical basis for understanding human-nature interactions other than the biophilia hypothesis; on the other hand, this expression that correlates humans and nature corresponds with the previous findings of nature connection through community gardening (Kingsley et al., 2009); (Y. Black, 2020; Lovell et al., 2015; Nova et al., 2020; Okvat & Zautra, 2011; Poulsen et al., 2014).

There is very limited research on the relationship between ‘heaven-human union’ theory and the conception of nature connection, especially in the field of psychology (S. Liu, 1989; X. Zhang, 2017). It should be noted that it is not easy to test this hypothesis.

7.3.4 Behavioural Mechanisms of Conducting Nature-Based Activities

Chapter 2 has shown that conducting nature-based activities can be explained by one’s personal attitudes and behaviour controls. Positive attitudes towards nature activities support people’s behaviours including keeping houseplants and engaging in community gardening. For houseplants care behaviour, the Theory of Planned Behaviour (TPB) model was used to examine these constructs in a novel study of houseplants care in China. It was found that one’s personal attitude and perceived behavioural controls can directly predict their future houseplants care behaviour,

without being influenced by subjective norms. A potential explanation for this was that houseplants care behaviour is recognised in China as a positive or neutral behaviour for social norms, thus it is barely influenced by others' views.

The qualitative results from Chapter 2 also indicated reasons why participants chose to keep houseplants. Six key themes were found: *improve mood and reduce stress*; *good looking and pleasing to look at*; *positive feelings of having plants*; *personal hobby*; *cooking purposes*; and *improvement in quality of life*. These findings are mostly consistent with the results of Chapter 4 on community gardening, in particular the theme 'positive attitude towards community gardening', indicating that people's attitudes towards a green activity can facilitate their actual behaviours. It may be so because of the active interactions between humans and nature (e.g., cooking plants, aesthetic purpose, growing them as a hobby). Also, participants of the houseplant survey indicated that important characteristics of houseplants are *nice scent*, *green colour*, *good looking*, *cheaper cost of plants* and *ease of growing*, and the *size* and *texture* of plants when considering which houseplants to select. These findings can be used to inform the choice of plants used in houseplants or other nature-based interventions. It is very important to know the characteristics of houseplants people prefer to keep, and what motivates them to start houseplants care behaviour.

7.4 Nature-based Activities/Intervention, Mental Health, and Daily Life: A Critical Synthesis

From the home setting to the community and natural environments, this thesis has found various nature-based activities – houseplants care behaviour, community

gardening, and mindful green walking – beneficial to people’s mental health. The fundamental insight from the findings is that people’s *active* interaction with nature, rather than just being passively affected by natural settings, leads to a greater level of nature connectedness, positive mood, mindfulness, and mental wellbeing.

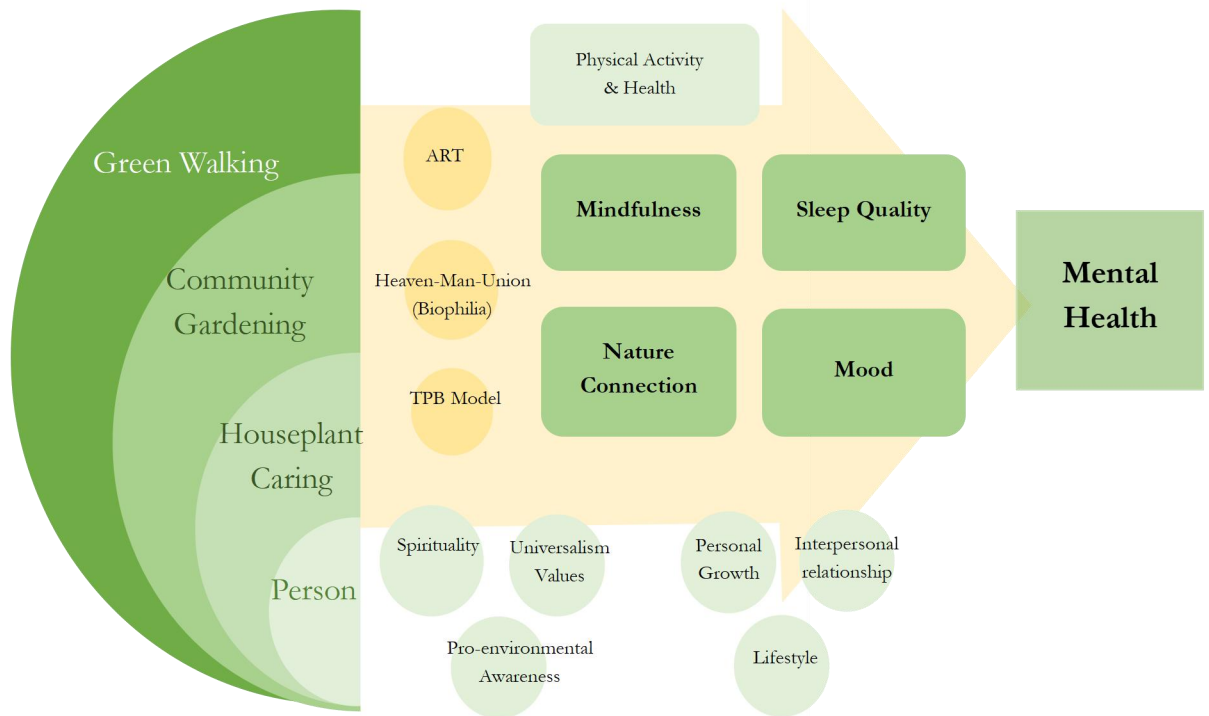
While the previous research provided some evidence that the *presence* of houseplants may benefit our mental health with respect to stress reduction, wellbeing improvement and feeling of escape (Dzhambov et al., 2021; Raanaas et al., 2010; Toyoda et al., 2020), the results reported in Chapter 3 confirmed that more *active* engagement with houseplants care behaviour is positively related to a greater level of mental wellbeing, trait mindfulness, and nature connectedness. This finding is consistent with the studies on the effectiveness of horticultural therapy on mental health (especially for the elderly, for reviews, see [Wang et al., 2023](#); [Yeo et al., 2020](#)). More than this, it also indicated that *regular* and *self-guided* engagement (rather than a relatively short-term intervention with professional guidance) with houseplants can be beneficial to mental health for adults, and that houseplants carers reported significantly higher levels of mental wellbeing than non-houseplants carers, a comparison that has rarely been made in previous studies. Moreover, the exploration of the values and patterns of houseplants care behaviour using Schwartz’s value theory, the transtheoretical model, and the theory of planned behaviour also added to the knowledge base of behavioural mechanisms of engagement in nature-based activities. Although it was a cross-sectional study and further experimental studies are needed, it is the first investigation of houseplants care behaviour, contributing to the evidence base of the mental health benefits of indoor nature connections.

The constructivist grounded theory study on the Chinese community gardeners also contributed to the evidence base. Based on the findings, a variety of mental health benefits were found from *regular* and *active* engagement with gardening activities. Some of the findings are consistent with previous research conducted in Western contexts (e.g., Draper & Freedman, 2010; Okvat & Zautra, 2011; Whatley et al., 2015). For instance, community gardening activities can improve gardeners' mindfulness and mental wellbeing, reduce anxiety and stress (Y. Black, 2020; Kingsley et al., 2009, 2019; Koay & Dillon, 2020; Michaels, 2013; Okvat & Zautra, 2011; Pitt, 2014), increase physical exercise (Al-Delaimy & Webb, 2017; Sanchez & Liamputtong, 2017; T. L. Scott et al., 2020), enhance social support and interpersonal relationship (P. A. Carney et al., 2012; Kingsley et al., 2019; Sanchez & Liamputtong, 2017), facilitate acquisition of skills (Armstrong, 2000; Hale et al., 2011; Mehta et al., 2019), and foster a healthier lifestyle (P. A. Carney et al., 2012). Several novel findings were also found, such as the use of medical herbs, which is typically related to Chinese culture and traditional medical practice, and participants' specific affection for and positive evaluation of community gardens within the collectivist context. Moreover, we found that *active* gardening activities along with *mindful* observation often facilitated the participants' deep and profound reflections over individual existence and its relation to nature (e.g., the notion of *tian-ren-he-yi*, 'harmonious union of heaven and man'). Overall, this grounded theory study addressed the research gap in community gardens in China. Although the conceptual model developed in Chapter 4 needs further validation by further studies, it provided valuable and insightful data to the knowledge and evidence base, according to which

community gardens deserve to be integrated into one's daily life and promoted widely in China.

The research on nature-based walking started with a systematic review of the effectiveness of nature-based walking interventions on mental health (Chapter 5), which provided some evidence that nature-based walking may enhance positive mood and emotion, reduce stress and anxiety, and increase nature connectedness and mindfulness levels, all contributing to mental wellbeing. The RCT study on mindful greenspace-based walking interventions (Chapter 6) added to the evidence base. First, it demonstrated that the mood, sleep quality, and mindfulness level of the experimental group improved more than those of the controlled group. Second, sleep quality was found to be the mediator between the intervention and mood, which may support the assumption that sleep quality might be a potential pathway between nature connection and mental wellbeing (see 1.2.3.2). Overall, the findings of the RCT study are consistent with previous research on nature-based physical activities integrated with mindfulness practice (Caldwell et al., 2008; de Aquino-Lemos et al., 2015; Nisbet et al., 2019) and support the assumption that some forms of *active* engagement with nature facilitate the beneficial role of nature connection (see 1.3.3).

Figure 7. A visual representation of the relationships between nature-based activities/intervention involved in this thesis, theoretical frameworks, and major findings with regards of mental health.



Although some of the effects were not measured objectively, the thesis contributes to the evidence base regarding the effectiveness of nature-based activities/interventions on mental health by addressing several gaps. First, there is no research on the mental health benefits and behavioural mechanisms of houseplants care behaviour among the Chinese population. Similarly, while community gardens have received sufficient academic attention in the Western context, how community gardening may benefit Chinese urban adults remains under-researched. Moreover, despite a growing number of studies on greenspace-based walking, there is very limited research on mindful green walking. In terms of theories and mechanisms, the thesis provides some fresh insight for a better understanding of the linkages between nature connection and mental wellbeing. Foremost, the positive correlation between nature connectedness,

mindfulness, and mental health (see 2.4 and 4.4.2) may validate the proposition that active engagement and interaction (such as mindfulness practice) with the surrounding environment facilitate the restorative experiences implied by Attention restoration theory (Kaplan, 2001; Pasanen et al., 2018; see also 1.2.2.3 and 1.3.3). Also, the notion of *tian-ren-he-yi* (the harmonious union of heaven and human, see 4.4.2) suggests an understanding of human-nature relationship differing from that proposed by the Biophilia hypothesis (1.2.2.1).

This series of studies on three nature-based activities was conducted in different social-cultural and political contexts, ranging from underdeveloped areas (some participants were from small-sized cities of lower economic level in China) to highly developed city (Edinburgh in the UK). As addressed in 1.3.4, the purpose of this was derived from a wider concern about the mental health issues of the populations experiencing from urbanisation and health inequalities from a global perspective, against which we advocated nature-based activities/interventions that may be specifically advantageous to the populations who live in urban settings and have some difficulties accessing the health care system. On the other hand, however, social-cultural factors were associated with some of the findings. For instance, although the Chinese participants did not regard *Fengshui* practice as a reason for engaging in houseplants care behaviour, the long-standing, highly culture-specific notions related to *Fengshui* as a kind of philosophy of environment may influence how the Chinese houseplants carers perceive the indoor nature and interact with houseplants. Relatedly, the Chinese community gardeners reflected the human-nature relationship through a typical Chinese culture-based concept, i.e., *tian-ren-he-yi*,

which may be very different from other cultural constructs. In addition, the gardeners' positive attitudes to *collective work* may be associated with values in a communist-based society. Likewise, the UK-based participants of mindful green walking may be influenced by the cityscape, a complex representation of the local social-cultural notions about human-nature relationship. Nevertheless, the overall positive results in this study indicate that while nature-based activities/interventions are largely beneficial to mental health, the mental health benefits may be achieved through various pathways in different cultural-social backgrounds. Taken as a whole, the findings in this thesis provide some encouraging reasons for advocating using everyday nature to maintain and promote mental health in different populations across the world, while the diverse forms, experiences, and perceptions of human-nature interactions should be considered when exploring potential theories and pathways about mental health benefits and nature connection and developing specific nature-based interventions.

Taking together, using a range of complementary methods, and diverse sample populations, the thesis provides some encouraging evidence and feasible conceptual framework for the proposition that *physically and mentally active and regular* engagement with nature in various everyday settings generally contribute to people's mental wellbeing by enhancing the level of nature connectedness and mindfulness, reducing the sense of stress and anxiety, improving mood and sleep quality, and facilitating physical activities and social interactions. *Active* and *regular* nature-based activities may feasibly increase the 'doses' (frequency, duration, and intensity) of one's nature connection and maximise the mental health benefits in a cumulative way.

These mental health benefits of nature connection may motivate individuals to maintain and increase nature-based activities, and vice versa. Indeed, based on the TPB model established in Chapter 3 and the qualitative data from the community gardeners and greenspace walkers (4.4.2 and 6.4.3), the beneficial nature-based activities may encourage individuals to foster and mould a healthier lifestyle. To sum up, the effectiveness of the three nature-based activities, which cover most of the areas and routines of one's daily life, may bring a cumulative and various psychological bonuses to one's mental health, encouraging future researchers to develop an integrated, comprehensive framework composed of more nature-based practices incorporated in a person's everyday settings and routines with an aim to increase urban residents' contact with nature and promote their mental health.

7.5 Strengths and Limitations of Thesis

Overall, this thesis has several strengths. First, the thesis involves different cultural populations – studies about gardening and house-planting were conducted in China; and nature mindful walking intervention was delivered in the U.K. The research findings from such wide populations all confirmed the benefits of active nature connection for mental health. This demonstrates that the psychological effects of nature-based activities and interventions on people in China and the U.K. may be consistent and universal, although interesting cultural effects have been found in relation to community gardening in China, which are worthy of further research.

Second, the thesis invited participants of different ages, from young to older adults. Participants in the survey study about houseplants care in China, and the intervention

study about mindful nature walking in the UK are mostly young and well-educated. By contrast, the community gardening project involves participants ranging in age from 20 to 70 years old. It more comprehensively represents the effects of nature-based interventions/activities on an adult population.

Third, a range of research methods and analytic techniques have been used in this thesis. To explore the psychological benefits of nature-based activities and interventions that take place in home settings, communities, and outdoor environments, this thesis employed a cross-sectional survey method, qualitative interview techniques, a systematic review procedure, and the randomised control experimental method to answer the research questions. Both qualitative and quantitative data analysis methods were used; to provide deep insights into participants' experiences and perceptions of active nature connection, and to investigate quantitatively how nature-based activities impact city residents' mental health outcomes in wider populations in different cities. Moreover, the longitudinal data in the intervention study was analysed and therefore used to interpret whether nature-based interventions improve participants' mental health over time.

Furthermore, different types of nature activities/interventions were included in this thesis. For example, nature connections can take place indoors with houseplants, community settings with community gardens, or in natural environments such as walking in green spaces. Hence, the evidence regarding the psychological effects of nature-based activities/interventions has been demonstrated across a variety of natural contexts.

Lastly, a variety of theoretical models were used to guide research, as well as an overall contextual model to consolidate investigations. Each of these research strengths has led to elements of novelty and originality in the studies reported in this thesis.

Each empirical chapter has addressed the limitations of the specific study reported in that chapter. However, there are several limitations that have an impact on the research described in this thesis as a whole. First, the online survey tool that was employed in the empirical studies has some limitations. For example, the online survey was powered by the Jisc Online Survey, which does not support the Chinese language. Therefore, participants in China were warned that due to operational errors, English hints and tips were presented by default, which confused participants who were not used to English. Some participants reported to the researcher about this issue, which was impossible to solve due to ethical reasons (i.e., the ethical committee recommended us use the Jisc server, which they believe is safer than other online surveys). This impeded some older participants' participation, along with those who had a relatively poor educational background, from responding to the survey.

Second, only limited demographic data was gathered in one study, the grounded theory study, as it may lead to participants being identifiable, especially as the researcher met all the interviewees in person. The administrators of each community garden only informed the researcher of the participants' age range. The demographic

information of participants was therefore too limited to describe the sample characteristics in detail or relate them to previous studies conducted in Western contexts.

Third, the RCT study has limited power due to sample size, especially for mediation analysis (Chapter 6). There were 104 participants in total for the intervention study, however, G*Power calculated that at least 138 participants were needed to make sure the data was sufficiently powered for the statistical analysis. Missing values from the post-intervention stage and follow-up stage led to a reduced and unbalanced sample size. With such limitations, there is an increased risk of Type II error, and the main effects of time (pre- to post-intervention) and group (nature versus urban) may not have been detected. Furthermore, the effect size of correlations and regression tests may be underestimated as a result of the sample size. A larger sample size and complete follow-up data would allow for more complex data analysis and modelling in future research.

Furthermore, for all quantitative studies in this thesis, only self-reported measurements were used. For example, participants' attitudes, intentions, and behaviours are reported on a five-point Likert scale due to the difficulties of observing their real behaviour regarding the frequency and time of taking care of the plants. Although evidence shows a weak link between social desirability and self-reported ecological-related behaviour (Byrka et al., 2010; Milfont, 2009), future research on houseplant interventions should observe participants' planting behaviour over a certain period of time, to corroborate the findings reported in this thesis. In

addition, in relation to the walking intervention study (Chapter 6), the large amount of data generated by sleep diaries was difficult to manage and incorporate with other sleep quality related data. Future studies would be encouraged to use an objective sleep measurement instead of a sleep diary and self-reported measures.

The final limitation of this thesis is highlighted when considering evaluation and statistical analysis. This thesis employed comprehensive and adequate data analysis. However, for the walking intervention study (Chapter Six), only the main effects and interaction effects of interventions were examined. Other potential variations in the effects of intervention could not be explored within the scope of this thesis. For instance, how did participants' exam pressure and other social activities negatively influence their sleep quality and mood? The data from sleep diaries reflected some abnormal signs of participants' sleep patterns – a couple of participants slept in the early morning and got up at noon of the same day during the exam days. Future studies would benefit from employing multilevel modelling or more complex statistical models to test whether the effectiveness of interventions varies with student lifestyle and work/study pressure. As there may be different variables that influence the effectiveness of outdoor walking interventions, future studies may also consider evaluating a wider range of mental health outcomes. By doing so, individual differences can be detected and well-controlled for walking interventions.

7.6 Further Directions and Implications for Research

Human-nature interactions through houseplants, gardening, and outdoor walking have been confirmed in this thesis to be beneficial for our health and deserve to be

promoted among wider populations.

Further directions for research have been discussed in each separate empirical chapter. Overall, future research can be framed on the basis of the studies conducted in this thesis in several ways. Firstly, future studies can focus on how to incorporate gardening, houseplants, and mindful walking in nature to form new nature-based interventions. For example, experimental research could look at whether gardening and walking in nature contribute in the same way to better mental health outcomes (i.e., sleep, mood, wellbeing, mindfulness). Secondly, in terms of houseplants care, it may also be useful to examine the relationship between ownership of houseplants and the actual time that people spend taking care of them, as well as whether strong ownership of houseplants leads to a stronger emotional attachment and a longer time spent taking care of the plants. Thirdly, further studies can improve the overall duration of nature walking interventions but reduce the frequency of the walking (e.g. walking twice a week for a month) to reduce the drop-out rate. Time-series research design is also useful to examine the best dose and approach for conducting mindful nature walking interventions for mental health improvement. Finally, but most importantly, based on the conclusions of this thesis, future studies might conduct cross-national comparisons to determine whether nature-based interventions will have different effects on adults' mental health. It would be possible to evaluate the total dose of exposure to nature by combining houseplants, gardening, and walking to develop an overall metric of nature exposure.

The findings relating to houseplants and gardening offer suggestions for self-help

mental health strategies through regular houseplants care behaviour and community gardening engagement in China. In relation to gardening, scientific evaluation of further experimental studies will be required to test the effects of outdoor community gardening and indoor houseplants care on Chinese urban adults. Overall, the findings indicate the benefits of community gardening relating to mental and physical health in Chinese urban areas. As this thesis has highlighted, community gardening can be promoted in more urban areas, including schools and residential communities for the sake of health and wellbeing.

Chinese adults are currently facing severe mental health problems; China accounted for 17% of the worldwide burden of mental, neurological, and substance abuse problems in 2013, and it is anticipated that this will increase by 10% by 2025 (Charlson et al., 2016). The prevalence of uneasiness, discouragement, and alcohol abuse within the populace was shown to be expanding (Huang et al., 2019). However, the treatment gap for mental health disorders is exceptionally large in China due to poorly established mental health services (L. Liu et al., 2018). Besides the limited number of studies regarding human-nature connection, few applications of nature-based interventions have been identified and used in China. Connecting with nature with a well-tailored approach is an effective and simple way for Chinese people to improve their mental wellbeing.

Furthermore, according to the findings from Chapters 2 and 3, houseplants caring and further interventions based on this may be applied to promote the mental health of the Western population, especially those who live in areas of intense urbanisation.

Likewise, the novel themes found in Chapter 4, particularly *medical herbs* and *parenting*, may be helpful for further development of the practice of community gardening in Western countries (i.e., outdoor education movement; forest school, etc.), which has been well established.

The findings from Chapter 6 add new evidence on the effectiveness of nature-based interventions (i.e., green exercise). As Chapter 1 reviewed, many empirical studies regarding the effects of green exercise on mental wellbeing have been conducted amongst children and school settings (Barton et al., 2015; Mnich et al., 2019; Wood et al., 2013, 2016). This thesis evaluated a green exercise carried out in a mindful way with an adult UK population, and confirmed its effectiveness for improving nature connectedness, mindfulness, sleep and mood. As physical exercise improves sleep duration and reduces sleep latency in bed (Driver & Taylor, 2000), it is reasonable that green exercise can improve sleep quality for those who are suffering sleep difficulties. Furthermore, as being in nature has been found to help cultivate mindfulness, it has been demonstrated that being mindful during green exercise enhances our relationship to nature, and increases our physical activity (Longshore et al., 2019b). This thesis provides scientific evidence on this topic and confirms that nature walking interventions can improve trait mindfulness.

The qualitative data regarding feelings about the outdoor walking intervention reveals both positive and negative aspects. For example, participants felt their mood and sleep quality improved after the intervention, and their mindfulness was enhanced during the intervention days. In addition, they believed the intervention

helped them to be physically active, have more chances to stay outdoors and foster a healthy lifestyle. Nevertheless, a couple of participants reflected that their walking environments were noisy and crowded, and they felt uneasy walking multiple times a week as it was energy-consuming. Two participants also reflected that they did not feel the intervention was helpful for their sleep quality. All the above feedback from the participants will assist with framing further interventions.

Though group (nature versus urban) differences were not statistically significant on measured outcomes, we could look at the mean scores of moods, trait mindfulness and sleep quality: the nature walking group reported higher scores on trait mindfulness and lower scores on mood and sleep quality (lower score indicates a better outcome) than the urban walking group. Further studies would benefit from controlling the non-nature walking group to be more urbanised without significant greenery and open views.

These findings suggest that mindful outdoor walking might be an appropriate intervention for young adults, especially those experiencing high levels of stress such as university students. The intervention protocol developed for this thesis could form the basis of a university intervention for student mental health.

There are other psychological treatment implications from the findings of this thesis. Houseplants care, community gardening, and nature-based walking can be incorporated with other evidence-based psychological treatments as complementary treatments in mental health care services. For example, for patients who struggle

with going outdoors, indoor plant care provides them with chances to connect with nature. Houseplants care has a significant therapeutic effect on adults' patients in nurse homes (T. L. Scott et al., 2016; Tse, 2010). Through physical connection (i.e. touch, smell, view) and affective connection (i.e., feeling of love, smooth, comfortable, relaxed) with plants, additional benefits may occur for patients' mental and physical health recovery (Y. F. Yao & Chen, 2017). Furthermore, many psychological treatments address the importance of taking exercise and going outdoors into nature, such as Morita Therapy and Mindfulness-Based Interventions (Choe et al., 2020; Sugg et al., 2020). The findings from this thesis provide evidence of the positive psychological effects of houseplants care, gardening and mindful nature walking, suggesting other treatments use such activities to improve the mental health conditions of people in need.

7.7 Conclusions

Overall, the results from this thesis indicate that, from indoor houseplants caring to outdoor community gardening, and walking in the wider natural environment, nature-based activities and interventions can effectively improve adults' mental wellbeing, positive mood, sleep quality, and mindfulness and reduce anxiety and rumination worldwide. These findings have theoretical implications and real-world applications for clinical and non-clinical policy and practice. Further research could examine the effectiveness of nature-based interventions in wider populations, and practitioners are encouraged to incorporate nature-based activities/interventions with other evidence-based interventions to better improve people's mental health. This thesis also contributes significantly to scientific understanding in this

under-researched field and will stimulate future psychological studies into the intricate interactions that exist between humans and nature.

“Fully connecting with nature and growing foods here has made me realise that I am also a being who belongs to nature. I am the same as other plants and creatures.”

- Participant living in a busy urban

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Appendix A: Supplementary Materials for Chapters 2 & 3

Ethical Approval Letter

Ethics Approval Letter CLIN776



SCHOOL of HEALTH in SOCIAL SCIENCE

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Edinburgh EH8 9AG

Telephone 0131 651 3969
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06 June 2022

Dear Jingni Ma

Application for Ethical Approval

Reference: CLIN776

Project Title: Understanding home-planting behaviour and its psychological effects in China

Thank you for submitting the above research project for review by the School of Health in Social Science Research Ethics Committee (REC). I can confirm that the submission has been independently reviewed and was approved on 29th May 2020.

The standard conditions of this approval are:

- I. Conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the REC.
- II. Advise the REC (by email to ethics.hiss@ed.ac.uk) of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.
- III. Make submission for approval of amendments to the approved project before implementing such changes.
- IV. Advise in writing if the project has been discontinued.

The School's Research Ethics Policy and further information and resources are available on the School's website.

You may now commence your project; we wish you the best of luck.

Yours sincerely,

Sanni Ahonen

Administrative Secretary
School of Health in Social Science

Questions of houseplants care behaviours

Which stage are you in for home-planting (e.g., watering, feeding, looking after, maintaining and repotting, etc.)?

- 1 *Precontemplation*: I'm not ready to do this;
- 2 *Contemplation*: I plan to do this soon;
- 3 *Preparation*: I'm ready to do this in the next 6 months;
- 4 *Action*: I've been doing this within the past 6 months;
- 5 *Maintenance*: I've been doing this for over 6 months;

How long did you spend on home-planting in the last week? ____ hour(s)

How many pots of plants do you responsible for looking after at home? ____

For how long have you been planting in your resident(s)? ____year(s)

Participant Recruitment Flyer – Proposed English Version



*"Understanding **Home-planting** Behaviour and Its Psychological Effects in China"*

Research participants needed!



What is it about?

- An online survey study about home-planting;
- Conducted by a Ph.D. research project at the University of Edinburgh in the U.K.;
- To examine the beliefs, attitudes, intentions, current behaviour and psychological effects of home-planting.



Can I participate in?

Yes! If you are :

- A Chinese citizen;
- Living in urban area;
- Age 18 or above;
- Able to read written Chinese;
- Without severe diagnosed mental illness;
- Not regularly engaging in outdoor or community gardening.

How long I will take?

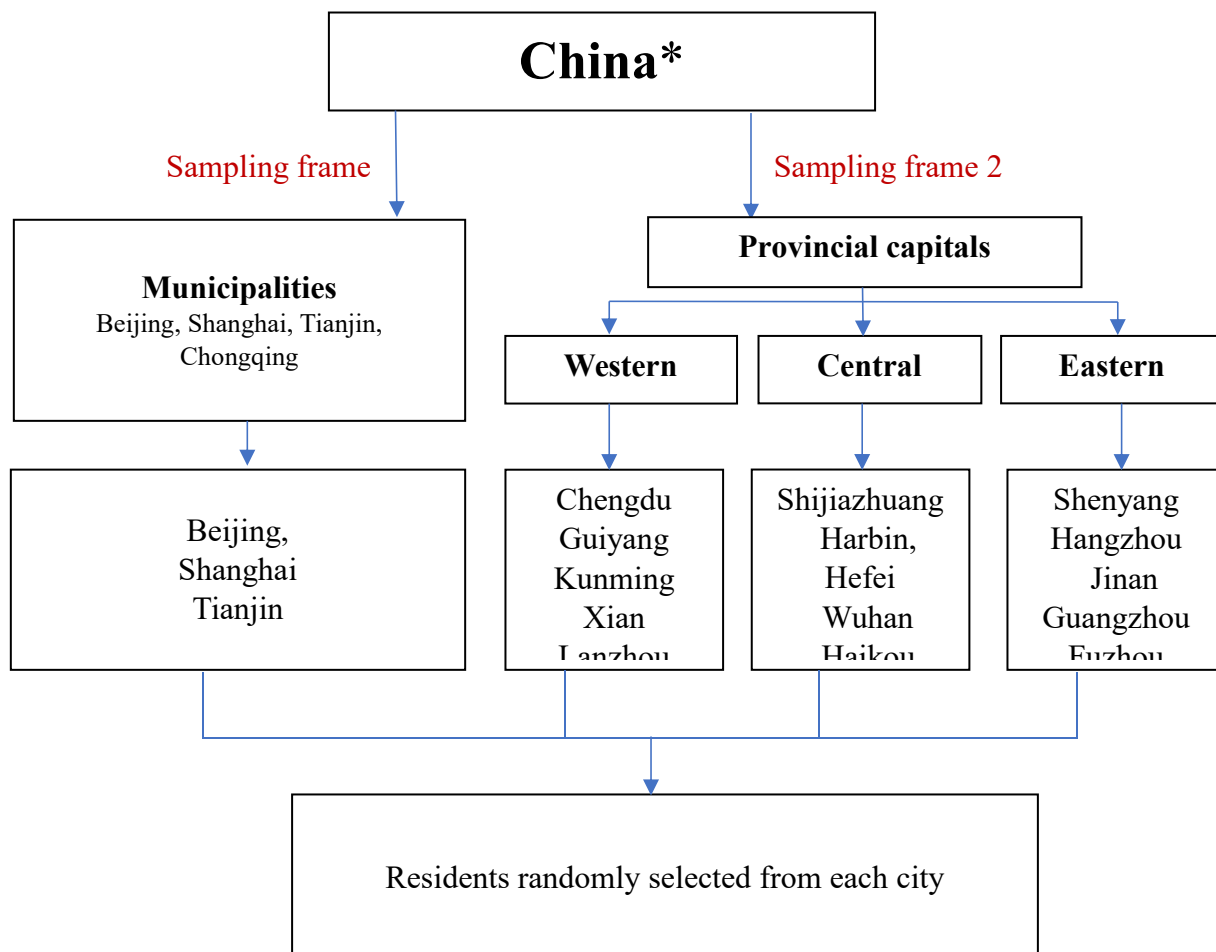
In this online survey, there are seven parts to fill. It may take approximately 15-20 minutes.

Can't wait!
Click the link below
Xxxxxxxxxx
Or scan the QR code below
Xxxxxxxxxx



Diagram of Sampling Process

* 22 provinces, 5 autonomous regions, 4 province-level municipalities (excluding Hong Kong, Macau and Taiwan).



Questions about Preferable Characteristics of Plants

Which **characteristic** of plants are most important to people for planting?

1) Nice scent of plants:

- 1 Extremely unimportant
- 2 Unimportant
- 3 Neither unimportant nor important
- 4 Important
- 5 Extremely important

2) Ease of growing:

- 6 Extremely unimportant
- 7 Unimportant
- 8 Neither unimportant nor important
- 9 Important
- 10 Extremely important

3) Cheaper cost of purchasing and maintaining plants:

- 11 Extremely unimportant
- 12 Unimportant
- 13 Neither unimportant nor important
- 14 Important
- 15 Extremely important

1 Texture of plants (e.g., soft or fragile texture):

- 2 Extremely unimportant
- 3 Unimportant
- 4 Neither unimportant nor important
- 5 Important
- 6 Extremely important

7 Small size of plants:

- 8 Extremely unimportant
- 9 Unimportant
- 10 Neither unimportant nor important
- 11 Important
- 12 Extremely important

13 Green coloured plants:

- 14 Extremely unimportant

- 15 Unimportant
- 16 Neither unimportant nor important
- 17 Important
- 18 Extremely important

19 Good looking and ornamental:

- 1 Extremely unimportant
- 2 Unimportant
- 3 Neither unimportant nor important
- 4 Important
- 5 Extremely important

Questions about Reasons of Being House-Planter

What are the **reasons** you have become a home-planter?

Healthy reasons:

1 To be more connected with nature:

1 Strongly disagree

2 Disagree

3 Neither disagree nor agree

4 Agree

5 Strongly agree

6 To improve the indoor environment (for example, plants can provide

more oxygen due to photosynthesis):

7 Strongly disagree

8 Disagree

9 Neither disagree nor agree

10 Agree

11 Strongly agree

12 To improve human living comfort:

1 Strongly disagree

2 Disagree

3 Neither disagree nor agree

4 Agree

5 Strongly agree

6 To view them for relaxing (e.g., reduce tension and anxiety):

1 Strongly disagree

2 Disagree

3 Neither disagree nor agree

4 Agree

5 Strongly agree

Aesthetic reasons:

6 To decorate the room(s):

7 Strongly disagree

8 Disagree

9 Neither disagree nor agree

10 Agree

11 Strongly agree

Cultural reasons:

- 1 To practise *Fengshui*:
- 2 Strongly disagree
- 3 Disagree
- 4 Neither disagree nor agree
- 5 Agree
- 6 Strongly agree

- 7 Others (please indicate it)

Open Answers From Participants– Reasons of Houseplants Care

- 1 Improve wellbeing.
- 2 Watering and soling are able to reduce my daily fatigue and make me relaxed.
- 3 A kind of company.
- 4 I just like it.
- 5 To do something.
- 6 Killing boredom.
- 7 It (home-planting) seems like a common habit for city residents, so I naturally have this habit.
- 8 For connecting with nature.
- 9 Killing boredom.
- 10 Comfort my eyes.
- 11 Replacement to raising pets.
- 12 Leisure.
- 13 Good taste.
- 14 A kind of self-cultivation.
- 15 For viewing it.
- 16 Distract my attention from other things through having plants at home.
- 17 Re-bridging the link with the lonely home.
- 18 Because it is very convenient to buy.
- 19 For using in photography.
- 20 Just like it.
- 21 For eating green (organic) vegetables.
- 22 Good looking.
- 23 I'm a florist, and it is unavoidable to have plants. I raise plants mainly for breaking down the boring home environment.
- 24 Accompany.
- 25 Improve my ability/skill of planting.
- 26 I like plants.
- 27 Relaxing my mood.
- 28 Enrich my daily life/and improve life quality
- 29 Cultivate a personal hobby.
- 30 For my hobby.
- 31 Good looking.
- 32 I like green plants.
- 33 (This is) my interest. I enjoy myself in observing the process of plants growing up.

- 34 Find things to do and reduce stress.
- 35 Self-accomplishment, beauty.
- 36 Eating fruits.
- 37 Good looking.
- 38 Viewing plants is very comfortable.
- 39 Recently, I heard that raising plants alleviate menopausal syndrome and are especially good for anxiety reduction. So, I spend much time on growing plants with my mom. This is a very utilitarian reason.
- 40 Improve my temperament.
- 41 My hobby.
- 42 I like plants.
- 43 I like it.
- 44 Killing time.
- 45 To feel the process of plants growing and changing.
- 46 For my happiness.
- 47 Killing time.
- 48 Improve mood.
- 49 (Planting is) Eco-friendly behavior.
- 50 Improve mood.
- 51 Happy feeling when harvesting.
- 52 I grow garlies for cooking.
- 53 Life leisure, calm mood.
- 54 Simply find something to do.
- 55 (plants) are vigorous.
- 56 My interests.
- 57 To feel kinds of surprises that came from various forms of life.
- 58 If I would like to plant, that might be because I like some specific kind of plants and want to see them at home.
- 59 Pleasing my mood and eyes.
- 60 I like it.
- 61 Interesting.
- 62 Happiness
- 63 Like it.
- 64 Just like it.
- 65 My hobby.
- 66 To decorate my large rooms.

1 Improve wellbeing.	34 Find things to do and reduce stress.
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3 A kind of company.	36 Eating fruits.
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33 (This is) my interest. I enjoy myself in observing the process of plants growing up.	66 To decorate my large rooms.



中国城市家庭室内种植行为及其心理效应的问卷研究

Page 1: 研究简介



THE UNIVERSITY
of EDINBURGH

关于城市居民家庭室内种植行为及其心理效应的研究



研究目的

这项线上问卷研究旨在测试和研究中国民众对于家庭室内种植的态度、倾向、当前种植行

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为及其种植行为带来的心理效应。家庭室内种植行为在此研究中指个体在居住场所（通常指无私人花园的公寓）内种植和照顾（例如浇水，施肥，铲土和维护花草植物蔬菜）植物的过程。室内种植是一项非常有趣的活动，我们坚信很多居住在中国的人们都有室内种植的习惯和爱好。如果您愿意参加这项研究，您需要：1) 现居中国以下城市：北京、上海、广州、天津、成都、贵阳、昆明、西安、兰州、石家庄、哈尔滨、合肥、武汉、海口、长沙、沈阳、杭州、济南、福州；2) 已成年（大于等于十八岁）；3) 可以顺畅阅读中文。此外，您最好每月参加室外园艺（如果有的话）不超过一次。如果以上所述与您的个人情况不符，我们万分感谢您的时间，但请您关闭浏览器并退出此问卷，感谢您的配合。

邀请函

此项研究旨在了解家庭室内种植行为本身，以及这个行为本身如何培养个体的正念水平（正念是一种关注当下、心态平和而不对生活经验进行判断的一种心理状态），提升我们在日常生活中的心理幸福感。我们将通过询问您的基本信息，养花草的频率和习惯，对养花草的个人态度，以及您的个人价值观来了解中国居民室内养花草的动机和机制。我们也会询问您一些关于与大自然亲近程度，心理健康水平和正念水平的问题。

我们期待您的答案和分享，以帮助我们更好的了解室内种植行为以及其能带来的积极体验。这份问卷没有严格要求您的作答时间，我们预估将会花费您15分钟左右的时间。

我是英国爱丁堡大学的一名博士生，这项研究是我博士论文的一部分。此研究将在我的学术导师Dr Stella Chan，和第二导师Dr Paul Graham Morris的指导下进行。此研究已通过了爱丁堡大学临床心理学学术伦理委员会的批准。

参与福利

我们会向每一位参与者整理并提供免费的室内种植和有关心理健康的免费读物或信息，这些信息会在随后的部分显示。希望这些信息对您了解自身心理健康和种植知识有帮助。我们希望您向此研究提供的数据能够帮助我们更好的了解家庭种植行为和您的心理幸福感。根据过往经验，此类研究问卷参与者会感受到这个过程非常有趣且有意义，我们希望您会喜欢这个研究话题。

保密协议

此研究中的数据收集完全无法识别你的个人身份，您不会被问到关于您姓名或任何可识别您身份的信息。我们不会将你提交的数据转至第三方，但您完全匿名加密的数据也许会由于公共福利而用与其他研究中。

您所提供的全部数据将会被永久储存为电子格式。这些数据会被研究者安全地储存在欧盟

认证的加密储存服务器中，且原始数据只会被储存在爱丁堡大学加密控制的服务器中。研究者需使用密码才可访问，您的数据只允许能被研究者及其团队接触，因此您无需担心数据泄漏的问题。

当您回答每个问题时，切记您的答案没有对错之分。我们对您的真实想法感兴趣，如果您不想回答某些问题，您可以停止作答。但我们希望您可以回答完毕这些对我们至关重要的所有问题。

退出或撤回数据

您参加这项研究应属自愿，如有需要您可以随时停止作答。但是我们将不能撤销您已作答提交的数据。这是因为所有的数据都是匿名加密的，因此我们将无法识别您的个人数据并撤销它。敬请谅解。

研究结果的呈现

此项研究的结果将有可能被发表在学术期刊杂志上，或被报告在学术会议的演讲上等。如果您希望得到一份研究结果的书面总结，请联系研究者并获取研究总结。

更多信息

- 研究者本人非常愿意回答您关于这项研究的更多问题，如有需要请联系以下邮箱：
s1608391@ed.ac.uk
- 如您希望联系到此项研究的学术导师，请您发邮件至：Stella.Chan@ed.ac.uk
- 如您需要联系到非研究队伍中的人去讨论此项研究，请联系 Karen Goodall 博士：karen.goodall@ed.ac.uk.
- 如果您想要投诉此项研究，请联系爱丁堡大学健康学院院长 Matthias Schwannauer 教授：m.schwannauer@ed.ac.uk
- 如果您需要投诉，以下是正式投诉链接和投诉表格：<http://www.ed.ac.uk/files/imports/fileManager/WEB%20Complaint%20Form.pdf>.
- 如果您需要更多心理方面的援助，我们为您提供全国免费心理援助热线（40016619995）。或访问以下网址寻求关于健康（包括心理健康）方面的资讯。如您认为有必要，我们建议您与医生接洽面谈。注意，以上热线与本研究无直接关联，我们仅希望在您需要的时候提供帮助。

Page 2

如需截图此研究简要信息，我们提供了以下页面供您使用。

-
- 研究题目：关于中国城市居民家庭室内种植行为及其心理效应的研究
 - 研究目的：探索家庭种植行为背后的心理机制和其能给个体带来的心理效应。
 - 联系人：马婧妮

School of Health in Social Science, 健康学院

Clinical Psychology, 临床心理学

The University of Edinburgh (<https://www.ed.ac.uk/>), 爱丁堡大学

电子邮件: S1608391@ed.ac.uk

- 相关信息：

以下列出了一些跟种植以及心理健康有关的相关读物，如有兴趣，请您浏览。

- <http://m.1nongjing.com/201702/167011.html>
- <https://www.diyju.com/yuanyi/zhongzhi/>
- <https://www.bbc.com/zhongwen/simp/world-52522820>
- <http://www.chinacdc.cn/jkzt/hjws/>

Page 3: 参与者知情同意书

1. - 我已仔细阅读并了解了告知参与者信息表； - 我的年龄大于十八岁； - 我自愿参加此项研究且我的问题已经被满意答复； - 我了解我提交的匿名数据在未来可能由于公共利益而被用于其他研究； - 我了解我可以随时退出作答。 * *Required*

☒ 我了解并同意以上所有条例

Page 4: 基本信息

2. 请问您目前的现居地是以下哪个城市？ * Required

- ☐ 北京
- ☐ 上海
- ☐ 天津
- ☐ 广州
- ☐ 成都
- ☐ 贵阳
- ☐ 昆明
- ☐ 西安
- ☐ 兰州
- ☐ 石家庄
- ☐ 哈尔滨
- ☐ 合肥
- ☐ 武汉
- ☐ 海口
- ☐ 长沙
- ☐ 沈阳
- ☐ 杭州
- ☐ 济南
- ☐ 福州

3. 请问您的性别是？ * Required

- ☐ 男
- ☐ 女
- ☐ 不便透露

4. 请问您处于哪个年龄阶段？ * Required

- ☐ 18-25
- ☐ 26-34
- ☐ 35-44
- ☐ 45-60
- ☐ 60以上

5. 请问您目前的婚姻状况是？ * Required

- ☐ 未婚
- ☐ 在约会中
- ☐ 已婚
- ☐ 分居
- ☐ 丧偶/离异

6. 请选出能最准确描述您的受教育水平的选项 * Required

- ☐ 小学或以下
- ☐ 初中毕业或以下
- ☐ 高中毕业或以下
- ☐ 专科/本科
- ☐ 硕士研究生及以上

7. 请问您目前的工作状况为？ * Required

- ☐ 学生

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- 全职工作
- 打零工
- 待业
- 已退休

Page 5: 室内家庭种植行为测量

8. 对于室内家庭种植行为（例如浇水，喂养，照料，维护和种植盆栽植物），请问您目前处于以下描述的哪个阶段？ * Required

- ☐ 考虑阶段 - 我还没有准备做这件事
- ☐ 思忖阶段 - 我计划尽快着手做这件事
- ☐ 准备阶段 - 我准备在半年之内着手做这件事
- ☐ 行动阶段 - 我已经着手这件事不少于半年了
- ☐ 行为稳定阶段 - 我有这个行为/习惯超过半年了

9. 如果您已经在进行室内种植，或打算未来种植植物，请问以下哪些种类的植物是您愿意种植的？（可多选）

- ☐ 花
- ☐ 叶类植物
- ☐ 多肉盆栽
- ☐ 蔬菜（如，蒜，小西红柿，小辣椒等）
- ☐ 以上都有

10. 上周您总共花了多少个小时在家庭种植上？（请您填写一个数字。比如您上周总共花了三个半小时在照顾花草上，请填写“3.5”，如您没有开始种植行为，可填“0”，诸如此类） * Required

Please enter a number.
Please make sure the number is between 0 and 168.
Your answer should be no more than 3 characters long.

10.a. 您负责在家照顾几盆植物？（请您填写一个数字） * Required

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Please enter a whole number (integer).

11. 从您有种花养草的习惯开始算起，大概有多少年的时间了？（请您填写一个数字）

* Required

Please enter a number.

Page 6: 室内种植花草的原因

12. 您觉得以下什么原因是您会成为家庭种植者的原因？ * Required

Please don't select more than 1 answer(s) per row.

Please select at least 6 answer(s).

	非常不同意	不同意	不好说	同意	非常同意
为了亲近自然	☐	☐	☐	☐	☐
为了改善室内环境 (例如, 植物可以通过光合作用提供更多的氧气)	☐	☐	☐	☐	☐
为了提高生活舒适度	☐	☐	☐	☐	☐
为了观看植物达到放松的效果 (例如减少紧张和焦虑)	☐	☐	☐	☐	☐
为了装饰房间	☐	☐	☐	☐	☐
为了提升家里的风水	☐	☐	☐	☐	☐

12.a. 其他原因 (如有, 请用简单的词语描述)

13. 如果您要在家养花草, 以下哪些植物的特性是您要特别考虑的？ Optional

Please don't select more than 1 answer(s) per row.

Please select at least 6 answer(s).

	非常不重要	不重要	不好说	重要	非常重要

植物是否散发宜人的香气	☐	☐	☐	☐	☐
植物是否好养活	☐	☐	☐	☐	☐
购买和养活植物的花费	☐	☐	☐	☐	☐
植物的质地是否柔软（如摸起来很舒服，等）	☐	☐	☐	☐	☐
植物的体积是否是较小的	☐	☐	☐	☐	☐
植物是否是以绿色为主的	☐	☐	☐	☐	☐
植物是否好看且具有观赏性	☐	☐	☐	☐	☐

Page 7: 对种植室内植物的态度

14. 请根据您的自身的情况，勾选出符合您个人态度的选项 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 2 answer(s).

	1 非常不像我	2	3	4	5	6	7 非常像我
我相信家庭室内种植行为无论如何对人都是有益处的	☐	☐	☐	☐	☐	☐	☐
我相信我会非常乐意在家种植一些花草植物	☐	☐	☐	☐	☐	☐	☐

15. 请根据您的自身的情况，勾选出符合您主观规范的选项 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1 非常不同意	2	3	4	5	6	7 非常同意
我认为那些对我很重要的人（例如家人、朋友、同学、同事）会支持和认同我的家庭种植行为	☐	☐	☐	☐	☐	☐	☐

16. 请根据您的自身的情况，勾选出符合您行为意愿的选项 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1 绝对没有可能	2	3	4	5	6	7 绝对有可能
您在家种一些植物（比如花草蔬菜）的可能性有多大？	☐	☐	☐	☐	☐	☐	☐

17. 请根据您的自身情况，勾选出符合您情况的答案： * Required

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1 非常不同意	2	3	4	5	6	7 非常同意
如果我愿意的话，我完全有能力在家种些植物并照顾好它们	☐	☐	☐	☐	☐	☐	☐

18. 请勾选出符合您实际情况的答案

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1 非常困难的	2	3	4	5	6	7 非常容易的
一般而言，对我来说，在家种植物是...	☐	☐	☐	☐	☐	☐	☐

19. 请勾选出符合您实际情况的答案 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 1 answer(s).

	1 非常不同意	2	3	4	5	6	7 非常同意
只要我想的话，即使有人反对我，我也可以找到方法进行家庭种植	☐	☐	☐	☐	☐	☐	☐
当我遇到有关在家种植植物的困难时，我通常可以想到一些对策和备选方法	☐	☐	☐	☐	☐	☐	☐

Page 8: 简化版自然亲近度量表 (NR-6)

20. 对于以下每个情境，请使用以下所示的1到5的等级来评定您对每个陈述的认可程度。请根据您的真实感受做出回应，而不是您认为“大多数人”的感受。 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 6 answer(s).

	1 非常不同意	2 有点不同意	3 中立	4 有点同意	5 非常同意
1. 我理想的度假地点应当是一个远离尘嚣、与自然亲近之地。	☐	☐	☐	☐	☐
2. 我常常会思考我的一举一动会如何影响到环境。	☐	☐	☐	☐	☐
3. 我与自然的连结以及环境本身我精神世界的一部分。	☐	☐	☐	☐	☐
4. 不管我身在何处，我都会特意留意身边的野生动植物。	☐	☐	☐	☐	☐
5. “我是谁”的一个重要部分是我与自然的关系。	☐	☐	☐	☐	☐
6. 我感到我与所有生物以及地球本身息息相关。	☐	☐	☐	☐	☐

Page 9: 施瓦茨价值观问卷 (PVQ - 40)

21. 以下简要地描述了一些人，假定其性别为男。如果您是女性，可认为以下所描述的个人为女性。请阅读以下描述并思考所描述的人与您在多大程度上相似。（如您到此已感到疲倦，我们建议您可以休息一会再填写。请尽量不要随意填写答案或弃填。我们感谢您的耐心和时间！） * Required

Please don't select more than 1 answer(s) per row.

Please select at least 40 answer(s).

	非常像我	像我	有些像我	有一点像我	不像我	一点也不像我
1. 有新的点子和有创意对他来说很重要。他喜欢以他独特的方式行事	☐	☐	☐	☐	☐	☐
2. 富有对他来说很重要。他想拥有很多钱和贵重物品	☐	☐	☐	☐	☐	☐
3. 他认为世界上所有人都应该得到一视同仁的待遇是重要的，每个人在生活中都应有平等的机会	☐	☐	☐	☐	☐	☐
4. 自我表现对他很重要。他希望别人能欣赏他的言行	☐	☐	☐	☐	☐	☐
5. 生活在安全的环境里对他来说很重要。他会尽量避免危及他安全的任何事情	☐	☐	☐	☐	☐	☐

6. 他喜欢惊喜，且总寻找新的事情来做。他认为在一生中做很多不同的事很重要	☐	☐	☐	☐	☐	☐
7. 他相信我们应该按照人们说的来做,即使没有旁人监督也要遵守规则	☐	☐	☐	☐	☐	☐
8. 聆听与他人不同的意见对他来说很重要。即使他不同意别人的意见,他也会试着去了解别人的意见	☐	☐	☐	☐	☐	☐
9. 他觉得不去要求太多对他很重要。他深信人应该知足	☐	☐	☐	☐	☐	☐
10. 他寻找每个享受人生的机会。做能给他带来快乐的事情对他来说很重要	☐	☐	☐	☐	☐	☐
11. 自己做决定对他很重要。他喜欢自由及不依赖他人	☐	☐	☐	☐	☐	☐
12. 帮助周围的人对他来说很重要。他希望能关心他人的健康和幸福	☐	☐	☐	☐	☐	☐

13. 做一个事业有成的人对他来说很重要。他喜欢给别人一个好的印象	☐	☐	☐	☐	☐	☐
14. 政府能保障个人安全对他来说很重要。他希望国家强大以保护它的公民	☐	☐	☐	☐	☐	☐
15. 他喜欢也经常寻找冒险的活动。他希望过令人兴奋的生活	☐	☐	☐	☐	☐	☐
16. 举止得体对他来说很重要。他尽量避免去做别人认为是不对的事	☐	☐	☐	☐	☐	☐
17. 从别人那里得到尊重对他来说是重要的。他喜欢别人照他说的去做	☐	☐	☐	☐	☐	☐
18. 对朋友忠心对他来说很重要。他想为与他很亲近的人做更多的奉献	☐	☐	☐	☐	☐	☐
19. 他强烈认为每人都应该关心大自然。保护环境对他来说很重要	☐	☐	☐	☐	☐	☐

20. 宗教信仰对他来说很重要，他尽可能遵守宗教规范	☐	☐	☐	☐	☐	☐
21. 事物干净整洁对他来说很重要，他不喜欢事情一团糟	☐	☐	☐	☐	☐	☐
22. 对不同的事情充满兴趣对他来说很重要。他喜欢去了解不同的事物来满足他的好奇心	☐	☐	☐	☐	☐	☐
23. 他认为世界上的人应和平共处，促进世界和平对他而言很重要	☐	☐	☐	☐	☐	☐
24. 雄心壮志对他来说很重要。他想要证明他的能力	☐	☐	☐	☐	☐	☐
25. 传统对他来说很重要。他尽可能的去遵守宗教和家庭传承的习俗	☐	☐	☐	☐	☐	☐
26. 享受人生的快乐时光对他来说很重要。他十分“娇惯”自己	☐	☐	☐	☐	☐	☐
27. 满足他人需求对他来说很重要，他尽力支持他所认识的人	☐	☐	☐	☐	☐	☐

28.他认为应该尊重父母长辈，服从对他来说很重要	☐	☐	☐	☐	☐	☐
29.他希望每个人，甚至他不认识的人，都得到公正的待遇，保护社会上的弱者对他很重要	☐	☐	☐	☐	☐	☐
30.他喜欢惊奇，对他来说，拥有刺激的生活很重要	☐	☐	☐	☐	☐	☐
31. 他尽力避免生病，保持健康对他来说很重要	☐	☐	☐	☐	☐	☐
32. 比别人领先对他很重要。他立志做得比别人好	☐	☐	☐	☐	☐	☐
33. 原谅曾经伤害过他的人对他来说很重要。他尽量去想别人的好处, 而不去怨恨别人	☐	☐	☐	☐	☐	☐
34.独立对他来说很重要，他喜欢靠自己	☐	☐	☐	☐	☐	☐
35. 安定的环境对他而言很重要，他关注维护社会治安	☐	☐	☐	☐	☐	☐

36.对他人有礼貌 对他来说很重要，他尽量不打 扰或惹恼他人	☐	☐	☐	☐	☐	☐
37. 他想要享受人 生，拥有快乐的 生活对他很重要	☐	☐	☐	☐	☐	☐
38.谦虚对他很重 要，他尽量不去 吸引别人的注意	☐	☐	☐	☐	☐	☐
39.他总是想成为 决策者，喜欢当 领导者	☐	☐	☐	☐	☐	☐
40.适应大自然的 环境对他来说很 重要，他认为人 们不应该改变大 自然	☐	☐	☐	☐	☐	☐

Page 10: 沃里克爱丁堡心理健康量表 (WEMWBS)

22. 以下是一些关于感觉与想法的句子 请在每题句子选出最能够形容你下面选出最能形容你过去两星期的经验 * Required

Please don't select more than 1 answer(s) per row.

Please select at least 7 answer(s).

	1 从来没有	2 很少有	3 有些时候有	4 很多时候都有	5 不停有
我一直对未来感到乐观	☐	☐	☐	☐	☐
我一直感到自己是有用的	☐	☐	☐	☐	☐
我一直感觉轻松	☐	☐	☐	☐	☐
我一直能妥善地处理问题	☐	☐	☐	☐	☐
头一直能清晰地思考	☐	☐	☐	☐	☐
我一直感觉与人亲近	☐	☐	☐	☐	☐
我一直能对事情做决定	☐	☐	☐	☐	☐

Page 11: 正念问卷 (FFMQ)

23. 请根据以下给予的等级来评定每句话。在每句话后面选择最符合您真实情况的等级。请您每题只填写一个答案即可，每道题都需填写完才可进入下一页。（如您在填写过程中感到疲倦，我们建议您可以稍事休息再继续填写。请不要随意填写答案或弃填。您的参与和真实的答案对我们很重要，感谢您的时间！） * Required

Please don't select more than 1 answer(s) per row.

Please select at least 39 answer(s).

	1 一点也不符合	2 较少符合	3 有些同意	4 非常符合	5 完全符合
1. 在行走时，我会 有意关注身体部位 在行进中的感觉。	☐	☐	☐	☐	☐
2. 我擅长于用言语 描述我的情感。	☐	☐	☐	☐	☐
3. 我为自己有不理智 的情绪或不合适 的情绪而责备自 己。	☐	☐	☐	☐	☐
4. 我感受到了我的 情绪和情感，但我 不必对它们做出反 应。	☐	☐	☐	☐	☐
5. 在做事的时候， 我经常走神，而且 很容易被干扰。	☐	☐	☐	☐	☐
6. 在洗澡时，我会 留心于水滴过身体 的感觉。	☐	☐	☐	☐	☐
7. 我能清晰表达自 己的信念、观点以 及期望。	☐	☐	☐	☐	☐

8. 我没有注意到我在做什么事情，这是因为我在做白日梦，在担忧或分心于外界。	☐	☐	☐	☐	☐
9. 我观察自己的情绪，而不迷失其中。	☐	☐	☐	☐	☐
10. 我告诉自己，我不应该以我现在的这种方式来感受此时的情感。	☐	☐	☐	☐	☐
11. 我留意到食物和饮料是如何影响着我的想法、身体的感觉和情绪的。	☐	☐	☐	☐	☐
12. 我难以找到词语来表达我的所思所想。	☐	☐	☐	☐	☐
13. 我很容易分心。	☐	☐	☐	☐	☐
14. 我认为我的一些想法是异常的、不好的；我不应该那样想。	☐	☐	☐	☐	☐
15. 我会注意我的一些感觉，比如：微风吹拂我的头发、阳光照在我的脸上的感觉。	☐	☐	☐	☐	☐
16. 我很难用合适的言语来表达我对事物的感受。	☐	☐	☐	☐	☐
17. 我会评判自己的想法是好的或是坏的。	☐	☐	☐	☐	☐

18. 我难以把注意力集中在当前发生的事情上。	☐	☐	☐	☐	☐
19. 当我有悲伤的想法或景象时，我会“退一步”，并去觉知那些想法或景象的存在，而不被其所控制。	☐	☐	☐	☐	☐
20. 我会注意一些声音，比如：时钟的滴答声、小鸟的唧喳声、或者汽车穿梭的声音。	☐	☐	☐	☐	☐
21. 在困难的情境下，我会暂停一下，不马上做出反应。	☐	☐	☐	☐	☐
22. 当我身体有种感觉时，我很难找到合适的词语来描述它。	☐	☐	☐	☐	☐
23. 我好像是自动地在做一些事情，并没有完全意识到它。	☐	☐	☐	☐	☐
24. 通常，当我有令人伤感的想法或者景象时，我能很快恢复平静。	☐	☐	☐	☐	☐
25. 我告诉我自己，我不应该思考我此刻正思考的东西。	☐	☐	☐	☐	☐
26. 我闻到了周围一些东西的气味或者芳香。	☐	☐	☐	☐	☐

27. 即便是我感到非常地不安时，我也能找到词语来表达它。	☐	☐	☐	☐	☐
28. 我草草地做完一些事情，而没有真正地集中注意力在其上。	☐	☐	☐	☐	☐
29. 当陷入令人烦恼的情绪或情境中，我能做到只是去注意它们，而不做出相应反应。	☐	☐	☐	☐	☐
30. 我想有些情绪是不对的或者是不合适宜的，我不应该体验到它们。	☐	☐	☐	☐	☐
31. 我注意到了艺术品和自然界中事物的一些视觉元素，如：颜色、形状、纹理还有光和影子。	☐	☐	☐	☐	☐
32. 我总是倾向于用词语来描述我的体验。	☐	☐	☐	☐	☐
33. 当我有令人痛苦的想法或景象时，我通常只是去在注意它们，顺其自然。	☐	☐	☐	☐	☐
34. 我总是自动地工作或完成某项任务，而没有意识到我在做什么。	☐	☐	☐	☐	☐

35. 通常当我有些令人困扰的想法或者景象时，我会根据我当时所想的的内容或者脑海中出现景象来判断自己是对还是错。	☐	☐	☐	☐	☐
36. 我会去注意，我的情绪是如何影响我的想法和行为的。	☐	☐	☐	☐	☐
37. 我通常能够非常详细地描述出我此刻的感觉。	☐	☐	☐	☐	☐
38. 我发现自己做事情的时候，不专心在所做的事情上。	☐	☐	☐	☐	☐
39. 当不理智的想法出现时，我会自我否决。	☐	☐	☐	☐	☐

Page 12: 问卷结束，感谢您的参与！

再次感谢您的时间和参与！您宝贵的答案对本研究意义非凡！祝您生活愉快。

Recruitment Advertisement – Chinese Version



您好，我们诚挚地邀请您参与一项英国爱丁堡大学的心理学研究。本研究试图了解室内种植的行为机制以及其如何影响个体的心理幸福感。这是一个**线上问卷**形式的研究，您可以通过扫描文章末端的二维码或点击链接进入问卷页面，根据您的真实情况填写此项问卷。



这是什么研究？

- 一项关于**家庭种植**和**心理幸福感**的线上问卷研究；
 - 调查研究您对家庭种植的态度、信念以及其如何影响您的幸福感及其他心理效应；
 - 这是一项由英国爱丁堡大学一位临床心理学在读博士生主导的研究。
-

我可以参加吗？

是的！只要您满足以下条件：

- 现居中国；
- 并居住在以下城市：北京, 上海, 广州, 天津, 成都, 贵阳, 昆明, 西安, 兰州, 石家庄, 哈尔滨, 合肥, 武汉, 海口, 长沙, 沈阳, 杭州, 济南, 福州；
- 已成年（大于等于18周岁）；
- 可流畅阅读中文；
- 参与户外园艺每月不超过一次。

需要多久？

- 这份线上问卷需要花费您**15分钟**左右的时间填写。
- 前半部分会询问您目前的家庭种植情况（就算从未有过种植经验也可以参加），后半部分会询问您关于心理健康、幸福感以及价值观的问题。
（所有题目的答案没有对错之分，请您根据自身情况如实作答即可）。
- 提前感谢您的参与！



小提示：由于问卷服务器原语言设置为英语且不可改动系统设置，因此在填写过程中有可能偶尔弹出英语的提示，请您自动忽略，不影响作答。服务器被严格管控，您的信息被严格保密，请您放心填写。

Submit and continue >

小易能三问

- （当您看到这个按钮，表明您已经填完一页，
按此按钮进入下一页）。

Finish ✓

小易能三问

- （当您看到这个按钮，请点击并表示您已完成此问卷）。
- 如果您使用手机浏览器打开问卷，由于手机型号的不同，问卷排版可能受到影响。小部分用户可能会在问卷问题里看到“不完整”的表格，如有发生，请您缩放屏幕以便看到完整问卷。

开始填写！请您轻触以下链接🔗：

https://edinburgh.onlinesurveys.ac.uk/homeplanting_514

或扫二维码进入问卷页面📱：



感谢您的参与！祝您开心每一天！🌻

Appendix B:

Supplementary Materials for Chapter 4

Ethical Approval Letter



SCHOOL of HEALTH in SOCIAL SCIENCE
CLINICAL AND HEALTH PSYCHOLOGY

The University of Edinburgh
Medical School
Doorway 6, Teviot Place
Edinburgh EH8 9AG

Telephone 0131 651 3969
Fax 0131 650 3891
Email submitting.ethics@ed.ac.uk

Jingni Ma
PhD Student
Department of Clinical and Health Psychology
School of Health in Social Science
University of Edinburgh

24 June 2019

Dear Jingni,

Application for Level 2 Approval

Reference: CLIN639

Project Title: The perceived benefits and barriers of engaging in community gardening in China

Academic Supervisor: Paul Morris

Thank you for submitting the above research project for review by the Department of Clinical and Health Psychology Ethics Research Panel. I can confirm that the submission has been independently reviewed and was approved on the 10th June 2019.

Should there be any change to the research protocol it is important that you alert us to this as this may necessitate further review.

Yours sincerely,

Kirsty Gardner
Administrative Secretary
Clinical Psychology

Participant Information Sheet and Consent Form



PARTICIPANT INFORMATION SHEET

The Perceived Benefits and Barriers of Engaging in Community Gardening



INVITATION

This is a study about benefits and barriers of engaging in community gardening. I am a PhD student at the University of Edinburgh in the U.K. I am conducting these interviews as a part of my doctoral thesis, which is supervised by Dr. Paul Graham Morris. This project has been approved by the Clinical Psychology Research Ethics Committee at the University of Edinburgh.

WHAT WILL HAPPEN

If you decide to participate, you will be interviewed by a researcher in person for 40-60 minutes. The researcher will ask you questions about your perceptions of:

- 1 Benefits (if applicable) of engaging in community gardening;
- 2 Barriers (if applicable) of gardening in community gardens;

This interview is open-ended to explore your thoughts, feelings and experiences about community gardening.

PARTICIPANTS' RIGHTS

- 1 You can stop the interview process at any stage without explanation;
- 2 You have right to ask the researcher to delete or withdraw any identifiable information that you have provided;
- 3 You can decline to answer questions that you do not wish to answer.

If you have any questions or want to know more details about this study, please feel

free to ask the researcher before the interview commences.

CONFIDENTIALITY/ANONYMITY

The researcher will record the interview via a Dictaphone. The audio recording will then be transferred to a secure university of Edinburgh server. All the interview recordings will be permanently deleted once the researcher has transcribed and anonymized them. The researcher will remove all identifiable information during anonymization, so that it will be impossible to identify you. Only the researcher and her supervisor have access to the non-anonymized information in the recording, transcripts when they are transcribing and re-checking the data. The unidentifiable data will be used by the researcher for her doctoral thesis and may later be used to help produce an academic research paper. In the thesis, though some anonymized quotations answers from your interview may be quoted, these will be non-identifiable.

Anything said during the interview is fully confidential. The only exception would be in the unlikely event that you shared something that indicated a serious danger to yourself or others. In this case, the researcher would have to inform the relevant authorities to help prevent risk of harm.

FURTHER INFORMATION

The researcher is pleased to answer your questions about any details of this research. You can contact the researcher via: s1608391@ed.ac.uk

If you wish to contact the project supervisor Dr. Paul Graham Morris, he can be contacted via: p.g.morris@ed.ac.uk

If you have any complaints regarding this research and wish to contact someone who is not part of the research team, please contact the head of school Professor Matthias Schwannauer via: m.schwannauer@ed.ac.uk

CONSENT FORM

PROJECT TITLE: The perceived benefits and barriers of engaging in community gardening in China.

PROJECT SUMMARY: This study explores the potential benefits and barriers of gardening in community gardens. The result of this research will provide a deeper insight of whether community gardening can be effective for improving wellbeing.

By ticking the following boxes, you are agreeing that:

- 1 You have read and understood the Participant Information Sheet: ☐
- 2 You have had opportunity to ask any questions about this study, and any questions have been answered satisfactorily: ☐
- 3 You are over 18 years old and agree to participate in this interview: ☐
- 4 Anonymised data from this study can be used for research thesis and it also can be used to support further projects that are in the public interest: ☐
- 5 You are participating in this study voluntarily without coercion: ☐

Participant Recruitment Flyer



"The perceived benefits and barriers of engaging in community gardening in China"



Research Participants Needed

What is this research about?

Hi, I'm a PhD student at the University of Edinburgh in the UK doing a project about community gardens and psychological well-being. A community garden refers to a garden which people can use to grow plants and vegetables. My project aims to explore the perceived benefits and barriers of engaging in community gardening in China.

Who is eligible to join this?

You are welcome to join this research if you are:
1) Adult (over 18-years old); 2) Can communicate in fluent Mandarin; 3) Have been involved in community gardening regularly.

What will happen?

In this study you will be interviewed for maximum 60-mins, and will be asked some questions about your feelings, perceptions of engaging in community gardening. I would really like to hear your point of views and experiences about community gardening.



How to join?

If you would like to take part in the study, or to know more details about this, please let me know by emailing:
S1608391@ed.ac.uk



Please do not hesitate to contact me, I will provide refreshment or a cup of tea to thank you for your valuable time.

Research Approval Letter of Community Garden in Shanghai

Research Approval Letter



Dear administrator of The University of Edinburgh,

We can confirm that the project "*The perceived benefits and barriers of engaging in community gardening in China*", has been approved to collect data (conducting interviews) in our organization. We will cooperate the process of interviewing and make sure the personal security of Miss Ma when she stay in our community gardens. The participant recruitment process also has been approved as well - we permit Miss Ma to attach researcher flyer in our public boards and we allow her directly to approach the participants in our community gardens.

Kind regards,

四叶草堂 (Clover Nature School),

Sign:



Research Approval Letter of Community Garden in Guangzhou

广州市越秀区馨和社会工作服务中心

GUANGZHOU YUEXIU DISTRICT XINHE SOCIAL WORK SERVICE CENTER

Research Approval Letter

Dear administrator of The University of Edinburgh,

We can confirm that the project "*The perceived benefits and barriers of engaging in community gardening in China*", has been approved to collect the data (conducting interviews) in our organization. We will cooperate the process of interviewing and make sure the personal security of Miss Ma. The participant recruitment process also has been approved in this community garden- Miss Ma is allowed to recruit participants from the staffs and the memberships in our community garden. We are happy to offer plant seeds and gardening-discount for people who have been interviewed.

Kind regards,

萃园 (Garden of Talent Gathering),

Based on Oriental Horticultural Therapy Research Centre (OHTRC).

Sign: *Rose Zhao*



Research Approval Letter of Community Garden in Shunde

广州市越秀区馨和社会工作服务中心

GUANGZHOU YUEXIU DISTRICT XINHE SOCIAL WORK SERVICE CENTER

Research Approval Letter

Dear administrator of The University of Edinburgh,

We can confirm that the project "*The perceived benefits and barriers of engaging in community gardening in China*", has been approved to collect the data (conducting interviews) in our organization. We will cooperate the process of interviewing and make sure the personal security of Miss Ma. The participant recruitment process also has been approved in this community garden- Miss Ma is allowed to recruit participants from the staffs and the memberships in our community garden. We are happy to offer plant seeds and gardening-discount for people who have been interviewed.

Kind regards,

花解忧杂货铺 (Cure with Flower) ,

Based on Oriental Horticultural Therapy Research Centre (OHTRC).

Sign: *Rose Zhao*



Research Approval Letter of Community Garden in Beijing

Research Approval Letter

Dear administrator of The University of Edinburgh,

This letter will confirm that the research project "*The perceived benefits and barriers of engaging in community gardening in China*", has been approved to collect data and conduct interviews in the Keyu community garden. This research has been found in line with the socialist core concept of development, and it will be promising and valuable for Chinese society. So, we will cooperate the process of recruiting participants and conducting interviews among our community residents.

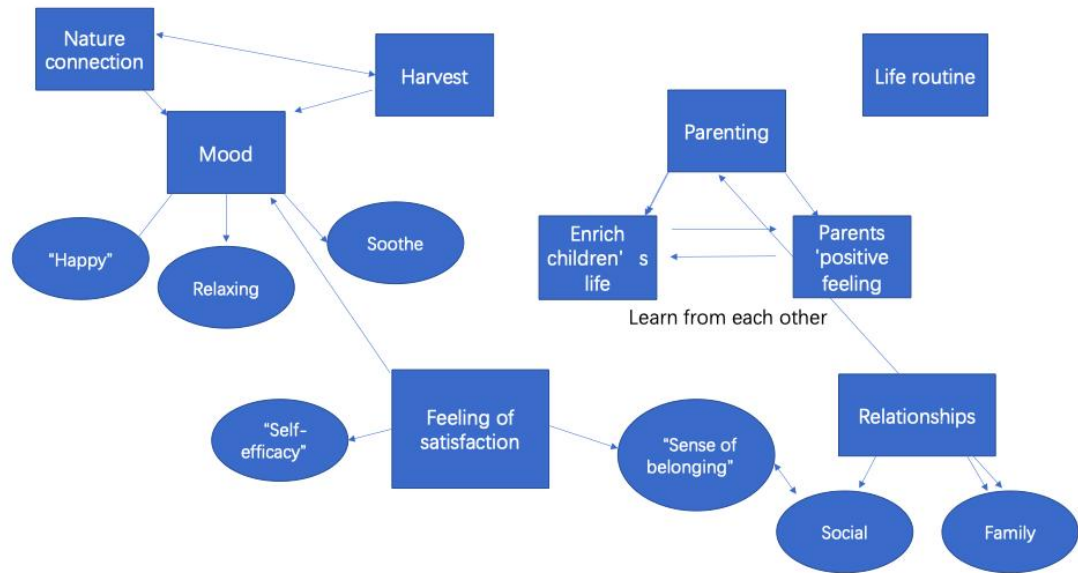
Kind regards,

科育社区 (Keyu Community) ,

Publicity Department of Zhongguancun Party Committee.

Sign: 科育社区

Diagram of Example of clustering memos



Examples of Free Memo Writing

Motivation of being a community gardener

In some interviews, I asked them whether they have a habit of growing flowers and vegetables at home. This question does not seem to be directly related to the community garden, but the purpose of asking these questions is to figure out why they still want to participate in the community gardening besides indoor planting...and what is their motivations...I intended to ask more about the other benefits they perceive of community gardening, not just planting flowers and vegetables. Some participants said that because the community garden creates opportunity for them to meet different people, to increase interpersonal communication ... Other said that because they are the leaders of the garden, so they must come because other residents need to take the lead in this matter, set an example, and be responsible...

It is very important to investigate why some persist coming to the garden, it is more important than the benefits they perceive briefly, especially for those who participate regularly. Because for these gardeners, there must be perceived unusual benefits that can be obtained in the community gardens to make it persistent.

Also, I tried to compare participants' motivations of participation between different ages and genders. Participants of different ages and genders hold different or completely opposite views on the same issue. When such a point of view appears, I must dig deeper and ask clearly, rather than rashly. For example, do retirees and young people experience similar benefits in participating in community gardens?

(Created 16/07/19)

Healing garden

Many interviewees mentioned how the flowers and plants they grew in community gardens played a healing role at critical moments. For example, after being bitten by a mosquito, it can be better to wipe the mint grown in the garden. Or after catching a cold, soak in water with herb plants grown in the garden, and the effect was immediate.

This belongs to the direct healing of the garden plant itself. In terms of spirit, plants can also heal people. Even if you do nothing, just water the flowers, and admire the plants, you can feel relaxed and comfortable spiritually. This is nature's healing for people. On the contrary, gardeners also heal nature, such as watering, soil replacement, and deworming are all healing nature.

Therefore, this process is mutual. As long as gardeners participated in it, humans, and nature (gardens) have a mutual healing relationship. When people stop participating, the relationship between man and nature is 0 or 1; either black or white. When man enters the ecological cycle of the natural garden, the relationship between man and nature becomes entangled, which will generate more resonance.

(created 10/07/19; supplemented on 18/12/19)

Appendix C:

Supplementary Materials for Chapter 5

Reasons for Excluding Studies

Study	Reason(s) for exclusion
A'Court & Beverley (2017)	No greenspace-based walking is involved.
Abraham, A <i>et al.</i> (2010)	This is a review article.
Adevi, A. A <i>et al.</i> (2018)	Case study, no control group.
Ainslie & Philip N (2002)	No control group; dependent variables are not specific in wellbeing.
Ambrey, C. L (2016)	This is a survey-based study; no intervention conducted.
Astell-Burt, T <i>et al.</i> (2013)	This is a survey-based study; no intervention conducted.
Baklien, B <i>et al.</i> (2016)	Participants are children; qualitative research.
Balter, O <i>et al.</i> (2018)	No control group, the walking intervention is not specific green based.
Bartion J <i>et al.</i> (2009)	Control group is not eligible.
Beaney & Katharine (2009)	Participants are children; qualitative research.
Berman, M. G <i>et al.</i> (2008)	No eligible control group; dependent variables are not wellbeing related.
Brown, D.K <i>et al.</i> (2014)	Dependent variables are not wellbeing related.
Browne, J <i>et al.</i> (2015)	There is no real intervention conducted.
Brownson, R. C <i>et al.</i> (2004)	Walking intervention is not natural-green-based.
Brownson, R. C <i>et al.</i> (2005)	The walking intervention is not green based; did not measure wellbeing level.
Carman, J & Carman, N (2007)	Irrelevant to this topic.
Chen, L. J <i>et al.</i> (2018)	Survey-based and self-report research; no real intervention conducted.
Coles & Richard (2014)	No walking/hiking intervention conducted.
Cook & Mandy (2017)	No intervention conducted.
Chippendale (2021)	No control group(s).
Davis, Deborah S <i>et al.</i> (2003)	No eligible control groups.
De Bloom, J <i>et al.</i> (2014)	No walking/hiking intervention involved.
Degenhardt & Buchecker (2012)	No control group; outdoor activities are not natural-green-based.
Diessner, R <i>et al.</i> (2015)	The dependent variable is not wellbeing related.
Doughty <i>et al.</i> (2011)	No control group(s).
Duvall (2011)	The walking intervention is not natural-green-based.
Ellison & Andrew, M (2010)	Not aim at testing effectiveness of natural-green-based

Faulkner, J. <i>et al.</i> (2013)	intervention(s). No eligible control group; not mentioned the walking was greenspace-based. Not specifically mentioned the walking took place in the green space
Freeman <i>et al.</i> (2017)	Control groups walked in both blue and urban areas.
Gidlow <i>et al.</i> (2016)	Case study, no intervention(s).
Gilchrist & Kathryn (2014)	No eligible control group; the control group was involved in built walk.
Gladwell, V. F <i>et al.</i> (2016)	No control groups.
Grant, G <i>et al.</i> (2017)	Dependent variable is not relating to psychological wellbeing.
Gueguen, N & Stefan, J (2016)	No intervention conducted.
Hadavi (2017)	Review article, not relevant.
Haluza, D <i>et al.</i> (2014)	No control groups.
Han, K. (2017)	Review article, not relevant.
Hanson, S & Jones, A (2015)	No eligible control group; the control group was walking in urban setting.
Hartig <i>et al.</i> (2003)	Walking intervention is not natural-green-based.
Ireland, A. V <i>et al.</i> (2018)	No eligible control groups.
Ivarsson, C. T & Grahn, P (2012)	No abstract and full text.
Jackson, C (2003)	No eligible control groups.
Kelley <i>et al.</i> (1997)	Control group is walking indoor.
Kalevi M <i>et al.</i> (2016)	No control group; not aimed at testing effectiveness of walking intervention(s).
Korpela, K <i>et al.</i> (2017)	Not mentioned walking in green space; not test effectiveness of intervention.
Korpela & Kalevi (2007)	No abstract and full text.
Kreitzer, M. J (2015)	No walking/hiking intervention conducted.
Lepille, R <i>et al.</i> (2017)	I appropriate method.
Lauwers <i>et al.</i> , (2021)	A case study.
Mapes & Neil (2010)	No real walking intervention involved, not specific natural-green-based setting.
Marselle, M <i>et al.</i> (2012)	Non-experimental settings.
Marselle, M.R <i>et al.</i> (2013)	Not green-based intervention; not aimed at testing effectiveness of intervention.
Marselle, M. R <i>et al.</i> (2015)	Walking intervention is not greenspace-based.
Marselle, M. R <i>et al.</i> (2016)	Non-experimental settings; walking group may not green-based.
Marselle & Melissa (2013)	

Marselle <i>et al.</i> (2014)	Non-experimental settings.
McManus & Maria (2012)	No intervention conducted.
	Dependent variables are irrelevant to psychological wellbeing.
Mitchell, B. L <i>et al.</i> (2014)	
Mobily, K. E <i>et al.</i> (1996)	No intervention conducted.
Mutz, M & Muller, J (2016)	Participants under 18-years-old.
Mygind <i>et al.</i> , (2021)	Review article.
Nielsen, T. S & Hansen, K. B (2007)	Survey-based research; no real intervention conducted.
Nose, H (2014)	Walking intervention is not natural-green-based.
Niedermeier, M, <i>et al.</i> (2017)	Dependent variable is not wellbeing related.
Nordbo & Prebensen (2015)	Non-experimental setting; no control group.
O'Brien, L (2014)	Qualitative research.
Patel & Deven (2017)	No intervention conducted.
Perkins <i>et al.</i> (2011)	Participants under 18-years-old.
Plante <i>et al.</i> (2007)	Lab-based experimental condition; not natural-green-based intervention.
Pretty, J <i>et al.</i> (2007)	No eligible control group.
	No control group; walking intervention irrelevant to natural green space.
Raine, R <i>et al.</i> (2017)	Not natural-green-based walking; dependent variables are wellbeing irrelevant.
Revell, S & McLeod, J (2017)	
Richards, J <i>et al.</i> (2015)	Not mentioned natural-green-based.
Robertson, R <i>et al.</i> (2012)	Review article; physical activities not natural-green-based.
Roderer, K & Cervinka, R (2012)	No intervention conducted.
Roe, J & Aspinall, P (2011)	No eligible control group.
Rogerson, M <i>et al.</i> (2016)	Green exercise irrelevant to walking/hiking.
Romagosa, F <i>et al.</i> (2015)	No intervention conducted.
Shanahan, D. F <i>et al.</i> (2016)	No intervention conducted.
	Participants were viewing pictures before walking.
Stigsdotter <i>et al.</i> (2017)	
Song <i>et al.</i> (2013)	Not greenspace-based walking.
Sugiyama, T. & Thompson, C.W. (2007)	No intervention conducted.
Sugiyama, T <i>et al.</i> (2008)	Survey-based, no intervention conducted.
Takayama, N <i>et al.</i> (2014)	No control group(s).
Coon <i>et al.</i> (2011)	Review article.
	No walking/hiking intervention conducted in the natural green space.
Triguero-Mas, M <i>et al.</i> (2017)	

Turner, T. L & Stevinson, C (2017)	No eligible control group(s).
Tsunoda, et al., (2021)	Irrelevant topics.
Verra, M. L <i>et al.</i> (2015)	Dependent variables are irrelevant to psychological wellbeing.
Wang, D <i>et al.</i> (2015)	Dependent variables are irrelevant to psychological wellbeing.
Willis, K <i>et al.</i> (2016)	Not specific walking/hiking interventions.
Wilson, M <i>et al.</i> (2012)	Online survey measurement; no intervention; no control group(s).
Wolf, I. D & Wohlfart, T (2014)	No intervention, no control group(s).
Wolf, I. D <i>et al.</i> (2015)	No control group(s).
Wood, L <i>et al.</i> (2017)	No intervention conducted.
Woods & Allen Dale (1985)	No intervention.
Wu, L. L <i>et al.</i> (2015)	The intervention is not green based.
Yang <i>et al.</i> (2018)	No control group.
Yamaguchi, M <i>et al.</i> (2006)	No eligible control group.
Young et al., (2021)	Irrelevant topic.

Appendix D:

Supplementary Materials for Chapter 6

Ethical Approval Letter



SCHOOL of HEALTH IN SOCIAL SCIENCE

The University of Edinburgh
Medical School
Doorway 6, Teviot Place
Edinburgh EH8 9AG

Email ethics.hiss@ed.ac.uk

09 February 2022

Dear Jingni Ma,

Reference: CLIN813

Project Title: The Effects of Outdoor Walking on Sleep Quality, Mindfulness and Mood

Thank you for submitting the above research project for review by the School of Health in Social Science Research Ethics Committee (REC). I can confirm that the submission has been independently reviewed and has received a favourable opinion on 29/01/21.

The standard conditions of this are:

- I. Conduct the project strictly in accordance with the proposal that you have submitted and that has been granted ethics favourable opinion, including any amendments made to the proposal required by the REC.
- II. Advise the REC (by email to ethics.hiss@ed.ac.uk) of any complaints or other issues in relation to the project, which may warrant review of the favourable opinion granted to the project.
- III. Make submission for approval of amendments to the project before implementing such changes.
- IV. Advise in writing if the project has been discontinued.

The School's Research Ethics Policy and further information and resources are available on the School's website.

Best of luck with your project.

Yours sincerely,

Sergio Mori
Administrative Secretary
School of Health in Social Science

Participant Information Sheet



PARTICIPANT INFORMATION SHEET

The Effects of Outdoor Walking on Sleep Quality and Mood

You are being invited to take part in the research about how walking is related to sleep and mood. Jingni Ma, a PhD student in clinical psychology at the University of Edinburgh is leading this research, supported by her supervisor Professor Jo Williams. Before you decide to take part, it is important that you understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

WHAT IS THE PURPOSE OF THE STUDY?

The purpose of the study is to understand how walking in different settings, such as nature and urban settings, may influence sleep, mindfulness and mood.

WHY HAVE I BEEN INVITED TO TAKE PART?

You are invited to participate in this study because you are:

- 1) an adult (aged 16 and above) university or college student;
- 2) self-recognised you have some levels of sleep difficulties;
- 3) not receiving formal or informal treatments of sleep difficulty within the past 6 months (e.g. using sleep medicines or receiving psychological intervention/ training for sleep difficulties);
- 4) self-identified to have sufficient English language proficiency to fill in the questionnaires;
- 5) not in high risk group related to the Covid-19.**

You must stay at home (self-isolate) and not take part in this study if:

- 1 you or someone you live with has coronavirus (COVID-19) symptoms
- 2 you've been told by the NHS Test and Trace service that you've been in contact with a person who has coronavirus
- 3 you're self-isolating because you recently entered the UK

In addition, as this study focuses on walking and daily physical activity, for the sake

of your own health and safety, if you have any disabilities (e.g. severe physical injuries, etc.) with you that might impede your engaging in a daily walking activity, you may not find this study suitable. If you are not sure whether you are eligible or not, please feel free to contact the researcher to discuss further.

DO I HAVE TO TAKE PART?

No – it is entirely up to you. If you do decide to take part, please keep this Information Sheet and complete the Informed Consent Form to show that you understand your rights to the research, and that you are happy to participate. You are free to withdraw at any time and without giving a reason. Please note down your participant number (which is on the Consent Form) and provide this to the researcher if you would like to withdraw from the study.

WHAT WILL HAPPEN IF I DECIDE TO TAKE PART?

This is an experimental study which will invite you to take part in a 7-day walking session. Please do not hesitate to ask questions relating to this study and the researcher will answer your questions to your satisfaction. If you decide to take part, you will be asked to sign off an online research consent form to confirm your participation.

You will walk in nature or in urban settings individually by yourself during the **daytime**. You are not suggested to wear headphones while you walking for your safety. Nature walking route is located in the Meadows which is a large public park in central Edinburgh. The urban setting is a route designed by the researcher which starts from the Southside, crosses the Princess street, and ends back to the southside (circular route). This route is near city buildings, commercial shops, roads with heavy traffics and crowded passers-by and is without significant greenery. The researcher will send you the walking map before you start walking, which clearly shows the walking routes.

Your participation will last 15 days in total.

During the **day 1~ day 3** you will complete a simple sleep diary (8 questions) (please fill the sleep diary every day for 15 days); a demographic survey (12 questions); a short questionnaire about your physical activity level (7 questions); a short questionnaire about your mood (19 questions).

During the **day 4 ~ day 10**, you will be randomly assigned into either nature or urban walking group and **start** your daily walking session lasting 30 – 35 minutes a day by yourself. You will complete questionnaires about your mood, sleep quality (9 questions), feeling of nature connection (6 questions) just before and after the walking sessions (only on day 4 and day 10); and fill a short survey (13 short questions) about mindfulness level before and after each walking session (twice a day during day 4 to day 10). After the week walking sessions, you are invited to fill in a Feedback Form, but it is not compulsory.

During the **day 11 ~ day 14**, you will **stop** participating in walking sessions, but you can do as much or as little activity as you like. You will complete the sleep diary and a simple survey about caffeine and alcohol intake.

In the last day (**day 15**), you will fill in three surveys about sleep, mood physical activity and mindfulness level as you have done before.

Don't worry about the complicated timing of filling the questionnaire, the researcher will email you with the survey link to remind you in time.

WHAT ARE THE POSSIBLE BENEFITS OF TAKING PART?

There may be no direct benefits, but by attending this walking intervention, you may be encouraged to be more physically active and to build up a healthier lifestyle. You will be helping the researcher and the University to better understand how walking may improve sleep quality and wellbeing.

ARE THERE ANY RISKS & DISADVANTAGES ASSOCIATED WITH TAKING PART?

Participation in the study will take approximately 3.5 hours/15 days of your time. There are no significant risks associated with participation. You will walk for 30-35 minutes for 7 days. In case you might feel tired and have hydration needs during the walking session, please bring water and food with you if necessary. Please walk safely and follow the traffic rules. If you feel unwell before walking, you can cancel the walking and inform the researcher about this. Please do not hesitate to contact the researcher via email/twitter if you have any inquiries about the research.

During the time you are filling the survey about your mood, you may be more aware of pre-existing mood difficulties, if you feel so, please feel free to look at the support information below and hope these are helpful.

Risks of participation (COVID-19)

We have taken specific steps to minimise the risk of exposure to the Coronavirus during the study by adhering to the Scottish Government guidance (<https://www.gov.scot/coronavirus-covid-19/>) Further, you will only interact with researchers who are well, and have had no known contact with COVID-19 positive individuals for the past 14 days. However, even with these control measures, there remains some additional risk of exposure from participating in this study. Please be aware that your participation will be ended if the Government reinforces lockdown and/or University suspends any in-person research.

What if I am unwell?

If you feel unwell or have been in contact with a COVID-19 positive individual in the past 14 days, then please contact the researcher (Jingni Ma, 07821815564), and we will postpone or cancel the research interaction.

WHAT IF I WANT TO WITHDRAW FROM THE STUDY?

Your wellbeing and feelings are the most important, so you can discontinue this study at any time. If, at any stage, you no longer want to be part of the study, please inform the researcher and provide your participant number. If you prefer to remove your data from your data set, please inform the researcher and provide your participant number before the data analysis. You should note that your data may be used in the production of formal research outputs (e.g. journal articles, conference papers, theses and reports) prior to your withdrawal and so you are advised to contact the researcher at the earliest opportunity should you wish to withdraw from the study.

DATA PROTECTION AND CONFIDENTIALITY

Your data will be processed in accordance with Data Protection Law. All information collected from you (including your contact details) will be kept strictly confidential and unidentifiable. Your data will be referred to by a unique participant number rather than by your name. The participant number is used so that anyone outside the research team is unable to identify you.

The unidentifiable survey data you provide in this study will be retained and stored in an electronic format till the end of the year 2025. The data will be safely stored in University data store which is password protected. The researcher will keep your data safely and will not disclose the information to any third party. These data are only used by the research team (comprising PhD student and her supervisors) and will not be combined with other data.

The University of Edinburgh is the sponsor for this study based in the United Kingdom. We will be using information from you in order to undertake this study and will act as the data controller for this study. This means that we are responsible for looking after your information and using it properly.

For general information about how we use your data go to:

<https://www.ed.ac.uk/records-management/privacy-notice-research>

WHAT WILL HAPPEN WITH THE RESULTS OF THIS STUDY?

The results of this study may be summarised in published academic articles, reports and presentations. You will not be identifiable from any published results. If you would like to know the findings of this study, please feel free to contact the researcher.

WHO IS ORGANISING AND FUNDING THE RESEARCH?

This study has been organised by Jingni Ma and with involvement of her supervisor Professor Jo Williams and sponsored by the University of Edinburgh.

WHO HAS REVIEWED THE STUDY?

The study proposal has been reviewed by the School of Health in Social Science Ethics Committee.

WHO CAN I CONTACT?

1. If you have any further questions about the study, please contact the main researcher, Ph.D. student Jingni Ma, who would be pleased to help. You can contact her via: S1608391@ed.ac.uk. If you wish to contact the project supervisors Professor Jo Williams, please contact them via: Jo.Williams@ed.ac.uk. If you would like to speak to someone impartial about taking part in the study, please contact Dr Karen Goodall via: karen.goodall@ed.ac.uk.

2. If you have any complaints regarding this research, please contact Head of School, School of Health in Social Science Professor Matthias Schwannauer via: m.schwannauer@ed.ac.uk

3. Here is the complaint form if you wish to make a formal complaint:

<http://www.ed.ac.uk/files/imports/fileManager/WEB%20Complaint%20Form.pdf>

FURTHER SUPPORT

1 If you need more information about mental health and wellbeing, please check these links:

<https://www.nhs.uk/using-the-nhs/nhs-services/mental-health-services/>

<https://www.mind.org.uk/#>

<https://breathingspace.scot/>

2 If you would like to seek help, you may find it helpful to speak with your GP.

You may also find the following link to mental health helplines helpful:

<https://www.nhs.uk/conditions/stress-anxiety-depression/mental-health-helplines/>

3 For information about strategies to improve sleep quality, please see:

<https://www.nhs.uk/live-well/sleep-and-tiredness/how-to-get-to-sleep/>

4 If you are interested in planning your own walks or joining other walking groups, please visit here for more information: <https://www.ed.ac.uk/transport/walking>

Instruction of Mindful Walking

Instruction of Mindful Outdoor Walking, 2nd version, created on 1st March 2021

Instruction of Mindful Outdoor Walking



Study title: The Effects of Outdoor Mindful Walking on Sleep Quality and Mood

Dear participant,

Thank you so much again for taking part in this 7-day outdoor mindful walking sessions.
Here is an instruction to guide you on how to be mindful while you walk.

- When you start your walk, please remember to walk slowly and steadily and observe your body sensations.
- Be aware of the environment around you during each of your walk – to notice the smells, sights, sounds, temperature.
- While you are walking, try to focus on your body. Your breaths, footsteps, and your moment-to-moment experiences without being lost in mind rumination about the things you are worrying about.
- If your mind wanders, try to return your focus to the environment where you walk.

Please do not wear headphones during your walk. Be mindful and focus on the present moment.

I hope you enjoy this journey!



Feedback from the Participants about Their Perspectives for the Intervention

Feedback for the intervention (both positive and negative)

- 1 Helpful for improving sleeping; Try to choose some closer places.
- 2 The walking sessions are great, and I like them. This study, I believe, will help people like me.
- 3 I think walking regularly is good for my mental health. I can breathe the fresh air and come across other people.
- 4 Positive: comfortable, easy, nice weather; Negative: too many people there (meadows).
- 5 1) I feel relaxed when I am in the moment of walking, but when I finished the walking and went home, I may feel down again; 2) I may become more tired when I was walking in a very tired situation, so I would take a nap when I went home; 3) I usually can't help thinking about other things when I was walking, and I think this might be because of the noisy surroundings.
- 6 I go out for a walk every afternoon, especially when there is a lot of homework. Going out for a walk for half an hour helps me clear my mind, and then it helps me sleep better at night. But I usually feel sleepy after going out for a walk, especially at 8 or 9 o'clock. I feel very sleepy and can't concentrate.
- 7 Positive: 1) when we walk with full exposure to sunlight, the body produces relation which facilitates sleep; 2) good for our eyes; Negative: 1) I always feel tired at night, because I spent time walking about 30mins during this period.
- 8 I paid much attention to observe others and feel the emotions, it's really good.
- 9 Very helpful for concentration and relieve anxious, make me calm down.
- 10 Feel more mindful and relaxed, I can fall asleep more quickly than before.
- 11 Gooooood.
12. On the fifth day, I had the urge to run, so I went to Meadows for a run from that day. My biggest feeling after participating is that I started to look at the flowers on the road and the expressions of people coming and going. Many people laughed and I felt a little happy.
- 12 Good. Better If some questions in survey could be explained.
- 13 The compulsory outdoors walking gave a relief to me, especially during this time when deadlines are near. It really helped provide a much-needed break and stress relief. However, the environment may sometimes be too noisy or crowded and may not provide too good an experience to the participant.
- 14 The walking was very helpful in terms of relieving me from the pressure of essay writing. They study provided a new perspective into the everyday walking and taught me to focus on the environment and pay attention to my own emotions rather than just inattentively walking.
- 15 It really helps to set up a time doing activities. However, it is difficult to continue doing activities after the session.
- 16 So many questionnaires.
- 17 Positive to my health status.
- 18 Make me feel better after walking (mentally and physically)
- 19 Positive: I can force myself to go outside and feel fresh air; Negative: sometimes I

- easily found my mind wandering.
- 20 Great, it really helps me to sleep early and get up early.
 - 21 It helps me to have a better quality of sleep.
 - 22 This is a good way to release stress especially during the pandemic period. It takes a long time to walk.
 - 23 It helps me get to sleep quickly. After that I feel more active than before.
 - 24 Going for an outdoor walk really makes me feel fatigue and sleepy right after the walking. So, I usually will take a nap after walking and that probably leads to the problem that I still cannot fall asleep quickly at night. Positive: clear instruction , participants know clearly about what they should do and how to fill the questionnaires; Negative: it would be better if participants are given the chance to choose the walking route.
 - 25 These walking sessions help me relax my mind and pay more attention to my emotions and feelings. It is also a kind of exercise for me and feel closer to nature. One downside may be when the weather is windy or cloudy, it could influence my walking pace.
 - 26 Outdoor walking is a quite good activity. It helps improve my mood and makes me pay more attention to the nature. However, it did not improve my sleep although I always felt tired after walking.
 - 27 Positive: I could walk outside and do exercises.
 - 28 Positive: help me take daily exercise somehow. Negative: when I have to stay up at night (doing assignment), the sleeping diary makes me feel guilty.
 - 29 I think it only worked a little to help sleep at night.
 - 30 Reduce pressure.
 - 31 I think it's a good idea to take part in positive thinking. I used to go for runs and walks, but I used to walk with my headphones on and think about things, so I always got lost and didn't know where I was going. Then I think the biggest change I feel is that I'm more focused. Like if I'm in a bad mood I try to stop thinking about it and focus on the task at hand. And I'm sleeping better, I'm taking less time to fall asleep, and I'm more regular.
 - 32 I have more time to focus on myself rather the phone. I have learnt to communicate with myself.
 - 33 It is pretty good and relieve my stress.
 - 34 In the past, the reason for lockdown I like to stay in the room. Because this event makes me want to go for walk, maybe more like mindful walk, more often.
 - 35 It is a good opportunity, but I have lots of deadlines recently. Walking through Princes Street may let us go shopping more frequently.
 - 36 Walking outside helps lift up my spirit.
 - 37 I enjoyed that it gave me a sense of purpose and motivated me to leave the house. But I found it difficult to remain mindful walking around the princess street, it was always really busy and hot.

Suggestions from participants about the intervention and the research

Suggestions for this study and the intervention

- 1 I think the walking could start with 15 minutes on the first day and gradually increase the time to make it easier to participate.
- 2 I feel there is the need for a more accurate recording of sleep time, maybe you can develop an app.
- 3 The walking places are limited.
- 4 Can walk in different weather.
- 5 Stricter monitoring of the participant's walking could be carried out to ensure greater accuracy of the data collection.
- 6 Participants may forget to fill in the forms occasionally (either before or after walking) as they would have to manually click into a link. Perhaps a simple app could be created to consolidate these links and help provide greater ease for the participants and easier monitoring of progress for the experimenters.
- 7 I want to walk in different places for each day.
- 8 May some introduction of what might be interesting along the road be helpful, which can lead me to pay more attention and not be distracted.
- 9 Use an app to track your walking, when the walking is done, there will have sense of achievement.
- 10 It is good but it will be great to test walking in different places such as shopping center, park or a random street.
- 11 There's one suggestion on the period this investigation is conducting, it is during the end of semester, probably also the start of the dissertation. And I think somehow it might affect the relationship between mindful walking and sleep.
- 12 Maybe some exercises apps such as KEEP can be included in this study to monitor participants' walking and ensure their walking route.
- 13 Walking session is well-arranged. However, I think the researchers can collect walking track from participants, which may increase credibility of the study. Just a small piece of advice:)
- 14 Princess Street also has many gardens and green places.
- 15 Some of the questions in the survey are too long and abstract to get the point.
- 16 Sometimes I think 30 minutes' walk is a bit short.
- 17 Maybe using other apps to record every day's work, which is helpful.

Participant Recruitment Advertisement



THE UNIVERSITY
of EDINBURGH

Will Outdoor Mindful Walking Help Us Sleep Better ?

Interested in taking part in a PhD Project in Clinical Psychology?

This study is to investigate the effectiveness of the outdoor mindful walking in your **mood, sleep quality, and mindfulness.**

If you are a university student in Edinburgh (aged over 16), and want to improve your **sleep quality, mindfulness and mood.** Please contact the project researcher to find out more!

This study will take 15 days. You re invited to fill a couple of online questionnaires from day 1 ~ day 3. From day 4, you will **start** your 7-day walking session in either Meadows park or the Princess street of Edinburgh city. After all the walking sessions, you will have a rest and complete questionnaires again. **All the tests are online and remote.**

Contact the researcher to find out more!

Email: S1608391@ed.ac.uk

Twitter: [@iamjingni](https://twitter.com/iamjingni) (Maggie Ma)



Page 1 of 1



Sleep Diary

Sleep Diary: General Instructions

What is a Sleep Diary? A sleep diary is designed to gather information about your daily sleep pattern.

How often and when do I fill out the sleep diary? It is necessary for you to complete your sleep diary every day. If possible, the sleep diary should be completed within one hour of getting out of bed in the morning.

What should I do if I miss a day? If you forget to fill in the diary or are unable to finish it, leave the diary blank for that day.

What if something unusual affects my sleep or how I feel in the daytime? If your sleep or daytime functioning is affected by some unusual event (such as an illness, or an emergency) you may make brief notes on your diary.

What do the words "bed" and "day" mean on the diary? This diary can be used for people who are awake or asleep at unusual times. In the sleep diary, the word "day" is the time when you choose or are required to be awake. The term "bed" means the place where you usually sleep.

Will answering these questions about my sleep keep me awake? This is not usually a problem. You should not worry about giving exact times, and you should not watch the clock. Just give your best estimate.

Please remember to fill in your Participant ID Number at the top!

Sleep Diary: Item Instructions

Use the guide below to clarify what is being asked for each item of the Sleep diary.

- 1 *Date:* Write the date of the morning you are filling out the diary.
- 2 *What time did you get into bed?* Write the time that you got into bed. This may not be the time that you began "trying" to fall asleep.

- 3 *What time did you try to get to sleep?* Record the time that you began "trying" to fall asleep.
- 4 *How long did it take you to fall asleep?* Beginning at the time that you wrote in question 2, how long did it take you to fall asleep?
- 5 *How many times did you wake up, not counting your final awakening?* How many times did you wake up between the time you first fell asleep and your final awakening?
- 6 *In total, how long did these awakenings last?* What was the total time you were awake between the time you first fell asleep and your final awakening. For example, if you woke 3 times for 20 minutes, 35 minutes, and 15 minutes, add them all up ($20+35+15=70$ min or 1 hr and 10 min).
- 7 *What time was your final awakening?* Record the last time you woke up in the morning.
- 8 *What time did you get out of bed for the day?* What time did you get out of bed with no further attempt at sleeping? This may be different from your final awakening time (e.g. you may have woken up at 6.35 a.m. but did not get out of bed to start your day until 7.20 a.m.).
- 9 *How would you rate the quality of your sleep?* "Sleep Quality" is your sense of whether your sleep was good or poor.
- 10 *Comments* If you have anything that you would like to say that is relevant do your sleep, feel free to write it here. If you need more room please attach a separate sheet.

Sleep Diary

Participant ID: _____

Example						
Today's date	4/5/11					
1. What time did you get into bed?	10.15 pm					
2. What time did you try to go to sleep?	11.30 pm					
3. How long did it take you to fall asleep?	55 min					
4. How many times did you wake up, not counting your final awakening?	3 times					
5. In total, how long did these awakenings last?	1 hour 10 min					
6. What time was your final awakening?	6.35 am					
7. What time did you get out of bed for the day?	7.20 am					
8. How would you rate the quality of your sleep? 	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	
9. Comments (if applicable)						

Appendix E:

Publications



Article

Interaction with Nature Indoor: Psychological Impacts of Houseplants Care Behaviour on Mental Well-Being and Mindfulness in Chinese Adults

Jingni Ma 

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Abstract: (1) Background: The rapid growth of urbanisation and the increased prevalence of mental problems have been concerns in China. ‘Green prescription’ such as keeping houseplants has been found to be an effective means of interacting with nature and improving mental health outcomes. The purpose of this study was to examine the psychological effects of keeping houseplants in the home and to examine how ‘connection to nature’ relates to mental well-being and mindfulness among Chinese adults living in urban areas; (2) Methods: A cross-sectional survey was completed by 421 (66.3% female) participants from 19 representative Chinese cities; (3) Results: Results revealed that participants who self-classified themselves as ‘houseplants carers’ reported higher levels of mental well-being compared with ‘non-houseplants carers’. Specifically, hours spent on taking care of houseplants, the number of houseplants, and the years of keeping houseplants were positively associated with greater levels of mental well-being and the trait of mindfulness. (4) Conclusions: The findings of the current study have implications for use of therapeutic horticulture for people who are seeking to improve their mental well-being and mindfulness in urban China.

Keywords: restorative environment; houseplants care; well-being; mindfulness; nature relatedness



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1. Introduction

Keeping houseplants indoors appears to generate psychological well-being benefits [1]. Houseplant care in this study refers to the behaviour of keeping and growing pot plants in one’s place(s) of residence. The plants (e.g., flowers, vegetables, green plants, succulent plants) in question may have been cultivated from an early stage (e.g., as seedlings), or they may have been raised entirely from seed. Individuals who regularly take care of their plants over six months are recognised as ‘houseplants carers’ within the current study. Houseplant care is a way of connecting oneself to nature especially when staying indoors.

1.1. Houseplant Care, Mental Well-Being, and Mindfulness

Houseplants are part of our natural environment. The impact of keeping houseplants on being connected with nature and on mental health has been the object of increasing academic attention in recent years. It has been demonstrated that there is a positive relationship between the accessibility of green spaces, well-being, and mental health [2–4]. Access to nature improves human wellbeing by mitigating attention fatigue and reducing stress. There is a reciprocal connection between mindfulness and connectedness to nature [5], and natural environments can strengthen the effects of mindfulness-based interventions [6].

The potential mechanism here may be that natural environments encourage one’s meditative awareness and strengthen the symbolic relationships between nature and human beings. The more time one spends in natural surroundings, the more one will feel an affinity with the natural environment (e.g., mountains, water, clouds, plants) which in turn fosters one’s trait mindfulness [7]. This process can also be explained by the biophilia hypothesis [8], which suggests that humans have an inherent need to be connected with nature, which in turn reflects our natural affinity for other living creatures.

China is now experiencing a rapid process of urbanisation with transformative sociocultural implications. It is indicated that 300 to 400 million Chinese will become urban inhabitants by 2050, bringing the country's urbanisation rate to around 75% [9]. In addition, the prevalence of 'mental disorders' in China was 9.3% in 2019 [10]. This can also be a low-cost and self-guided approach to alleviating certain psychological symptoms as a substantial number of Chinese people live in apartments without access to gardens. For example, one experimental study found that even a short duration of exposure to flora (five minutes in the presence of plants) can effectively reduce one's level of stress as shown in the Chinese sample [11]. Furthermore, greater number of indoor plants provides more opportunities for people to acquire visual exposure to flora, which reduce people's stress level [12,13].

It should be noted that simply spending time with plants is not the same as active planting behaviour. It may be hard to detect whether the psychological benefits that participants gained from interaction with plants were related to their passive rather than active interaction with plants. For instance, some experimental laboratory studies, have identified psychological benefits of simply viewing plants [14,15]. In addition, previous studies of the effect of indoor planting on psychological well-being have been largely based on the workplace settings rather than in people's homes. For example, past research demonstrated that employees' stress is mitigated by higher quantities of indoor flora in indoor working environments [16,17]. Such studies, however, have predominantly focused on the viewing of indoor plants or being in the same environment as plants in a passive manner, rather than involving in consistent behaviour on growing plants [14,18]. Conversely, it remains unclear whether it is really feasible to promote houseplant care behaviour on an everyday basis. It is still unknown whether the levels of engagement in keeping houseplants (e.g., frequency and year of house planting, stages of plant ownership) impact on Chinese urban residents' mental well-being and mindfulness levels, and any reliable information about the preferable characteristics of houseplants in urban China can be provided.

1.2. The Current Research

The current study sought to understand the differences of mental well-being and mindfulness amongst houseplants carers and non-houseplants carers, and test the relationship among houseplants care engagements, degree of nature relatedness, mental well-being, and trait mindfulness. The research questions were as follows:

1. How do mindfulness levels and mental well-being differ amongst people at different stages of houseplant care behaviours?
2. How do engagements of houseplant care behaviours (The actual houseplants care behaviour in this study has three dimensions, namely: the hours spent taking care of plants in one week (behaviour 1), the total numbers of plants (behaviour 2) taking care of, and the years spent planting indoors (behaviour 3)) relate to mental well-being and mindfulness levels?
3. How does the degree of nature relatedness relate to mental well-being and mindfulness levels?

The hypotheses were that (a) participants who recognise themselves as houseplants carers will report greater levels of mental well-being and mindfulness than those who classified themselves as non-houseplants carers; (b) more hours spent taking care of plants would be associated both with higher levels of mental well-being and with greater mindfulness; (c) greater numbers of plants kept indoors are associated with higher levels of mental well-being and mindfulness; (d) longer years of conducting houseplants care are related to greater levels of mental well-being and mindfulness; (e) greater levels of nature relatedness would be associated with greater mental well-being and mindfulness.

2. Materials and Methods

2.1. Design

This is an online questionnaire-based cross-sectional study. Questionnaires are an effective and practical tool for harvesting information and are widely used in psychological research.

2.2. Participants

According to power calculations using G*Power software [19], this study required a minimum of 400 participants to ensure the statistical power of conducting Pearson's correlation test and MANOVA test with medium effect size ($f^2 = 0.25$). In total, 430 participants initially participated in this study. Nine survey responses were excluded due to large amounts of missing data (up to 90%). This study achieved a sample comprised of 421 participants and most of them aged between 26 to 34 years (66.3% female).

2.3. Inclusion and Exclusion Criteria

Participants had to be: (1) Chinese residents; (2) fluent in reading written Chinese; (3) aged 18 or over; (4) living in an urban area of the targeted Chinese cities. We include participants who only take care of indoor houseplants. Participants should not have been involved in community or outdoor gardening on a regular basis because they may have higher levels of nature relatedness and better mental health than our target participants.

This study used a stratified sampling design to recruit representative participants. An established sampling model was adopted and modified for this study, as specified by the Chinese General Social Survey (CGSS) [20]. China contains twenty-six provincial capitals and four municipalities, and these provided the primary sampling units (PSU). Therefore, two sampling frames were used due to inconsistent development in the economy and geography of Chinese cities. The first sampling frame contains four municipalities, whereas the second sampling frame contained the two provincial capitals with three clusters (western, central, and eastern regions). Following the stratified sampling design set out by the CGSS, nineteen cities were targeted which were representative of the general profile of Chinese cities in terms of economy, demographics, and geography. They were selected to reflect both the developing cities in the three main regions of China, and the larger, more developed cities. The residents of these cities may reasonably be seen as representative of urban citizens in mainland China (see Supplementary Materials Section S1).

There were five categories for different occupations, namely: student, full-time job, part-time-job, unemployed and retired. Meanwhile, the selected cities were divided into four groups: municipalities, western region, central region, and eastern region. Ideally, at least 20 participants (for a minimum sample size of 400) would be recruited from each layer (i.e., $4 \times 5 = 20$).

2.4. Measures and Procedure

The Jisc Online Survey was utilised and the survey was distributed to the targeted nineteen Chinese cities between the 30 May and 30 June 2020 and was promoted through social media (e.g., Weibo; Online forums about indoor planting in Baidu; WeChat). The questionnaire consisted of seven parts as follows:

Demographic information: Questions regarding marriage and employment status, age, educational background, gender, and city of residence were asked.

Profile of Plant Ownership and Houseplant Care Behaviour: Descriptive questions about participants' houseplant care behaviour were included. Firstly, questions were asked to allocate participants into different stages of houseplant behaviour based on the Transtheoretical Model (or Stages of Change [21]). The TIM is an integrative model of behavioural change which can be employed to determine participants' current houseplanting behaviour in different stages of change, namely: precontemplation, contemplation, preparation, action and maintenance [21].

Participants chose a category which most appropriately described their behaviour (see Supplementary Materials Section S2). If participants self-recognised that they have already been a ‘house planter’ (in the stage of action and maintenance), they were also asked to report weekly hours spending on taking care of plants, numbers of plants taking care of at home, and years of keeping houseplants. Otherwise, participants who were not house planters could report a number 0 in each of this question or leave it as blank.

Additionally, to better understand the ownership of houseplants of the participants, preferable characteristics of plants were asked (see Supplementary Materials Section S3). This measure comprised six items, which were rated on a five-point Likert scale from “extremely unimportant” to “extremely important”. Items in this measure included: “nice scent of plant”, “small size of plants”, and “green coloured plants”, and which were items adopted from a previous study [17].

Nature Relatedness: The Nature Relatedness Scale (NR-6) was used to examine participants’ degree of cognitive and affective connection with nature. The higher scores of relatedness with nature indicated stronger subjective feelings of nature connection [22]. The scale demonstrated a robust internal consistency and contained six short questions regarding one’s cognition, affect and experiences of nature connection. The NR-6 scale has proven robust in terms of both internal consistency and reliability ($\alpha = 0.83$).

Mental Well-being: The Chinese version of the Short Warwick-Edinburgh Mental Well-being Scale (S-WEMWBS) was adopted. The WEMWBS has shown itself to be a valid and reliable measurement of mental health and well-being. Likewise, testing of the Chinese version of the short WEMWBS has led to its validation and the confirmation of its reliability ($\alpha = 0.89$) [23].

Mindfulness: The Five Facets Mindfulness Questionnaire (FFMQ) was used to measure trait mindfulness levels. The measure consists of 39 items and was developed from a variety of mindfulness-based measurements [24]. The FFMQ can explore an individual’s mindfulness in five areas, namely: observing, describing, acting with awareness, ‘non-judgemental to inner experience’, and ‘non-inactivity to inner experience’ [24]. The Chinese version of the FFMQ has demonstrated reliable psychometric properties for all subscales except for the non-reacting (Cronbach’s α : Observing = 0.75, Describing = 0.84, Actaware = 0.79, non-judging = 0.66, non-reacting = 0.45) [25].

2.5. Data Cleaning and Analysis

SPSS 24 was utilised for the purpose of statistical analyses. As each question of the survey required an answer, no missing data resulted. When statistical analysis was performed, a few missing data were identified, which was replaced in version 24 SPSS software. Initially, descriptive statistics, including percentage and mean, provided an overview of each stage of change in relation to age, gender, occupation, city of residence. The Shapiro–Wilk test was also used to check the normality of all the continuous variables.

As not all the continuous variables in the current study were normally distributed ($p < 0.05$), for the first and the second research questions, Spearman’s correlation was conducted to examine the relationship among scores on houseplants care behaviour, nature relatedness, mental well-being, and mindfulness levels. The stage of planting behaviour (within five possible categories) provided the independent variable for the final research question, the dependent variables were mental well-being and mindfulness levels. Multivariate analysis (MANOVA) was carried out to assess disparities in levels of mindfulness and well-being among five ‘stage of planting’ groups of participants.

2.6. Ethical Consideration

Participants voluntarily took part in the study and their data was anonymised. Informed consent was obtained from all individual adult participants included in the study. All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki Declaration and comparable ethical standards and its later amendments or comparable ethical standards. This study gained ethical approval by the Clinical

and Health Psychology Ethics Committee of the University of Edinburgh on 29 May 2020 (Reference number: CLIN776).

3. Results

3.1. Demographics and Exploratory Statistics

Darker colours on the map (Figure 1) represent greater numbers of participants. This study recruited 421 participants from the targeted cities in mainland China. The average number of participants per city was 21. There were variations, however, with the fewest individuals supplied by Jinan ($n = 11$), and a relatively large sample from Guangzhou ($n = 57$). In terms of ideal sampling, the objective was for each city to provide 20 participants. Discrepancies in participant numbers in certain cities may have been due to the nature of the online survey; obtaining an exactly equal number of individuals for each locale was always unrealistic. The researcher conducted the same recruitment method in each city (e.g., finding potential candidates, distributing the survey on social media in each city). The rate of response was stronger in southern and eastern coastal areas than in northern or inland regions.

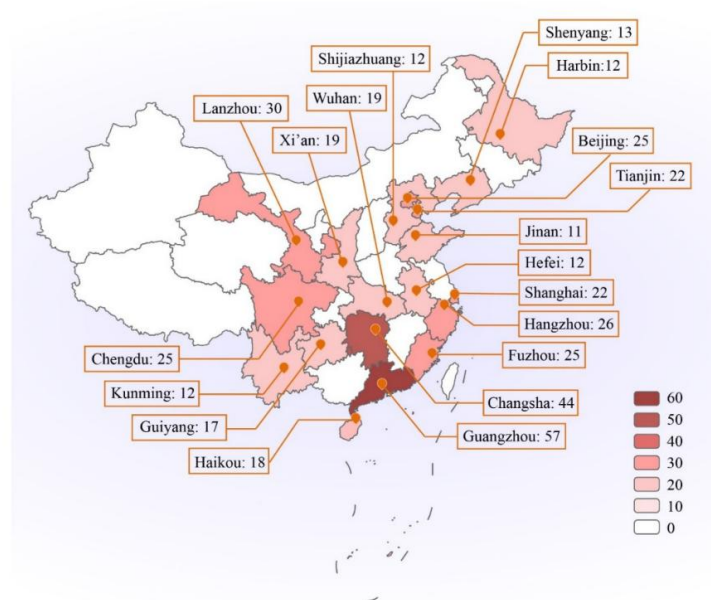


Figure 1. The distribution of participants in mainland China. Note. The number of participants is indicated in the map, the city of the participants' living is marked by orange icon. The darker colour represents the greater numbers of participants.

Demographic information regarding the participants is provided in Table 1. The survey participants included a high proportion of female, well-educated and relatively young individuals. According to an ANOVA test, there was no significant difference in mental well-being between residents of the 19 Chinese cities: $F(18, 386) = 1.33, p = 0.17$. Similarly, there were no statistically significant differences in mindfulness levels between residents of the Chinese cities; $F(18, 402) = 0.51, p = 0.96$.

Table 1. Sample demographic information.

Classification of Variables	(n = 421)	
	n	%
Gender		
Male	133	31.6
Female	279	66.3
Prefer not to say	9	2.1
Age Range		
18–25	144	34.2
26–34	181	28.7
35–44	34	8.1
45–60	51	12.1
>60	11	2.6
Highest Level of Education		
Primary School	1	0.2
Middle School and below	10	2.4
High School and below	21	5.0
College & Bachelor’s degree	198	47.0
Postgraduate and above	191	45.4
Employment Status		
Student	115	27.3
Full-time job	247	58.3
Part-time job	6	1.4
Unemployed	21	5.0
Retired	32	7.6
Marriage Status		
Single	198	47
Dating	66	15.7
Married	147	34.9
Separated	2	0.5
Divorced or Widowed	8	1.9
Stage of Indoor Planting		
Precontemplation	136	32.3
Contemplation	25	5.9
Preparation	20	4.8
Action	75	17.8
Maintenance	165	39.2

3.2. Stages of Houseplant Care Behaviour and Plant Ownership

Overall, 43% of individuals who recognised themselves as non-planters (in the stages of pre-contemplation, contemplation, and preparation stages) elected to participate, which was surprising. By contrast, over half (57%) of participants self-reported themselves as house planters based on the description of Stages of Change Model. Among the planters, they spent 1.28 h to take care of their houseplants on average (SD = 2.90); they owned 5.12 numbers of houseplants on average (SD = 8.62); and these houseplant-owners have already kept their plants for 4.17 years on average (SD = 6.31). Table 2 also shows mean and SD of dependent variable on five stages of changes in houseplants care.

Table 2. Descriptive statistics of mental well-being and mindfulness levels on different Stage of Change groups.

Variables	Stage of Change Model on Houseplants Care	Mean	SD	n
Mental Well-being	Total	3.80	0.76	405
	Precontemplation	21.11	3.09	130
	Contemplation	21.44	2.28	24
	Preparation	22.00	3.10	19
	Action	22.89	3.24	74
	Maintenance	22.85	3.20	158
Overall Mindfulness Level	Total	22.18	3.21	405
	Precontemplation	3.08	0.29	130
	Contemplation	3.21	0.28	24
	Preparation	3.28	0.21	19
	Action	3.22	0.37	74
	Maintenance	3.19	0.33	158
F1_Observing	Total	3.16	0.32	405
	Precontemplation	3.06	0.66	130
	Contemplation	3.32	0.61	24
	Preparation	3.25	0.61	19
	Action	3.28	0.78	74
	Maintenance	3.31	0.70	158
F2_Describing	Total	3.22	0.70	405
	Precontemplation	3.17	0.61	130
	Contemplation	3.32	0.54	24
	Preparation	3.38	0.44	19
	Action	3.36	0.71	74
	Maintenance	3.34	0.59	158
F3_Acting with Awareness	Total	3.29	0.61	405
	Precontemplation	3.25	0.64	130
	Contemplation	3.52	0.68	24
	Preparation	3.48	0.68	19
	Action	3.49	0.70	74
	Maintenance	3.35	0.76	158
F4_Nonjudging	Total	3.36	0.71	405
	Precontemplation	2.95	0.59	130
	Contemplation	2.80	0.58	24
	Preparation	3.21	0.54	19
	Action	2.94	0.63	74
	Maintenance	2.89	0.65	158
F5_Nonreactivity	Total	2.93	0.62	405
	Precontemplation	2.94	0.61	130
	Contemplation	3.05	0.48	24
	Preparation	3.05	0.49	19
	Action	2.98	0.56	74
	Maintenance	3.03	0.53	158
F5_Nonreactivity	Total	2.99	0.56	405

Figure 2 indicates the preferable characteristics of houseplants for participants to take care of, 44.42% of participants believed nice-scented plants were important and very important to them; conversely, 40.62% of participants believed that this was unimportant to them. For green-coloured plants, 46.08% and 40.62% of the participants believed it was important, or unimportant, respectively, for them to consider keeping. Additionally, more participants (39.19%) believed the small size of plants was unimportant to them than those who believed it was important (34%). Similarly, more than half (57.72%) of participants believed the texture of the plants was unimportant to them. Notably, participants concerned

about how good the plants looked (81%), the ease of growing (84.80%) and cheaper cost of purchasing and maintaining their plants (54.16%), were important to very important to them. In conclusion, when keeping houseplants, Chinese adults preferred to take care of plants which were good-looking, easy to grow, and cheap to purchase.



Figure 2. Preferable characteristics of plants.

3.3. How Do Mindfulness Levels and Mental Well-Being Differ amongst People at Different Stages of Houseplant Care Behaviour?

A MANOVA was used to test group differences between house plant behaviour groups (between subject variable) and mental well-being and mindfulness level (see Table 3).

Table 3. Multivariate Tests of Differences (MANOVA) of mental well-being and trait mindfulness amongst five Stage of Change groups.

Stage of Change on Houseplants Care	MANOVA Test					
	Value	<i>f</i>	Hypothesis <i>df</i>	Error <i>df</i>	<i>p</i>	Partial Eta Squared
Pillai's Trace	0.12	2.04	24.00	1592.00	0.00	0.03
Wilks' Lambda	0.88	2.06	24.00	1379.20	0.00	0.03
Hotelling's Trace	0.13	2.07	24.00	1574.00	0.00	0.03

The results showed, Pillai's trace = 2.04, $F(24, 1592) = 2.04$, $p < 0.01$. $\eta^2 = 0.03$, implying that 3% of the variance in the dependent variable was accounted for by stage of change. For mental well-being, significant houseplant group differences were found $F(4, 400) = 6.96$, $p < 0.001$, $\eta^2 = 0.07$. Post hoc test showed that mental wellbeing scores of the pre-contemplation group increased and was statistically different from action ($p < 0.01$) and maintenance ($p < 0.01$) groups. The contemplation group was significantly different and increased from action ($p = 0.05$) to maintenance ($p = 0.04$) groups on mental wellbeing as well. Mental wellbeing scores of the preparation group were not significantly different from any other houseplant groups.

Furthermore, as Figure 3 below shows, participants who identified themselves in latter stages of houseplants care behaviour evinced a greater level of mental well-being. From the stage of pre-contemplation through to the action stage of home planting, levels of well-being rose sharply, and this increase persisted in a stable manner from the stage of action to that of maintenance.

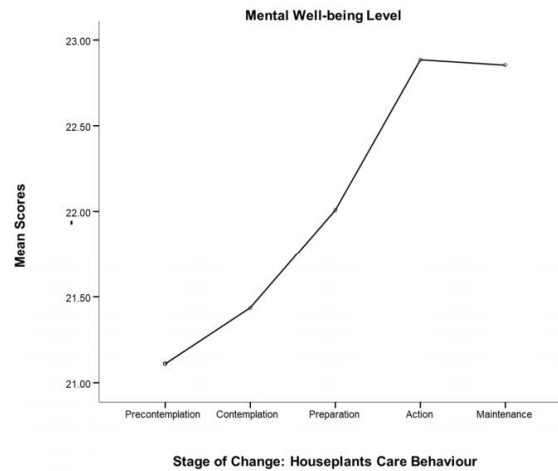


Figure 3. Houseplants care behaviour and mental well-being.

There was a significant houseplant group difference for overall trait mindfulness, $F(4, 400) = 3.85, p < 0.01, \eta^2 = 0.04$. The scores increased from the stage of pre-contemplation to that of preparation (determination), with a peak value in the preparation stage. Subsequently, the mindfulness levels increased, and remained stable in the contemplation and maintenance stages (see Figure 4). A post hoc test indicated that the overall mindfulness scores in the pre-contemplation group were significantly different from those in contemplation ($p = 0.01$), preparation ($p < 0.01$), action ($p < 0.01$) and maintenance ($p < 0.01$) groups. Moreover, the contemplation group did not show significant differences to any other groups on the score of overall mindfulness.

For each subscale of FFMQ, results shown that only for observing ($F = 3.61, p = 0.01$) and for describing ($F = 2.45, p = 0.05$) were there statistically significant differences between the five houseplant behaviour groups (see Figure 5).

Post hoc tests indicated that levels of observing in the pre-contemplation group were significantly different; it decreased from pre-contemplation to preparation, and then increased to action ($p = 0.04$) and maintenance ($p < 0.01$) groups; contemplation and preparation groups were not significantly distinct from other groups on observing scores. Additionally, for describing levels, similarly, the pre-contemplation group was only significantly different from action ($p = 0.04$) and maintenance ($p = 0.02$) groups.

In summary, the results show that scores of mental well-being, overall mindfulness, and its subscales of observing and describing scores, were highest in the preparation to action stages of house planting behaviour, and the group differences between pre-contemplation and action, as well as maintenance groups, were significant on measured outcomes. It suggests that there was a significant difference on levels of mental well-being and mindfulness between non-house planters and house planters.

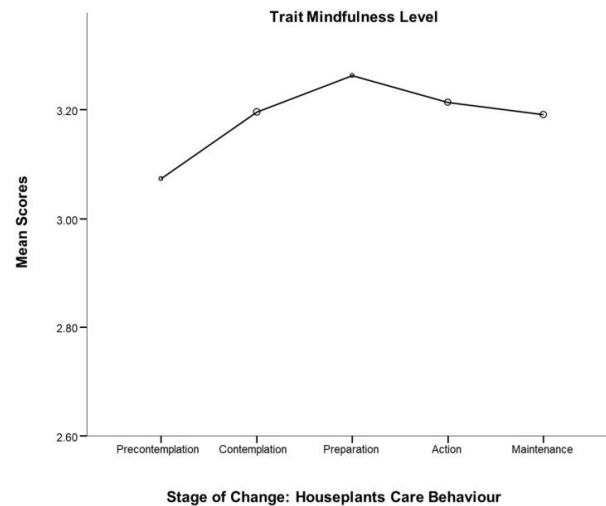


Figure 4. Houseplants care behaviour and mindfulness.

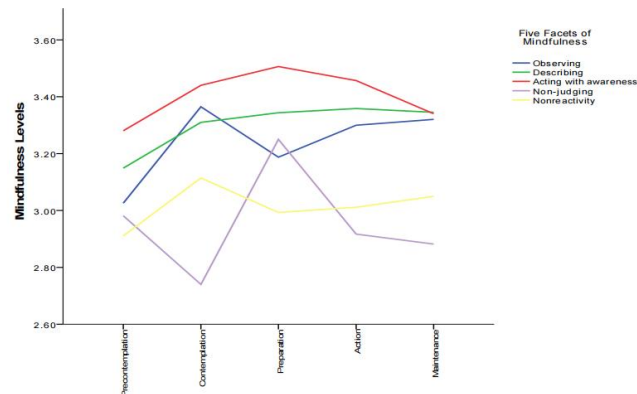


Figure 5. Subscales mindfulness and houseplants care behaviour.

3.4. Engagement of Houseplant, Mental Well-Being and Mindfulness

Table 4 below shows the results of analyses to test associations between levels of engagement of caring for houseplants, degrees of mental well-being, nature relatedness and trait mindfulness. The results indicated that having spent more hours in the last week, owning greater numbers of houseplants, and spending longer years of keeping houseplants, are statistically significant and correlated with greater levels of nature relatedness, mental wellbeing, and trait mindfulness. Furthermore, higher levels of nature relatedness were significantly associated with greater degrees of mental well-being and mindfulness. It is notable that the effect magnitude of these associations was sizeable (i.e., $r = 0.31$; 0.34 ; see more details in Table 4).

Table 4. Correlations between houseplant behaviour and mindfulness, nature connectedness and wellbeing.

Variable	1	2	3	4	5	6	Mean	SD
1. NR-6		0.34 **	0.28 **	0.31 **	0.28 **	0.32 **	3.80	2.90
2. S-WEMWBS			0.41 **	0.24 **	0.21 **	0.28 **	22.18	3.21
3. CH-FFMQ				0.13 **	0.10 *	0.17 **	3.16	0.32
4. Hours of caring					0.78 **	0.68 **	1.28	2.90
5. houseplants (last week)						0.73 **	5.12	8.62
6. Numbers of houseplants							4.17	6.31
7. Years of keeping houseplants								

Note. * $p < 0.05$, ** $p < 0.01$ (2-tailed). $n = 421$. Abbreviations: Nature Relatedness (NR), hours spent taking care of plants in the preceding week (behaviour 1), the total numbers of plants at home (behaviour 2) and the total years spent raising plants at home (behaviour 3).

4. Discussion

The present study investigates the psychological impact of indoor houseplant care behaviour on mental well-being, trait mindfulness, and nature relatedness amongst Chinese adults living in urban areas. This study involved 421 samples (66.3% female), and most of them were young and well-educated. Over half of the participants categorised themselves as houseplants carers, and they reported that on average, they spent 1.28 h on taking care of their houseplants in the last week, owned 5.12 pots of plants, and had spent 4.17 years keeping houseplants.

Firstly, this study indicates that mental wellbeing and mindfulness levels were significantly different among participants at differing stages of houseplants care behaviour. Mental well-being was higher among houseplants carers than non-houseplants carers, participants who are currently growing houseplants (in Action group) reported the highest levels of well-being in comparison with other four behavioural groups of participants. For the mindfulness level, participants who prepared for growing houseplants reported the highest levels of overall mindfulness among other behavioural groups; nonetheless, participants who are actively growing houseplants (in Action and Maintenance groups) reported higher levels of overall mindfulness than non-houseplants carers (in Precontemplation and Contemplation groups). In other words, the participants were at their most mindful when they were preparing to begin keeping houseplants. That might be because only smaller numbers were involved at some stages, which would likely affect the reliability of mean scores for those stages.

Secondly, participants in the contemplative stage of keeping house plants were more likely to look around them, rather than attempting to act precipitously. Moreover, people preparing to take care of houseplants showed the highest levels of ‘non-judging’, ‘describing’, and ‘acting with awareness’. Again, the data reflected a connection between the stages prior to starting houseplants care, and enhanced mindfulness. The possible reasons for this are as follows: (a) the boundaries between houseplants carers than non-houseplants carers were too detailed. There were five ‘types’ of houseplants carers in this study, which may have created ambiguity regarding the differences between planters and non-planters in terms of mindfulness levels. Moreover, (b) the measurement of mindfulness the study deployed is commonly used to test mindfulness changes, before and after a mindfulness-based intervention. Further research is needed to examine differences in mindfulness before and after engaging in plant-cultivation behaviours/interventions. In any case, to investigate the effect of domestic plant cultivation on rumination, meditation and mindfulness in greater detail, interviews will be required.

Thirdly, for the houseplant carers in urban China, the findings suggest the more hours spent taking care of plants in the last week, keeping greater numbers of houseplants, spending more years taking care of plants, and possessing greater levels of nature connectedness were positively correlated with greater levels of mental well-being and trait mindfulness. These findings coincide with previous studies of the relationship between horticultural

activities and mental well-being [26]. Further studies can test the role of mindfulness in the relationship between houseplants care behaviour and improvement of mental wellbeing by using an experimental research design, to reveal the mechanism of improvement of mental well-being via mindfulness.

The findings are novel because these add to the body of literature on the benefits of houseplants for mental health and mindfulness. Cultivating one's own mindfulness via the literal 'cultivation' of plants is a reasonable and intuitive concept that may attract many individuals. For instance, one project ('Green Mindfulness') at a Canadian university integrated plants with mindfulness practice, aiming to improve students' well-being [27]. However, the relationship between improved mindfulness and indoor house planting has been sparsely researched.

Lastly, this study provides an insight on the preferred characteristics of plants amongst Chinese adults. Ease of growing is the most important factor that people, especially beginners, consider when raising plants at home. The aesthetics of the plants is also an important factor that people consider. Overall, less than half of the participants believed that green coloured, small sized, and soft textured plants were important for them to plant. This study suggests that ease of growing, aesthetics, and affordability are the important aspects Chinese adults consider when keeping houseplants. This finding can be incorporated with further self-guided planting interventions for adults in China. Further relevant studies are encouraged to collect data regarding the preferable plant species that urban residents like to grow indoor, which may also provide valuable knowledge for designing and promoting the therapeutic use of nature indoor.

4.1. The Significance of the Present Study

The present study is original in its exploration of association of indoor houseplants care behaviours with Chinese city residents' mental well-being and mindfulness level. This study concurs with earlier research regarding the well-being advantages derived from indoor plants [28]. The present study also shows that a variety of planting behaviours offer one way to enhance one's connection with nature. The increase of self-perceived mental well-being among some participants was consistent with previous studies on the positive relationship between nature connectedness and well-being [22]. This can partially explain why participants at different stages of their planting behaviour evinced significantly different levels of well-being and mindfulness. Further studies are desirable to use experimental design to explore whether nature connection is a mediator for the improvement of mental well-being and mindfulness within home planting behaviours.

It has been demonstrated by much prior research that those horticultural activities promote human mental health in various ways. Nonetheless, few of these studies examined the relationship between planting-related behaviour and mindfulness, especially in the sense of keeping plants being deployed to cultivate mindfulness. Gardens can be excellent places to practise meditation and to become centred on the present moment [29,30]. For many Chinese urban residences, either private gardens or outdoor community gardens may not be very prevalent or common. However, the present study provides an inexpensive and easily conducted approach, which may be further developed into nature-based interventions, and even be prescribed by medical practitioners. Further research should address the therapeutic influence of plant cultivation among individuals of different nationalities and cultures.

The findings from the current study can assist with developing a rational intervention to enrich lives within the general population. Such practices and interventions may also be directed to the management of everyday stress, and not exclusively to mental or emotional pathologies.

4.2. Limitations

There are several limitations to the present study. Firstly, as it is a cross-sectional study, differences of mindfulness levels between planters and non-planters are still unclear. To

investigate mindfulness discrepancies between these two categories, additional studies are desirable. In addition, the Stage of Change Model, which was employed in this study to theoretically identify participants' current behaviour of house planting, contributed to unbalanced numbers of participants in each group, further relevant research can group participants into (a) actively growing houseplants; and (b) not currently growing houseplants. Secondly, although stratified sampling was used to recruit representative participants among Chinese city residents, the nature of online surveys meant that the participant numbers from each city were unequal. Third, since most participants were young and relatively well-educated, they may not be strongly representative of the wider population. In addition to the sample, the present study excludes potential participants who had regular experience in outdoor gardening, it may reduce sample size and increase the difficulties to recruit representative participants. Further studies may consider including more participants who have or have not engaged in outdoor gardening and other nature-based activities.

5. Conclusions

Growing houseplants is a way of connecting with nature indoor and cultivate better mental well-being and mindfulness levels in urban China. The present cross-sectional study is the first empirical study in China to confirm aspects of the houseplants care behaviours were associated with greater levels of mental health and trait mindfulness. Taking care of a greater numbers of plants and spending longer time on it were correlated with greater levels of mental well-being and mindfulness. Significant group differences between different stages of change have been found in mental well-being and trait mindfulness. The present study provides evidence that may be deployed both to illustrate the mental-health advantages of houseplants care behaviour, and to assist in the formation of mechanisms to promote this healthy behaviour in urban China.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/ijerph192315810/s1>, Section S1: Diagram of Sampling Process; Section S2: Questions of houseplants care behaviour stage; Section S3: Questions about preferable characteristics of plants.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the BPS ethical code and approved by the The Clinical and Health Psychology Ethics Committee of the University of Edinburgh, where gave ethical approval for this study (Reference number: CLIN776) for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study. Written informed consent has been obtained from the participant(s) to publish this paper.

Data Availability Statement: Not applicable.

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Conflicts of Interest: The authors declare no conflict of interest.

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Original Research

Effectiveness of a mindful nature walking intervention on sleep quality and mood in university students during Covid-19: A randomised control study

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ABSTRACT

Objective: The aim of this project was to conduct a randomised control study to examine whether outdoor mindful walking in nature can effectively improve university students' sleep quality, mood, and mindfulness during the Covid-19 pandemic in the U.K.

Methods: Participants were measured at T₀ (pre-study baseline), T₁ (pre-intervention), T₂ (post-intervention), and T₃ (follow-up). A total of 104 participants (female = 94) who were experiencing sleep difficulties were randomly allocated to either an experimental (i.e., nature) or control (i.e., urban) walking environment. Participants in each walking condition independently undertook a daily 35-minute walk for a week (7 days). Subjective sleep quality, total mood disturbance, mindfulness, and degree of nature connectedness, and participants' perspectives on the intervention, were collected.

Results: Findings suggest that both groups resulted in significant improvements in participants' trait mindfulness, sleep quality and mood after the intervention. However, mindful walking in nature did not bring additional mental health benefits to participants relative to those who walked an urban environment. Participants provided their perspectives about the intervention, which will assist with future intervention development.

Conclusions: Findings contribute to the evidence-base on the effectiveness of outdoor mindful walking interventions for enhancing mental health. These findings contribute new knowledge on how mindful walking outdoors reduces university students' mood disturbances and improves sleep quality and mindfulness level.

Introduction

Walking 'in nature' has repeatedly been shown to bring more benefits than walking in other outdoor settings, such as built urban environments with busy streets, heavy traffic, and little greenery^{1–4}. Walking in green space exposes people to a range of environmental sensory inputs including natural soundscapes (e.g., birdsong), visual stimuli including landscapes and flora and fauna, olfactory stimuli (e.g., plants) and tactile stimuli (e.g., heat of the sun, breezes, ground underfoot), which may also result in a greater sense of connection to nature^{5,6}.

Nature connectedness has been found to improve one's mood and reduce 'negative thoughts'⁷. Even passive interactions with nature may enhance one's state of mindfulness⁸, while also improving mood and nurturing self-esteem⁹. According to Attention Restoration Theory, walking 'in nature' may reduce concentration fatigue (ART¹⁰).

ART divides human attention into two components, namely: direct, and effortless. The former is controlled by cognitive functions, which are associated with the consumption of brain capacity⁴. ART proposes that connections with nature allow people to observe the environment around them with 'effortless attention'. Effortless attention is involuntary and refers to the brain's inherent tendency to capture stimuli. Overuse of direct attention may result in mental fatigue and stress¹¹. Moreover, the human attraction to nature allows cognitive processes to be relaxed, an experimental studies indicate that natural scenery has a lower attentional requirement than urban scenery¹².

ART focuses on cognitive aspects of consciousness, and more precisely, explains how nature positively affects human cognitive function⁵. As people spend more time in natural environments, greater present-moment awareness is experienced⁸. Trait mindfulness is positively associated with positive mood, and 'mind-wandering' was found to be the mediator between mindfulness and negative mood¹³. ART

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suggests that effortful attention may contribute to mental fatigue and mind-wandering, which therefore are related to mood disturbances¹⁴. Furthermore, a recent systematic review ($n = 13$) indicated that sleep quality and quantity was improved by nature exposure¹⁵. This suggests that green exercise has potential to be developed into an effective intervention to improve sleep quality and mood¹⁵.

The present study

College and university students experience a high incidence of mental-health concerns and sleep problems, and these may negatively impact students' mood, stress, and well-being levels, and thus impair academic achievement¹⁶. Up to 60% of university students have experienced sleep difficulties and 20% of students may encounter sleep disorders¹⁷. A cross-sectional study of 26 countries found that poor sleep quality and other sleep disturbances were experienced by 10.4% of university students¹⁸.

It has been reported that university students' lives and studies have been negatively impacted by the Covid-19 pandemic. Specifically, the mental well-being and sleep quality of many students have been harmed by the long-termed enforced quarantine and isolation^{19–22}. For example, one study found 25% university students reported symptoms of anxiety and strong concerns about academic and financial pressures because of lockdown²³. Nearly one-third of college students reported their feelings of loneliness, worry, grief, depression, and PTSD related symptoms as they experienced frequent relocations²⁴. There is an urgent need to address students' mental health issues during the COVID-19²⁵, therefore this study focused on this population, aiming to investigate whether nature-based mindful walking is an effective intervention to improve university students' levels of nature connection, mindfulness, mood, and sleep quality. The research questions and hypotheses were as follows:

- 1) Will mindful walking improve sleep quality and mood, regardless of the walking environment? The hypothesis was: mindful walking in both nature and urban environments would improve participants' sleep quality, mood, nature connectedness and mindfulness.
- 2) Compared with walking in urban environments, will 'nature walking' bring additional benefits in terms of mindfulness, connection to nature, mood, and sleep quality? The hypothesis was: green walking would lead to significantly greater improvements in mood, sleep quality, mindfulness, and nature connectedness than urban walking.

Materials and methods

Participants

Using G*power software²⁶, a-priori power analyses assuming a small effect size ($f^2 = 0.25$) and 5% α error probability²⁷, it was estimated that a sample of 32 participants would be sufficiently powered to carry out the planned analyses (see below for details). Leaflets were distributed across a university's campuses and student accommodation and promoted via social media to recruit potential participants. The researcher contacted various department administrators who helped to promote (i.e., retweet the Twitter, email the students) this study. Interested individuals were invited to contact the principal researcher to obtain an information sheet and consent form.

A total of 118 university students registered their interests in this project, and 104 ($m = 23.6$ years, 90.4% female) consented to participate in the intervention between March and June 2021. Each group was assigned 52 participants. Two participants in nature group and three participants in urban group withdrew and gave their reasons. After the intervention, 20 and 28 participants of nature and urban group respectively were tested at follow-up. For the online questionnaire, 38 and 47 participants completed the survey in nature and urban groups at

T1, respectively, and each group lost one participant at T2. Additionally, only 61 sleep diaries were returned to the researcher (nature = 28; urban = 33). The Consort Flow Diagram²⁸ in Fig. 1 shows more details about the allocation to conditions.

Inclusion and exclusion criteria of participants

Participants were eligible for inclusion if they were: 1) adult university or college students (aged 16 and above); 2) self-identified as experiencing some level of sleep difficulties; 3) not in receipt of treatments for sleep problems, formally or informally, within the preceding six months (e.g., using sleep medicines or accepting psychological training for sleep difficulties); 4) self-identified as having sufficient English-language proficiency to fill in the questionnaires. Individuals who perceived themselves to be in high-risk categories regarding Covid-19 were excluded. Individuals with disabilities that might impede their engagement in a daily walking intervention were advised that they would not be suitable for participation.

Ethical considerations

Ethical approval was granted by the relevant Ethics Committee at the University of Edinburgh (reference number: CLIN813). As this study was conducted just after lockdown during the Covid-19 pandemic, participants in both walking groups were reminded to follow the latest government rules (two-metres social distancing). Participants chose their own times for walking, did not meet each other, were not accompanied by the researcher or other friends, and walked alone in either an urban or natural setting. The researcher also reminded participants to wash their hands carefully before and after the walking sessions. The risks that the activity entailed were minimised because it was conducted outdoors.

Intervention

Randomisation

This study employed a randomised controlled trial design. Participants were randomly assigned into either the experimental (i.e., nature) or control (i.e., urban) mindful walking groups. Participants firstly completed the baseline measurements, and they were randomly assigned into groups afterwards. Randomisation strategy was employed to minimise the variability of evaluation, and to avoid confounding variables from other known and unknown factors²⁹. Since the sample size was relatively small ($n = 104$), block randomisation was employed to prevent an imbalanced number for each group³⁰. A randomised list was generated using Microsoft Excel.

Nature versus urban mindful walking

The natural setting was a public park (see Fig. 2.1), a large area of open grassland crossed by lines of trees, covering 58.4 acres. The urban route (see Fig. 2.2) included the city's busiest commercial street, comprising many shops, tall buildings, crowds people and heavy traffic. However, it does run next to large formal gardens and is overlooked by the historic Edinburgh castle. All aspects of the urban walking intervention were equivalent to those of the nature walking group except for the environment. Both routes were chosen with due consideration for safety, and 30–35 minutes to walk at a moderate pace.

A guide on mindful walking was developed based on previous published guidance for walking meditation^{31–33} and sent to each participant before they started the walking intervention (see Appendix. A). The mindfulness instruction focused on teaching participants to observe their body movements, their breath, and to be in the moment. The researcher gave clear guidance in advance regarding how to be mindful during the walking to ensure the participants fully understood how to mindfully walk and be involved in the environment around them. Additionally, for participants' safety and for the consistency of the intervention, participants were asked to walk during the daytime.

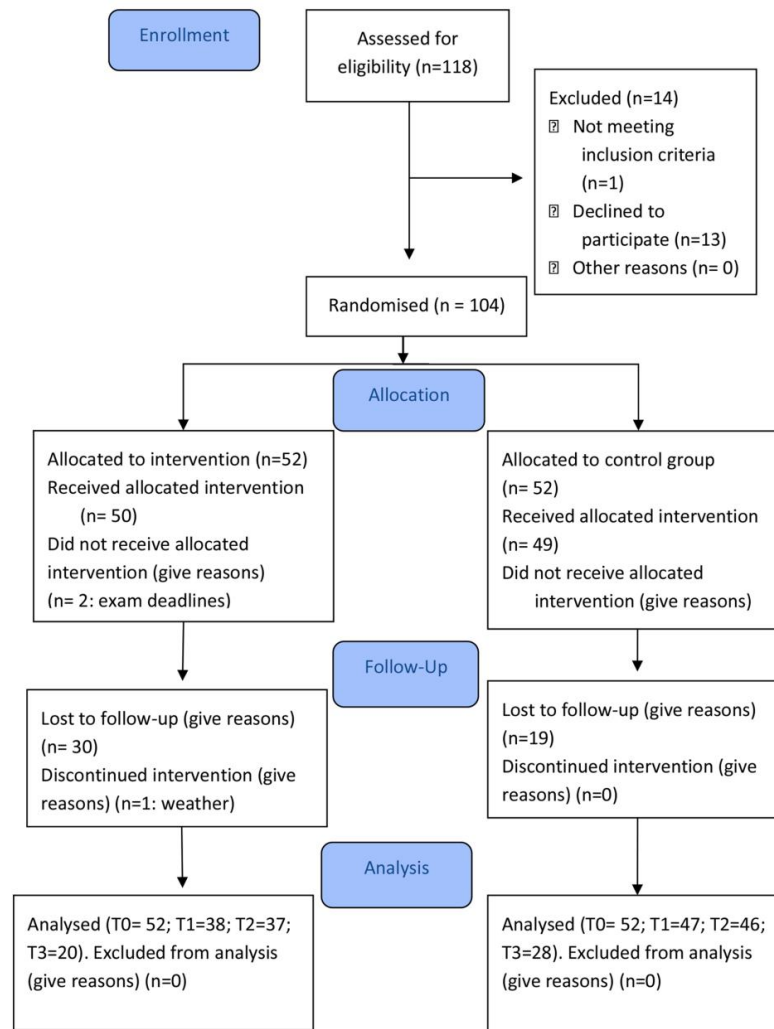


Fig. 1. CONSORT flow diagram. Randomised allocation to intervention environment (natural/urban) from enrolment to allocation time and to the follow-up test.

Measures and procedures

All the standardised questionnaires were completed digitally via Jisc online survey. The outcome measures included participants' subjective sleep quality, mood states, physical-activity (PA) levels, degrees of nature relatedness, and *state* and *trait* mindfulness.

Demographics. Questions regarding demographic variables included gender, age, educational level, and status regarding weekly physical activity. Participants' previous experience of walking in nature

and exposure to nature, accessibility to green spaces (e.g., whether they lived near to or far away from green spaces), mental-health conditions, and treatment history regarding sleep difficulty (if any), were also asked.

Sleep quality. The Pittsburgh Sleep Quality Index (PSQI) was employed to measure changes of sleep quality. PSQI is a self-reported questionnaire that contains four open-ended questions regarding an individual's sleep habits. The remaining 'component scores' address a variety of factors, namely: subjective sleep quality, sleep latency, sleep

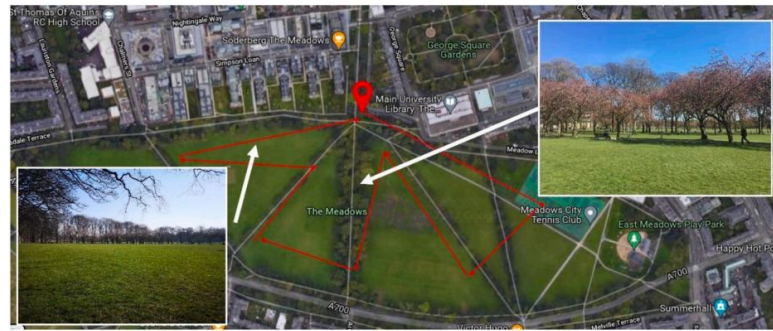


Fig. 2.1. Route map and inset photographs of the natural environment walk. The designed route displayed in red line. The photo in left hand and right hand were taken in February and May of 2021, respectively, by the researcher of this study. Copyright of these photos are reserved.

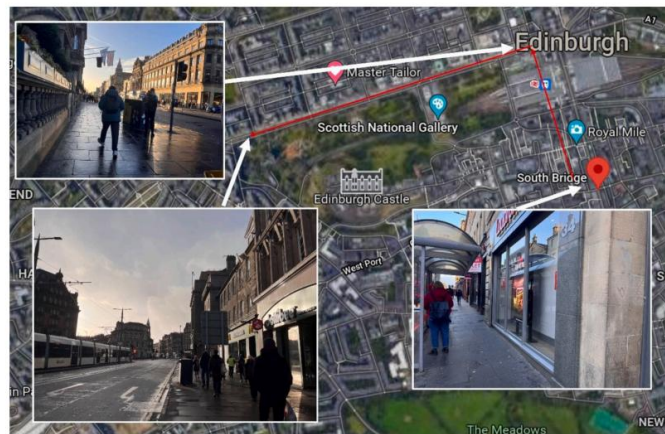


Fig. 2.2. Route map and inset photographs of the urban environment walk. The designed route displayed in red line. The photo in right hand and left hand were taken in February and May of 2021, respectively, by the researcher of this study. Copyright of these photos are reserved.

duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, daytime dysfunction, and overall rating of sleep quality in the last month³⁴. A single global score is used to represent the entirety of the responses: the higher the global score, the poorer the sleep quality. The internal consistency ($\alpha > .70$) of PSQI has been found to be adequate³⁵. It has also been widely reported that PSQI is a valid and reliable tool to assess sleep quality among different populations.^{36–38}

Mood. The Short Form of Profile of Mood State (POMS-SF) was used to measure participants' daily mood states before and after their walking sessions. It is also highly flexible in capturing a participant's mood over the course of one week, as it captures his/her mood in the preceding week, 'today' and 'right now'.³⁹ The standard version includes 65 items with 5-point Likert response scales ranging from 'not at all' to 'extremely'. This study used the POMS short version of 37 items⁴⁰. The internal consistency of the short-version POMS is comparable to that of the original version ($.75 < \alpha < .92$) among both clinical and non-clinical samples^{40,41}.

Physical activity (PA). The short form of International Physical

Activity Questionnaire (IPAQ) includes seven questions relating to the duration of vigorous/moderate physical activities, as well as the walking and sitting that participants had engaged in during the preceding week⁴². A robust level of stability is reflected in the test-retest reliability data ($\alpha < .80$)⁴². The internal reliability is also adequate ($.79 < \alpha < .98$)⁴³.

Nature Connection. The degree of nature connection was measured by the Nature-Relatedness Scale, which includes six short questions with five-point Likert scale (1 = strongly disagree, 5 = strongly agree) to assess the strength of one's connection to nature⁷. The NR-6 scale has proven robust in terms of both internal consistency and reliability ($\alpha = .83$)⁷.

Mindfulness. Two measures were used to capture changes in mindfulness levels before and after walking. The Mindful Attention Awareness Scale (MAAS) and the Toronto Mindfulness Scale (TMS) were used to assess *trait* mindfulness and *state* mindfulness, respectively. MAAS was designed to measure changes of an individual's trait-mindfulness level overtime and has exhibited good psychometric properties ($\alpha = .83$). It has also been widely used across a range of different

samples^{44,45}. Conversely, the TMS was designed to evaluate state mindfulness which reflect the instant changes of mindfulness levels before and after each walking session. It has also showed robust levels of internal consistency and validity (.84 < α < .88)⁴⁶.

Feedback form. Two open ended questions were asked in the follow-up test: 1) what feedback for the intervention you would like to provide (both positive and negative aspects)? 2) do you have any suggestions on this intervention?

The study took 15 days in total, day 1 to day 3 were baseline period, and participants started one-week daily walking intervention from day 4 to day 10. The outcome variables were measured at four time points: pre-study baseline (T₀), pre-intervention (T₁), post intervention (T₂), and at follow-up (T₃) five days after the post-intervention. Notably, state mindfulness was tested before and after each daily walk.

During Phase 1 (day 1 - day 3), baseline data was collected (T₀) including demographic information, sleep quality, mood states, PA, and mood. In Phase 2 (day 4 - day 10), participants undertook their walking interventions every day for a week. Data were collected at T₁ (day 4) and T₂ (Day 10), and participants' POMS, PSQI, MAAS, and NR-6 were measured at these two time-points. TMS was completed before and after each walking session. In Phase 3 (day 11 - day 14), participants ceased walking and rested for three days. In this time participants could do as little physical activity as they liked, and the researcher did not monitor this. In Phase 4 (day 15), at the T₃ data collection point, the researcher sent the follow-up assessment (using POMS, MAAS, PSQI and a feedback form) to the participants.

Statistical analysis

IBM's SPSS 25 statistics software was used. Descriptive statistics were explored, and Shapiro-Wilk test was adopted to test parametric assumptions and the violation of assumptions. As sample dropped down from T₁ to T₃, and to ensure the power of statistics analysis, two separate ANOVAs were conducted to compare the effects of the intervention from T₁ to T₂, and T₂ to T₃, respectively. A series of independent sample t-tests were employed to explore the difference of variations at baseline on measured dependent variables. For the open-ended questions regarding the feedback, content analysis was adopted to summarise the key information and generate themes⁴⁷. The following steps were performed to analyse qualitative data with the current study: familiarise with contents, initial coding, structuring codes, generating themes, and defining the themes⁴⁸.

Results

Sample characteristics

The descriptive statistic shows the mean and standard deviation of the tested variables at baseline (see Table 1).

Exploratory data analysis

Independent t-tests show that sleep quality (PSQI: $t = .45$, $p = .66$), total mood disturbance (TMD: $t = .81$, $p = .42$), trait mindfulness (MAAS: $t = .63$, $p = .53$), and nature relatedness (NR-6: $t = -.18$, $p = .86$) were not significantly different between the two walking groups at T₁, indicating that the two groups were matched at baseline, (Tables 2).

In addition, participants in both groups reported that their walking sessions took place most frequently from 16:00 to 17:00 pm (see Appendix C). An independent sample t-test showed that there was no statistically significant difference between two groups in walking duration in minutes: $t(57) = -1.78$, $p = .08$. Moreover, the Shapiro-Wilk test indicated that walking duration was not normally distributed ($p < .001$). Therefore, walking duration was not included as a co-variant in the following data analysis (section 3.3).

Table 1
Sample characteristics and outcome variables at pre-study baseline.

Variables N = 104	Descriptive Statistics Mean (SD)/Frequencies (%)	95%CI for mean [Lower Bound, Upper Bound]	Shapiro-Wilk test (p)
Age (mean, SD)	23.6 (2.23)		
Gender (female/male)	94:10		
Level of education N (%)	Undergraduate 7 (6.7) Postgraduate (master student) 87 (83.7) Postgraduate (PhD student) 10 (9.6)		
Frequency of accessing natural environment N (%)	Never 3 (2.9) Once a week 51 (49) 2–3 times a week 35 (33.7) Over 3 times a week 15 (14.4)		
Distance of living from natural green spaces N (%)	< 1 mile 63 (60.6) 1–3 miles 36 (34.6) 4–6 miles 2 (1.9) 10 miles and above 3 (2.9)		
Treatment history of sleep difficulties N (%)	Pills 7 (6.7) Psychotherapy 2 (1.9) Non-medical supplements 7 (6.7) Deep breathing/relaxing/meditation 18 (17.3) All above 1 (1) Never 69 (66.3)		
Physical activity level (mean/SD)	Vigorous 207 (186.27) Moderate 165 (135.83) Walking 204 (138.13) Sedentary 420 (120)	-24.28, 438.28 -3.66, 333.66 32.49, 375.51 271, 569	<.001 .64 .26 .44
Mood (mean/SD)	Total mood disturbance (TMD) 28.58 (3.80) Depression 083 (1.03) Vigour 2 (.66) Confusion 1.90 (.96) Tension 1.57 (.81) Anger .54 (.71) Fatigue 1.76 (.74)	23.87, 33.3 -.46, 2.11 1.18, 2.82 .69, 3.09 .55, 2.58 -.34, 1.42 .84, 2.68	.19 .04 .64 .06 .87 .12 .98

The effectiveness of the intervention

A series of 2 (Group type: Nature, Urban) $\times$ 2 (Time: T₁, T₂) ANOVAs with repeated measured on the Time was conducted on the sleep quality, mood, nature connectedness, and mindfulness scales. Results revealed significant effects of time on improvement of sleep, mood, and trait mindfulness. However, there was no significant interaction effect on group and time for the measured outcomes.

Sleep quality. There was no significant interaction between group and time on sleep quality, $F(1, 81) = 1.49$, $p = .23$, $\eta^2 = 0.02$, or main effect of group, $F(1, 81) = .19$, $p = .67$, $\eta^2 < .01$. Significant effect of time was found with medium effect size, $F(1, 81) = 6.86$, $p = .01$, $\eta^2 = .08$, driven by a reduction of sleep quality of both groups from pre-intervention to post-intervention. The mean scores of sleep quality of

Table 2

Summary results table of outcome means and SD from T₁ to T₃.

Outcome measures Mean (SD) [95%CI ^a]	Nature T1(n = 38)	T2(n = 37)	T3(n = 20)	Urban T1(n = 47)	T2(n = 46)	T3(n = 28)
PSQI	5.32 (3.03) [4.31; 6.33]	3.89 (2.42) [3.08; 4.70]	5.0 (2.16) [4.12; 6.18]	5.09 (2.67) [4.27; 5.91]	4.57 (3.14) [3.49; 5.37]	5.71 (2.88) [4.60; 6.83]
MAAS	2.77 (1.14) [2.19; 3.17]	3.0 (.88) [2.72; 3.31]	3.11 (.77) [2.74; 3.47]	2.64 (.92) [2.35; 2.92]	3.02 (.70) [2.80; 3.24]	3.13 (.83) [2.80; 3.45]
NR-6	2.50 (.68) [2.28; 2.73]	2.77 (.73) [2.53; 3.02]	-	2.53 (.84) [2.25; 2.77]	2.58 (.79) [2.33; 2.81]	-
TMD	29.77 (4.27) [28.20; 30.99]	27.34 (3.95) [26.12; 28.76]	26.40 (3.24) [24.89; 27.92]	29.16 (4.37) [27.83; 30.49]	27.77 (3.74) [26.64; 28.91]	26.70 (3.88) [25.17; 28.13]

Note. ^a CI: Confidence Interval. For the PSQI and TMD, the lower scores indicate better sleep quality and less mood disturbance, respectively. For the MAAS and NR-6, the higher scores indicate greater levels of trait mindfulness and nature relatedness, respectively.

both intervention groups reduced from the pre-intervention to the post-intervention indicating improvement in sleep quality. Inspection of means indicated that participants in the nature group decreased in mean sleep scores more than the urban group, indicating that sleep quality of the nature group improved more than urban group on average (See Fig. 3.1).

Mood. There was no significant interaction between group and time on total mood disturbance (TMD), $F(1, 80) = .61, p = .44, \eta^2 < .01$, or main effect of group, $F(1, 80) = .02, p = .89, \eta^2 < .01$. There was a significant main effect of time with medium effect size, $F(1, 80) = 8.09, p < .01, \eta^2 = .09$, suggesting that participants, regardless of group, reported a reduction in mood disturbance (See Fig. 3.2).

Trait Mindfulness. There was no significant interaction between group and time on trait mindfulness, $F(1, 82) = .33, p = .57, \eta^2 < .01$, or main effect of group, $F(1, 82) = .13, p = .72, \eta^2 < .01$. There was a significant main effect of time with medium effect size, $F(1, 82) = 5.15, p = .03, \eta^2 = .06$ (See Fig. 3.3). This showed that for both walking conditions trait mindfulness scores improved following the intervention.

Nature Relatedness. There was no significant interaction effect ($F(1, 82) = .86, p = .36, \eta^2 = .01$), main effect of group ($F(1, 82) = .36, p = .55, \eta^2 < .01$), or main effect of time ($F(1, 82) = 1.95, p = .17, \eta^2 = .02$) (See Fig. 3.4) for nature relatedness.

State mindfulness. This was measured before and after each walking session. For the subscale curiosity there was no significant

interaction between group and time, $F(1, 99) = .30, p = .59, \eta^2 < .01$, main effect of group, $F(1, 99) = .29, p = .59, \eta^2 < .01$, or main effect of time, $F(1, 99) = .01, p = .91, \eta^2 < .01$. Similarly, no significant interaction effect ($F(1, 80) = .10, p = .76, \eta^2 < .01$), main effect of group ($F(1, 80) = 1.78, p = .19, \eta^2 < .01$) or time ($F(1, 80) = .01, p = .94, \eta^2 < .01$) for the subscale decentring (see Table 3).

Follow-up analysis

Two-way ANOVAs: 2 (Group type: Nature, Urban) $\times$ 2 (Time: T₂, T₃) were conducted to investigate the effectiveness of the mindful walking from the post-intervention to the follow-up timepoints.

Sleep quality. No significant interaction effect between group and time, $F(1, 45) = .04, p = .85, \eta^2 < .01$, nor main effect of group was found, $F(1, 45) = 1.29, p = .26, \eta^2 < .01$. A significant main effect of time was found with large effect size, $F(1, 45) = 18.25, p < .01, \eta^2 = .29$, suggesting that the sleep quality for both groups increased from the post-test to the follow-up.

Mood. There was no interaction effect between group and time ($F(1, 45) = .03, p = .86, \eta^2 < .01$), main effect of intervention group ($F(1, 45) = .33, p = .57, \eta^2 < .01$), or main effect of time ($F(1, 45) = .19, p = .67, \eta^2 < .01$), indicating that the effects of the intervention on mood maintained after the post intervention to the follow-up timepoints.

Trait Mindfulness. Similarly, from the post intervention to the

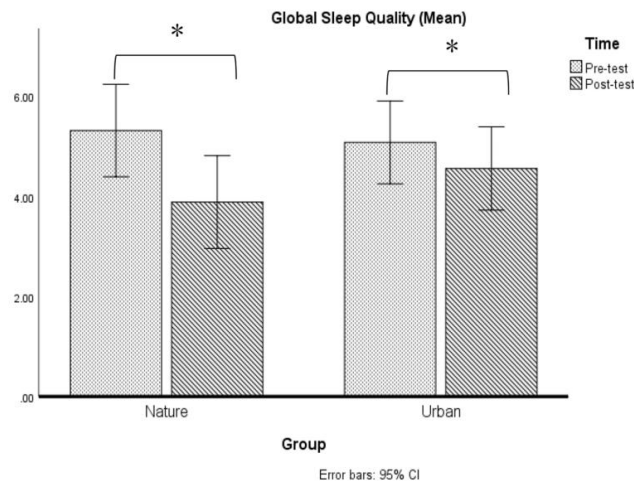


Fig. 3.1. Intervention effectiveness measured by sleep quality.

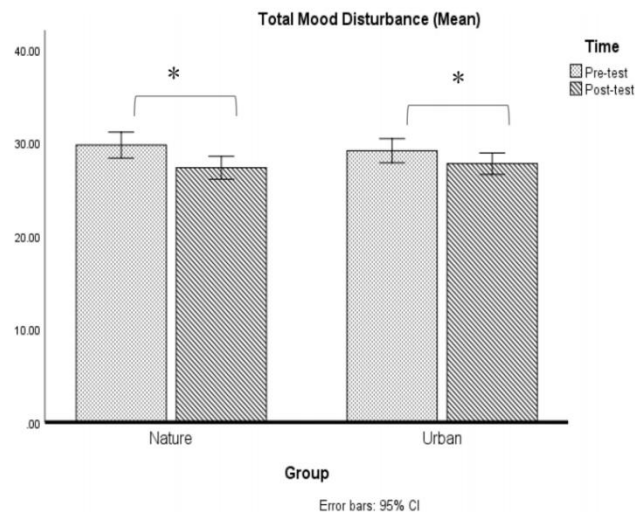


Fig. 3.2. Intervention effectiveness measured by TMD.

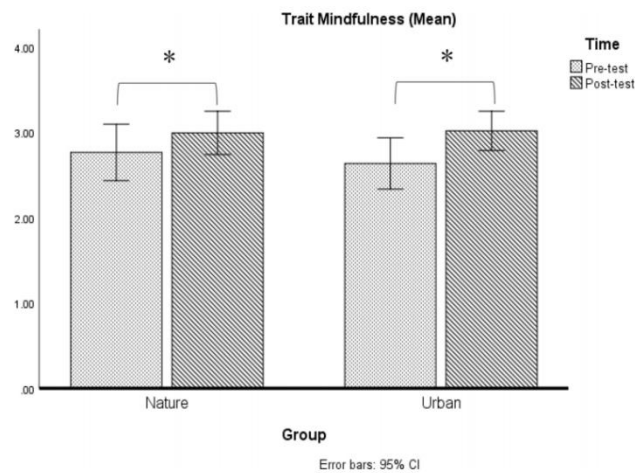


Fig. 3.3. Intervention effectiveness measured by trait mindfulness.

follow-up test, there was no significant interaction effect between intervention group and time ($F(1, 46) = .98, p = .33, \eta^2 < .02$), no significant main effect of intervention group ($F(1, 46) = .39, p = .53, \eta^2 < .01$) and no main effect of time ($F(1, 46) = .25, p = .62, \eta^2 < .01$). It indicates that the intervention's effects on trait mindfulness were sustained from the post-intervention to the follow-up timepoints.

Qualitative data analysis

Feedback forms collected participants' views and suggestions about mindful walking interventions (see Appendix B). Thirty-eight open-ended answers were analysed using content analysis. Six and three themes regarding positive and negative perspectives about mindful walking were generated, respectively.

Participants perceived their sleep quality improved after the intervention. Positive mood improved and anxiety and stress were perceived

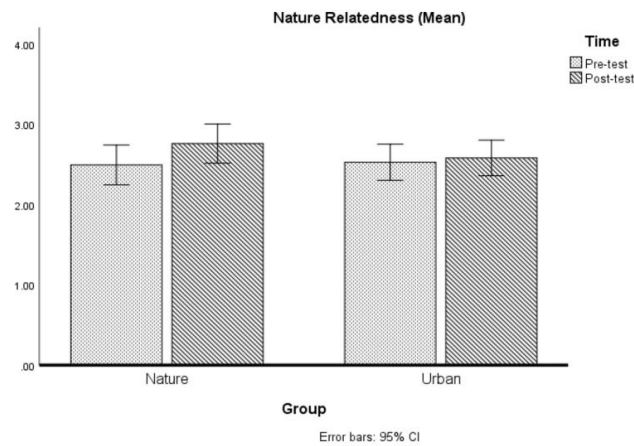


Fig. 3.4. Intervention effectiveness measured by nature relatedness.

Table 3
State mindfulness before and after each single walking intervention.

TMS Outcome	Nature(n = 52)				Urban(n = 49)			
	Curiosity		Decentering		Curiosity		Decentering	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean (SD)	13.53 (3.68)	14.04 (3.41)	15.30 (3.49)	15.50 (2.81)	14.11 (3.01)	13.78 (3.46)	14.78 (3.59)	14.57 (3.44)
95%CI ^a	[12.38; 14.67]		[14.2; 16.39]		[13.11; 15.12]		[13.58; 15.97]	

Note. ^a CI: Confidence Interval. Mean summary scores were adopted to represent the trait mindfulness level for each subscale; higher scores indicate greater levels of state mindfulness.

as decreasing following the intervention. Moreover, mindfulness practise during the walking was perceived as cultivating their sense of mindfulness and their concentration. Participants reported that it was enjoyable to stay in outdoor environments, breathe fresh air and be close to nature. In addition, the daily walk was perceived as regulating their life and bedtime, and some participants felt they became more regular and healthier. The negative feelings regarding mindful walking were described as crowded walking places, time/energy consumed by the walks, and two participants reflected that mindful walking intervention were not very effective for sleep quality improvement. Overall, the positive themes were more prevalent than themes regarding the negative aspect of the intervention. Example quotes can be found at Table 4.

Participants also recommended improving the follow-up timepoint of the intervention. They also advised that further research could use mobile Apps to track participants' walking routes and physical exercise data to increase accuracy. Future studies may consider adding objective measurements to track all walking data to control anticipated confounder variables. Additionally, participants suggested reducing the frequency of the intervention as some of them felt tired after seven consecutive walking sessions.

Discussion

General Discussion

As the university students experienced frequent lockdowns, quarantine, and accommodation relocations during the Covid-19 pandemic, their experience of depression, anxiety, negative emotions, and attention incapacity increased, which were threatening their mental

health^{49–52}. Sleep difficulties and mood disturbance became more prevalent than before because of the Covid-19 pandemic^{53–55}. Incorporating outdoor walking in nature with mindfulness practise was hypothesised to improve university students' sleep quality and mood. Therefore, this randomised control study investigated the effectiveness of outdoor mindful walking intervention in nature on sleep quality, mood, mindfulness, and degree of nature relatedness amongst adult university students in the U.K.

Results showed that outdoor mindful walking for both groups improved university students' sleep quality, mood, and trait mindfulness levels regardless of environment. There were no significant interaction effects of group (nature versus urban walking route) and time were found for all measured outcomes, indicating that mindful walking in a natural environment does not bring additional psychological benefits to the participants compared with those who walked in an urban environment.

These results support other findings from other studies showing that outdoor walking can improve mood regardless of environment^{4,26,57}. Most earlier studies have employed time-series designs or single group within-subject designs to evaluate the effectiveness of nature walking on mental health outcomes measuring participants' mood, depression, rumination, well-being and have shown that nature walks were more effective than urban walking on improvement of mood and rumination^{1,4}. Only Berman and colleagues⁵ and Johansson and colleagues⁵⁷ indicated that both types (rural and urban environments) of walks benefit mood improvement and rumination reduction without significant group differences. However, few studies measured both trait and state mindfulness, as well as degree of nature connectedness and level of sleep quality.

The present findings were inconsistent with a previous study which showed that only nature walking reduced negative mood, rumination, and anxiety, and improved positive affect^{3,58}. This discrepancy may be due to different intervention design. Bratman and his colleague's study^{3,58} only used a single walking session, while the present study designed a consecutive mindful walking intervention for each day over one week. Therefore, it appears that multiple sessions of the mindful walking intervention would be more effective than a single session.

The present study not only conducted two types of outdoor walking (nature versus urban), but it also involved self-monitored mindful practise during the walking. After one week of walking, the mindful outdoor walking intervention was found to be effective in improving trait mindfulness, which supports the previous study that asserts that consecutive mindful walking in nature improves both positive mood and mindfulness level⁵⁹.

Few of previous studies have conducted mindful walking in nature and measured the effects of nature connection on improvement of mindfulness. The present study has extended previous literature by using a wider range of outcome variables including mindfulness. One unexpected finding was that there was no significant improvement of nature relatedness for participants in nature group after seven consecutive walking. This finding is partly consistent with one study, which has shown that the degree of nature relatedness did not significantly improve after walking for four times, however, it significantly increased when participants walked for eight weeks⁶⁰. That study implied that the longer the forest walking, the greater the level of nature relatedness that participants may perceive. It is still unclear whether frequent that nature walking can boost a more sense of nature relatedness. Further studies should investigate the impact of frequency, intensity and duration of nature exposure with mindful walking on participants' perception of nature relatedness.

The social distance policies during Covid-19 has reduced human traffic in the study location, resulting in the urban walking route being less busy and the nature walking route being more crowded than usual. This may have increased the similarity of the two walking locations. Like one previous study concluded, if the urban walking route was not urban enough, it may potentially decrease the effect size of group differences on mood improvement⁶¹. Future studies should select urban walking routes in inner city areas without significant naturalised places, and choose nature walk routes in more naturalised green spaces.

Strengths and Limitations

The present study has several strengths. First, repeated walks have been conducted in the intervention compared with previous research most of which only used single walking session^{1,2,3,26,28,44}. Second, the randomised control study design reduces potential confounder biases which may hamper the effects of the intervention detected. Third, the qualitative data, including the perceived positive and negative aspects of the intervention, to assist future researchers develop effective mindful walking interventions.

Several limitations of the present study were identified, including: unbalanced gender distribution of participants; high homogeneous walking locations (nature versus urban); the exclusive use of self-report measures; and the under-investigation of changes of weather. More specifically, as the participants were largely female, the effects of the intervention on sex differences could not be investigated. Previous studies indicated sex differences in outdoor recreation activities – males are more likely to participate in nature-based activities (e.g., hiking, hunting, camping) than females⁶⁵. However, one empirical study highly valued and benefited from the experience of walking outdoor⁶⁶. Further studies are encouraged to recruit more male participants and explore the sex differences on effectiveness of mindful nature walking.

Seasonal changes and health routine data were not measured in the current study. Although the differences of season may influence the effects of outdoor mindful interventions, the present study was conducted

Table 4
Description, frequency, and percentage of participants' views of the intervention.

Content	Description	Examples (Quotes)	N	%
Positive aspects				
Sleep quality improvement	Participants feel that were sleeping better and falling asleep more quickly.	"It helps me sleep better at night" "I can fall asleep more quickly than before"	7	18.42
Mood improvement	Participants felt relaxed, calm, and improvement of positive mood; walking interventions reduce negative emotion, stress, pressure, and anxiety.	"The walking was very helpful in terms of relieving me from the pressure of essay writing" "This is a good way to release stress especially during the pandemic period"	25	65.79
Mindfulness cultivation	Mindful walking helped participants be more concentrated/focused to observe inner mind and outdoor environment.	"Feel more mindful and relaxed...than before" "I started to look at the flowers on the road and the expressions of people coming and going" "These walking sessions help me relax my mind and pay more attention to my emotions and feelings"	11	28.95
Healthy lifestyle	Participants' life became more regular than before – regular bedtime and walking exercise; it is motivated to go outside and keep regular exercise.	"I can force myself to go outside and feel fresh air" "It really helps me to sleep early and get up early" "It helps me take daily exercise somehow"	15	39.47
Being active	Being more active in mentally and physically	"After that I feel more active than before" "Walking outside helps lift up my spirit"	4	10.53
Outdoor environment	Stay outdoors for fresh air and nice weather; close to nature.	"I can breathe the fresh air and feel closer to nature"	6	15.79
Negative Aspects				
Walking environment	A little bit far, crowded, busy and noisy sometimes.	"Walking environment are crowded and noisy sometimes"	4	10.53
Time/Energy-consuming	Walking interventions were sometimes time-consuming and lead to feeling of tiredness.	"I always feel tired at night, because I spent time walking about 30mins..."	5	13.16
Non-improvement of sleep	A few of participants felt walking interventions did not improve their sleep quality.	"I think it only worked a little to help sleep at night"	2	5.3

in Edinburgh city, where the weather changes and the greenery of the urban park involved in this study were not dramatically changed during data collection. Nevertheless, further studies should evaluate weather as a co-variant to better understand the effect of the intervention. Similarly, as the baseline data was collected, daily routine data was not further evaluated. However, future studies are encouraged to include

daily health status data, such as body temperature, feeling of tiredness, levels of vigorosity, and heart rate, which may provide valuable information of how individual differences in health status impact intervention effectiveness.

Moreover, the time of walking may influence the effects of the intervention. One previous study indicated that although people's fatigue increases from morning to afternoon, walking patterns can be constant throughout the day⁶⁷. Another experimental study demonstrated that chronotype (morning-type, evening-type, or neither-type) is likely to affect one's psycho-biological exercise responses⁶⁸. In the present study, participants mostly walked from 4 pm to 5 pm, which were chosen by themselves, and might reflect their general circadian chronotypes. Future studies may benefit from evaluating whether walking time and circadian chronotype of participants influence the effectiveness of mindful walking intervention.

Finally, one meta-analysis suggested the best dose of the green exercise is from 10 to 60 minutes in a day⁶⁹. However, the most effective duration of mindful walking in nature has rarely been examined. An intervention study conducted a one-month mindful walking amongst elder adults, comprising eight walking sessions, which found to be effective on reducing negative affect⁷⁰. The seven consecutive mindful walking sessions in the present study were effective, so future studies could further investigate the best dose and frequency of mindful walking for young adults.

Clinical implications and further direction

Firstly, sleep difficulties and mood problems are prevalent amongst university students⁷¹, and may compromise their academic ability⁷². Additionally, research has suggested that sleep patterns have changed, and sleep efficiency was poorer than usual during the Covid-19 pandemic among the university students^{73,74}, which was related to increased stress and anxiety levels^{74,75}. The current study suggests that mindful walking outdoors could be an effective way to support university students and young adults to cope with their sleep problems and mood disturbances. Outdoor mindful walking is self-guided and easy to engage in, so students' welfare services can encourage their students to self-help using this activity.

Qualitative data highlighted that most participants perceived outdoor mindful walking as fostering a healthier lifestyle and encouraging them to be more active. It enhanced subjective sleep quality and improved their mood. Some negative aspects of the intervention were also mentioned by participants, which are useful for professionals to shape future interventions to enhance acceptability among university students. For example, we recommend mindful walking in nature with multiple walking routes in quiet places; and mindful walking either with less frequent sessions or for shorter periods (less than 45 minutes).

Future studies should examine the effectiveness of nature walking interventions with other populations. It is also worthwhile adding nonactive control groups in a RCT study (i.e., group participants practise mindfulness without walking outdoors; or indoor mindful walking group without views, etc.). Finally, comparing the effectiveness of different types of mindful walking (indoor versus outdoor), as well as various forms of mindful practise (with or without physical activity) could inform the development of effective interventions for improving university student's mental health outcomes.

Conclusions

Outdoor mindful walking in either a natural environment or an urban area for one week is associated with improvements in sleep quality, trait mindfulness and mood among university students in the U. K. Upon further evaluation and development, walking interventions can be implemented to support university students cope with sleep difficulties and mood disturbance. RCT studies with non-active control groups are needed to confirm the best dose of outdoor mindful walking

to improve sleep, mood, mindfulness and other mental health outcomes among university students and other populations.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request (not available for commercial use due to ethical restrictions).

Declaration of Competing Interest

No conflict interests.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.explore.2022.08.004.

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