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Using the Integrative Behavioural Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE)

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Abstract

Background:
Infectious disease has become an increasing field of interest due to the recent COVID-19 pandemic on a long-standing background of nosocomial infections, which have contributed to excess and largely avoidable morbidity and mortality, worldwide. In the hospital setting, the appropriate use of personal protective equipment is the mainstay of preventing the transmission or acquisition of nosocomial pathogens and yet, adherence among health professionals has been less than desirable. Suboptimal adherence to personal protective equipment remains a key issue within Saudi Arabia but there has been little understanding of the factors contributing to this problem. Therefore, this research addressed this gap through conducting a mixed-methods study that evaluated factors associated with nurses PPE use.

Methods:
A mixed-methods study design was used to develop and field a closed-ended survey is strongly influenced by the Integrated Behavioural Model (IBM). The (IBM) was used to elicit the psychological, behavioural, and contextual factors (e.g., attitudes, subjective norms, and perceived control) influencing nurses' adherence to PPE guidelines. In keeping with the IBM, research was conducted in a phased approach: a convenience sample of nurses was obtained from two hospitals in the North of Saudi Arabia: 14 completed open-ended interviews (phase 1, qualitative elicitation phase) and in phase 2 (quantitative behavioural prediction phase), 279 nurses completed a self-report survey informed by the phase 1 data, using random sampling: the response rate was 96.5%. Data were gathered from August 2020 to April 2021.

Results:
Based on the themes identified through the qualitative content analysis, survey items were constructed for each construct (e.g., attitudes) using a 7-point bipolar scale. The final instrument demonstrated high internal consistency (Cronbach alpha of 0.92) and desirable test-retest reliability (intraclass coefficients mostly exceeding 0.80). For the direct measures of the independent variables, the mean scores for attitudes, subjective norms and perceived behavioural control were 5.7, 5.5 and 3.5, respectively, on the 7-point scale, indicating that nurses tended to hold positive attitudes, receive positive influence from others and perceptions of others' judgements upon their intentions to adhere to PPE precautions. For the indirect measures, the mean scores for behavioural beliefs and outcome evaluation, control beliefs and power and normative beliefs were 6.0, 5.1 and 4.4, respectively. These findings
also indicate that most nurses held favourable intentions to comply with PPE due to understanding of its importance in protecting patient safety but encounter numerous obstacles in adhering to PPE guidelines all the time. Multiple regression analyses showed that the overall model accounted for 62% of the variance in nurses’ intentions to comply with guidelines ($R^2 = 0.62$, $p=0.000$). Notably, the attitudes construct was the strongest predictor of nurses’ intentions to comply with guidelines ($R^2=0.58$, $p<0.001$), followed by subjective norms ($R^2=0.32$, $p<0.001$), and perceived control ($R^2=0.15$, $p<0.001$). Overall, nursing adherence during the COVID-19 pandemic received influence from a broad range of factors; some acting as barriers to PPE adherence, whilst others encouraged said adherence. Nurses’ attitudes imparted the strongest influence over PPE adherence, taking precedence over the more practical and hierarchical influences of PPE access and usage.

**Implications:**

This study provided the first insight into the varied factors influencing adherence to PPE among Saudi Arabian nurses. Key recommendations for ongoing practice include a need for ongoing and regular education and training to maintain nurses’ positive attitudes towards PPE adherence, recruiting and deploying infectious disease nurses to act as role models in infection prevention and control, introducing measures to mitigate nursing anxiety and fear of using equipment and establishing a means to evaluating infection rates. Overall, it is intended that this work will lead to meaningful improvements in nursing adherence to personal protective equipment and in turn, reduce adverse patient outcomes related to nosocomial infections.
Chapter 1. Introduction

1.1 Overview

This thesis was completed in order to understand the factors influencing the personal protective equipment (PPE) behaviours of nurses working in local Saudi Arabian hospitals in response to anecdotes of poor infection prevention and control practices, which represent a direct threat to patient safety. This is particularly pertinent given the growing burden and seriousness of healthcare-associated infections and most notably, the ongoing COVID-19 pandemic, which has also been found to spread rapidly within inpatient settings due to the ease of virus transmission. Such evidence is discussed and cited within the following subsections of this introductory chapter; information that provides the context and rationale for exploring the factors influencing PPE adherence among healthcare workers in more depth is discussed within the literature review in chapter two. The third chapter details and justifies the methodology and methods used to explore nurses’ views concerning the factors mediating PPE use within Saudi Arabian hospitals. Chapter four presents the development of a qualitative survey, its participant recruitment, data collection, data analysis plan, and testing of the trustworthiness of data. Chapter five describes the qualitative study results, including the coding and theming summary. Chapter six shows the development of the quantitative survey, its respondent recruitment, sample size calculation, and the characteristics of the participants. Chapter seven mainly depicts the overall results of the study. It also details the results of the mixed-methods study including a qualitative component, which was used to develop the quantitative survey, and the findings of the pilot and final survey of nurses. Finally, chapter eight summarises the key findings and discusses the results in light of the wider literature, which is followed by the review’s strengths and limitations, the implications for local nursing practice, infection prevention and control guidelines and PPE policy. A conclusion with key recommendations for future research has been shown in the ninth chapter. The remaining subsections of this chapter provide context for the study and rationale to review the literature concerning the factors influencing PPE adherence among health workers.

1.2 Problem of Nosocomial Infections

Stringent infection prevention and control measures are vital to tackling the ever-growing problem and burden of healthcare-associated infections, also known as nosocomial infections, which can be formally defined as infections occurring within patients during the first 48 hours of admission or within 30 days of patients having received inpatient care (Revelas, 2012). Traditionally, nosocomial infections were separated into discrete categories
of hospital-associated and non-hospital associated infections but due to the commonality of causative organisms, such terms have been grouped into the universally accepted term of healthcare-associated infections, albeit such infections are disparate from community-associated infections due to variant aetiologies (Friedman et al., 2018). Across literature, however, healthcare-associated infections can be divided into several subtypes based on the source of pathogen colonisation and the organ system that becomes infected, which include central venous catheter-based infections, urinary catheter-associated infections, ventilatory associated pneumonia, surgical site infections and skin and soft tissue infections (Haque et al., 2018). Healthcare-associated infections are frequently described as one of several silent epidemics with the problem being prevalent within acute hospital settings that experience high patient volume and turnover and causing excess costs and resource use, and importantly, avoidable morbidity and mortality (Friedman et al., 2018). The preventability of nosocomial infections simply stems from the premise that pathogens are transmitted between humans (staff to patients or patients to patients) and between fomites and humans (objects to patients or objects to staff and patients), and can, therefore, be prevented through compliance with stringent hygiene, decontamination, and infection prevention measures (WHO, 2011). Thus, healthcare workers are in a unique position to tackle the problem by being responsible for following PPE guidelines and being dedicated to continuously improving the quality and safety of care (Sutton et al., 2019).

1.3 Epidemiology and Burden of Nosocomial Infections

Healthcare-associated infections are a worldwide problem with data showing that the risk of acquiring an infection during hospital admission approximates 7% in high-income nations and exceeds 10% in less developed countries (Danasekaran et al., 2014). Considering that countries with average population sizes of 70 million persons observe more than six million hospital admissions each year, an 8% risk of acquiring a nosocomial infection is substantial and one that demands acknowledgement and prioritisation at all possible levels (Shi et al., 2020). In Saudi Arabia, a nation considered to fall within a high-income and developed status, hospital admissions are estimated to be more than 1.6 million per year and thus, a 7% risk of nosocomial infections would equate to 112,000 cases: all potentially avoidable through stringent infection prevention and control (Ministry of Health, 2020). This figure excludes the 880,000 annual admissions to private hospitals and thus, is an under-estimate of the true potential infectious risk to Saudi residents (Ministry of Health, 2020). Notably, the Ministry of Health has also found that infectious diseases account for almost 1% of all
inpatient deaths, which is similar to that of sepsis, diabetes mellitus, hypertension, traumatic injuries and renal failure, although being 10-20-fold lower than the mortality attributed to cardiovascular disease, which may explain the lack of prioritisation of PPE measures and poor compliance among healthcare workers (Ministry of Health, 2020).

1.4 Geographic Distribution of Nosocomial Infections

The problem of nosocomial infections has been reported internationally. In North America, the Centre for Disease Prevention and Control (CDC) reported that one in 25 hospitalised patients develops a healthcare-associated infection with attributed deaths approaching 100,000 (CDC, 2020). Due to the extent and burden of the problem, healthcare-associated infections are ranked among the leading causes of premature mortality in the United States for the last 20 years with costs that have totalled more than $30 billion per year; a total of $600 billion over the two-decade period. Similarly, data drawn from the National Point Prevalence Survey conducted within the United Kingdom revealed that the prevalence of healthcare-associated infections was 6.5% (Public Health England, 2012). This has been shown to equate to 300,000 cases per year within UK National Health Service Hospitals with costs exceeding £1 billion per annum and the problem incurring excess morbidity in the form of patient suffering and protracted lengths of stay, and mortality exceeding 22,000 deaths (Bate et al., 2018). A recent study explored the problem of healthcare-associated infections across six major hospital centres in Saudi Arabia and found the prevalence rate to be 6.8%, representing a 1.2% decrease from prior data published in 2006 where the prevalence totalled 8.0% (Balkhy et al., 2006; Alshamrani et al., 2019). While a 1.2% improvement is clinically meaningful given the large proportion of inpatients that experience or die from said infections each year, this could also be construed as a suboptimal improvement in nosocomial infection rates given the vast increase in awareness of infectious diseases among health professionals and the implementation of standardised guidelines concerning infection prevention and control (Alhumaid et al., 2021; Almatari et al., 2021; Assiri et al., 2014). The importance of tackling nosocomial infection rates both in Saudi Arabia and worldwide ultimately lies in understanding the factors that influence PPE adherence. While much is known about the common organ systems affected by healthcare-associated infections, there is ever-growing and unprecedented pressure for healthcare workers to comply with PPE precautions given the ongoing COVID-19 pandemic; the most significant infectious health threat to the human race since the early 1900s (Liang et al., 2021). As of June 2022, cases of COVID-19 have already exceeded 538 million and deaths are approaching 6.4 million; Saudi Arabia is
currently ranked 76th in terms of case burden (798,474 cases), whilst deaths have totalled 9,215 (Worldometer, 2021).

1.5 Extent of the Problem of PPE Adherence

1.5.1 Overview

The World Health Organisation emphasise that almost all hospital-associated infections could be prevented through simple adherence of healthcare staff to proper hand hygiene and other infection control precautions as this can prevent inter-person transmission of infectious microorganisms (WHO, 2020). Although much of the transmission, and morbidity and mortality of COVID-19 has been due to the efficiency of the respiratory droplet and airborne spread of the virus outside of healthcare settings, optimal use of PPE including face masks and respirators is key to preventing intra-hospital transmission (Lotfi et al., 2020). The importance of PPE adherence within such settings should not be undermined given that a large number of inpatients are likely to have a degree of immunosuppression as a result of co-existing and acute health problems, rendering them increasingly prone to COVID-19, among other nosocomial infections (Fung and Babik, 2021). Despite the wide availability of infection prevention and control guidelines and a robust evidence base to support the efficacy of PPE measures in preventing infection rates, there has been growing research showing that some healthcare workers fail to adhere to PPE guidelines or fail to use PPE at all in situations where infection prevention is necessary (Mani et al., 2010). This is alarming given that most hospitals observe large patient volumes and due to the proximity and frequency of contact encounters, pathogens can be rapidly transmitted between staff and patients, which has been previously known to cause large outbreaks, as well as fuelling infectious disease epidemics, such as SARS-COV-1 and MERS, and the most recent COVID-19 pandemic (Mani et al., 2010).

On the contrary, strict compliance with PPE guidelines among health workers has been found to markedly reduce healthcare-associated infection rates and particularly with infections that can be transmitted by the faecal-oral route; pathogens that are responsible for the commonest nosocomial infections (Banfield and Kerr, 2005; Landers et al., 2012; Gerba, 2009). While much of the responsibility for preventing the spread of infectious organisms within healthcare environments falls under the roles and duties of healthcare staff, research also recognises that poor hand hygiene practices among patients are seldom a source of the spread of nosocomial pathogens (Barker et al., 2014). Thus, healthcare workers not only have a responsibility to self-comply with optimal PPE practices but also in educating patients on proper hand hygiene and any other relevant infection prevention measures whilst admitted to
inpatient facilities. However, it is important to explore the extent of PPE adherence among healthcare workers in Saudi Arabia as a means of rationalising the study herein. Evidence has already shown that proper compliance with PPE guidelines and in particular the correct donning and doffing of PPE, can be as low as 50% among care workers operating within varied health settings. It is, therefore, important to understand whether local PPE adherence is as suboptimal as that observed internationally (Morioka et al., 2020; Neuwirth et al., 2020; Panayi et al., 2020).

1.5.2 Peri-Pandemic PPE Adherence in Saudi Arabia

Since the emergence of COVID-19 publications have appeared which detail the PPE adherence behaviours of healthcare workers in Saudi Arabia but it is important to also explore the pre-pandemic adherence given that resolution of COVID-19 at some point in the future may see a reversion to prior adherence levels (Al Khathlan and Padhi, 2021; Albeladi et al., 2021; Bazaid et al., 2020). Most of this research has identified that PPE adherence is a problem in Saudi Arabia but there has been little insight into the factors influencing such adherence. In a cross-sectional study exploring the knowledge and practices of PPE measures among a cohort of 5,105 Saudi residents, Bazaid et al. (2020) found that whilst knowledge levels were desirable in 90% of persons (scoring 2/2), practices were poor (3/6) for hand hygiene and thus, highlighting the complexity of adherence behaviours; behaviours that cannot be reliably predicted from knowledge alone. Although this study was not conducted among healthcare workers in Saudi Arabia and was subject to limitations of temporality and self-reporting bias, the findings reflect a wider disregard for understanding the factors influencing health behaviours and using such information to tailor public information and education as a means to reducing infection risk. Concerningly, research has shown that the extent of PPE adherence among Saudi healthcare workers can be as poor as that of the lay population (Petherick et al., 2021; Al Khathlan and Padhi, 2021). In another cross-sectional study of 215 respiratory therapists working within various Saudi hospitals and managing the ventilators of patients with COVID-19, Al Khathlan and Padhi (2021) showed that adherence to PPE guidelines was only 80.9%, and thus, conferring the risk of acquiring and transmitting pathogens among some of the most vulnerable inpatients. Adherence was assessed using a 5-point scale for each PPE behaviour, but the authors did not define what specific PPE measures were examined, and thus, reducing the validity of the adherence rate estimate. Moreover, the estimate was derived from the most desirable response on the five-point scale (‘always use PPE’) and thus, likely represents an underestimate of complete adherence with a
4.2% reporting adherence ‘most of the time’ and a 14.8% reporting adherence ‘occasionally’.

The authors also found that high-risk perceptions (adjusted OR 2.32; 95% CI 1.09, 3.27) and a practice experience of greater than five years (adjusted OR 2.00; 95% CI 1.14, 3.15) were significant and the strongest predictors of desirable PPE adherence behaviours and thereby, supporting some of the evidence previously presented. No other demographic factors of respiratory therapists were found to significantly predict adherence behaviours (all p>0.05). However, the study was limited by several issues including confounding bias and reliance upon a Likert-type scale to dichotomise adherence behaviours, which may have led to a type of response bias.

A similar extent of adherence has also been found for various healthcare workers operating within Saudi hospitals, Albeladi et al. (2021) conducted an observational study using an online self-reported questionnaire to measure adherence extent but was underpowered. Participants were predominantly doctors (52%), followed by nurses (16%) and other allied health workers, with most working within hospitals in Dammam (14.5%), Riyadh (14.5%) and Makkah (8.5%); only 0.5% were from the Tabuk region, which was the setting of the study reported herein. It was not clear how the extent of adherence to specific PPE use was measured and thus, there are unclear but likely risks of measurement and response biases. Despite this, adherence varied markedly depending upon the specific PPE used; 94% for face mask use, 83% for surgical face mask use, 10% for N95 respirator use, 68% for wearing eye protection or a face shield, 85% for wearing an apron and 95% for wearing gloves. Overall, adherence to PPE use was 80.2% and thereby, similar to that reported elsewhere. Notably, there were no significant differences in PPE adherence between doctors and non-doctors (all p>0.05), although nurses and other allied health workers tended to avoid reusing face masks, as compared to doctors (27% v. 40%). Such findings must be interpreted with caution given the potential bias risks and the limited reporting and objectivity expressed by the publishing authors. The study also failed to explore the reasons for suboptimal adherence among said healthcare workers and thus, limiting knowledge about how the problem could be resolved.

1.5.3 Pre-Pandemic PPE Adherence

Problems with adherence to PPE guidelines among health workers in Saudi Arabia were also evident before the COVID-19 pandemic. In a cross-sectional descriptive study, Abukhelaif (2019) explored the knowledge, practices and factors influencing adherence to PPE among nurses working at the King Fahad Hospital in the Al-Baha province of Saudi Arabia in 2017. A cohort of 185 nurses, all of whom who had had a minimum practice experience of six months,
was recruited from across various hospital departments. Nurses were specifically selected for the study given that they are the most abundant health professional within said hospitals and engage in more patient care and contact events, than any other professional and thereby, have the highest likelihood of transmitting pathogens. A response rate of 92.5% was attained, thus, minimising concern for non-response bias. Knowledge and adherence practices to PPE were based on Likert-type scales, thus, also conferring risk of measurement bias as respondents may have had to choose between one of two options when responses were intermediate to said options. Regarding knowledge, the results showed that 76.2% of respondents displayed excellent knowledge, whilst 16.8% and 7.0% were rated as having good and satisfactory knowledge. Adherence to PPE was based on glove-wearing with 86% of nurses reporting that they would don fresh gloves before each patient contact encounter, however, the clinical observations revealed that this only occurred in 57% of cases. Therefore, there was a marked discrepancy between self-evaluations of PPE adherence and actual adherence practices, which poses several implications for the methodology and methods of the study presented herein. The authors also found that nurses with more than three years of practice experience, a bachelor’s level of education or higher, and female nurses, reported and were observed to practice significantly more favourable glove-wearing behaviours compared to their counterparts (all p<0.05). The findings of this study have more generalisability to reflect the problem of poor PPE adherence among hospital nurses in Saudi Arabia but given the single-centre design, the applicability to nurses working in the Tabuk region is less favourable.

In another study of cross-sectional design, Nour et al. (2017) explored the knowledge, attitudes and practices regarding infection control among various healthcare providers working at the Umm Al-Qura University Medical Centre in Makkah, Saudi Arabia. The authors found that less than half of subjects (48.8%) provided correct responses regarding various questions about PPE knowledge and infection risk. Building upon this, attitudes were markedly adverse or uncertain regarding the purpose of PPE in protecting self, staff, and patient safety; only 61% exerted positive attitudes towards such measures. This evidence was based on a cohort of 54 healthcare providers but the proportion of nurses, doctors, pharmacists, and other allied health professionals was not reported to elicit whether the findings reflected those of a specific profession or those generically. The small sample size also confers issues of type II error, a threat to internal validity, and generalisability with the results being unlikely to reflect the views of other care workers at the stated centre. Data was collected via Likert-type scales, but the psychometric validity of the instruments was not
reported and nor were they calculated in the statistical analysis. Finally, self-reported PPE practices were only found to be correct (by WHO guidelines) in 70% of cases, thus, supporting poor PPE adherence behaviours in this cohort. However, again the nature of the study design limits the internal and external validity of the findings presented. This is in addition to the authors failing to employ credible methods to explore the factors influencing suboptimal adherence behaviours. Poor PPE adherence has also been observed among healthcare workers operating within hospitals in the Asir region of Saudi Arabia where overall compliance was 65.4% (Al-Mohaithef et al., 2020). A considerable variance in adherence was observed between departments with more desirable adherence being observed in intensive care and paediatric units, as compared to poorer adherence in general medical and surgical wards Paul et al. (2020). However, such research was methodologically comprised of similar issues to those of prior literature included in this chapter.

Suboptimal compliance to PPE guidelines has also been observed among nursing and other healthcare students working and gaining experience within Saudi Arabian hospitals and thereby, suggesting that PPE adherence behaviours receive initial influence at the undergraduate level and may continue to exert influence following professional registration. Firstly, Tumala (2021) conducted a cross-sectional study to explore the infection prevention precaution behaviours of 224 nursing students who were working within four teaching hospitals in Saudi Arabia in 2017. The authors found that the overall adherence rate was 84.8% and thus, was only marginally superior to the compliance rates of nurses and other healthcare workers as previously reported. Importantly, 15.2% were deemed as being suboptimal compliant with PPE guidelines, and thus, conferring risk of pathogen transmission across the hospital centres. The authors utilised the validated Compliance with Standard Precautions scale to ascertain the adherence extent of nursing students, which had been previously validated and found to confer a Cronbach alpha of 0.89, thus, reducing some concern for measurement-type bias. However, as the instrument was self-completed by respondents, the risks of response bias could have existed given the nurse’s inexperience and student status, which could have pressured some individuals into reporting more desirable adherence behaviours that deviated from their actual (true) practices. Multiple regression analysis revealed that nursing students’ age, gender, marital status, training in infection control and duration of internship only accounted for 19.6% of the variance in PPE adherence behaviours (R²=0.196, p<0.001), thus, revealing that the study design was not amenable to eliciting all important factors influencing adherence behaviours. Secondly, Colet et al. (2017) conducted a similar study of nursing students who were gaining experience
within a different Saudi hospital. The design was cross-sectional with data relying upon self-reported information regarding PPE practices and thus, co-existing with risks of response bias. However, the same validated Compliance with Standard Precautions scale was used to ascertain adherence extent, thus, limiting concern for measurement bias. Based on a cohort of 236 students, the authors found that the overall compliance rate was poor (61.0%) and much lower than that reported by Tumala (2021). A range of nursing students was included regarding the duration of clinical exposure and seniority, thus, presenting uncertainty in what factors may explain such variances in PPE adherence behaviours. However, this may be attributed to inter-institutional differences in PPE education and training, as well as the PPE behaviours of health workers conveyed to students during placements, as such persons may exert influence or act as role models for students. Also, in keeping with Tumala (2021), the multiple regression analysis of Colet et al. (2017) revealed that the significant predictive factor of favourable PPE compliance was the duration of nursing student experience, but the overall model only accounted for 11.8% of the variance in PPE practices. This further highlights the limitations of cross-sectional studies in eliciting the factors influencing PPE adherence; this may be better ascertained through utilising behaviour theories, which are explored in the literature review chapter. Poor adherence among student nurses in Saudi Arabia has also been supported by other research but evidence has been subject to similar methodological issues (Alshammari et al., 2018; Cruz, 2019).

1.6 Summary Statement and Literature Review Aim

Recent research has found that healthcare workers operating in Saudi hospitals do not always comply with PPE guidelines and this poses a serious infectious threat to both staff and patients (see section 1.5.2 and 1.5.3). It is worth noting that there have been wider policy related issues in Saudi Arabia, that seem to have contributed to larger-scale deficiencies in infection prevention and control. These issues include a lack of standardisation and consistency in the translation of policy recommendations into practice changes. The inconsistency has generated excessive variances in infection prevention and control measures across the Saudi nation on regional, organisational, and departmental levels (Alslamah and Abalkhail, 2022). In light of the ongoing COVID-19 pandemic, issues of poor guideline compliance persist despite care workers being aware of and frequently exposed to the morbid and mortal effects of the virus. Moreover, evidence has shown that suboptimal use of PPE is significantly and independently predictive of COVID-19 infection, but such research has failed to explore the factors influencing poor adherence behaviours, which has restricted understanding of how measures
could be implemented to improve PPE adherence and in turn, patient and care provider safety (Çelebi et al., 2020; Rubbi et al., 2020; Schmitz et al., 2021; Buonafine et al., 2020). Therefore, to help guide the methodology and methods of the primary study presented herein, a structured approach to the literature review was undertaken to summarise the evidence that has evaluated the factors influencing PPE compliance of healthcare workers both outside and within the Saudi Arabian health system.
Chapter 2. Literature Review

2.1 Search Strategy

A systematic search for the literature of relevance to the topic of interest was undertaken in September 2021 using several online electronic databases. Such information sources were selected given that they represent the most powerful, reliable, and efficient means of searching for, retrieving and accessing the texts of past, present and in-press health research (Aveyard, 2018). The specific databases chosen for searching comprised the Cumulative Index of Nursing and Allied Health Literature (CINAHL), MEDLINE, the Cochrane Registry of trials (CENTRAL) and Scopus. This combination of databases was selected based on several factors; 1) extensive indexing to health-related journals including those focused upon topics centred around infectious disease and the prevention and control of infections, 2) unique coverage of journals and articles to optimise the capturing of all relevant literature and 3) having a potential to recall more than 95% of studies of importance to the review based on MEDLINE being found to confer recall accuracies over 90% for other review topics (Bramer et al., 2017; Pollock and Berge, 2018). Whilst this database search had the potential to retrieve almost all studies relevant for this review, additional search methods were employed to broaden the search and to limit the risk of bias; the incidental preclusion of one or more relevant studies (Le Cleach et al., 2016). This included a focused search for grey literature using the database OpenGrey and performing a broad search for scientific publications using Google Scholar (Preston et al., 2015). In addition, the citations of all eligible studies were screened and in turn, a snowball screening method was employed to help identify any relevant articles missed from journals indexed in the former databases (Nama et al., 2019).

Search terms applied to MEDLINE, CENTRAL, CINAHL and Scopus were developed from the literature review aim and supplemented with all synonymous phrases and acronyms that were identified following a preliminary review of potentially relevant evidence. Terms were also mapped to categories based on the population, exposure/interest, and outcomes (PEO) framework, to help capture studies specific to the review aim (Aveyard, 2018). Such terms were, however, modified before database application, to improve the precision and efficiency of searching (Pollock and Berge, 2018). Modifications were applied to appropriate terms and included truncation syntax, to permit the searching for variant terms, subject heading mapping (MeSH), to map terms to umbrella categories to broaden searching, and Boolean logic, to combine terms in a string using operators OR/AND (Ecker and Skelly, 2010). A
summary of the search strategy is provided below, however, the searching of OpenGrey and Google Scholar was based on a selection of key generic terms given the inability to apply the same syntax and precision-optimising operations (Bramer et al., 2018).

2.2 Keywords

["healthcare worker*" OR "healthcare profession*" OR “health worker*” OR “health profession*” OR "nurse"] AND [“factor” OR “predictor*” OR “variable*” OR “mediator*”] AND [“infection prevention” OR “infection control” OR “standard precaution*” OR “personal protective equipment” OR “PPE” OR “hand hygiene”]

2.3 Inclusion and Exclusion Criteria

After the retrieval of literature, articles were limited to the following inclusion criteria: publication in the past 10 years (2011-2021), English language and reporting data specific to each of the PEO elements of the review aim. Evidence was restricted to these criteria to ensure the information would hold relevance to informing the methods of the study proposed and to eliminate errors associated with the translation of non-English studies. It was not possible to perform a non-English search for evidence and nor was it feasible to translate non-English studies into English. Recognising that a proportion of studies of relevance to this review would have been conducted within Saudi Arabia, English translation was not required given that Saudi health research is almost always published in both Arabic and English languages. The former criteria were used to guide the process of evidence selection, which followed the usual steps of replicate discard, title/abstract screening, and full-text review (Pollock and Berge, 2018). Studies eligible for review were identified using the PRISMA-based process of evidence filtering (title/abstract and full-text screening), which has been summarised in Figure 1. A total of 652 records were retrieved and following the removal of duplicates, 603 unique records were title/abstract screened. This resulted in the exclusion of 566 studies for failing to meet the inclusion criteria. The remaining 37 articles were full text screened and again, 13 studies were excluded for the following specific reasons: 1) an ineligible population; studies conducted among health professionals working in the community (n=7), 2) an ineligible exposure; studies failing to report upon the issue of PPE adherence (n=3) and 3), ineligible outcomes; studies not reporting upon the factors influencing PPE use (n=3). The 24 eligible studies have been critically and comparatively discussed in the remainder of this chapter.
2.4 Evidence Overview

Based on the breadth of evidence captured of relevance to the review aim and for potentially steering the methodology and methods of the proposed study, a series of generic themes were recognised and employed to enable a structured reporting of the evidence and the key outcomes. As such, the findings are summarised in the following subsection in a logical order to permit terminal focusing upon the evidence specific to the Saudi Arabian setting.

2.5 Factors Influencing PPE adherence
2.5.1 Overview

This primary section of the background literature review evaluates the captured evidence concerning the varied factors influencing PPE adherence. This encompasses research eliciting factors in the absence of underlying theory (section 2.5.2) and theory-based research,
such as studies utilising the Integrated Behavioural Model, Protection Motivation Theory, and the Theory of Planned Behaviour (section 2.5.3).

2.5.2 Non-Theory-Based Evidence of PPE Adherence

In a prospective cohort study conducted within three departments dedicated to managing patients with COVID-19 in a large hospital in Germany, Neuwirth et al. (2020) explored the extent of PPE adherence as compared to units that were not managing COVID-19 patients. Based on more than 1,280 PPE process steps, the results showed that adherence was significantly more favourable in COVID-19 units, compared to non-COVID-19 wards (85% v. 76%, p<0.001) with suboptimal compliance and inter-unit differences being attributed to variances in situational awareness, infectious disease risk awareness and practice experience among healthcare workers. Adherence was assessed based on national guidelines, on which, a checklist of 18-items was devised to determine the extent of PPE compliance with a threshold exceeding 80% considered to be sufficient adherence, whilst values below 80% were considered as suboptimal adherence. However, this introduces outcome bias as even incomplete PPE adherence could have been classified as sufficient adherence despite breaches that could confer risk to patient safety. The observations were performed by a trained infectious control nurse and thus, limited the risk of measurement bias; although a residual risk would have existed given variances in specific PPE donning and doffing techniques between said nurse and other care workers. However, as the reasons for poor compliance were not extensively explored, several factors influencing PPE use were likely missed. Some limitations to this study also reduce the value and applicability of the findings reported; observations performed by one observer with a risk of performance and detection biases and being based on one hospital in Germany. In a similar study conducted within a 1,100-bedded tertiary hospital in Israel, Lamhoot et al. (2021) identified that there was suboptimal adherence to the donning and doffing procedures of PPE within the emergency department and wards managing patients with COVID-19. Suboptimal donning/doffing was identified to occur significantly more often within the emergency department, as compared to general wards (72-78% v. 85-96%, p<0.01). The postulated reasons for this difference and suboptimal compliance overall were reported to comprise time pressures, patient acuity of illness, short staffing, staff distress and knowledge about COVID-19 status; positivity/negativity, however again, the specific reasons influencing PPE adherence were not explored directly. In addition, the findings of the study may only apply to the operations and resources available to healthcare workers within the specific hospital centre. These findings
suggest that nurses encounter considerable hindering factors to adhering to PPE guidelines even in the absence of the discussed research using behaviour theories to uncover all the pertinent factors influencing PPE adherence.

In contrast to the prior evidence, Al Youha et al. (2021) specifically explored the factors associated with COVID-19 infections among healthcare workers to recognise whether PPE use accounted for this serious and avoidable problem. The authors showed that the donning of gloves was associated with a significantly increased risk of contracting COVID-19 (adjusted OR 2.93; 95% CI 1.19, 7.22), as was working as a nurse as opposed to other care professions (adjusted OR 1.77; 95% CI 1.15, 2.71). While the wearing of gloves would be expected to decrease, rather than increase, the risk of COVID-19 by acting as a physical barrier to transmission via mucous membranes, it may be that glove-wearing increases perceptions of safety during the provision of care and in turn, reduces the perceived need to adhere to other precautions, such as hand hygiene and eye protection, which would increase the risk of COVID-19. Moreover, care providers in the study may have also worn gloves for an excessive amount of time which could have rendered the barrier ineffective and/or may have led to touching of self with gloves donned; thereby, increasing the likelihood of COVID-19. This may also have been due to limited access to PPE during the pandemic within Kuwait, and indeed, the authors stipulated that access to PPE was 74.4% during the study’s observation period. Thus, the availability of PPE rather than poor adherence could account for most of the COVID-19 infections among the health workers. The authors also explored a range of other PPE practices (hand hygiene, mask-wearing and respiratory use) and their influence on COVID-19 risk but no significant observations were found (all p>0.05). This study was based on a cohort of 847 healthcare providers working within a large hospital centre in Kuwait, with 20.5% having had a prior positive COVID-19 test, which provided a reasonably representative sample of inpatient care workers, although generalisability is limited given the single-centre Kuwaiti setting.

In another study that specifically explored the factors influencing PPE use but used a more informative mixed-methods design to capture and analyse quantitative and qualitative data, Morioka et al. (2020) surveyed a cohort of 735 nurses working across 28 tertiary hospitals in Japan before the COVID-19 pandemic in early 2019. In the qualitative component, 15 nurses working in various departments were interviewed revealing various factors influencing nurses’ beliefs and attitudes towards PPE adherence. Said factors included discomfort with PPE, fear of transmitting or acquiring multi-drug resistant organisms, being observed by colleagues during PPE donning/doffing and when providing patient care, prioritisation of PPE use by
managers, observations of patient morbidity due to infectious disease, outbreaks of multi-drug resistant organisms and ward closures, the anatomical site of infection and perceived risk of infection, a patient's clinical and functional status, and time pressures. Although such evidence was categorised into the factors influencing PPE adherence through the shaping of nurses' attitudes and beliefs about infection risk and seriousness, which is somewhat synonymous with behaviour theories, the authors did not stipulate the use of a specific theory to attain optimal validation of the factors driving suboptimal PPE adherence. However, the approach does highlight the value of exploring clinical behaviours through theoretical assumptions given that prior clinical and non-clinical experiences shape an individual's attitudes and cognitions that directly influence actions. The quantitative component of Morioka et al. (2020), which comprised multiple linear regression, also provided support for differing factors influencing PPE use; knowledge of PPE use (B=0.365, p<0.01), beliefs about the efficacy of PPE use (B=-0.344, p<0.01), past exposure to outbreaks of infectious disease and patient morbidity (B=0.090, p=0.037) and beliefs about never being the cause of the spread of infection (B=0.088, p=0.044). However, such findings may have been limited by reliance upon self-reported PPE use evaluations, which could have been biased or erroneous, as well as non-response bias and a small sample of respondents included in the regression model, which could have increased the risk of type II error.

Evidence is drawn from other settings in the pre-COVID-19 era but during other infectious epidemics and outbreaks including severe acute respiratory syndrome coronavirus-1 (SARS-COV-1), the Middle Eastern Respiratory Syndrome (MERS) coronavirus, tuberculosis, seasonal influenza and H1N1 influenza has also provided valuable insight into the factors influencing PPE adherence among health workers (Houghton et al., 2020). In the cited study, a systematic synthesis of qualitative research regarding the barriers and facilitators of PPE adherence among healthcare workers involved in the management of patients with respiratory infections, the authors synthesised findings from 20 primary studies conducted across Asia, Africa, and Australia and the Americas. (Houghton et al., 2020). The results showed that the key barriers to optimal PPE adherence included an inability to follow national or international guidelines due to their length, ambiguity, lack of specificity to specific health settings and complex clinical situations, and dynamicity with recommendations changing regularly over time. In addition, other barriers included time pressures, stress and fatigue where care workers prioritised task completion and meeting patients’ needs over stringent adherence to PPE precautions, inadequate support from supervisors and managers, a lack of education and training in PPE use and non-mandatory nature of annual updates to training in PPE, a
lack of space in the clinical environment to isolate patients and in donning/doffing PPE, poor availability and quality of PPE, and perceptions that wearing PPE induced distress upon patients or stigmatised them as a result of potentially having an infectious disease. In contrast, few facilitators of PPE adherence were identified but those associated with reports of compliance included awareness and recognition of the value of PPE in preventing infectious-related morbidity and mortality, limiting visitors to have sufficient time to don/doff PPE within infectious units and working among cultures that prioritised patient safety and the prevention of nosocomial infections. Credibility in the review findings is a given due to the adoption of extensive and rigorous methods used to search for key literature and extract data for synthesis, although given the breadth of studies included, the factors hindering PPE adherence may not be shared by nurses operating in Saudi Arabia.

In another, but a more dated review of evidence regarding the factors influencing PPE use during respiratory infectious disease outbreaks, the Institute of Medicine (2011) found that PPE related behaviours were affected by three categories of factors: individual, environmental, and organisational. The individual and environmental factors encompassed issues influencing PPE adherence that have already been identified in the prior literature, such as knowledge about PPE, attitudes concerning infectious disease risk and the availability and quality of PPE. However, the authors emphasised that a large proportion of PPE adherence behaviours received greater influence from organisational factors including cultures, policies, education and training, performance feedback and supervisor and management expectations of PPE use. The authors also alluded to the findings of Gershon et al. (1995) who found that healthcare workers were 2.5-fold more likely to adhere to safety measures including PPE use when there were perceptions of an organisation-wide commitment to improving patient safety, as compared to staff lacking such perceptions. However, this study was based on a cross-sectional survey of healthcare workers operating across various centres in the United States and thus, co-exists with risks of response, selection, and non-response biases, as well as issues of external validity and generalisability to the Saudi Arabian context. The Institute of Medicine (2011) also found that the positive and negative re-enforcement of PPE behaviours, such as in the form of praised feedback for optimal compliance and verbal warnings for poor compliance, were reported to influence PPE adherence and patient safety, although it was not clear where such reports were derived. Moreover, few of the studies included in the collective analyses of Houghton et al. (2020) and the Institute of Medicine (2011) utilised theories of behaviour to recognise the factors influencing PPE use; information that is important in
understanding healthcare workers’ cognitions and motives that directly drive behaviours to comply or not comply (Davis et al., 2015).

**Summary of PPE Adherence**

In summary, this component of the literature review evidences that non-theory-based studies exploring the factors influencing PPE adherence varied in rigour and that various superficial factors were noted in the findings as shaping PPE adherence such as the fear of contracting or transmitting infections and the discomfort of wearing specific PPE equipment. Adherence rates across the healthcare settings were found to vary between 70-90% and generally, adherence was better in acute clinical contexts and during the COVID-19 pandemic. However, the evidence reviewed offers insufficient explanation as to elucidate the origin of suboptimal compliance with PPE.

### 2.5.3 Theory-Based Evidence of PPE Adherence

The prior section discussed the evidence of PPE adherence that is not backed by any theory. This tends to be natural evidence experienced in hospitals all over the world. As PPE adherence is a medical invention having a long history in medical science, different scientists tried very hard to associate PPE adherence with different theories to experiment with the evidence of PPE adherence in detail and invent new knowledge about PPE adherence in the medical science. The theories and their association with PPE adherence are discussed in detail in the below section.

#### 2.5.3.1 Integrated Behavioural Model

A recent commentary reported by Chan et al. (2021) utilised the Integrated Behavioural Model; a composite model comprising the theory of planned behaviour and self-determination theory, to understand the factors influencing individuals’ intentions to comply with COVID-19 prevention behaviours, of which, some would include the wearing of PPE. Although not an original study, the authors highlight the importance of the model in predicting adherence behaviours; supporting the notion that when social conforms are promotive of an individual’s psychological needs, behaviours are likely to receive autonomous motivation (personal interest), as opposed to controlled motivation based on external pressures. Thus, PPE adherence behaviours are likely to be shaped by an individual’s attitudes, subjective norms, and perceived behavioural control with the overarching need to sustain the safety of self, although such mediators may apply to health workers where prioritisation of others’ safety is often held above their own risk and wellbeing. Furthermore, the authors suggested that
external factors could influence COVID-19 prevention behaviours to some degree with the introduction of legislation to wear PPE, cultural norms that reject the medical model and the efficacy of PPE, and discrimination towards persons adhering to PPE recommendations being just a few examples. Such external motivations likely alter intentions and actions in complying with PPE to prevent COVID-19 through diminishing autonomous motivations and enhancing controlled motivations, as well as modifying attitudes, subjective norms, and perceived behavioural control to increase the ease of and desire to utilise PPE (Chan et al., 2021).

2.5.3.2 Protection Motivation Theory

Other research has explored the utility of protection motivation theory for predicting PPE use behaviours to prevent COVID-19 among general populations (Prentice-Dunn and Rogers, 1986). The theory of protection motivation has grown in popularity due to its focus on individuals’ risk perceptions and how such perceptions shape intentions and behaviours that promote protective actions; the stringent use of PPE in the context of infection control (Milne et al., 2000). The theory has been used to predict behaviours in response to an individual’s perceived threats to health and thus, is useful in unusual circumstances, such as the ongoing COVID-19 pandemic, although it may have unreliable applicability in situations of less virulent and non-epidemic infections as is the case for most nosocomial infections (Milne et al., 2000; Bashirian et al., 2020). Using the theory, Ezati Rad et al. (2021) found that the use of PPE significantly correlated with perceived vulnerability to COVID-19 ($R=0.192$, $p<0.001$), perceived severity of COVID-19 infection ($R=0.092$, $p<0.001$), perceived efficacy of PPE in preventing virus transmission/acquisition ($R=0.398$, $p<0.001$), self-efficacy ($R=0.497$, $p<0.001$) and protection motivations ($R=0.595$, $p<0.001$). In contrast, poor use of PPE to prevent COVID-19 was significantly correlated with maladaptive behaviour rewards ($R=0.243$, $p<0.001$) and perceived costs of PPE ($p=0.121$, $p<0.001$). However, the internal validity of the study was subject to biases of the cross-sectional design including temporality-related bias, and issues of external validity due to the single-centre design. Moreover, the applicability may be limited due to the restriction of respondents to highly educated young adults, in addition to which, the results are based on a general sample of the Iranian population as opposed to healthcare workers. Second, Chen et al. (2021) conducted a similar cross-sectional analysis of the general population in Taiwan to understand the factors influencing motivations to utilise COVID-19 PPE and in attaining the vaccination. The authors found that respondents with low motivation for using PPE and gaining the vaccine had a significantly lower perceived vulnerability to COVID-19 infection, perceived severity of infection, self-efficacy, response
efficacy and knowledge, as compared to those with high motivations. Such findings support the evidence of the prior study but again the findings are methodologically limited by issues within the cross-sectional design and the applicability of the sample analysed. Moreover, the protection motivation theory fails to consider important factors influencing PPE adherence intentions and behaviours including various cognitive and environmental mediators, which are better accounted for within other theories, such as the theory of planned behaviour and the Integrated Behavioural Model (Grindley et al., 2008). Similar to the studies of Ezati Rad et al. (2021) and Chen et al. (2021), Mortada et al. (2021) utilised protection motivation theory to identify the determinants of preventative behaviours towards COVID-19, which are mostly related to PPE practices and decision making. The study comprised cross-sectional research with data collected via online self-reported questions and given this approach, risks of response bias may exist. A cohort of 385 healthcare workers was recruited, which comprised doctors (29.4%), nurses (43.1%), pharmacists (11.2%) and specialist technicians (16.4%) who were working within primary care or frontline departments in various hospitals in Saudi Arabia during a post-COVID-19 lockdown period. A dedicated questionnaire was devised from the author’s review of the related literature and following consensus discussions with other investigators; internal consistency was desirable with Cronbach alpha being >0.70 for all items, thus reducing the concern for measurement bias. Baseline data revealed that 61.8% of respondents were working within primary care centres and this factor may impede the applicability of the findings to healthcare workers operating within acute hospitals. The results showed that numerous variables predicted workers’ intentions to comply with COVID-19 precautions including gender; favouring females (p=0.01), profession; favouring nurses (p<0.0001), and receipt of training in infection prevention and control (p=0.02) and the availability of PPE (p=0.001). Regarding the constructs of the protection motivation theory, the coping appraisal domains of self-efficacy and response-efficacy were found to significantly predict PPE compliance behaviours (both p<0.001) but such significance was not observed for response-costs (p=0.46) and nor was significance attained for the domains under threat appraisal; perceived severity (p=0.08) and perceived vulnerability (p=0.108). However, the p-value for perceived severity only marginally exceeded the usual significance threshold of 0.05 and as p values <0.1 are sometimes considered significant, perceived severity of COVID-19 infection are likely to have influenced the PPE behaviours of healthcare workers. Logistic regression analysis revealed that self-efficacy was the strongest significant predictor of intentions to comply with COVID-19 prevention precautions (p=0.008), followed by the availability of PPE (p=0.018) and gender (p=0.013). However, it was not clear how much of
the variance in PPE adherence behaviours the domains of the protection motivation theory accounted for, thus, highlighting the limitation of using said theory to explore the factors mediating healthcare providers’ PPE practices.

2.5.3.3 Theory of Planned Behaviour

In an early study conducted by O'Boyle et al. (2001), the authors utilised a longitudinal observational design to explore the adherence behaviours of 120 nurses working within critical care and post-critical care departments in a large United States hospital. Exploration of the adherence factors was guided by the theory of planned behaviour via structured equation modelling. The focus was placed upon compliance with proper hand hygiene techniques with adherence assessed through direct observation of practices in nurses’ clinical departments. Whilst direct observation can usually provide more accurate and reliable information regarding PPE adherence compared to self-reported practices, observations can be subject to the Hawthorne effect where awareness of respondents being observed can lead to altered behaviours in a way that may be viewed as more favourable. Thus, the evidence of this study could have been prone to overestimating the degree of correct PPE adherence. Nurses were also asked to self-report their hand hygiene practices comparing objective and subjective data. The survey instrument used observed a Cronbach alpha of 0.87, thus, limiting concern for reliability, however, the reliability of two of the theory’s constructs (subjective norms and outcome evaluations) was not possible to calculate as these comprised only one survey item each. However, this issue increases concern for measurement-type bias. Based on a total observation time of 215 hours, the overall mean adherence to correct hand hygiene practices was 70%; the highest rates being 87% for handwashing post completion of care and after direct contact with bodily substances, and the lowest rates being 3% for hand washing and washing before touching self and 57% before performing invasive procedures. When considering the self-reported adherence of nurses, the overall compliance rate was found to be overestimated as previously predicted; 82% and ranging between 71-89%. The difference between the subjective and objective evaluations of adherence was statistically significant (p<0.01) and thereby, highlighting the poor situational- and self-awareness skills of resident nurses.

The structured equation model revealed that various relationships between hand hygiene compliance and the constructs of the theory of planned behaviour existed; statistical significance was demonstrated for all paths with control beliefs influencing nurses’ attitudes, perceived behavioural control and intentions to comply directly (all p<0.05), normative beliefs
influencing intentions through subjective norms (both p<0.05) and outcome evaluations influencing intentions through shaping nurses’ attitudes towards hand hygiene compliance (both p<0.05). However, the greatest coefficients were observed for control beliefs (0.756), followed by normative beliefs (0.545) and outcome evaluations (0.245), thus, highlighting their central role in influencing attitudes, subjective norms and perceived behavioural control that direct intentions to comply with optimal practices. Notably, the theory of planned behaviour constructs was found to account for 56% of the variance in hand hygiene practices (R²=0.56) and thus, is a more useful approach to exploring the factors that influence PPE practices, compared to other methods reported previously. Finally, the authors also found that the intensity of work activity significantly influenced observed hand hygiene behaviours (coefficient 0.329, p<0.05), which suggests that time pressures imposed upon nurses due to work demand and other factors, such as limited staffing, influence hand hygiene behaviours in a way that can bypass cognitive intentions to adhere to hand hygiene guidelines.

In another early study using the theory of planned behaviour to explore hand hygiene compliance behaviours of healthcare workers, Pessoa-Silva et al. (2005) utilised a cross-sectional survey to capture the attitudes and views of 80 nurses and doctors working within a neonatal critical care unit in Switzerland. The survey was self-completed by respondents and thus, conferred a risk of response bias, although its internal consistency was desirable with Cronbach alpha values exceeding 0.70 for all items. Response bias may have been exacerbated due to the extent of survey items expected of healthcare workers to complete (n=74), particularly if the surveys were completed during operational hours where respondents may have felt pressured into completing the survey quickly and therefore, that potentially making their responses biased. The results revealed that the majority of healthcare workers (87%) believed that they could improve the quality of their hand decontamination practices and 74% believed that healthcare-associated infections could be prevented through proper hand hygiene practices. This was despite 43% of respondents claiming to have never received training on hand hygiene by specialist infection control nurses and educators. Intentions to comply with hand hygiene measures were generally positive (64%) but varying considerably depending upon the acuity of the clinical situation encountered; urgent problems negating hand hygiene, whilst non-acute problems permitted hand washing before and after contact with patients. Mean scores for attitudes regarding hand hygiene, ease of compliance with hand hygiene, subjective norms, and behavioural norms, were positive and favour optimal intentions to adherence to proper practices (mean scores 5.7-6.3 on a 7-point bipolar scale). However, multivariate analysis revealed that only perceived control in the difficulty in
complying with hand hygiene (OR 3.1; 95% CI 1.1, 8.7) and positivity of views regarding supervisors (OR 2.9; 95% CI 1.1, 7.8) was significantly predictive of intentions to comply with hand hygiene guidelines, although the bivariate analysis revealed the significant predictors to also include attitudes towards hand hygiene (OR 3.32; 95% CI 1.17, 9.39, p=0.02). However, credibility in the study could have been affected by response biases and the Hawthorne effect given the presence of infection control observers across the hospital departments where health workers were operating. In addition, ascertaining intentions to comply with hand hygiene practices does not directly translate into actions/behaviours observed in practice, particularly as respondents may have felt pressured into providing desirable responses to reflect their dedication to providing safe and high-quality care. Furthermore, the evidence cannot be reliably applied to reflect the factors influencing the intentions of other healthcare workers in other settings due to the small sample size and the limited representativeness of such respondents.

In a more recent study of healthcare workers, Jenner et al. (2010) investigated the hand hygiene behaviours of 104 staff working within a large hospital in the UK using the theory of planned behaviour. Respondents participating included nurses (76%), therapists (16%), healthcare assistants (4%) and doctors (3%) and survey items centred around each theoretical construct were rated on a 7-point bipolar scale. The overall internal consistency was desirable for all constructs (>0.70) and therefore, limiting concern for bias. The authors found that attitudes and personal responsibility were significant predictors of intentions to comply with hand hygiene policy (p<0.05) but no significant associations with subjective norms or perceived behavioural control were observed (p>0.05). Notably, intentions were found to be a strong predictor of hand hygiene behaviours with correctly classified cases totalling 79%, thus, contradicting the prior statement that intentions do not directly translate into actions in practice. Although in a minority of cases (the residual 21%), intentions did not predict infection control behaviours in the cited study. In contrast to the predictors of intentions, the significant predictors of hand hygiene behaviours included perceived behavioural control (p<0.05), as well as the barrier of the availability and location of hand basins (p=0.05). However, other barriers were not found to significantly predict hand hygiene practices; these included the acceptability of handwashing agents (p=0.558), time pressures (p=0.134) and satisfaction with paper towels (p=0.653). Some methodological limitations to this study, however, also diminish confidence in the findings reported. Such limitations included reliance upon self-reported data and the risk of response biases, inability to infer causation between predictors and intentions/behaviours; a problem encountered by much of the cross-sectional
literature included herein, and a small and unrepresentative sample of healthcare workers. In a more insightful and generalisable study reported by Sax et al. (2007), the authors explored the determinants founded upon the theory of planned behaviour to hand hygiene practices among 2,961 healthcare workers who had extensive exposure to hand hygiene campaigns. Therefore, this cohort was expected to display desirable attitudes, subjective norms, and perceived behavioural control for intentions to comply with best hand hygiene practices. The majority of respondents were nurses (60.4%), followed by doctors (26.0%) and nursing assistants (13.5%) and for behavioural beliefs, the results showed that perceptions of infection severity were the major determinant of behaviour in 32.1% of respondents and that knowledge of the efficacy of hand hygiene in prevention infections determined hand hygiene behaviours in 86.0% of respondents. For normative beliefs, the majority of healthcare workers believed that social pressures from patients, colleagues and influential supervisors were predictive of hand hygiene compliance, whilst for control beliefs, the ease of performing hand decontamination was the most influential factor. The significant predictors of desirable adherence to hand hygiene policy, defined as adhering to >=80% of hand hygiene opportunities, included female gender, receipt of infection control training, exposure to a prior hand hygiene campaign, peer pressure from colleagues and simplicity of adhering to policy (all p<0.05). Whilst this study conveyed a more applicable series of findings due to the markedly large sample size, the evidence was still prone to response bias and potentially the Hawthorne effect, gave the self-reported nature of data collection and the presence of infection control specialists across health workers’ departments.

In an Australian study, White et al. (2015) conducted cross-sectional research among nurses working in hospitals in Australia to explore the barriers and facilitators influencing compliance with the WHO’s five key moments for hand hygiene. A purposive sample of nurses, who lacked specific or advanced training in infection control, was recruited from various departments including intensive care units, general medical wards, and surgical wards. Nurses’ attitudes, views, and beliefs regarding the use of PPE were captured via focus groups; an interview approach that co-exists with a risk of bias when one or more members of a group dominate in responding to questions leading to the views of others going amiss. In addition, nurses completing the focus groups were given a financial incentive, which may have heightened the risk of selection bias conferred by the selective sampling technique employed. A total of 27 nurses completed the focus groups and their characteristics were sufficiently diverse to confer some applicability to other nurses working in Australian hospitals but not regarding nurses working in Saudi Arabia as is the case for essentially all non-Saudi studies.
related to the topic of PPE adherence. The results revealed responses that are congruent with the three core constructs of the theory of planned behaviour. Firstly, nurses reported that adhering to infection control precautions was key to protecting themselves and others from infectious pathogens, although some nurses reported that frequent and rigorous hand hygiene was damaging to the skin; a factor that may have impeded adherence to hand washing and/or glove-wearing but one that was not directly quoted. Secondly, nurses identified that optimal adherence to PPE precautions occurred when support from supervisors and observation by infection control staff was present. In addition, nurses admitted complying better with PPE measures in the presence of patients’ visitors, which may reflect nurses’ desire to be viewed as role models and advocates of patient safety. In contrast, nurses reported that doctors tended to be unsupportive of PPE use and often failed to advocate best PPE practices, which may have detracted nurses from stringently adhering to PPE guidelines. Moreover, nurses’ perceptions of patients’ views regarding the use of PPE also influenced nurses’ intentions to comply with PPE precautions; in some cases, patients disliked PPE due to conceptions that others would believe they were unclean, whilst in others, patients favoured PPE due to conceptions that infections were a serious problem in hospital environments. Finally, nurses reported directly upon several barriers and facilitators to PPE adherence.

Facilitators comprised the ready availability of PPE and washing basins, regular education and training in infection control, and hospital campaigns that prioritised improvements in infection control. In contrast, the barriers included clinical emergencies that negated the use of PPE due to the imminent need to perform life-saving interventions, allergies to PPE, insufficient education and training in infection control, time pressures and lack of available equipment. Whilst the findings of this study provided valuable insights into the factors influencing PPE adherence among nurses working in hospital environments, the study did not employ an extensive range of techniques to enhance trustworthiness, and this reduces the overall credibility, dependability, and confirmability. The factors identified are likely to be shared or encountered by nurses operating in other settings including Saudi Arabia, but applicability cannot be assumed, given the marked variances in health operations and other clinical processes across western and non-western settings.

In the final study of this subtheme, that was conducted during the COVID-19 pandemic, Shubayr et al. (2020) explored the factors influencing infection control behaviours of dental healthcare workers operating within the Jeddah province of Saudi Arabia. A cohort of 324 respondents completed the questionnaires that were centred around the constructs of the theory of planned behaviour with the internal consistency exceeding usual limits and reducing
the concern for bias. The results ultimately revealed that workers held positive attitudes towards COVID-19 infection prevention and control, although attained lower and less than average scores for the constructs of subjective norms and perceived behavioural control, suggesting that much of the respondents’ intentions to adhere to PPE guidelines were influenced by their attitudes of the seriousness and risk of COVID-19 to themselves, other staff and service users receiving treatment. However, both attitudes and subjective norms were found to significantly predict health workers’ intentions to comply with COVID-19 PPE guidelines (both p<0.001), thus, suggesting that respondents’ perceptions of others’ expectations regarding compliance with infection control measures influenced intentions as much as their attitudes towards COVID-19. Notably, attitudes and subjective norms were found to account for 44% of the variance in health workers’ intentions to adhere to PPE guidelines, thus, being useful, compared to evidence that has not utilised behaviour theory. However, some caution is advised in interpreting the results given the low response rate relative to the number of health workers registered in Saudi Arabia and due to the cross-sectional design, which precludes the ability to infer causation between the theoretical constructs and intentions to comply with PPE guidelines.

Summary of the theory base of research about PPE adherence

In summary, this section of the literature review evaluated the value of theory-based evidence that has investigated the factors influencing PPE adherence. Various theories were used in the studies reviewed, including the Integrated Behavioural Model, Protection Motivation Theory, and the Theory of Planned Behaviour, much of the literature has used the latter theory to explore the influence of attitudes, behaviours, and perceived control upon said adherence. The evidence reported upon a comprehensive range of factors that influenced PPE adherence and through the Theory of Planned Behaviour, a trajectory and progression of issues appeared to contribute to the failings in PPE adherence. Therefore, the theory appears suitable for exploring PPE adherence in the Saudi Arabian context.

2.5.3.4 Evidence Gap

It is important to note that few studies have investigated the factors influencing compliance behaviours regarding PPE practices other than hand hygiene, which represents an important knowledge gap both within Saudi Arabia and internationally. In addition, few studies have been conducted among health workers to explore the factors influencing PPE practices using theories other than the theory of planned behaviour. Indeed, evidence utilising specific
behaviour theories to explore the factors influencing PPE compliance among health workers in Saudi Arabia has been much scarcer, than international evidence.

2.6 Summary of Key Findings

In summary, this literature review explored the evidence that has examined the factors influencing the intentions and behaviours of health workers in complying with PPE guidelines and through a critical evaluation of numerous studies, identified that theoretical models and frameworks were most useful in eliciting the highly influential factors driving PPE related practices. Such evidence was reflected in research showing that theories, and particularly, the theory of planned behaviour, can identify predictors of PPE adherence that account for around 50% of the variance in health workers’ intentions and behaviours in complying with said practices. One of the most notable research gaps identified was simply a lack of theory-based studies exploring the factors influencing PPE practices among health workers in the context of Saudi Arabia. This issue has obstructed understanding of the broad range of factors and their complex inter-relationships that are influencing PPE behaviours locally, which is likely to be fuelling poor adherence among nurses and other health professionals. As a result, this issue may be heightening, unnecessarily, patients’ risk of nosocomial infections and related morbidity and mortality. This research aims to address this knowledge gap by identifying the predictors of PPE adherence among nurses working within a Saudi Arabian hospital based on a composites behaviour theory; the Integrated Behavioural Model is summarised and justified within chapter three.
Chapter 3. Methodology and Methods

3.1 Overview

This third thesis chapter details and justifies the methodology and methods used to address the central research question given below. The research question, along with a series of objectives and hypotheses, are considered fundamental components of credible research. They act as a central point of focus for designing and employing appropriate methods to sufficiently answer research problems. In addition, these elements seek to maintain researcher objectivity throughout the research period through persistent awareness of the purpose and potential impact the outcomes could have upon patient care (Farrugia et al., 2010).

3.1.1 Research aim:

This research specifically aims to use the Integrated Behavioural Model (IBM) which is suitable for identifying and understanding the factors influencing the behavioural intentions of the nursing workforce regarding compliance with standard infection prevention and control precautions in the northern region of Saudi Arabia.

3.1.2 Research Question:

What factors influence nurses’ intentions to adhere to guidelines regarding standard precautions for infection control and prevention in Saudi Arabian hospitals?

3.1.3 The research objectives:

i) To explore the beliefs of nurses which underpin their behavioural intentions to comply with personal protective equipment (PPE) guidelines.

ii) To determine the magnitude and direction of influence of the three core IBM constructs (attitudes, subjective norms, and perceived behavioural control) upon nurses’ intentions to comply with PPE guidelines.

3.2 Methodology and Perspective

To address the research question, a primary methodological approach was adopted as this was amenable to generating novel evidence related to the factors influencing nurses’ intentions to comply with PPE recommendations, particularly as there has been a scarcity of evidence reporting upon this construct within the Saudi Arabian context (Paul et al., 2020). Indeed, authors acknowledge the value of primary (original) research within the academic and
clinical communities given that contemporary practice is guided by the principles of evidence-based medicine (LoBiondo-Wood and Haber, 2021). This model ultimately seeks to inform and guide health professionals on how to approach or manage all aspects of patient care by ensuring that the provision of care or treatment falls in line with the best available research evidence (Sackett, 2000). In turn, such evidence should lead to care decisions that promote patient safety or have the potential to improve patient valued and clinically meaningful outcomes as research represents the most objective and scientific means to overcoming the limitations of anecdotal practice, which have been associated with harm and other patient adversities (Barratt, 2008). Regarding the literature review, evidence was scarce in the local region of Saudi Arabia regarding the factors influencing PPE compliance among nurses. In addition, the PPE guidelines designed to protect patients from nosocomial infections may be compromised because of their failure to be locally specific and culturally sensitive. Thus, conducting a primary methodological study in Saudi Arabia provides the optimal means to address this issue, as well as identify the barriers and facilitators that may be influencing guideline adherence. Such evidence could then be used to inform changes to evidence-based guidelines and as a result, increase adherence to infection control guidelines and subsequently improve patient outcomes. As identified in the literature review, the alternative approach of designing and conducting a review of the literature (secondary methodology) would not address the research question given the scarcity of evidence specific to the identified research problem.

Regarding this study, both quantitative and qualitative methods were adopted, although quantitative data comprised the primary approach for the study given that numerical measures have been long accepted as the ideal means of generating scientifically credible and objective research evidence (Noyes et al., 2019). However, to develop the quantitative survey instrument, as discussed in the relevant subsection of this chapter, a qualitative perspective was used to interview nurses to identify and understand the various complex factors influencing PPE compliance decisions and behaviour before designing the quantitative research instrument. Qualitative perspectives are usually applied when a research area or paradigm of interest cannot be reliably ascertained using quantitative means and instead, demands methods to acquire the views, experiences, beliefs, and desires of respondents regarding ill-defined contexts or exposures (Lakshman et al., 2000). However, whilst some limitations to qualitative methods exist, such data has become increasingly useful within the research and clinical contexts, given that these are contemporary shifts away from paternalistic models of care, towards care that prioritises and focuses upon patients’ valued
needs, whether medical or non-medical (Kaba and Sooriakumaran, 2007). In effect, qualitative methods enable researchers to understand the nature of a construct, as well as the factors affecting the construct and those inter-related with variances of the construct (Lakshman et al., 2000; Watkins, 2012; Chafe, 2017; Levers, 2013).

3.3 Justification of the Research Paradigm

Qualitative methods were important for the elicitation component of generating the quantitative survey, as they sought to preserve the dynamic complexities of human cognition and behaviour by adopting a holistic and individual perspective (Lakshman et al., 2000). Notably, the value and impact of qualitative research can be enhanced through the incorporation of theoretical principles as this ensures methods and analyses are grounded by defined ontological and epistemological dimensions (Hastings et al., 2020). For the research conducted, a pragmatic paradigm was adopted as this was amenable to the mixed methods design of this research and given its value in permitting the investigator to make interpretations about the research findings within real-world situations (Salkind, 2010; Evans et al., 2011). Indeed, such a paradigm has been previously used to inform qualitative and mixed-methods studies centred around the IBM, and thus, the position was amenable to understanding the barriers and facilitators of infection control guideline adherence as perceived by Saudi Arabian nurses (Olya et al., 2019; Cohen et al., 2000). The pragmatic position was ultimately concerned with exploring nurses’ experiences about the nature of clinical practice reality and seeking to understand why responses related to PPE guideline adherence were obtained (Evans et al., 2011). To achieve this, the researcher utilised their own clinical experience to elicit and explore the views of nurses in their practices. This ensured a connection between researcher interactions with participants, whilst avoiding influences of subjectivity. Techniques used to enhance the trustworthiness of qualitative research were used to support the pragmatic paradigm, which is described in section 4.4.

Specific limitations to qualitative research can occur when exploratory approaches to collecting data are utilised and more so, when few or no techniques, that are known to enhance the trustworthiness of qualitative research, are employed, which range from respondent validation to author reflexivity (Noble and Smith, 2015). However, this research sought to overcome some of the limitations in qualitative methods by utilising several methods that can optimise the validity, dependability and confirmability of the results or accounts of respondents, as discussed in the relevant subsection (Noble and Smith, 2015). A similar position was adopted for the quantitative survey, as described in chapter 6, although despite
rigour in quantitative research, such methods can also be vulnerable to issues of researcher subjectivity, as well as systematic error, random variation, and bias (Pannucci and Wilkins, 2010).

As the qualitative component of this research was employed for the elicitation phase of informing the development of the quantitative survey tool, as opposed to supplementing the quantitative findings as usually described within mixed-methods research, it was important to denote whether this approach was methodologically feasible (Tariq and Woodman, 2013). Indeed, several authors advocate the use of qualitative approaches to developing quantitative surveys as such approach can elicit key information from the respondents of interest that may otherwise go unidentified and unaccounted for within experimental studies – an issue that would have ultimately hindered the credibility and impact of this research for current PPE practice, guidelines, and policy (Strickler, 1999; Barton, 2015; Kumar, 2015).

3.4 Justification of the theoretical Model

In keeping with methodological principles designed to generate the most informative evidence, theory in the form of the Integrative Behavioural Model (IBM) was used to inform the identification, exploration and understanding of the factors influencing nurses’ compliance behaviour with PPE recommendations (Ajzen, 1991). The IBM represents an amalgamation of two theories: The Theory of Planned Behaviour (TPB) and The Theory of Reasoned Action (TRA) and thus, adopts the benefits of both theories in understanding the factors influencing human behaviour (Ajzen, 1991). The TRA predominantly assumes that the behaviours of individuals are under complete voluntary control, although it also considers, albeit to a lesser extent but more appropriately, that behaviours can be influenced by non-voluntary or external factors as described under its construct of perceived behavioural control (Trafimow, 2009). The TPB represents an important extension of the TRA both in terms of overcoming its fundamental limitation of having a naïve falsifications perspective, and by considering all factors influencing the behavioural intentions of individuals, which include those governing self- and external controls over one’s actions (Figure 2) (Trafimow, 2009).

The TPB is based upon three main constructs with each having two subconstructs, which include: 1) attitudes comprising subjective attitudes and beliefs regarding a behaviour, 2) subjective norms comprising beliefs regarding others’ views including those important or valued by the subject and those external to one’s network and 3) perceived behavioural control comprising factors that influence one’s control over a behaviour and respondents’
perceptions about the ease or difficulty of performing or engaging in a behaviour (Figure 2) (Ajzen, 1991).

- The first construct of attitudes represents (see section 5.1) a reflection of an individual’s intent in undertaking a specific action or behaviour, which tend to receive multiple cognitive influences due to various factors that motivate, perpetuate or hinder desires to engage in the said behaviour.

- The second construct, which is centred around an individual’s beliefs, represents a reflection of individuals’ intrinsic views and values regarding the acceptability or non-acceptability of an intended or actioned behaviour and this can also receive influence through the shaping of attitudes regarding the behaviour.

- The third construct of perceived control is a reflection of the norms and cultures within an individual’s social network or society, which define the foundations of acceptable and non-acceptable behaviours. In addition, the construct denotes the aspects of an individual’s capability to control such behaviours whether or not one is or feels pressured into engaging in the behaviour (Ajzen, 1991).

Figure 2. TRA (white boxes) and TPB (grey boxes) for understanding human behaviour (Glanz et al., 2008).

In isolation, the TPB is also subject to some limitations for understanding human behaviour, which includes its presumption that individuals possess the capacity and resources to perform the desired behaviour to its optimal extent independent of their initial intentions (Ajzen, 1991). In addition, the TPB does not consider or attempt to account for other factors that can influence behavioural intentions and executed behaviours, such as emotions and perceptions of fear and threats to self, affect or mood, previous experiences related or unrelated to the
behaviour and socioeconomic determinants influencing behavioural intentions (Ajzen, 1991). Furthermore, the TPB implies that decision making regarding behaviour is a simple and linear process and thus, does not consider the often dynamic and temporal nature of decisions that may vary considerably (Sniehotta et al., 2014). Building on the temporality of decision making, the TPB also fails to account for the interval between intentions to perform a behaviour and the actual execution of specific behaviour, which can lead to a misinformed understanding of behaviour when relying upon intentions alone (Sniehotta et al., 2014). Whilst the IBM, as with other theories, cannot account for all of the limitations of the TPB, it supplements the theoretical basis for understanding human behaviour by accommodating the constructs of the TRA, TPB and other relevant theories, such as the Health Belief Model and Social Cognitive Theory, and it places greater emphasis upon intentions to conduct behaviour and the factors influencing such intentions as the primary dictator of actioned behaviour (figure 3) (Montano and Kasprzyk, 2015; Glanz et al., 2008). In terms of the contribution of the IBM to the three core theoretical constructs of the TPB, the IBM reminds investigators to consider individual autonomy and capacity as influences of perceived behavioural control and greater distinguishing of injunctive and descriptive norms within the construct of subjective (perceived) norms (Dai et al., 2018; Glanz et al., 2008). In regard to PPE adherence, using the IBM model will therefore help to better understand the complex and intricate inter-construct relationships and influences, which can then be used to visualise a pathway of multiple factors contributing to deviances from PPE guidelines; much like the well-recognised Swiss-Cheese Model of Adverse Events and Patient Safety (Wiegmann et al., 2022).

Figure 3. The IBM: a composite of the TRA, TPB and other theories (Glanz et al., 2008).
Overall, the IBM is appropriate for identifying and understanding the attitudes, norms, perceptions, and controls of nurses engaging or not or partly in the specific behaviour of PPE compliance, which is important as this can directly affect patient care and outcomes due to the ability of PPE to attenuate the risk of infectious disease (Trinh and Vo, 2016). This statement is a reflection of other authors’ views, acceptance and evaluations of the IBM for understanding behaviour where it has been shown to have desirable validity and reliability for predicting a person’s intentions to perform a specific behaviour and executing the behaviour, particularly in the context of health and therefore, the theory is ideal for research focusing upon compliance behaviours among healthcare staff (Fishbein and Ajzen, 2015). Indeed, the IBM has been used extensively across health research to explore and understand the behaviours of both healthcare providers and service users and with a sufficient level of reliability as to reduce concern for bias or other systematic errors in underlying methodologies (Branscum and Lora, 2017; Reid and Aiken, 2011; Fishbein, 2009).

In the context of infection prevention and control, the TPB and IBM have been adopted to useful effect with evidence showing that the theories can be employed to identify the key factors hindering adherence to proper hand hygiene practices and the donning of PPE among nurses, which led to key recommendations for practice change as a means to improving care (White et al., 2015; Erasmus et al., 2020). Importantly, such factors and recommendations may not have been recognised if an alternative theoretical model was imposed and the IBM was deemed essential to eliciting all the factors influencing PPE compliance in the local context.

3.5 Overview of Study Design

The study was conducted within two hospitals located in north of Saudi Arabia. The study protocol was reviewed by the investigator’s research department within the University of Edinburgh, School of Health in Social Science and received formal ethical authorisation from the Institutional Review Board within the Tabuk region (see section 3.8 for further ethical considerations in this research). A phased mixed-methods design was used: first, a qualitative elicitation phase was used to develop the survey instrument by piloting the interview guide (n=2) and then field testing (n=12). This was followed by a quantitative phase that consisted of piloting the survey among a small group of nurses (n=43) and then conducting the main survey with the main population of nurses (n=278) (see Figure 4): samples were mutually exclusive.
3.6 Study Setting and Local PPE Guidelines

The setting for the main study comprised two hospitals located in the Tabuk region, in the north of Saudi Arabia. Notably, both hospitals are large institutions accommodating a total of 770 inpatient beds and providing secondary and tertiary level care for more than 600,000 people within their catchment area. Various departments within the hospital were eligible for nurse recruitment for the qualitative and quantitative elements, which included the intensive care units, general medical, surgical wards and infectious disease and isolation units. The nursing population across both hospitals was 990; 540 on-site one and 450 on-site two. Nurses were recruited across various wards and departments within the hospitals to help capture a representative sample of nurses.

All nurses working in the hospitals are expected to comply with local guidelines and those about infection prevention and control and specifically, PPE use, are provided by the Ministry of Health within its guidelines – *The Infection Prevention and Control Manual* (Ministry of Health, 2013). These guidelines provide specific information regarding general PPE use and hand hygiene practices, of which, the latter has been translated from the World Health Organisation’s (WHO) most recent standards for preventing the transmission of infectious disease and reducing the rate and sequelae of nosocomial infections (WHO, 2009b). As noted in chapter 2, there have been growing concerns regarding hand hygiene practices and PPE adherence within Saudi Arabian hospitals and indeed, one factor thought to be compounding patient safety is the ambiguity of local guidelines, although many other barriers and facilitators of correct PPE use exist (Memish, 2002) – a pertinent objective of this study was to identify those important facilitators and barriers. A 1 to 7 scale-based survey questionnaire is used to collect the quantitative data for the study (Appendix 2).

3.7 Participant Eligibility
Respondents who were eligible for inclusion in this study included nurses who had been registered with the Saudi Commission for Health Specialties for a minimum term of six months as this was deemed the minimal period of practice experience required to contribute valuable information to the research question. These nurses also had to have gained practice experience in one or both hospital settings (intensive care units, general medical, surgical wards and/or infectious disease and isolation units). All nurses meeting this criterion were eligible to participate and thus to generate a representative sample of nurses, no restrictions were defined for age, gender, ethnicity, nationality, or seniority/position.

3.8 Ethical Considerations

This research protocol was approved by the investigator’s local research department within the University of Edinburgh, School of Health in Social Science (appendix 9) and received formal ethical approval and Institutional Review Board authorisation from the Tabuk region before participant recruitment and data collection (Appendix 8). However, it was important to delineate the pertinent ethical issues and how such issues were minimised or averted as this provided transparency in the research processes and assurance that the rights and wellbeing of nurse respondents were upheld. Measures to address ethical concerns or issues were by recommended research practices as defined within the Medical Research Council’s document *Good Research Practice* (Medical Research Council, 2012).

Firstly, all nurse respondents engaging in the qualitative interviews and the pilot and final quantitative survey were required to read, understand, and complete formal consent forms, which required the printing of their names and signing and dating of each form. Given that the qualitative and quantitative elements were conducted electronically, consent forms were completed in electronic format before commencing the interviews and surveys. The consent form was developed in English with simple information provided to the probable respondents to give them a short description of what the researcher intended to do. After acknowledging the consent form, respondents were given two options; take part in the study or not. Any nurse unwilling to participate in the study was not questioned further. The researcher interviewed only those respondents who were willing to participate in the study.

Overall, consent is a critical component of research involving human respondents as it ensures that individuals are provided with sufficient information to make an informed decision regarding participation, as well as an understanding of how their data will be managed and discarded. Notably, the investigator removed themselves from engaging in the consent process, to
eliminate any risk of coercion. However, all respondents were informed of their right to withdraw their consent at any point and their right to access all data held about them, which was in keeping with local data protection policy.

The second ethical concern of note was the gathering and management of personally identifiable data and thus, to protect the confidentiality of all respondents, such data were coded using a numerical system and where appropriate, redacted. However, personal details of respondents engaging in the qualitative interviews were retained securely in the non-anonymised form to permit member checking at a later time point. Details held about these respondents simply included their name, contact email, and contact phone number, which was data stored securely on a password-protected computer file and server. After member checking was completed, the personal details of all respondents were anonymised for transcript generation and data analysis.

Finally, all research data was stored by data protection requirements – electronic data was secured on an encrypted device and retained by the investigator in a secure location. All research offices in the investigator’s institution were secure from unauthorised access. Notably, some participants held concerns regarding the privacy of their data even despite assurances that it would be protected and therefore, for such respondents, their data was discarded after the analysis was completed. There were also potential issues regarding the understanding of respondents' responses as the interviewer translated the interviews into Arabic for nurses who were not fluent in English and there may have been misinterpretations due to Arabian dialects. However, such responses were confirmed for accuracy with senior nurses and thus, any translation issues were negligible. Funding for this research was attained from numerous sources, from which the investigator allocated a budget for conducting research and sponsorship provided by a research organisation.
Chapter 4. Qualitative Phase (Methods): Survey Development

4.1 Participant Recruitment

For the qualitative component of this study, nurses meeting the eligibility criteria were recruited using purposive sampling. Recruitment targets were set to 12 nurses, but data collection continued to the point of theoretical data sufficiency (saturation), to optimise trustworthiness (Noble and Smith, 2015). Nurses were informed about the study by email invitations and posters distributed around the hospital site; responding nurses were screened for eligibility by the researcher. Notably, two additional participants were recruited to partake in the ‘pilot’ phase of the interview process as a means of ascertaining interview question feasibility. These participants were disparate from the final sample of 12 nurses who completed the full survey.

4.2 Data Collection

Two participants were presented with a series of questions that were developed by the primary investigator and their supervising team (Appendix 1) based on the literature review evidence and to accommodate the constructs of the IBM, to determine the feasibility and acceptability of the topic guide for the interviews and to make any revisions or additions to the topic guide for the final interviews of the participants. The nurses provided feedback that the topic guide was feasible and acceptable for the interviews.

Using this initial version of the interview guide, one-to-one interviews between the investigator and the nurse participants were conducted via Skype software due to the ongoing COVID-19 pandemic, which demanded social distancing measures to mitigate the spread of infection. All interviews were conducted in English and were audio-recorded and transcribed verbatim by the investigator. The interviews lasted approximately 60-90 minutes. No participants experienced time-pressure or coercion to provide rapid responses even if the expected interview duration was exceeded. All the materials used in the study were written in English and the responses were also collected in English. The consent form was in English.

4.3 Qualitative Data Analysis Plan – Survey Development

The qualitative transcript data were analysed using content analysis to enable the reduction of the large amount of data captured and its organisation into summaries of the pertinent information regarding the factors influencing PPE compliance (Erlingsson and Brysiewicz,
Content analysis of the qualitative data was performed using the methods described by Schreier (2012). This involved four key processes 1) data condensation – deconstructing the transcripts into manageable summaries by removing irrelevant responses, 2) data coding – identifying patterns and consistencies within the data and grouping these within codes, 3) theme development – identifying related codes and grouping these into themes and 4) reporting upon the themes using appropriate titles and supportive quotations of the original participants. In keeping with the principles of thematic analysis, the investigator engaged in a process of transcript familiarisation before conducting the content analysis as this ensured sufficient awareness of the data and its meaning and thereby, minimised errors in analysis and reporting (Nowell et al., 2017). Moreover, content analysis was performed using the theoretical perspective grounded within the IBM, which was attained by aligning the codes and themes with each of the core- and sub-constructs of the model (Dai et al., 2018).

4.4 Trustworthiness in the Qualitative Data

In order to generate a valid and reliable survey instrument, the trustworthiness of the qualitative data informing the development of the survey was optimised using a number of techniques as recommended by Noble and Smith (2015): 1) constant comparative analysis; 2) investigator triangulation with the primary researcher’s supervisors reviewing the codes and themes derived from the original transcripts, in order to assess accuracy in the analysis and/or translate any closely related codes or themes into key codes or themes (Carter et al., 2014); 3) the original nurse participants were contacted after derivation of the final codes and themes, in order to review their specific responses as to whether they had been accurately represented from their direct accounts and that the meaning had not be misinterpreted and 4) the investigator adopted a reflexive and objective position throughout the conduct of the qualitative interviews and analysis of the transcript data, in order to further minimise the risk of subjectivity related bias (Noble and Smith, 2015). In this regard, the investigator retained a research diary and logged every process in chronological order as a means of guiding reflection regarding if, how and whether their views, beliefs or values impacted the data collection and analysis (research subjectivity bias). In turn, any researcher bias identified through reflective practice was acted upon by reviewing or repeating the research processes affected.
5.1 Qualitative Findings: Content Analysis

5.1.1 Overview

As the author adopted the theoretical perspective comprising the Integrated Behavioural Model (IBM), the content analysis permitted alignment of the codes and themes with the key constructs of the IBM, which included attitudes (experiential and instrumental attitudes), perceived norms (injunctive and descriptive norms) and personal agency (perceived behavioural control and control beliefs or self-efficacy) (Dai et al., 2018). Data sufficiency was reached after conducting twelve interviews with nurses and this point defined the final sample of data that was used to inform the content analysis, which is detailed in the following subsection. In terms of structure, a description of the most pertinent results for each IBM construct and subconstruct is given before each tabular summary. An inductive approach to coding and analysis was undertaken in order to ensure the codes and themes emerged naturally from the response data, as opposed to being subject to the subconscious biases of the investigator. This involved five key steps recommended by Thomas (2006):

1. Preparing the raw qualitative data with cleaning and standardising the formatting and presentation.
2. Familiarisation with the data with in-depth reading of the transcripts to generate sufficient understanding of the data and to identify the various elements or events emerging.
3. Generation of categories or initial themes with the inductive approach involving categorisation of the data in relation to key phrases/responses and their meaning.
4. Coding the data of interest by identifying key elements within the categories and segmenting this into discrete initial codes by a process of reduction; degrading segments of text into codes until it can no longer be reduced into disparate codes. Thus, the most primitive codes are recognised via this process.
5. Continuous revision of the codes and grouping of codes related to one another to generate the themes; categories of data with each comprising a specific meaning or a meaning considerably different to other themes. Examples are shown in - Appendix 11.
### 5.1.2 Coding and Theming Summary

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Details</th>
<th>Theme Details</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Content with providing high quality care</td>
<td>Using PPE where appropriate elicited feelings that both staff and patients were protected from infectious disease</td>
<td>Prioritising patient care and safety</td>
</tr>
<tr>
<td>2</td>
<td>Supportive feelings</td>
<td>Ability to access and provide patient care with senior staff when needing to use PPE during the care of patients with invasive devices.</td>
<td>Cultures that fail to advocate the best infection prevention and control practices</td>
</tr>
<tr>
<td>3</td>
<td>Fear and anxiety when avoiding PPE use</td>
<td>Senior staff failing to be constructive in their approach to poor PPE adherence and making nurses feel afraid using threats.</td>
<td>Cultures that fail to advocate the best infection prevention and control practices</td>
</tr>
<tr>
<td>4</td>
<td>Fear of blame from others when using scarce PPE stocks</td>
<td>Senior staff expressing anger towards staff who use PPE and reduce stock levels</td>
<td>Cultures that fail to advocate best infection</td>
</tr>
<tr>
<td></td>
<td>Insufficient appreciation of nursing role and responsibilities</td>
<td>Some managers and senior staff failing to support, motivate and acknowledge nurses' hard work ethic, as well as little compensation for overtime, which has damaged morale and promoted compassion fatigue.</td>
<td>Cultures that fail to advocate best infection prevention and control practices</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>Angry and demotivated by hidden racism regarding appreciation of role.</td>
<td>Some nurses recognised that PPE was more readily available and promoted for use by nurses of Saudi rather than non-Saudi origin.</td>
<td>Cultures that fail to advocate best infection prevention and control practices</td>
</tr>
</tbody>
</table>

Table 1. Content analysis of nurses’ experiential attitudes concerning the factors influencing PPE adherence.

Each key construct of the IBM was used to structure the coding and thematic process of content analysis with the findings of the analysis reflected across tables 1-6. For the first subconstruct of experiential attitudes (Table 1), there were varied accounts regarding nurses’ feelings about their previous practice of using or desiring to use PPE, although most were feelings induced by factors outside of their control but compounded PPE compliance. In one regard, nurses who engaged with PPE by guidelines felt content and happy that they were providing care that protected themselves, patients, and colleagues from infectious disease.
Such nurses also felt supported and confident in using PPE when care was provided in the presence of senior nurses. However, nurses experienced negative feelings towards PPE use, which included fear and anxiety induced by the threatening nature of the senior staff. This was in addition to fear of being blamed for low PPE stocks, insufficient appreciation of role demand and even anger regarding hidden racism that emerged from disparities in nurse treatment between those of Saudi and non-Saudi origin.

For the second subconstruct of instrumental attitudes (Table 2) regarding the factors influencing PPE adherence among nurses, the data revealed that various beliefs regarding infectious disease transmission and its significance influenced behaviours related to PPE use. In this regard, nurses believed that adhering to PPE recommendations was key to protecting patients, among other persons, from infectious disease and adverse effects upon morbidity among patients including protracted lengths of hospital stay and even mortality. However, other nurses held beliefs that adhering to PPE recommendations was important in meeting arbitrary targets, such as infection rates within local departments, which suggested that there was a competitive element influencing PPE use across hospital wards, units, and departments. Finally, some nurses believed strongly in the underlying microbiological evidence to inform the need to utilise PPE to protect others from infection, which comprised interpretation and understanding of culture and sensitivity results of specimens taken from patients with suspected infections.

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Details</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Protecting patients from infection</td>
<td>Clear recognition that preventing the spread of microbes reduces the risk of infection</td>
</tr>
<tr>
<td>8</td>
<td>Protecting self, staff and friends and family from infection</td>
<td>As above but different population subgroup</td>
</tr>
<tr>
<td>9</td>
<td>Reducing infection rates</td>
<td>Clear recognition that preventing the spread of</td>
</tr>
</tbody>
</table>
Table 2. Indirect Measures: Behavioural Beliefs/Outcomes.

|   | within local departments | microbes promotes success in departments via monitoring of infection rates | care and safety |   |
|---|--------------------------|--------------------------------------------------------------------------|-----------------|
| 10 | Reducing hospital length of stay | Clear recognition that preventing the spread of microbes reduces length of stay by reducing the risk of nosocomial infections and any additional complications. | Prioritising patient care and safety | “Decrease morbidity and lengthy admissions” |
| 11 | Reducing mortality rates | Clear recognition that preventing the spread of microbes can prevent deaths in those who develop clinically significant infectious complications. | Prioritising patient care and safety | “Decrease mortality” |
| 12 | Monitoring microbiology cultures and sensitivities of patient specimens | Some strong beliefs that monitoring laboratory test results can guide PPE use. | Prioritising patient care and safety | “We are asked to look at test results to confirm infection and sometimes this encourages PPE wearing” |

For the second IBM construct of perceived norms and the subconstruct of injunctive norms (Table 3), analysis of the qualitative data revealed that nurses’ adherence to PPE was influenced by beliefs regarding the expectations other colleagues held about PPE use. Some nurses found that senior head nurses, who were regularly engaged in counting stocks, expected PPE to be conserved and secure within storerooms, which meant that usage of PPE stocks (although driven by guidelines’ adherence) was perceived to be bad practice. In addition, nurse managers expected nurses to complete paperwork in a timely and efficient manner, which placed undue time pressure upon nurses and restricted the time for in-person
care and in turn, regular compliance with PPE recommendations. However, other nurses – those who were minimally experienced, found that senior nurses acted as role models who expected them to use PPE appropriately, which ultimately, optimised use towards desirable compliance with guidelines.

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Details</th>
<th>Theme</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Adhere to PPE recommendations at all times</td>
<td>Prioritising patient care and safety</td>
<td>“We can’t change or remove the PPE as there is low stock”</td>
</tr>
<tr>
<td></td>
<td>Senior nurses acting as role models for less experienced nurses using critically unwell patients with nosocomial infections to demonstrate the importance of PPE adherence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Conserve PPE</td>
<td>Non-patient-oriented goals</td>
<td>“Usually in closed place and key with the head nurse who only give us one [piece of PPE]”</td>
</tr>
<tr>
<td></td>
<td>Head nurse seeking to ensure sufficient PPE available within storeroom and restricting access by storing in a locked room. Others counting supplies and questioning the use of PPE by nurses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Focus on completing paperwork</td>
<td>Non-patient-oriented goals</td>
<td>“Too much paperwork”</td>
</tr>
<tr>
<td></td>
<td>Some managerial staff advocating nurses to complete paperwork regarding PPE and failing to monitor actual practice.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Content analysis of nurses perceived injunctive norms concerning the factors influencing PPE adherence.
For the second subconstruct of descriptive norms (Table 4), analysis of the data revealed that many nurses’ behaviours regarding PPE use were influenced by beliefs regarding others’ behaviours towards PPE usage. For example, several nurses believed that infection control staff and other senior nursing staff would be monitoring and would prompt them should they not comply with PPE recommendations. However, some nurses found that medical staff, such as doctors, did not comply with infection prevention measures, and monitoring of PPE compliance was insufficient to stimulate nurses to engage in proper practices to prevent the transmission of infectious pathogens. In addition, many nurses found that insufficient adherence to PPE recommendations did not always result in actions to improve practice and even when concerns about patient safety were expressed, few actions at the department and organisation level were taken to address this important problem.

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Number</th>
<th>Details</th>
<th>Theme</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>16</td>
<td>Utilise PPE in accordance with local and national guidelines</td>
<td>Prompts to utilise PPE arising from infection control staff, managers, and head nurses.</td>
<td>Prioritising patient care and safety</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>Intermittency of PPE compliance monitoring</td>
<td>Role of infection control department to monitor adherence to PPE recommendations but this occurred infrequently.</td>
<td>System or departmental level issues</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>Poor reactivity to suboptimal PPE adherence</td>
<td>Education and training regarding PPE compliance only addressed when significant clinical events arise.</td>
<td>System or departmental level issues</td>
</tr>
<tr>
<td></td>
<td>Poor advocation of infection prevention and control measures</td>
<td>Some doctors failing to comply with hand washing, PPE use and other infection control policies, and thus, acting as a poor role model for nurses</td>
<td>Influence of role models</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Some nurses expressed concerns about patient safety related to PPE issues, but these were not acted upon.</td>
<td>“I have seen doctors who don’t wash hands and don’t wear gloves or wear the same gloves for different patients.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Failures to recognise, acknowledge and address nurses concerns about patient safety</td>
<td>System or departmental level issues</td>
<td>“I am worried about patients, but my views are not listened to.”</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Content analysis of nurses perceived descriptive norms concerning the factors influencing PPE adherence.

For the third and final IBM construct of personal agency and the first subconstruct of perceived behavioural control (Table 5), the qualitative data revealed that nurses felt that they could or had control of decisions and behaviour to utilise PPE to protect patients and others from infectious disease. Such control arose from a strong sense of responsibility to protect patient and colleague safety, which acted as a promoter of PPE use. However, most nurses perceived that they had little control over situations that compromised PPE use, which included the onset of medical emergencies where immediate patient intervention and doctors’ directions negated PPE use. Moreover, limited stocks of PPE induced rationing or selective use, insufficient education about the donning and the local importance of PPE and suboptimal quality PPE induced perceptions that equipment was useless in preventing pathogen transmission. Furthermore, poor nurse staffing was found to induce time pressure and negated PPE use as other patient needs were perceived to be more important.
<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Details</th>
<th>Details</th>
<th>Theme</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Self-responsibility to recognise the need to utilise PPE</td>
<td>Most nurses recognised that it was their responsibility to ensure PPE was complied with to protect patient safety.</td>
<td>Prioritising patient care and safety</td>
<td>“I am responsible for using [PPE] as I am the nurse providing care”</td>
</tr>
<tr>
<td>22</td>
<td>Physicians influence over PPE use</td>
<td>Some doctors advocating that there are more imminent clinical needs to negate PPE use, such as emergencies.</td>
<td>Prioritising patient care and safety</td>
<td>“Doctors shout when emergency and I tried to wear PPE”</td>
</tr>
<tr>
<td>23</td>
<td>Affected by poor PPE availability or limited supplies</td>
<td>Resulting from low PPE stock or poor distribution of PPE across wards and departments due to the decisions of the nurse manager and warehouse manager.</td>
<td>System or departmental level issues</td>
<td>“There are managers and other staff, but they don’t know what and how much we need”</td>
</tr>
<tr>
<td>24</td>
<td>Insufficient education</td>
<td>Lack of regular and up-to-date training on how to don all types of PPE correctly, the importance of PPE compliance and its benefits upon patient care and outcomes.</td>
<td>System or departmental level issues</td>
<td>“It is too infrequent, sometimes yes, but not always the topic of infection prevention”</td>
</tr>
<tr>
<td>25</td>
<td>Insufficient nurse staffing and a high proportion of</td>
<td>Low numbers of nurses limiting the time to provide care for</td>
<td>System or departmental level issues</td>
<td>“We have low staff and many patients, there is”</td>
</tr>
</tbody>
</table>
Table 5. Content analysis of nurses perceived behavioural control concerning the factors influencing PPE adherence.

For the second subconstruct of efficacy beliefs, the qualitative data revealed that nurses had variable degrees of self-efficacy in utilising PPE, which ultimately influenced adherence to infection prevention and control guidelines (Table 6). In one regard, nurses found that the majority of PPE was simple and easy to do, and they had received basic training in the past, which promoted the use of guidelines to protect patient safety. However, most nurses reported efficacy beliefs that compounded the use of PPE. For example, whilst all nurses had received basic education and training in PPE use, such information was outdated and ongoing education and training were lacking, which prevented adherence to the most recent infection prevention guidelines. Other factors compounding nurses’ self-efficacy in using PPE comprised: the experience of allergies to PPE, patients/relatives’ misconceptions regarding infectious status, insufficient knowledge about the specific routes or modes of infection, impaired tactile and sensory ability when providing care, the experience of getting the blame for using PPE stocks or using PPE incorrectly and non-specific infection prevention and control guidelines that created confusion in PPE use. The survey constructed using the findings of the content analysis is provided in Appendix 2. By IBM survey recommendations, a

| 26  | Poor quality PPE | Some nurses reported that the PPE was poor quality, and this affected their desire to use it and when worn, the safety of themselves and patients | System or departmental level issues | “Some nurses found problems with PPE; it is not suitable for use” |

| poorly trained/competent nurses | patients with essential needs often taking precedence over using PPE. In addition, poorly trained nurses in PPE use placed additional demand upon trained senior nurses. | not enough time on most days” |
bipolar 7-point scale was used to help gauge respondents’ responses or reactions to scenarios or questions based on each code identified in the content analysis (Miniard and Cohen, 1981).

<table>
<thead>
<tr>
<th>Code Number</th>
<th>Code Details</th>
<th>Theme</th>
<th>Direct Quotation Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Simple to use PPE correctly</td>
<td>Prioritising patient care and safety</td>
<td>&quot;Simple and easy to wear&quot;</td>
</tr>
<tr>
<td>28</td>
<td>Presence of education and training on how to utilise and dispose of PPE</td>
<td>Deficits in education and training</td>
<td>&quot;It is important to keep up-to-date but how and when is a problem&quot;</td>
</tr>
<tr>
<td>29</td>
<td>Attenuated by perceptions related to the stigma of infectious disease</td>
<td>Patient factors</td>
<td>&quot;Some patients angry that we wear PPE as they report not having a problem that can be transmitted&quot;</td>
</tr>
<tr>
<td>30</td>
<td>Allergic reactions to PPE</td>
<td>System or departmental level issues</td>
<td>&quot;One nurse had a bad allergic reaction to PPE&quot;</td>
</tr>
<tr>
<td>31</td>
<td>Lack of knowledge regarding infectious disease routes of transmission</td>
<td>Insufficient knowledge of the induction program for nurses regarding routes of infection transmission, which conferred uncertainty on what PPE to utilise.</td>
<td>Deficits in education and training</td>
</tr>
<tr>
<td>32</td>
<td>Restricted tactile and sensation when providing care</td>
<td>Some nurses recognised that PPE was restrictive of movement and sensation that affected some aspects of patient care.</td>
<td>System or departmental level issues</td>
</tr>
<tr>
<td>33</td>
<td>Blame-free environment</td>
<td>Some nurses found that they were often blamed for over-using PPE or for not using it correctly.</td>
<td>Cultures that fail to advocate best infection prevention and control practices</td>
</tr>
<tr>
<td>34</td>
<td>Ambiguous and non-specific PPE policies/guidelines</td>
<td>Local guidelines were not specific for certain patient groups or the type of infection and this affected compliance.</td>
<td>System or departmental level issues</td>
</tr>
</tbody>
</table>

Table 6. Indirect Measures: Control Beliefs/Efficacy Beliefs.
5.2 Instrument Development

The survey was constructed using the findings of the content analysis which is provided in Appendix 2. By IBM survey recommendations, a bipolar 7-point scale was used to help gauge respondents’ responses or reactions to scenarios or questions based on each code identified in the content analysis (Miniard and Cohen, 1981).

In effect, the modal salient beliefs related to the use of PPE and adherence to PPE recommendations among nurse respondents identified within the qualitative interviews were used to inform the focus and direction of questions that enquired about PPE use within the quantitative instrument. In addition, the qualitative elicitation phase was based on four key sources of information that can be sought from respondents regarding behaviour (Montano and Kasprzyk, 2015)

● Positive and negative feelings regarding the conduct of the behaviour (experiential attitudes and effect)

● Positive and negative outcomes of conducting a said behaviour (behavioural beliefs)

● Persons or groups of persons who favour or poorly favour the said behaviour (normative referents)

● Situational factors that promote or hinder the said behaviour and which make the behaviour easier or more difficult to conduct (control beliefs and self-efficacy)

Based on the four former types of qualitative question responses, the direct and indirect measures of nurses’ instrumental and experiential attitudes, injunctive norms, perceived controls and self-efficacy (Figure 5) were identified from the accounts of each subject and translated into survey questions using 7-point bipolar scales (Miniard and Cohen, 1981). In this regard, direct measures referred to respondents’ affective evaluations of behaviour concerning PPE use, whilst indirect measures focus on respondents’ beliefs regarding the said behaviour (Dai et al., 2018). Using this notion, the direct measures employed for the quantitative survey comprised: respondents’ attitudes, subjective norms, perceived control, and intentions, whilst the indirect measures included respondents’ behavioural beliefs regarding PPE use and its outcome evaluation, as well as beliefs regarding control or power over utilising PPE and normative beliefs. Following the calculation of the survey’s internal validity and reliability, as noted in subsection 7.2 & 7.3 all nurse respondents were invited to complete the survey online, which was distributed via email by the research administrator.
To demonstrate the process of survey item development from the qualitative data, a series of examples were projected as detailed below in Tables 7-9.

### Table 7. Descriptive Norms

<table>
<thead>
<tr>
<th>Item</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1 Quotation</td>
<td>“They [doctors] never wear it and touch all patients with the same gloves”</td>
</tr>
<tr>
<td>Code A</td>
<td>The poor advocation of infection prevention and control measures by others</td>
</tr>
<tr>
<td>Theme 1</td>
<td>Influence of Role Models</td>
</tr>
<tr>
<td>Survey Item Scale</td>
<td>How supportive are doctors of you wearing PPE?</td>
</tr>
<tr>
<td></td>
<td>Not supportive: 1__2__3__4__5__6__7__: Completely supportive</td>
</tr>
</tbody>
</table>

### Table 7. Descriptive Norms

<table>
<thead>
<tr>
<th>Item</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 2 Quotation</td>
<td>“Failure to follow [infection prevention and control guidelines] means spread of infection to both the practitioner and the patient so the harm is greater”</td>
</tr>
<tr>
<td>Code B</td>
<td>Protecting patients and staff from infections</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Theme 2</td>
<td>Prioritising patient care and safety</td>
</tr>
<tr>
<td>Survey Item 2 (Behavioural beliefs)</td>
<td>Following the PPE policy protects me, patients, staff and other persons from infectious disease</td>
</tr>
<tr>
<td>Survey Item Scale</td>
<td>Strongly disagree: 1 2 3 4 5 6 7: Strongly agree</td>
</tr>
</tbody>
</table>

Table 8. Behavioural beliefs

<table>
<thead>
<tr>
<th>Item</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 3 Quotation</td>
<td>“Not regular [education in infection prevention measures], just from time to time, same lectures how to wear and how to remove but any infection breakdown the nurses are responsible”</td>
</tr>
<tr>
<td>Code C</td>
<td>Protecting patients and staff from infections</td>
</tr>
<tr>
<td>Theme 2</td>
<td>Prioritising patient care and safety</td>
</tr>
<tr>
<td>Survey Item 3 (Control beliefs)</td>
<td>Insufficient nurse education about the clinical importance of PPE (impact upon outcomes) makes it difficult to comply with PPE policy</td>
</tr>
<tr>
<td>Survey Item Scale</td>
<td>Strongly disagree: 1 2 3 4 5 6 7: Strongly agree</td>
</tr>
</tbody>
</table>

Table 9. Control Beliefs.
Chapter 6. Quantitative Main Survey Methods

6.1 Respondents Recruitment

Nurses working across the two hospital settings in an area of Saudi Arabia were recruited randomly using a computer-based random number generator as this sampling technique can generate representative samples of respondents and research with a minimal risk of selection bias (Martinez-Mesa et al., 2016). Specifically, nurse managers were contacted to provide the work emails of resident nurses, and these were incorporated into a database and numbered to permit random sampling. The random number generator selected a number and this coincided with a nurse’s work email address, to which an invitation was sent, for the nurse to participate in the research study. A research administrator composited the emails of randomly selected nurses for the investigator to distribute invitations and consent forms. Confidentiality was assured by sole use of the internal email system at the hospital site. The responses were recorded without any identifiable information. A password protected computer was used to store and analyse the data. The researcher never published any personal information of the respondents. All communications were conducted in English.

6.2 Sample Size Calculation

A formal calculation of sample size and power was undertaken (Banerjee et al., 2009). Based on a total nursing population within the two hospitals of 990 (540 from centre one and 450 from centre two), the sample size to detect a change in effect size of 0.2 for a standard alpha threshold of 0.05 and a power >0.80 was 277 nurses. A 0.2-point change in effect size was deemed sufficiently sensitive enough to discriminate responses on the 7-point scales used within the quantitative survey as further described in the following subsection (Appendix 2). The power calculation was generated using G*Power v.3.1 software (HHU, Dusseldorf, Germany) and this was based upon Chi-squared analysis – the main inferential statistical test used to derive the independence of predictor variables in respect of the dependent variables.

6.3 Participants’ Characteristics

A total of 279 of 289 respondents accepting to participate completed the quantitative survey instrument in complete form with no missing data, which yielded a response rate of 96.5%. Reasons for non-completion or incomplete data were not clear but could have involved lack of receipt of survey invitation, lack of desire to participate in the research after consenting to partake, inability to re-access the survey and/or lack of time to complete the survey in full. A
summary of the characteristics has been provided in Table 10. The distribution of ages (Figure 6) among the cohort of nurses was dominated by those of 26-30 years (36.9%) and
31-35 years (34.4%). There was an unequal balance of subjects regarding gender with 82.4%
of the cohort being female and only 17.6% being male. The ethnicity of nurse respondents
was minimally diverse with Indian nurses comprising the major ethnic group (40.9%) (Figure
7). The educational attainment of respondents was dominated by the nursing bachelor’s
degree (86.7%), followed by diplomas (9.7%) and master’s degree (3.6%).

The majority of nurses had more than five years of experience. Specifically, 17.2% of nurses
had 1-5 years of practice exposure, whilst 48.0% had 6-10 years of experience and 34.8%
had more than 10 years of experience. The area/department of clinical practice nurses were
operating within at the time of survey completion varied with a diverse range of specialties
being reported (Figure 8). The majority of nurses were working in general medical wards
(19.4%) and surgical wards (15.1%), and notably, 10.8% were nursing supervisors and thus,
had no specifically assigned area of practice as they managed nurses working across multiple
areas.
Figure 8. Practice area of nurse subjects

<table>
<thead>
<tr>
<th>Age</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25 years</td>
<td>10</td>
<td>3.6</td>
</tr>
<tr>
<td>26-30 years</td>
<td>103</td>
<td>36.9</td>
</tr>
<tr>
<td>31-35 years</td>
<td>96</td>
<td>34.4</td>
</tr>
<tr>
<td>36-40 years</td>
<td>29</td>
<td>10.4</td>
</tr>
<tr>
<td>&gt;40 years</td>
<td>41</td>
<td>14.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>230</td>
<td>82.4</td>
</tr>
<tr>
<td>Male</td>
<td>49</td>
<td>17.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian</td>
<td>114</td>
<td>40.9</td>
</tr>
<tr>
<td>Saudi</td>
<td>96</td>
<td>34.4</td>
</tr>
<tr>
<td>Filipino</td>
<td>64</td>
<td>22.9</td>
</tr>
<tr>
<td>Egyptian</td>
<td>5</td>
<td>1.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor’s degree</td>
<td>242</td>
<td>86.7</td>
</tr>
<tr>
<td>Master’s degree</td>
<td>10</td>
<td>3.6</td>
</tr>
<tr>
<td>Diploma</td>
<td>27</td>
<td>9.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practice Experience</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 years</td>
<td>48</td>
<td>17.2</td>
</tr>
<tr>
<td>6-10 years</td>
<td>134</td>
<td>48.0</td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>97</td>
<td>34.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area of Practice</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical wards</td>
<td>54</td>
<td>19.4</td>
</tr>
<tr>
<td>-----------------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Surgical wards</td>
<td>42</td>
<td>15.1</td>
</tr>
<tr>
<td>General ICU</td>
<td>36</td>
<td>12.9</td>
</tr>
<tr>
<td>Emergency</td>
<td>31</td>
<td>11.1</td>
</tr>
<tr>
<td>Neonatal ICU</td>
<td>19</td>
<td>6.8</td>
</tr>
<tr>
<td>Operating Rooms</td>
<td>18</td>
<td>6.5</td>
</tr>
<tr>
<td>Cardiac wards</td>
<td>14</td>
<td>5.0</td>
</tr>
<tr>
<td>Burns unit</td>
<td>11</td>
<td>3.9</td>
</tr>
<tr>
<td>Cardiac ICU</td>
<td>8</td>
<td>2.9</td>
</tr>
<tr>
<td>Isolation wards</td>
<td>6</td>
<td>2.2</td>
</tr>
<tr>
<td>Day units</td>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td>Outpatient</td>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>Maternity ward</td>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>Not specified</td>
<td>30</td>
<td>10.8</td>
</tr>
</tbody>
</table>

Table 10. Subject characteristics (n=279)

### 6.4 Data Analysis Plan

The survey data were analysed using several descriptive and inferential statistical tests with IBM SPSS Statistics Software v.25 (2016). A significance (alpha) threshold of 0.05 was used to determine statistical significance as this is the usually accepted threshold to ascertain meaningful differences between groups (Banerjee et al., 2009). Descriptive statistics included means, ranges, and frequencies, whilst inferential tests comprised multiple and logistic regression. Logistic regression was used to assess the relationship between the IBM constructs and nurses’ intentions to desirably comply with PPE guidelines (scoring 6-7/7 on intention responses), which was dichotomised for statistical purposes (Appendix 6). Multiple regression analysis was used to ascertain the variables predictive of nurses’ intentions to comply with PPE guidelines when desirable compliance was not dichotomised (Burkner and Vuorre, 2019).

Notably, ordinal regression analysis also assumes that there is no multi-collinearity among the independent variables as this can otherwise lead to misinformed information regarding which factors influence or predict the outcome variable. Therefore, the collinearity of the independent variables was ascertained using linear regression analysis with collinearity.
diagnostics, which included the tolerance and variance inflation factor statistics. In addition, ordinal regression assumes that there are proportional odds of the independent variables with each expected to have an identical impact on the dependent variable. The proportional odds were, therefore, tested using the full likelihood ratio test and where violations existed, a separate binomial logistic regression analysis was performed (Burkner and Vuorre, 2019). The validity and reliability tests for the quantitative survey are detailed in subsection (7.2 & 7.3).

6.5 Validity in the Quantitative Data

The survey instrument was reviewed by the investigator’s supervisors to attain a degree of face and content validity (Truijens et al., 2019). Face and content validity was also ascertained by an expert nurse with a specialist interest in infection prevention, whilst construct validation was mediated by seeking review from three of the investigator’s supervisors with expertise in nursing and psychology who sought to assess the congruence of the survey items with each of the core constructs and subconstructs of the IBM (Kumar, 2015). The validity of the instrument was measured to determine whether the questions in IBM construct groups and the overall survey provided consistent and stable results over time among respondents known as test-retest reliability and internal consistency (Tavakol and Dennick, 2011). Test-retest reliability was determined by performing an intraclass correlation coefficient and this provided insight into the accuracy of agreement between survey measures between two-time points (Appendix 7). Internal consistency was evaluated by calculating Cronbach’s alpha. The extent of reliability using intraclass correlation coefficient and Cronbach alpha testing was as follows: >=0.9 very high reliability, 0.7-0.89 high reliability, 0.5-0.69 moderate reliability and <0.5 low reliability (Tavakol and Dennick, 2011). Concerning the overall survey development and the measures of validity and reliability formerly noted, any items with poor or high inter-item correlations were considered for removal (R<0.3 or R>0.7), as were those with a suboptimal Cronbach alpha (<0.70), which are instrument development decisions recommended by Kumar (2015). In addition, any items that were not completed inferred that the question or statement lacked clarity and thus, these were also removed from the final survey (Kumar, 2015). However, all items that were deemed to have context, construct, or theoretical relevance to address the research question were retained independently of whether they observed suboptimal inter-item correlation or internal consistency (Kumar, 2015).
Chapter 7. Quantitative Survey Results

7.1 Tests of Normality

Tests of normality were employed to ascertain whether the survey data fitted normal Gaussian-like distribution. Shapiro-Wilk testing revealed that all IBM construct groups (e.g., norms, attitudes) had a distribution that did not significantly deviate from a normal Gaussian-type pattern (all p>0.05) (See Appendix 3). The normal distribution of the data was further supported by minimal skewness and kurtosis with the majority of individual values falling within +/- 1.0 (Appendix 3), although moderate skewness and kurtosis were observed for intention (-1.526 and 1.998, respectively) and behavioural beliefs and outcome evaluation (-1.728 and 3.763, respectively).

Multicollinearity testing was also performed using tolerance and variance inflation factor (VIF) analyses to determine the degree of linearity among the independent variables and the impact of collinearity on the predictor variables (Appendix 4). Most statisticians accept that VIFs of 10 or as low as four are reflective of tolerance levels of 0.10 and 0.25, which provide sufficient certainty regarding excess multi-collinearity (Kim, 2019; O'Brien, 2007). At such VIFs and tolerance levels, authors suggest that researchers should exclude one or more variables from statistical analyses, to avoid issues of collinearity (O'Brien, 2007). However, modern definitions accept that multi-collinearity only tends to exist when the VIF is greater than 5 or 10 and/or when the tolerance is less than 0.1-0.2 (Kim, 2019). Therefore, as all tolerance values were well above the threshold of 0.2 (range 0.369-0.910) and all VIF values were below the threshold of 5 (range 1.09-2.52), there was high certainty that there was no meaningful multicollinearity among the data.

7.2 Pilot Survey and Validity Testing

A total sample of 43 nurses completed the quantitative pilot survey as part of an interim evaluation of the data to permit assessment of internal consistency and test re-test reliability. For internal consistency, the independent variable of nurses’ attitudes (individuals’ positive or negative evaluation of self-performance of a behaviour) and the independent variable of behavioural beliefs (beliefs about the positive and negative consequences of a behaviour) and outcome evaluation (perceptions of other evaluations of behavioural consequences) based on 15 survey items, the Cronbach alpha was 0.85, which is indicative of high internal consistency. For the independent variable of nurses’ subjective norms (perceptions whether other persons approve or disapprove of a behaviour) and the independent variable of
normative beliefs (perceptions about behaviours that are judged by significant others) and motivation to comply (motivation to comply with the expectations of salient referents) based on 23 survey items, the Cronbach alpha was 0.83, which is also indicative of high internal consistency. For the final independent variable of nurses perceived behavioural control (perceive ease or difficulty in performing a behaviour) and the independent variable of control beliefs (beliefs about factors that facilitate or hinder a behaviour; often linked to self-efficacy) and control belief power (beliefs about power over factors that hinder or facilitate a behaviour) based on 24 survey items, the Cronbach alpha was 0.83, which is indicative of high internal consistency. For the complete data set of former dependent and independent variables combined, the Cronbach alpha was 0.92, which is indicative of very high internal consistency.

7.3 Test-Retest Reliability

A pilot survey was distributed to 43 nurses where the survey was completed and re-completed by the same participating respondents after 7-days. Following a review of the pilot instrument and any revisions to the final survey, the instrument was emailed to eligible and randomly selected nurses for self-completion in electronic format. All respondents were requested to complete the surveys independently and at a convenient time when they could concentrate and be free from distractions, which was important to gather sufficient information regarding the factors influencing compliance with PPE guidelines. The survey was completed online and electronically using the Qualtrics® platform. Respondents were informed that they could either complete the survey in full or save partly completed responses for completion at a later point. For respondents who were yet to access or had only partly completed the survey, reminder emails were sent every two weeks, to optimise the response and completion rates.

For test-retest reliability, the independent variable of nurses’ attitudes, the six items were combined, and the responses averaged to form one index criterion. In addition, the ratings were reverse coded such that higher scores on all items reflected more positive/desirable attitudes of nurses, whilst lower scores reflected more negative/undesirable attitudes towards PPE use. This coding method was used for all other indices. The attitude index was found to have a mean of 5.2 (+/- 2.1) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.63 and the test-retest reliability (intraclass coefficient; ICC) was 0.63 (95% CI 0.44, 0.77, F (42, 462) = 2.69, p=0.000). For the independent variable of behavioural beliefs and outcome evaluations based on nine survey items, the index had a mean of 5.9 (+/- 1.4) and
ranged between 1.0 and 7.0. The Cronbach alpha was 0.92 and the test-retest reliability (ICC) was 0.94 (95% CI 0.91, 0.97, F (42, 714) = 17.61, p=0.000). For the independent variable of nurses’ subjective norms based on six survey items, the index had a mean of 5.3 (+/- 1.7) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.94 and the test-retest reliability (ICC) was 0.94 (95% CI 0.91, 0.96, F (42, 462) = 17.07, p=0.000). For the independent variable of normative beliefs and motivation to comply based on 17 survey items, the index had a mean of 5.2 (+/- 1.5) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.87 and the test-retest reliability (ICC) was 0.87 (95% CI 0.80, 0.92, F (42, 1386) = 7.57, p=0.000). For the independent variable of nurses perceived behavioural control based on five survey items, the index had a mean of 3.5 (+/- 1.9) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.82 and the test-retest reliability (ICC) was 0.82 (95% CI 0.72, 0.88, F (42, 378) = 5.42, p=0.000). For the final independent variable of control beliefs and control belief power based on 19 survey items, the index had a mean of 4.7 (+/- 2.0) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.88 and the test-retest reliability (ICC) was 0.88 (95% CI 0.82, 0.93, F (42, 1554) = 8.31, p=0.000). Finally, the dependent variable of nurses’ intentions to comply with PPE guidelines based on three survey items, the index had a mean of 5.9 (+/-1.4) and ranged between 1.0 and 7.0. The Cronbach alpha was 0.84 and the test-retest reliability (ICC) was 0.92 (95% CI 0.88, 0.95, F (42, 210) = 12.67, p=0.000. Based on the pilot survey results, the final survey was expected to take 30 minutes to complete.

7.4 Survey Results
Nurses (n=106, 38%) who reported that they would be completely (100%) compliant with PPE guidelines throughout their ongoing practice were analysed descriptively to permit comparison against the sociodemographic characteristics of those who reported that they would not be 100% compliant (n=172, 62%) (Table 11).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Compliant Nurses</th>
<th>Less Compliant Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>106</td>
<td>172</td>
</tr>
<tr>
<td>Dominant age group (%)</td>
<td>31-35 years (34)</td>
<td>26-30 years (40.7)</td>
</tr>
<tr>
<td>Gender</td>
<td>Female (84.9)</td>
<td>Female (80.8)</td>
</tr>
<tr>
<td>Dominant nationality (%)</td>
<td>Indian (39.6)</td>
<td>Indian (41.3)</td>
</tr>
<tr>
<td>Dominant practice experience (%)</td>
<td>6-10 years (44.3)</td>
<td>6-10 years (50.0)</td>
</tr>
<tr>
<td>Dominant educational attainment</td>
<td>Bachelor (85.8)</td>
<td>Bachelor (87.2)</td>
</tr>
<tr>
<td>Dominant practice area (%)</td>
<td>Medical ward (21.7)</td>
<td>Surgical ward (18.0)</td>
</tr>
</tbody>
</table>

Table 11. Proportions of fully compliant versus less compliant nurses by sociodemographic characteristics.
7.4.1 Dependent Variable: Intentions to comply with PPE policy

Regarding intentions to comply with PPE guidelines (a composite of three survey items with a range of 1 to 7), the median score was 6.7 (IQR 5.67 - 7), alpha 0.88 with 53.4-56.6% of nurses reporting strong intentions to comply (item ratings = 7). Item level variances are shown in Figures 9 and 10. These items show that most nurses intended to be completely compliant with PPE guidelines in their future practice, although a high proportion intended to be less than completely compliant with PPE guidelines.

Figure 9. Variance in intentions to comply with PPE guidelines item scores.

Figure 10. Variance in intentions item to comply with PPE guidelines scores, compliant versus less compliant nurses.

7.4.2 Independent Variable: Attitudes

Regarding nurses’ attitudes concerning adherence to PPE policy (composite of six survey items with a range of 1 to 7), the collective median score was 6.0 (IQR 5.2- 6.6), alpha 0.73 (following exclusion of one item that provided an alpha of 0.52). Item level variance is shown
in Figure 11. The data shows that nurses largely hold positive evaluations of the utility of PPE in protecting patients from harm due to infectious disease.

![Image](image_url)

**Figure 11. Variance in attitude regarding adherence to PPE policy item scores.**

### 7.4.3 Direct Measures: Subjective Norms (Independent Variable)

Subjective norms were a composite of six survey items with a range of 1 to 7, which revealed a collective median score of 6.0 (IQR 4.67- 6.67), alpha 0.93. Item level variance is shown in Figure 12. These items revealed that significant others, such as patients, visitors, managers, and factors, impart influence over nurses’ PPE use behaviours in a direction favouring use in relation to expected PPE compliance.

![Image](image_url)

**Figure 12. Variance in subjective norms influencing PPE adherence item scores.**

### 7.4.4 Direct Measures: Perceived Behavioural Control (Independent Variable)

Perceived behavioural control was a composite of five survey items with a range of 1 to 7, which revealed a collective median score of 3.25 (IQR 2.25- 4.75), alpha 0.77 following the removal of one item (confidence in adherence to PPE) that provided an alpha of 0.68. Item level variance is shown in Figure 13, which shows that most nurses demonstrate proactivity and wanted to utilise PPE which may deviate from stringent guidelines due to perceived difficulty related to the judgement and influence of others upon nurses’ own PPE behaviours.
7.4.5 Indirect Measures: Behavioural Beliefs and Outcome Evaluation (Independent Variable)

Behavioural beliefs and outcome evaluation comprised a composite of nine survey items with a range of 1 to 7, which yielded a median score of 6.33 (IQR 5.67- 6.89), alpha 0.92. Item level variance is shown in Figure 14. These items revealed that nurses held strong motivating factors for adhering to PPE guidelines; mostly due to the overarching value of PPE in maintaining patient safety and the safety of others through mitigating the risk of infectious disease.

7.4.6 Indirect Measures: Control Beliefs and Control Belief Power (Independent Variable)

Control beliefs and control belief power comprised a composite of 21 survey items (range 1 to 7), which provided a median of 5.33 (IQR 4.43- 5.93), alpha 0.91 (following the inclusion of two items [allergy and PPE use and training and education upon PPE use] that provided a previous alpha of 0.90). Item level variance is shown in Figure 15. These items ultimately show that most nurses observe limited control and power over various factors that hinder PPE use. These factors ranged from frontline elements, such as requirements to complete paperwork that hinder time spent in frontline practice and place time pressure upon completing duties of care and likely hindering PPE use, to organisational level factors including cultures aversive to the prevention of infectious disease, which falls outside of the control and influence of frontline nurses.
7.4.7 Indirect Measures: Normative Beliefs and Motivations to Comply (Independent Variable)

Normative beliefs and motivations to comply were a composite of 15 survey items (range 1 to 7), which yielded a collective median of 4.27 (IQR 3.73- 5.13), alpha 0.83 (following the exclusion of two survey items [allergy and PPE use and education and training upon PPE use] that yielded an alpha of 0.79). Item level variance is shown in Figure 16. These items show that nurses’ PPE behaviours tended to be minimally affected by perceptions of how other salient referents expected nurses to conduct care/comply with PPE guidelines. This is reflected in mixed agreement regarding the use of PPE during medical emergencies and in evaluations of laboratory test results, which was associated with greater agreement in using PPE.
## IBM Constructs and Survey Items

<table>
<thead>
<tr>
<th>IBM Constructs and Survey Items</th>
<th>Median</th>
<th>Interquartile range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitudes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPE policy and patient safety</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td><strong>PPE policy and patient harm</strong></td>
<td>1</td>
<td>1 - 4</td>
</tr>
<tr>
<td>PPE policy and patient recovery</td>
<td>7</td>
<td>5 - 7</td>
</tr>
<tr>
<td>PPE adherence difficulty</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td>PPE adherence comfortability</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td>PPE exposure effectiveness</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6</td>
<td>5.2 - 6.6</td>
</tr>
<tr>
<td><strong>Subjective Norms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other nurses’ expectations to comply with PPE</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Doctors’ expectations to comply with PPE</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Managers’ expectations to comply with PPE</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Other staff expectations to comply with PPE</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Patients’ expectations to comply with PPE</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Visitors’ expectations to comply with PPE</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6</td>
<td>4.67 - 6.67</td>
</tr>
<tr>
<td><strong>Perceived Behavioural Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Confidence in adherence to PPE</strong></td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>Access to PPE</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Personal decision to use PPE</td>
<td>2</td>
<td>1 - 5</td>
</tr>
<tr>
<td>Judgement to inform PPE use</td>
<td>2</td>
<td>1 - 6</td>
</tr>
<tr>
<td>Judgement of other staff to guide PPE use</td>
<td>2</td>
<td>1 - 5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>3.25</td>
<td>2.25 - 4.75</td>
</tr>
<tr>
<td><strong>Intentions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extent of intentions to comply with PPE</td>
<td>7</td>
<td>5 - 7</td>
</tr>
<tr>
<td>In proceeding months, intentions to comply</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>Determination to comply with PPE over proceeding months</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6.7</td>
<td>5.67 - 7</td>
</tr>
</tbody>
</table>

Table 12: Summary of survey scores for direct measures of the IBM constructs.

<table>
<thead>
<tr>
<th>IBM Constructs and Survey Items</th>
<th>Median</th>
<th>Interquartile range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Behavioural Beliefs &amp; Outcome Evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPE policy and protection from infection</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>PPE confidence in protection from infection</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>PPE lower infection rate</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>PPE will reduce length of stay</td>
<td>7</td>
<td>5 - 7</td>
</tr>
<tr>
<td>PPE reduce mortality</td>
<td>7</td>
<td>5 - 7</td>
</tr>
<tr>
<td>PPE and better nurse</td>
<td>6.5</td>
<td>5 - 7</td>
</tr>
<tr>
<td>PPE and perception of safety</td>
<td>7</td>
<td>6 - 7</td>
</tr>
<tr>
<td>PPE and patients’ perceptions of safety</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>PPE and portraying care for service user</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6.33</td>
<td>5.67 - 6.89</td>
</tr>
</tbody>
</table>

**Control Beliefs and Control Belief Power**

| Variance in PPE compliance | 5.5 | 4 - 7 |
| PPE use guided by nationality | 4 | 1 - 6 |
| Guilt regarding PPE use | 5 | 2 - 6 |
| Culture supportive PPE | 5 | 3 - 6 |
| Under appreciation | 6 | 4 - 7 |
| PPE use requires support from admin staff | 6 | 5 - 7 |
| PPE use requires support from doctors | 6 | 5 - 7 |
| PPE use requires support from nurse managers | 6 | 5 - 7 |
| PPE use requires blame free culture | 6 | 5 - 7 |
| Blame free culture improve PPE adherence | 6 | 5 - 7 |
| Negatively compound PPE use | 5 | 3 - 6 |
| PPE reduce racism | 5 | 2 - 6 |
| Poor availability of PPE impairs use | 6 | 5 - 7 |
| Poor quality of PPE impairs use | 6 | 5 - 7 |
| Poor manager reactivity to safety impedes PPE use | 6 | 5 - 7 |
| PPE use |  |  |
| Excess paperwork impedes PPE use | 6 | 4 - 7 |
| Guideline ambiguity impedes PPE use | 6 | 4 - 7 |
| Poor nurse staffing impedes PPE adherence | 6 | 4 - 7 |
| Lack of education impedes PPE use | 6 | 4 - 7 |
| **Allergies and PPE use** | 5 | 4 - 6 |
| **Training and education upon PPE use** | 6 | 4 - 7 |
| TOTAL | 5.33 | 4.43 - 5.93 |

**Normative Beliefs and Motivations to Comply**

<p>| Manager supportive of PPE use | 4 | 2 - 6 |
| Doctors supportive of PPE use | 4 | 2 - 6 |
| Other nurses supportive of PPE use | 4 | 3 - 6 |</p>
<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3 - 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory tests guiding PPE use</td>
<td>5</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Nurses as role models for PPE use</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Access to PPE stocks and patient safety</td>
<td>6</td>
<td>5 - 7</td>
</tr>
<tr>
<td>Short PPE stocks and patient safety</td>
<td>5</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Nursing practice complaint with PPE guideline</td>
<td>4</td>
<td>3 - 6</td>
</tr>
<tr>
<td>Other nurses practice complaint with PPE guideline</td>
<td>3</td>
<td>2 - 5</td>
</tr>
<tr>
<td>Monitoring of PPE adherence</td>
<td>3</td>
<td>2 - 5</td>
</tr>
<tr>
<td>Concerns about PPE addressed</td>
<td>4</td>
<td>3 - 5</td>
</tr>
<tr>
<td>Actions taken for patient safety regarding PPE</td>
<td>5</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Other staff responsibility for PPE adherence</td>
<td>6</td>
<td>4 - 7</td>
</tr>
<tr>
<td>Emergencies negate PPE use</td>
<td>5</td>
<td>2 - 6</td>
</tr>
<tr>
<td>Patients' reactions and PPE use</td>
<td>4</td>
<td>3 - 5</td>
</tr>
<tr>
<td>Allergies and PPE use</td>
<td>5</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Training and education upon PPE use</td>
<td>4.27</td>
<td>3.73 - 5.13</td>
</tr>
</tbody>
</table>

Table 13. Summary of survey scores for indirect measures of the IBM constructs.

7.5 Correlations and Regression
7.5.1 Correlations

Composited items for the variables of attitudes, subjective norms and perceived behavioural control were performed to permit correlations between the constructs and between the direct and indirect measures of said constructs. A summary of the correlation analysis is noted in Table 14. Overall, there was a significant and moderately strong correlation between nurses’ direct and indirect attitudes, with their intentions to comply with PPE guidelines. Other variables demonstrated weaker associations, such as subjective norms, and perceived behavioural control constructs with nurses’ intentions to comply with PPE guidelines. This pattern suggests that the factors influencing PPE use in nurses are multi-factorial and spanning across individuals’ positive and negative evaluations of adhering to PPE. Individuals’ perceptions of what significant others expect of PPE use and related adherence in nursing practice and the ease and difficulties in adhering to PPE guidelines when considering the various pressures and stressors of nursing practice were as expected. This
means that suboptimal adherence to PPE guidelines was not simply a product of nurses’ attitudes but influences outside of their direct control, such as working conditions and time pressures that often result from short staffing and excess demand-capacity gaps.

<table>
<thead>
<tr>
<th></th>
<th>Attitudes (direct)</th>
<th>Attitudes (indirect)</th>
<th>Subjective norms (direct)</th>
<th>Subjective norms (indirect)</th>
<th>PBC (direct)</th>
<th>PBC (indirect)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes (direct)</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes (indirect)</td>
<td>0.659*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjective norms (direct)</td>
<td>0.453*</td>
<td>0.572*</td>
<td>-</td>
<td></td>
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<td></td>
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<tr>
<td>Subjective norms (indirect)</td>
<td>0.292*</td>
<td>0.316*</td>
<td>0.186*</td>
<td>-</td>
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<td></td>
</tr>
<tr>
<td>PBC (direct)</td>
<td>0.018</td>
<td>-0.005</td>
<td>-0.010</td>
<td>-0.062</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>PBC (indirect)</td>
<td>0.234**</td>
<td>0.369**</td>
<td>0.284**</td>
<td>-0.167**</td>
<td>0.159**</td>
<td>-</td>
</tr>
</tbody>
</table>

**p<0.05
Table 14. Summary of Pearson correlation analysis for IBM constructs direct and indirect measures.

7.5.2 Multiple Regression
7.5.2.1. Model 1: Direct and indirect attitude vs intention

The regression model summary (Figure 17) for the first model depicts that R is 0.763, R-square is 0.581 and adjusted R-square is 0.578. So, at least 58.1% change in “intention” can be defined by the changes in “direct attitude” and “indirect attitude”. The ANOVA table depicts that the F value is 191.037, with a significance score of 0.000. The model is statistically significant with attitudes accounting for most of the variance in nurses’ intentions to comply with PPE guidelines. The R value (0.763) is high, and thus, suggesting that attitudes are strongly associated with intentions to comply with PPE guidelines. The coefficient in Figure 17 depicts that the standardised coefficient (beta) for direct attitude is 0.266, with a significance score of 0.000 and the beta for indirect attitude is 0.561 with a significance score of 0.000. So, the 26.6% positive change in intention can be defined by the change in direct attitude and the 56.1% positive change in intention can be defined by the change in indirect attitude and both the statements are statistically significant. This shows that positive attitudes influence positive views regarding intentions to comply with PPE.
The results of this model also indicate that the selected sample size represents the population very well. Collinearity Statistics depict that the independent variables are not statistically correlated with each other.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>F value</th>
<th>P (Significance Level)</th>
<th>Standardised Coefficients (Beta)</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct at iitude</td>
<td>.581</td>
<td>.578</td>
<td>191.037</td>
<td>.000</td>
<td>.266</td>
<td>5.122</td>
<td>.000</td>
<td>.177</td>
<td>.397</td>
</tr>
<tr>
<td>Indirect attitude</td>
<td>.561</td>
<td>10.808</td>
<td>.000</td>
<td>.516</td>
<td>.745</td>
<td>.017</td>
<td>.565</td>
<td>1.769</td>
<td></td>
</tr>
</tbody>
</table>

Dependent Variable: Intention (alpha 0.88)

* Statistically significant

Figure 17: Regression Summary-Model 1
Source: Primary Survey

7.5.2.2. Model 2: Direct & indirect subjective norms vs intention

The regression model summary (Figure 18) for the second model depicts that R is 0.576, R square is 0.332 and adjusted R-square is 0.327. So, at least 33.2% change in “intention” can be defined by the change in “direct subjective norms” and “indirect subjective norms”. The ANOVA table depicts that the F value is 68.299 -with a significance score of 0.000. So, the overall model is statistically significant with a moderate to strong associations observed. The coefficient in figure 18 shows that the beta for direct subjective norms is 0.541 with a significance score of 0.000 and the beta for indirect subjective norms is 0.121 with a significance score of 0.017. It can be stated here that a 54.1% positive change in intention can be defined by the change in direct subjective norms and a 12.1% positive change in intention can be defined by the change in indirect subjective norms and both the statements are statistically significant. Thus, positive subjective norms were associated with stronger intentions to comply with PPE guidelines. The results of this model also indicate that the selected sample size represents the population very well. Collinearity Statistics depict that the independent variables are not statistically correlated with each other.
### Table 1

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>F value</th>
<th>P-value</th>
<th>Standardised Coefficients (Beta)</th>
<th>t</th>
<th>Sig.</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Subjective Norms (alpha .928)</strong></td>
<td>.332*</td>
<td>.327*</td>
<td>68.299</td>
<td>.000</td>
<td>.541*</td>
<td>10.788</td>
<td>.000</td>
<td>.368</td>
</tr>
<tr>
<td><strong>Indirect Subjective Norms (alpha .832)</strong></td>
<td>.121*</td>
<td>2.412</td>
<td>.017</td>
<td>.027</td>
<td>.267</td>
<td>.965</td>
<td>1.036</td>
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</tbody>
</table>

Dependent Variable: Intention (alpha 0.86)

* Statistically significant

<table>
<thead>
<tr>
<th>Source: Primary Survey</th>
</tr>
</thead>
</table>

#### 7.5.2.3. Model 3: Direct & indirect PBC vs intention

The regression model summary (Figure 19) for the third model depicts that R is 0.389, R-square is 0.152 and adjusted R-square is 0.145. So, at least a 15.2% change in “intention” can be defined by the change in “direct PBC” and “indirect PBC”. The ANOVA table depicts that the F value is 24.574 with a significance score of 0.000. **The model is statistically significant, but the strength of the association in PBC with intentions was relatively weak.** The coefficient shows that the beta for direct PBC is -0.051 with a significance score of 0.365 and the beta for indirect PBC is 0.394 with a significance score of 0.000. **Direct PBC is not related to intention, but indirect positive PBC is associated with positive intentions.** Where the 39.4% positive change in intention can be defined by the change in indirect PBC, the statement is statistically significant. The results of this model also indicate that the selected sample size represents the population very well. Collinearity Statistics depict that the independent variables are not statistically correlated with each other.
<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>F value</th>
<th>P-value</th>
<th>Standardized Coefficients (Beta)</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct PBC (alpha .767)</td>
<td>.152*</td>
<td>.145*</td>
<td>24.574</td>
<td>.000</td>
<td>-.051</td>
<td>-.908</td>
<td>.365</td>
<td>-.115</td>
<td>.043</td>
</tr>
<tr>
<td>Indirect PBC (alpha .912)</td>
<td>.394*</td>
<td>7.007</td>
<td>.000</td>
<td>.313</td>
<td>.557</td>
<td>.975</td>
<td>1.026</td>
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</tbody>
</table>

Dependent Variable: Intention (alpha 0.88)

* Statistically significant

Figure 19: Regression Summary-Model 3
Source: Primary Survey

7.5.2.4. Model 4: Direct & indirect measure vs intention

The regression model summary (Figure 20) for the fourth model depicts that R is 0.789, R-square is 0.623 and Adjusted R-square is 0.606. So, at least 62.3% change in “intention” can be defined by the changes in education, direct Subjective Norms, direct PBC, department, gender, indirect Subjective Norms, age, experience, direct Attitude, nationality, indirect attitude. The ANOVA table depicts that the F value is 36.471 with a significance score of 0.000. The coefficient table depicts that the Beta for Direct Attitude is 0.229 - with a significance score of 0.000, the beta for indirect attitude is 0.405 - with a significance score of 0.000, the beta for direct subjective norms is 0.174 - with a significance score of 0.000, the beta for indirect subjective norms is 0.011 with a significance score of 0.795, the beta for direct PBC is -.011- with a significance score of 0.784, the beta for indirect PBC is 0.137 - with a significance score of 0.002, the beta for age is 0.059 with a significance score of 0.159, the beta for gender is -0.031 with a significance score of 0.531, the beta for department is 0.027- with a significance score of 0.496, the beta for nationality is 0.066 - with a significance score of 0.203, the beta for experience is -0.023 - with a significance score of 0.570, the beta for education is 0.033 - with a significance score of 0.400. education, direct subjective norms, department, indirect subjective norms, age, direct attitude, nationality, indirect attitude are positively related to intention. Whereas direct PBC, gender, and experience are negatively related to intention. The relationships between intention and direct attitude, direct subjective norms, indirect attitude, and indirect PBC are statistically
significant. But the relationships between intention and indirect subjective norms, age, gender, department, experience, direct PBC, nationality, and education are not statistically significant. The results of this model also indicate that the selected sample size represents the population very well. Collinearity Statistics depict that the independent variables are not statistically correlated with each other.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>F value</th>
<th>P-value</th>
<th>Standardized Coefficients (Beta)</th>
<th>t</th>
<th>Sig.</th>
<th>95.0% Confidence Interval for B</th>
<th>Collinearity Statistics</th>
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<tr>
<td>Direct attitude (alpha .727)</td>
<td>.623*</td>
<td>.606*</td>
<td>36.471</td>
<td>.000</td>
<td>229* 4.370 .000 .136 .359 .518 1.931</td>
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<tr>
<td>Indirect attitude (alpha .921)</td>
<td>.405*</td>
<td>6.704 000 .322 .589 .390 2.563</td>
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<tr>
<td>Direct SN (alpha .926)</td>
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<td>3.602 000 .066 .224 .609 1.642</td>
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<tr>
<td>Indirect SN (alpha .832)</td>
<td>.011 261 .795 -.090 .117 .759 1.317</td>
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<tr>
<td>Direct PBC (alpha .767)</td>
<td>-.011 -275 .784 -.063 .048 .910 1.099</td>
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</tr>
<tr>
<td>Indirect PBC (alpha .912)</td>
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<td>3.058 002 .054 .248 .713 1.402</td>
<td></td>
<td></td>
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<tr>
<td>Age</td>
<td>.059</td>
<td>1.412 .159 -.063 .385 .827 1.209</td>
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<tr>
<td>Gender</td>
<td>-.031</td>
<td>-.027 531 -.395 .204 .602 1.662</td>
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<tr>
<td>Department</td>
<td>.027</td>
<td>1.82 .496 -1.12 .247 .930 1.075</td>
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<tr>
<td>Na ionality</td>
<td>.068</td>
<td>1.276 .203 -.090 .423 .528 1.895</td>
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<tr>
<td>Experience at experience</td>
<td>-.023</td>
<td>-.569 570 -.330 .162 .838 1.193</td>
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<tr>
<td>Education</td>
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<td>842 .400 -.148 .369 .909 1.100</td>
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</tr>
</tbody>
</table>

Dependent Variable: Intention (alpha 0.88)

* Statistically significant

Figure 20: Regression Summary-Model 4
Source: Primary Survey

Summary:
In summary, direct attitude, indirect attitude, indirect PBC and direct SN have a positive impact on intention in both the all variable-model and the individual variable-model and the relationships are statistically significant (Figures 21 and 22). Indirect SN also has a positive impact on intention, but the relationship is not statistically significant for the all-variable model. Whereas the relationship is statistically significant for the individual-variable model. Direct PBC has a negative impact on intention, but the relationship is not statistically significant in any model. **Overall, positive attitudes, subjective norms and PBC are**
associated with positive intentions to comply with PPE guidelines but only attitudes and subjective norms were moderately to strongly associated with intentions and thus, appear to incur the greater influence with PPE-related behaviours in nurses.

Figure 21: Summary of Regression
Source: Primary Survey

Behavioral beliefs

R=0.76*/ R²=0.581

Evaluations of behavioral outcomes

Normative beliefs

Subjective norm

Intention to perform the behavior

Behavior

R=0.789*/ R²=0.623

Motivation to comply

Control beliefs

Perceived control

Perceived power

R=0.383*/ R²=0.152

Figure 22. Summary of relationship between predictor variables (IBM constructs groups) against nurses’ intentions to comply with PPE guidelines; *p<0.001.
8.1 Research Aims and Purpose

This research explored the factors influencing nurses’ adherence to PPE guidelines in Saudi Arabian hospitals, guided by the IBM framework (Trinh and Vo, 2016). The IBM comprises a composite of the theory of reasoned action and the theory of planned behaviour and thus, was ideally suited to identifying and understanding the attitudes, norms, perceptions, and controls of nurses engaging or not, or partly, in the specific behaviour of PPE compliance (Fishbein and Ajzen, 2015). Exploring this research area was important as poor PPE adherence can directly affect patient care and outcomes due to the risk of nosocomial infections and associated morbidity and mortality (Trinh and Vo, 2016). The IBM has been previously found to permit sufficient understanding of human behaviour due to its predictive ability regarding people’s intentions to perform a specific behaviour and in executing the behaviour, particularly in the context of health (Fishbein and Ajzen, 2015). The framework has also been used extensively across health research to explore and understand the behaviours of healthcare providers and service users and thereby, supporting its validity in this research (Branscum and Lora, 2017; Reid and Aiken, 2011; Fishbein, 2009).

The central research question was: what factors influence intentions towards adherence to guidelines regarding standard precautions for infection control and prevention among nurses operating in Saudi Arabian hospitals?

And the research objectives are: 1) to explore the beliefs of nurses which underpin their behavioural intentions to comply with PPE guidelines, and 2) to determine the magnitude and direction of influence of the three core (direct) IBM constructs (attitudes, subjective norms, and perceived behavioural control) upon nurses’ intentions to comply with PPE guidelines.

Following this, the hypotheses are:

- There is a positive relationship between attitudes & behavioural beliefs (independent variables) and intentions (dependent variable) regarding compliance with PPE recommendations.

- There is a positive relationship between subjective norms & normative beliefs (independent variables) and intentions (dependent variable) regarding compliance with PPE recommendations.
There is a positive relationship between perceived behavioural control & control beliefs (independent variables) and intentions (dependent variable) regarding compliance with PPE recommendations.

8.2 Overview of Key Findings

For the first objective, the findings showed that nurses believed that adhering to PPE guidelines would ultimately protect patients, staff and other person’s safety in the hospital setting but beliefs centred around influences external to their control, such as managers’ views and actions and organisational cultures, influenced the intentions of nurses to comply with PPE guidelines. For the second objective, it was clear from the results that nurses’ attitudes and behavioural beliefs and outcome evaluation accounted for the largest variance in their intentions to comply with PPE guidelines, which was proceeded by nurses’ subjective norms and normative beliefs and motivations to comply, and then by nurses perceived behavioural control and control beliefs and control belief power. In the survey, the primary factors influencing PPE adherence comprised a composite of nurses’ attitudes, subjective norms, behavioural beliefs, outcome evaluation, control beliefs and control belief power. The constructs of perceived behavioural control, normative beliefs, and motivations to comply contributed a lesser influence upon nurses’ intentions to adhere to PPE guidelines based on statistical insignificance in the final statistical model. Multiple linear regression showed that the IBM constructs accounted for 62% of the variance in nurses’ intentions to comply with PPE guidelines (R square=0.623 adjusted R square= 0.606, R=0.789, F=36.471(df=12), p=0.000). Constructs reaching statistical significance in the model included direct measures of attitudes (B=0.247; 95% CI 0.136, 0.359, p=0.000) and direct measure of subjective norms (B=0.145; 95% CI 0.066, 0.224, p=0.000) and indirect measures of attitudes (B=0.455; 95% CI 0.322, 0.589, p=0.000) and indirect perceived behavioural control (B=0.151; 95% CI 0.054, 0.248, p=0.002). Overall, these findings not only provide an insight into the value of the IBM in understanding the factors influencing PPE adherence in nurses, but the results may also enable nurses to better reflect upon their own practices, in order to understand the inter-relationship of factors influencing PPE behaviours.

8.3 Nurses’ Attitudes Towards PPE Compliance

Overall, nurses held positive views for each of the IBM constructs with mean scores favouring the most desired views that would promote PPE compliance and protect patient safety. In this regard nurses held favourable attitudes towards PPE use to the extent that it promoted patient safety, recovery from ill health and protection from pathogen exposure whilst avoiding harm
and being straightforward to use and comfortable to wear. Items assessing nurses’ attitudes towards PPE adherence were related to perceptions regarding the effectiveness of PPE upon infection prevention, the comfort of PPE, difficulties in adherence to PPE guidelines, and perceptions of PPE upon patient safety. For the composite, the mean score was 5.7/7.0, thus, indicating that, on average, nurses held favourable attitudes towards utilising PPE, however, some conflicting variance was noted in item scores where nurses tended to observe positive attitudes regarding the impact of PPE upon patient safety but less positive attitudes regarding the impact upon patient harm. Thus, there appears to be some misconceptions about patient safety among nurses as any threats to patient safety could contribute to harm and indeed, various evidence has shown that nosocomial infections are one of the most extensive and burdensome inpatient health problems, worldwide (Khan et al., 2017). Regarding the indirect measures of the attitudes construct, nurses tended to believe and were confident that using PPE would protect persons from infectious disease, and that use would reduce hospital infection rates and mortality secondary to hospital-acquired infections. In addition, using PPE by guidelines was found to confer feelings of competence and safety in practice provision.

The influence of behavioural beliefs and outcome evaluation upon nurses’ attitudes to comply with PPE guidelines was reflected in a mean construct score of 6.0/7.0, which was consistent across items, thus, observing less variance than the direct measures. The importance of favourable attitudes towards PPE has been reflected across a body of prior research. In one study, Ra’awji et al. (2018) found that 97% of healthcare workers reported adhering to hand hygiene practices at all times and 96% believed that PPE guidelines were trustworthy to inform safe and correct PPE practices. In another study, Paul et al. (2020) identified several similar factors and issues that compounded PPE use during an outbreak of the Middle Eastern Respiratory Syndrome (MERS) coronavirus. The authors showed that nurses observed higher mean scores regarding knowledge (16.4), attitudes (6.9) and practices (6.7) concerning infection control precautions, compared to junior and resident doctors (15.2 and 16.3, 6.4 and 6.7 and 5.8 and 6.0, respectively). Such favourable attitudes of nurses support the attitudes recognised in this research but specific insight into the factors influencing attitudes was not available for comparative discussion. However, Paul et al. (2020) found that healthcare workers’ attitudes differed by the area of practice with above-average scores being observed in intensive care units, the emergency department, operating theatres, paediatric wards and infection control units. This research included nurses working across varied hospital sites and indeed, showed that similar variance in PPE compliance existed; more
favourable compliance is noted within acute settings and settings comprising vulnerable patients. Previous research has also identified that attitudes of healthcare professionals convey a dominant influence over PPE adherence. In a study conducted during the SARS-COV-1 epidemic, Ko et al. (2004) utilised the Theory of Planned Behaviour to elicit the factors influencing nurses’ intentions in caregiving. The results showed that 43% of nurses reported positive intentions to care for SARS-COV-1 patients yet only 25.4% offered to care for such patients. Only nurses’ attitudes regarding SARS-COV-1 were found to significantly influence intentions to comply with PPE precautions. Other factors including nurses’ self-efficacy, duration of practice experience, and the availability of PPE were not found to impart significant influence over PPE adherence. Specifically, nurses’ attitudes were significantly associated with intentions to adhere to PPE guidelines with an effect size greater than all other IBM construct combinations ($R = 0.76$, $R^2=0.581$, $p<0.001$).

Notably, research conducted during times of infection outbreaks, such as with the Middle Eastern Respiratory Syndrome (MERS) coronavirus, that affected and was and continues to be contained within Saudi Arabia, has revealed that the knowledge and attitudes of health workers are considerably more favourable than compared to levels related to less-infectious pathogens that do not possess the same endemic potential (Khan et al., 2014). Such observations have been increasingly reported about the recent and ongoing COVID-19 pandemic where the attitudes and practices of healthcare professionals both within and outside of Saudi Arabia have improved considerably in response to the morbid and mortal nature of the severe acute respiratory syndrome coronavirus-2; SARS-COV-2 (Abolfotouh et al., 2020; Ciris Yildiz et al., 2020; Hossain et al., 2020). As this study was conducted during the COVID-19 pandemic, the findings are likely to be a true representation of the factors influencing PPE adherence in the region given the increasing awareness of the seriousness of infectious diseases, such as SARS-COV-2, and in turn, respondents feeling ethically obliged to provide highly accurate accounts of their views regarding PPE guideline compliance. However, the findings may represent a less valid insight into the factors influencing PPE guideline adherence prior to the COVID-19 pandemic given the peri-pandemic context of this study. In addition, the findings may not be reflective of the factors influencing nurses’ PPE adherence when the risk of pathogenic nosocomial infections is higher than general risk within hospital settings. For example, factors influencing PPE adherence are likely to be different in specialised infectious disease units. Moreover, it is not clear how the ongoing COVID-19 pandemic will influence nurses’ attitudes and behaviours
towards PPE adherence in view of nurses’ experiences of excess morbidity and mortality among infected inpatients and uncertainty as to the resolution of the pandemic in the near future.

8.4 Nurses’ Subjective Norms Towards PPE Compliance

Nurses assumed that other healthcare staff, managers and patients would expect them to comply with PPE guidelines but found that such persons were unsupportive of PPE use despite many being in positions of influence (see section 5.1.2). This, along with the behaviours of others, appeared to influence nurses’ beliefs about whether or not others approved or advocated specific behaviours about PPE adherence. Overall, nurses believed that their own and other nurses’ practices were compliant with guidelines, although not 100% of the time with mean scores falling below the maximum possible score. Most subjective norms of nurses were influenced by the perceived expectations of others with regard to nurses in complying with PPE guidelines. These included patients, patients’ relatives, other care staff, and hospital managers. The mean composite score for these direct expectations was 5.5/7.0, thus showing that nurses valued how their practices were portrayed by others. In the indirect measures of subject norms, nurses also revealed various obstructions to PPE compliance, which largely included support from other staff, PPE stocks, other PPE adherence behaviours, monitoring of PPE compliance, and acting upon concerns raised about patient safety and patient acceptability of PPE wearing.

As previously noted, subjective norms were the second most significant factor accounting for the variance in intentions of nurses to comply with PPE guidelines. These findings have been supported by the study of Ra’awji et al. (2018) where the direct IBM construct of subjective norms revealed that nurses, on average, tended to comply with PPE policy all of the time. Moreover, evidence taken from observations of health workers within Saudi Arabia has revealed that the factors influencing poor PPE adherence include physical contact with patients or objects within a patient’s environment, working in high-risk areas such as intensive care, and working morning shifts as compared to evening shifts (AlNakhli et al., 2014; Mahfouz et al., 2013; Alsubaie et al., 2013). These determinants show that health workers’ intentions to comply with PPE precautions receive influence from their perceptions or judgements of being observed and observations of others, suggesting that subjective norms are a key factor influencing PPE adherence behaviours. Whilst this study identified that several experiential and cognitive motivations influenced nurses’ intentions to comply with PPE practices, the wider research indicates that the IBM does not explain the entire picture of
events affecting PPE practices and in turn, patients’ risk of nosocomial infection. The limitations of IBM are noted in subsection 8.6. In other research on healthcare workers’ PPE practices in Saudi Arabia, there has been evidence to show that nurses’ intentions and actions to adhere to infection control precautions are largely mediated by their underlying experiential and instrumental attitudes and injunctive norms regarding views of others’ thoughts of PPE practices (a form of social pressure) (Al Hamid et al., 2019).

In another prior study supporting the contribution of subjective norms towards PPE adherence intentions in nurses, Kim and Oh (2015) used the Theory of Planned Behaviour to show that failure of PPE compliance in nurses was due to negative role modelling for those entering clinical practice following graduation. This was an important finding given that nurses are expected to act as role models and educators for other nursing staff (NMC, 2018). Although the findings of Kim and Oh (2015) were based on nursing students, the evidence supports the role of subjective norms in understanding the factors that affected PPE adherence in registered nurses. Correlation of the findings of this study with the wider literature is not always possible given the differences in generalisability of the populations included. Despite this, consistency across the evidence based on the Theory of Planned Behaviour suggests that nurses and other frontline health professionals encounter similar subjective norm related barriers to utilising PPE and adhering to best practice guidelines as reported herein (Robertson et al., 2018; Efstathiou et al., 2011; Gammon et al., 2008).

8.5 Nurses Perceived Control Towards PPE Compliance

Regarding control beliefs and control belief power, nurses reported that the way PPE is used varied considerably across their departments and that nursing managers would make them feel guilty about utilising scarce PPE stocks and underappreciated in their roles. In addition, organisational cultures were found to be minimally supportive of PPE adherence, but PPE access was not limited by nurses’ nationality as was noted in the pilot survey. Nurses believed that adherence to guidelines required sufficient support from other healthcare staff and a blame-free culture, but use would be impaired by low PPE stocks, suboptimal PPE quality, lack of specificity among infection control guidelines, excess administrial duties, poor staffing levels, lack of reactivity of supervisors in addressing nurses’ concerns about patient safety and limited education and training on PPE. As perceived behavioural control refers to perceived difficulties in enacting specific behaviours, it was not expected that this IBM construct would be reliably predictive of PPE compliance intentions given that the over-riding premise of nursing, is to uphold patient safety, which demands PPE compliance ( Sutton,
2009). In the direct item analysis, the mean score for the five items was 3.5, which revealed that nurses tended to be confident in adhering to PPE guidelines, as well as obtaining PPE when needed and using PPE based on personal decision making, as opposed to the decisions of other staff. In the indirect measures, nurses also believed that PPE adherence was affected by nationality, organisational culture, feelings of guilt and fear resulting from managers’ views, lack of support and role appreciation, insufficient knowledge of PPE, lack of or ambiguity in PPE guidelines and low nurse staffing levels.

Prior research has shown that a similar range of perceived control factors can affect adherence to PPE recommendations. In one example, Adegboyé et al. (2018) found that only 7.3% of respondents had been provided with educational opportunities to improve their infection control knowledge and practices, which supports the findings of this study where the majority of nurses agreed that insufficient education affected PPE guideline compliance. These findings are despite the protracted existence of formal, peer-reviewed, and published guidelines concerning best PPE practices (Gammon et al., 2008). Examples of the guidance available for health professionals include the Healthcare Infection Control Practices Advisory Committee and the Healthcare Infection Control Practices Advisory Committee, the Society for Healthcare Epidemiology of America, the Association for Professionals in Infection Control and the Infectious Diseases Society of America Hand Hygiene Task Force (Boyce and Pittet, 2002), the World Health Organisations’ (WHO) Guidelines on Hand Hygiene (WHO, 2009a) the WHO’s Global Alliance for Patient Safety; a campaign (Clean Care is Safer Care) launched in 2005 that sought to address issues of guideline unawareness and compliance (WHO, 2005). The WHO guidelines have also been extensively adopted, modified, and implemented within countries across the globe to help improve issues of suboptimal PPE practices and excess nosocomial infection rates and related morbidity, yet evidence evaluating post-implementation measures of guideline adherence has remained poor (Magiorakos et al., 2010; Gammon et al., 2008). Evidence drawn from a systematic review and meta-analysis based on 37 international studies also showed that hand hygiene practices have remained undesirable, albeit with some more favourable examples of compliance, with adherence rates ranging between 27-86% (Gammon et al., 2008). Notably, the vigilance of nurses and other health professionals in adhering to PPE recommendations during current times has also been driven by ongoing issues of staffing levels with excess and growing demand-capacity gaps, and short supplies of PPE, which were factors recognised as influencing PPE use in this study (Morley et al., 2020). Nurses’ mean scores for survey item 43 about the impact of low nurse staffing levels on their ability to comply with PPE guidelines
was 5.4 (SD +/-1.8) indicating strong agreement for the noted relationship. In Saudi Arabia, there have been ongoing problems with nurse staffing levels over the past decades due to several inter-related factors with evidence suggesting that there are only 40 nurses for every 100,000 persons and with a large proportion of operational nurses coming from overseas, which has presented further problems with care quality due to language barriers and variances in clinical proficiency (Aboshaiqah, 2016). A limited native nursing workforce is a particular problem reported by service users in Saudi Arabia given perceptions that such nurses are unable to understand and address individuals’ most pertinent health and sociocultural needs and notably, this has been reflected in native nurses’ preferences in caring for local, rather than foreign patients (Almalki et al., 2011). Short staffing, particularly in regard to native Saudi nurses, has also resulted from sociocultural views where communities are against male and female mixing and have retained beliefs that females are not suited to the role of nurses due to having to care for male patients and thus, recruitment drives have failed at the outset due to this ongoing issue (Aboshaiqah, 2016). Furthermore, there have even been reports of the nursing profession being assistants of doctors and thus, the attractiveness of nursing has suffered from such misconceptions, leaving the health system excessively dependent upon overseas workers (Aboshaiqah, 2016). The findings of this study also identified that hidden racism is ongoing and as this issue may not be tackled by Vision 2030, modifications to the policy may be required (Al-Dossary, 2018). Specifically, one of the survey items under the IBM construct of control belief power asked nurses whether they agreed that racism affected PPE compliance as others would be unable to assess their appearance and thus, their ethnicity due to being masked by PPE such as face masks and bodysuits. Although the level of agreement was marginal (4.3 on the 7-point scale), the variance was marked (SD +/-2.2), and thus, indicating that a proportion of nurses perceived the wearing of PPE to reduced racism because of masking appearance. This was a particularly alarming finding given that in most other geographic settings, racism within the healthcare professions, which is relatively rare or as suggested by other authors, remain present but are under-reported (Singh, 2003; Moorley et al., 2020). Aside from issues at the policy level concerning potential hidden racism, staffing levels and staff proficiency, and finite resources, it is imperative that the Ministry of Health align infection prevention and control policies with western-based policies as this may help to improve the appropriateness and standardisation of recommendations (Alslamah and Abalkhail, 2022). This may reduce the current excess variances in infection control practices across Saudi hospitals and in turn, improve infection rates and related morbidity and mortality. However, this will put pressure on
the Ministry of Health to reform and enhance the current services and policies for supporting best infection control practices. Evidence has shown that various infection control and prevention components, such as surveillance and microbiological laboratory support, are suboptimal (present in <60% of Saudi areas) and can vary between regions by 10-15% (Alslamah and Abalkhail, 2022).

Furthermore, this study revealed that nurses had limited opportunities to engage in professional development activities and a lack of education and training in PPE use was a clear factor impeding correct PPE use. Reasons for limited knowledge of nurses and other healthcare professionals regarding infection control precautions have not only been attributed to a lack of education and training in the post-graduate context but may also be a result of limited education at the undergraduate level. Indeed, in a cross-sectional survey of medical students, John et al. (2017) showed that only 41% of respondents received adequate PPE training but no students were required to demonstrate proficiency before entering registered practice. Moreover, the authors found that during simulations of patient encounters, more than 92.5% of students had one or more errors in PPE use and 44% had directly contaminated their skin with the simulation models surface and vice versa. Given a scarcity of similar research, the findings suggest that the undergraduate education of doctors and other health professionals regarding PPE use is insufficient, and this may account for the incomplete knowledge and in turn, affect attitudes, behaviours, and intentions of nurses to comply with PPE guidelines, particularly as nurses working in Saudi hospitals, have often received undergraduate training by western educational institutions or related curricula.

8.6 Theoretical Limitations and a Consideration of Alternative Theoretical Frameworks

In contrast to the Theory of Planned Behaviour, the Theory of Reasoned Action is a useful framework for understanding the factors influencing behaviours in health contexts including PPE adherence given that it focuses on identifying the dynamic aspects of experiential learning and social influence (Orr et al., 2013). Specifically, the Theory of Reasoned Action assumes that the intentions of individuals to perform specific behaviours are a result of voluntary control mechanisms based on behavioural beliefs, outcome evaluations, normative beliefs, and motivational factors. This contrasts with the Theory of Planned Behaviour, which implies that behavioural intentions receive dominant influence from non-voluntary or external factors as noted under the IBM construct of perceived behavioural control (Trafimow, 2009). Given widespread acceptance that the Theory of Reasoned Action is limited as there is little acknowledgement of the external forces influencing behavioural intentions, there has been a
scarcity of evidence exploring PPE use and guideline compliance behaviours based on this model (Wright, 2018; Sun et al., 2019; DiClemente et al., 2018). Other recent studies that have focused on understanding issues of PPE availability, usage and appropriateness have also emerged in response to the COVID-19 pandemic with Chan et al. (2021) using an integrated model comprising the Theory of Planned Behaviour and Self-Determination theory. The authors showed that the key barriers to PPE use were lack of adequate PPE supplies, the need to recycle PPE or improvise in using PPE to protect persons from infection, lack of trust in continuously changing guidelines and guideline ambiguity, which has also been supported by Hoernke et al. (2021). Indeed, similar findings were reported by nurses in this study where adherence to PPE guidelines was affected by short supplies of PPE and ambiguity in local PPE guidelines, but in contrast, this study did not find that fear of contracting infection due to the need to recycle and/or improvise in using PPE influenced nurses’ intentions to comply with guidelines. Such variances may be due to the different integrated models used with this study utilising the IBM, which did not comprise self-determination theory and thus, the survey items were not specifically developed to elicit nurses’ motivations and personality traits influencing PPE guideline adherence (Patrick and Williams, 2012). However, failure to adopt the self-determination theory is not considered a discrediting limitation of this study given that constructs within the IBM are likely to have captured much of the motivational factors influencing nurses’ intentions to comply with PPE guidelines; such factors would have been detected under the specific constructs of behavioural beliefs, control beliefs, normative beliefs, and motivations to comply.

In other research, authors have utilised the Theoretical Domains Framework model to help identify the factors influencing PPE compliance within healthcare settings. In one study, Smith et al. (2019) used the theory to help determine the barriers and facilitators of hand hygiene precautions among healthcare workers operating within long-term care facilities. The results revealed that the principal barriers to hand hygiene compliance included time pressures, excess workload, and lack of external control over staffing management and PPE supplies, with the former issues having been detected using the IBM among nurses surveyed in this study. In addition, Smith et al. (2019) showed that health workers’ beliefs about the risks and consequences of transmitting microorganisms to self or others were found to be the main factor influencing optimal hand hygiene compliance, which is congruent with the adherence motivations identified in this study with the IBM construct of behavioural beliefs being strongly associated with intentions to comply with PPE guidelines.
Whilst there are clear variances in the applicability of the findings of Smith et al. (2019) and other studies noted in the discussion section of this study due to differences in geographic and clinical settings, the evidence suggests that the factors influencing PPE adherence are commonly shared. In an earlier study that was also based on the Theoretical Domains Framework, Dyson et al. (2013) similarly showed that optimal PPE compliance among healthcare professionals working in the UK revealed that positive beliefs about the role of PPE, desirable motivation to adhere to PPE guidelines and positive support from peers and supervisors were associated with the highest level of PPE compliance. Such findings are however in contrast to the normative beliefs of nurses in this study where respondents, on average, agreed that other nurses, doctors, and nursing managers were supportive of them wearing PPE, although the mean rating score on the 7-point scale was four and thus, only marginally supporting agreement. In addition, the standard deviations across nurses’ normative beliefs were the highest of all IBM constructs (>±2), and thus, suggesting a marked variance in nurses’ views of supportiveness in utilising PPE. Therefore, in the local institution, it is likely that nurses are not sufficiently supported in wearing PPE or in complying with PPE guidelines, which as indicated by other components of the survey, maybe due to limited PPE stocks and organisational cultures that fail to prioritise infection control.

In a further study utilising the Theoretical Domains Framework but of qualitative design to permit the interviewing of physicians working in medical and surgical departments of a large Canadian hospital, Squires et al. (2014) found that nine domains of the model influenced respondents’ intentions to comply with PPE guidelines. The influencing domains congruent with the factors mediating nurses’ intentions in this study included knowledge, skills, beliefs about capability, beliefs regarding consequences, decision processes, external context and resources, professional role, and social influences. In the survey conducted, nurses agreed that insufficient education, and thus limited knowledge and skills in using PPE, made it difficult to comply with PPE guidelines. Nurses also agreed that adhering to PPE guidelines was important in protecting self, patients, and other staff from infectious disease, reflecting beliefs about consequences reported by Squires et al. (2014). Similarly, nurses agreed-upon items of the survey were congruent with capabilities in wearing PPE but notably, the decision-making processes affecting PPE use and guideline adherence received influence from various sources, including staff and patient expectations, as well as from personal judgement and the judgement of other clinical staff. This suggests that in contrast to physicians as reported by Squires et al. (2014), nurses in Saudi Arabia are encountering marked uncertainty and hesitancy in utilising PPE, which is conferring an unacceptable and avoidable risk to patient...
and staff member safety, particularly given the ongoing COVID-19 pandemic and residual cases from prior endemics, such as MERS.

A recent review of the application of theoretical models including the Theory of Planned Behaviour, Keller’s Model of Motivation Design and the Transtheoretical Model of Health Behaviour change revealed that such theories have not only been integral to understanding the factors influencing PPE practice decision making and thus, behaviours among health workers but also in informing interventions to improve PPE compliance (Al-Tawfiq and Pittet, 2013). The authors proposed that the combination of the former theories would generate an ideal framework for developing interventions to tackle issues of poor PPE use among health workers, although the findings of this review provide more specific information to account for the nuances of PPE practices within Saudi Arabian hospitals among nurses. Despite this, understanding the theories employed by Al-Tawfiq and Pittet (2013) are useful in recognising the limitations of IBM; a model that has not been extensively used to understand the behavioural intentions of healthcare workers regarding PPE use and guideline adherence (Glanz et al., 2008). In the former regard, the Transtheoretical Model of Health Behaviour change comprises five key components; pre-contemplation, contemplation, preparation, action, and maintenance, and when considering the problems of PPE adherence among nurses and other health professionals working in Saudi Arabia, devising initiatives that focus upon the pre-contemplation, contemplation and maintenance stages are likely to be key in improving the problem. Furthermore, Al-Tawfiq and Pittet (2013) suggest that the additional adoption of the attention, relevance, confidence, and satisfaction model is equally important in achieving behavioural change among healthcare workers given its overarching approach to enhancing problem-solving ability; a key trait to overcoming some of the barriers to PPE guideline adherence identified in this study. In health contexts, it is increasingly recognised that any initiatives seeking to change behaviour, whether among staff or service users, require consideration of change management theory and change management tools, which have been noted in the recommendations section of this discussion chapter (Batras et al., 2016). Support for theory-based interventions to improve PPE use among healthcare workers has also been evident in a review of the psychological framework literature reported by Srigley et al. (2015). The authors found that most studies had developed interventions based on various theories, but the most common theories included the Theory of Planned Behaviour, the Transtheoretical Model of behaviour change and the Theoretical Domains framework with a notable lack of studies that designed initiatives based on the IBM; a problem this review also seeks future research to address.
8.7 PPE Use in Other Settings and Behaviours

Across further research that has utilised the Theory of Planned Behaviour to elicit the factors influencing PPE use among persons outside of the health profession. For example, Norris and Myers (2013) conducted a cross-sectional survey of 268 motorcyclists in the UK to explore the factors influencing the wearing of protective clothing and found that anticipated regret and perceptions of the benefits of motorcycling PPE were significantly associated with participants’ intentions to wear the appropriate PPE. In addition, habitual use of PPE was significantly associated with increased intentions to wear high-visibility PPE. On the contrary, a lack of anticipated regret and aberrant perceptions of risk was significantly associated with lower intentions to wear the appropriate PPE. These findings highlight the value of the Theory of Planned Behaviour in understanding the factors predominantly influencing intentions to use PPE and whilst motorcycling is disparate from the health profession, the findings can be correlated with those identified in this study. In this regard, Norris and Myers (2013) showed that anticipated regret was a key factor influencing PPE use and indeed, this was supported by nurses surveyed in this study where there was marked anticipated regret, albeit not measured directly, concerning fear of transmitting virulent pathogens to patients, staff members and relatives. As formerly noted, such fears are likely to have been heightened in recent times due to the emergence and morbid impact of endemic viruses including MERS and COVID-19. However, it is important to note that motorcyclists are likely to have experienced fear about the threat to their own lives and thus, are likely to have been a more potent influencer of PPE use, than compared to the motives among nurses where the perceived risk would have comprised a clinical judgement of virulence factors, such as ease of transmissibility, infective dose, and clinical consequences of infection. A body of evidence has utilised the Theory of Planned Behaviour to better understand the factors influencing PPE use among motorcyclists, as well as taking risks, such as speeding and riding faster than perceived to be safe to keep up with other riders (Chorlton et al., 2012; Ali et al., 2011b; Aghamolaei et al., 2011). Indeed, risk-taking among nurses forms an overarching aspect of decision-making regarding PPE use; the findings of this study show that attitudes, behavioural beliefs, and outcome evaluations were the primary factors influencing intentions, which is similar to that of motorcyclists where risk-taking receives similar influences given the potentially serious consequences of motorcycling accidents. The seriousness of risk-taking regarding influencing PPE use has also been reflected in further evidence conducted outside
of the health professions. In two examples, Tavafian et al. (2011) and Ali et al. (2011a) surveyed cohorts of car drivers in Iran to explore the predictors of seat belt use through the application of the Theory of Planned Behaviour and found that attitudes, subjective norms, and perceived behavioural control, but not behavioural beliefs and outcome evaluations, were significantly associated with intentions to use seat belts (p<0.001). Similar findings have been supported in persons working within at-risk occupations where helmet use is considered important to protect employees from potentially serious injury, albeit with workers perceiving the risk as very rare and unlikely (Jafaralilou et al., 2019). Such findings are in contrast to the motorcycling literature formerly reported with seat belt use receiving disparate influences, however this is likely to be a result of lower perceptions of anticipated risk with drivers believing they have greater control over their actions and thus, risk, although this has been previously shown to be a result of the protective cage motor vehicles provide, as opposed to the lack of external protection motorcyclists observe (Trinh and Le, 2018; Tunnicliff, 2006). In this study, perceptions of risk among nurses regarding the transmission and acquisition of infective pathogens, previous research has shown that risk-taking often arises in situations of uncertainty where information to inform decisions is lacking or insufficient and when individuals are working under adverse conditions due to stress, tiredness, burnout and/or compassion fatigue (Salisbury, 2020; Brunton, 2005). Other authors also suggest that when health professionals are working under strenuous conditions for protracted periods, complacency and unconsciousness in decision making is likely to emerge and lead to increased risk-taking (Salisbury, 2020). Indeed, prior research has shown that when nurses are faced with decisional uncertainty, clinical reasoning, and judgement transition from being evidence-informed to one based on previous clinical experiences, which is reflective of anecdotal practices to an extent that has been associated with patient harm and other adverse outcomes in health settings (Rababa, 2018; Makridakis et al., 2019; Sackett, 2000). Furthermore, nursing experts recognise that the most imminent threat to patient safety is the nature of the human condition where susceptibility to making errors can occur both in the presence and absence (complacency) of stress (Reid and Catchpole, 2011). This study was not designed to elicit whether nurses’ intentions to comply with PPE guidelines was influenced by occupational stress and complacency, although from the wider evidence, it is likely that this accounted for some of the variances in the final predictive model. However, it should be noted that uncertainty in decision making and complacency in PPE use appears to have been blunted in the current context of the COVID-19 pandemic with all healthcare workers being aware and vigilant of adhering to PPE guideline recommendations.
given the serious impact of the virus has and continues to impart upon infected individuals, the wider population, healthcare worker wellbeing and health service functioning (Crosby and Crosby, 2020; Morley et al., 2020). A recent meta-analysis has also identified that decision-making behaviour in health contexts is significantly driven by affective forecasting (p<0.001); a composite measure of anticipated regret and anticipated effect, further highlighting that those judgements of benefits and risks for service users are an important factor mediating behavioural intentions (Ellis et al., 2018). However, this meta-analysis was based on studies with marked heterogeneity concerning the health professional and service user populations and the types of decisions health professionals encountered, meaning that affective forecasting may not always apply to decisions concerning PPE use. Despite this, some decisions were made at the public health level, and these would involve a large affective forecasting component given that health decisions on a large-scale demand overarching consideration as to whether the benefits outweigh the risks, as has been evident for the widespread administration of the COVID-19 vaccinations (Savulescu, 2021). Notably, Ellis et al. (2018) also considered constructs in addition to those of the Theory of Planned Behaviour to explain health workers’ intentions to perform specific behaviours or in making specific decisions, which included affective attitudes, anticipated regret, current affect, emotional intelligence, emotion education, empathy gap and hedonic adaptation, impact bias and focalism. Failure to consider these factors in this study represents one of several limitations, which are discussed later.

8.8 Summary

In summary, this survey of nurses working in a Saudi Arabian hospital revealed that the IBM model was useful in eliciting the various factors influencing PPE adherence behaviours, as well as the inter-relationship between said factors. Ultimately, the findings of the survey, along with support from the wider literature, showed that nurses’ attitudes are the most influencing factor driving PPE adherence behaviours, which is due to attitudes being patient-centric and thereby, influencing behaviours based on cognitions about the impact of PPE upon patient safety. The factors influencing PPE adherence in this study should be valued by the current nursing workforce in Saudi Arabia as this represents the first research to elicit the influencing factors using a representative cohort of hospital-based nurses and the IBM model to ensure sufficiency in eliciting said factors and their inter-relationships. In conclusion, nurses should use the findings of this study to reflect upon their own PPE practices as this may stimulate a drive to improve PPE adherence and patient safety on a large scale.
8.9 Study Strengths and Limitations

Although the findings of this study have provided a unique insight into the factors influencing adherence to PPE guidelines among nurses working within Saudi Arabia, the evidence has some methodological limitations. Firstly, the study utilised a cross-sectional design by developing and conducting a quantitative survey of nurses’ experiences of PPE use, which is an approach that confers several advantages and disadvantages (Sedgwick, 2014). In one regard, cross-sectional surveys are useful forms of research as they can be simple to design and rapid to conduct, which can permit the resolution of important knowledge gaps or uncertainties and minimise delays in practice or service changes needed to benefit service users of care operations. In addition, cross-sectional studies are amenable to collecting exposure and outcome-related variables at a single point in time and thus, minimise research costs and avoid the complexity that can sometimes lead to premature termination of vital research (Wang and Cheng, 2020). However, as data in survey research is collected at single time points, the outcomes must be considered against the clinical situation ongoing at the said period and due to the lack of temporality, such research is unable to infer causation between measured and outcome variables (Fedak et al., 2015). This issue also raised problems with reverse causation and indeed in this study, it was not completely clear, and can never be assumed, that suboptimal adherence to PPE guidelines did not lead to aversive attitudes, subjective norms and perceived control in utilising PPE by recommendations (Pandis, 2014). Moreover, survey research is prone to various systematic biases including non-response bias, recall bias and interviewer bias, which are discussed further in a later part of this subsection (Rosenman et al., 2011). Furthermore, the varying reliability and validity of the survey items and groups of items may have also influenced the credibility of this research but most of the measures were modest invalidity, thus, were of limiting concern for this issue (Truijens et al., 2019).

Secondly, two pertinent sampling factors were considered of the utmost importance to deriving impactful evidence to help improve PPE practices among nurses working in Saudi Arabia, which included sample size and sample representativeness. For the quantitative survey, a total of 279 out of 289 nurses completed the survey and this sample size was sufficient to attain the validity of statistical analyses as was initially calculated using G*Power software. Thus, the risk of type II error (false acceptance of the null hypothesis/hypotheses)
was minimised, which overall, provided certainty in accepting the three core hypotheses noted formerly (Banerjee et al., 2009). In addition to conferring a low risk of type II error, the reasonably large sample of nurses attained via the convenience sampling technique provided a desirable level of applicability (external validity) given that a sufficient diversity of nurses, in terms of their demographic and operational characteristics, were recruited and surveyed (Steckler and McLeroy, 2008). More specifically, nurses were recruited from across various hospital departments ranging from day-case units to intensive care and emergency rooms and thus, this research attained a cohort of nurses that can be deemed sufficiently representative of other nurses working in such institutions. This strength was also enhanced through the limited application of inclusion criteria used to define nurses eligible to participate in the research with the only limiting factor being a practice experience over six months. However, as the cohort was recruited from just two of several large hospital institutions within the Tabouk region of Saudi Arabia, the findings may not be representative of nurses working in hospitals in other regions of the nation. Thereby, whilst the findings are optimally applicable to other nurse populations as far as cross-sectional research can achieve, some caution must be used when seeking to translate the results into practice and guideline recommendations (Sedgwick, 2014). Moreover, the findings cannot be reliably applied to nursing populations working outside of Saudi Arabia, given the variances in nurse education and training, societal norms and cultures and operational differences in healthcare systems (Almalki et al., 2011).

Notably, convenience sampling was used to recruit nurses into the study and given the high level of uptake, sample size and extent of survey completion, some authors suggest that this reflects a sampling method reflective of random sampling (Charan and Biswas, 2013). Thus, this study also minimised the risk of selection bias that has been previously known to impair the generalisability of cross-sectional research studies and thereby, further enhancing confidence in the representativeness of the findings to other nurse populations in Saudi Arabia (Pannucci and Wilkins, 2010). Regarding survey completion and the limitations typical of cross-sectional surveys, this study observed a negligible risk of non-response bias; a type of bias that can occur when respondents with specific characteristics fail to participate and would have provided responses that would have altered specific outcome measures (Rosenman et al., 2011).

Thirdly, self-reported surveys can suffer from response biases as respondents may feel compelled to provide responses that deviate from the actual truth/intended responses as can occur as a result of social pressures (social desirability bias) or extreme response bias where respondents deliberately skew responses to sabotage research as a means to expressing or
coping with underlying psychological issues or stressors (Althubaiti, 2016). Furthermore, survey research can also be subject to recall bias, which occurs when respondents encounter difficulties in remembering past experiences to inform responses to specific questions and in turn provide answers that may or may not be correct. However, as this study was designed to elicit recent events of PPE usage, the risk of such bias is deemed to have been minimal (Althubaiti, 2016). This survey was also conducted during the COVID-19 pandemic and given the serious nature of the infectious disease and the importance of research seeking to help tackle the problem to spare morbidity and the loss of life, it is unlikely that nurse respondents would have been susceptible to providing responses that would be congruent with the response and/or recall biases (Liu et al., 2017).

Another strength of this study was the rigour used to develop a valid and reliable survey instrument with the survey items having been derived from a series of qualitative interviews with nurses and a pilot survey, which were analysed and reviewed with external experts in the field to ensure the inclusion of all important questions as to elicit all possible factors influencing PPE guideline adherence. However, the capacity of the survey to have elicited the entirety of factors influencing PPE use among nurses should be considered given the limitations of the qualitative component and the pilot survey. In the qualitative element, several extension methods and techniques were employed to help enhance the trustworthiness of the findings and to minimise the potential influence of researcher subjectivity, which was achieved by attaining data sufficiency, recruiting information-rich respondents via purposive sampling, and employing constant comparative analysis, member checking, investigator triangulation and author reflexivity (Noble and Smith, 2015). However, some experts continue to argue that qualitative research is always susceptible to issues of researcher subjectivity and interviewer biases, are given the nature of the relationship between investigators and participants and the difficulties in recognising and avoiding the capturing of biased responses (Galdas, 2017). Moreover, the qualitative component was based on a purposive sample of 14 nurses and whilst this is a reasonable sample size given that data sufficiency was achieved, there is a persistent risk that the findings remained a suboptimal representation of other nurses working in the two included hospital institutions (Martinez-Mesa et al., 2016). In turn, this problem may have affected the sufficiency of the survey items incorporated into the final instrument.

Aside from the qualitative component, the validity of the final survey instrument was assessed based on a pilot survey of 43 nurses who were disparate from the final cohort of nurse respondents, and this could have resulted in under- or over-estimation of validity due to
responses being based on a smaller cohort of nurses with less representative views of the factors influencing PPE adherence. However, given that pilot studies and psychometric evaluations of quantitative instruments tend to benefit from samples in the order of 40-50 respondents, it is unlikely that basing the analyses on a different nursing cohort impacted accuracy in the validity and reliability tests (Anthoine et al., 2014). A notable strength of this study was the high level of internal consistency (Cronbach alpha 0.92) and test-retest reliability across all dependent and independent variable combinations with most R values falling into a moderate correlation category (all p<0.05). This provides sufficient certainty that the survey was valid and reliable in accurately measuring the intended measures and in assuring that the survey item would elicit comparable results upon repetition (Bolarinwa, 2015). Finally, this study benefitted from the theoretical underpinnings of the IBM, which is known to accommodate the benefits of both the Theory of Planned Behaviour and the Theory of Reasoned Action and account for the limitations of relying upon one of the former theories alone, which is likely to have derived all-important and modifiable factors influencing PPE adherence among nurses in Saudi Arabia (Glanz et al., 2008). Previous research exploring the factors influencing PPE use has largely utilised the Theory of Planned Behaviour and thus, has been subject to the neglect of the external forces influencing behavioural intentions (Wright, 2018; Sun et al., 2019; DiClemente et al., 2018). Therefore, this research was able to provide some of the most extensive insights into the factors influencing PPE adherence among nurses and in light of other methodological strengths and a few limitations, has several implications for current nursing practice and local PPE guidelines as summarised in the following subsection.

8.10 Implications and Recommendations for Nursing Practice

Suboptimal adherence to PPE guidelines represents a threat to the safety of both patients and care providers working within local Saudi Arabian hospitals and as this representative survey provided insight into the varied factors influencing PPE use, key implications for current nursing practice are noted. Firstly, the survey identified that there were positive and significant relationships between attitudes/behavioural beliefs and intentions to comply with PPE guidelines, as well as between intentions and subjective norms/normative beliefs and between intentions and perceived behavioural control/control beliefs. It may be that strengthening favourable attitudes, behavioural beliefs, subjective norms, normative beliefs, and perceived control and control beliefs could benefit the rate of PPE use and in turn, individual safety. Therefore, it is recommended that educational institutions and healthcare
organisations involved in supporting nurses in transitioning into clinical practice and in supporting professional development throughout the nursing career are responsive to the findings of this study. Such bodies should take measures to assess whether the content is currently tailored towards supporting awareness of PPE use and importance and if not, altering the curriculum to help shape nurses in developing the qualities and skills that are known to facilitate PPE guideline adherence. Based on specific findings of this study across survey items, the following additional recommendations have been derived:

- Increasing the number of opportunities to provide education and training for nurses concerning PPE use, whilst ensuring nurses can attend educational sessions by making attendance compulsory and coordinating with nursing managers to ensure individuals have protected time away from frontline practice.

- Ensuring education and training in PPE use are provided at regular intervals, to ensure nurses’ practices are up to date given the latest evidence and to help tackle susceptibilities in nurses reverting to outdated or incorrect PPE practices.

- Nominating nursing role models across all wards and departments within hospitals to increase awareness of the importance of optimal PPE use among nurses, other health professionals, patients, and relatives of patients and to provide practical education and act as a source of support and expertise in times of uncertainty, as has been evident for COVID-19. In addition, it would be important for nursing role models to help address disparities in PPE use across and within departments by resolving misinformed practices and overall, improving the standardisation of PPE use for specific clinical situations. Moreover, nurses with concerns about PPE and patient safety would be able to have confidence in raising concerns to role models who can then take further actions to help resolve practice issues.

- Nominating a senior nurse within Saudi hospitals to act as a manager of all role models concerned with monitoring and educating others in best PPE practices, to ensure role models are adequately supported and provided with resources to enhance patient and staff safety.

- Ensuring the dissemination of this research to all relevant academic and clinical audiences, to generate support to attain a change in health policy as a means to addressing issues that negatively affect PPE guideline adherence. Such issues would include tackling problems of nurse short staffing, increasing the stockpiling of PPE supplies to reduce the impact of
shortages and providing a range of PPE options that can ensure the adequacy of fit, and effectiveness in protecting from infectious disease and having hypoallergenic properties.

- Nominating nurses as change agents with effective leadership skills to permit access to organisational hierarchies and to, in turn, alter hospital cultures to those that prioritise infection control and patient safety related to infectious disease. Adjusting subcultures will also be important in enhancing mutual support in using PPE among healthcare providers and thereby, reducing the impact of expectations upon PPE decision making.

- Developing novel measures to help reduce the impact PPE may have upon the perceptions of patients, to limit fear, anxiety, and distress regarding infectious disease in those with and without confirmed infections. This could include simple tasks, such as the wearing of name badges and given COVID-19, pictures of PPE wearer’s faces (portraits), to humanise PPE and limit its frightening and alienating nature (Brown-Johnson et al., 2020).

- Improving the processes of monitoring and evaluating infection control compliance among the health professions, to establish the areas of nursing practice that require more intensive support to improve levels of PPE compliance. Ensuring the creation and sharing of positive performance measures will help nurses see the true impact of PPE use through ascertaining change in objective measures of important outcomes, such as infection rates and length of hospital stay.

Furthermore, the author posits designing and implementing a novel intervention to help improve PPE compliance locally. The intervention would involve a strategy to target nurses’ attitudes and subjective norms as these constructs were found to contribute most of the variance in intentions to comply with PPE guidelines. The nature of the intervention proposed would include an educative and supportive approach to tackling aberrant attitudes and subjective norms of individual nurses as individuals with aversive attitudes and/or subjective norms could be recognised through a similar survey to that completed herein. The education and support would be provided within large groups of nurses, to optimise convenience, uptake, and completion of the program. This may help nurses in supporting one another to disclose information regarding PPE compliance issues and in becoming more self-aware and introspective regarding how their attitudes and subjective norms shape their intentions to comply with PPE guidelines and in turn, patient safety. The ultimate aim of the intervention would be to induce a degree of behavioural change in nurses’ PPE practices based on
improving self-awareness of attitudes and subjective norms that may lead to comprised quality and safety of care.

Addressing issues of suboptimal PPE practices and guideline adherence may be best served at the undergraduate level, particularly as education and training in early life and before professional registration may help to engrain greater motives, desires, and behaviours to adherence to infection control guidelines. In addition, a body of evidence has shown that deficits in infection control knowledge and poor practices are prevalent among healthcare students, thus, suggesting that targeting student nurses and providing them with more intensive education concerning infection control precautions may be key to improving part of the problem in Saudi Arabian hospitals (Colosi et al., 2011; Tavolacci et al., 2008; D'Alessandro et al., 2014; Gniadek et al., 2021). Evidence of poor knowledge and practices of infection control precautions has also been reported among healthcare students within Saudi Arabia, thus, indicating that suboptimal education and training at the undergraduate level is a globally shared issue but importantly, one that can be remedied to benefit the future patient and health worker safety (Al-Maweri et al., 2015; Khubrani et al., 2018; Tumala et al., 2019). One Saudi Arabia based study expanded upon the problem of poor infection control knowledge and practices among nursing students by seeking to identify the predictors of such outcomes, in a similar regard to this study, although the authors did not utilise the IBM of other theories to ascertain said predictors, instead linear regression analysis was employed (Cruz and Bashtawi, 2016). The former authors found that positive attitudes towards hand hygiene, awareness of the efficacy of infection control precautions upon patient wellbeing, attending hand hygiene seminars, being at an early stage of nurse training and being male were the significant predictors of more desirable hand hygiene practices. In this study, the direct measure of nurses’ attitudes towards infection control precautions was significantly associated with their intentions to comply with PPE guidelines, as was the indirect measure of nurses’ behavioural beliefs and outcome evaluation, thus, highlighting the importance of positive attitudes and beliefs concerning the efficacy of PPE in protecting patient and health worker safety.

One of the most notable predictors of hand hygiene knowledge and practices reported by Cruz and Bashtawi (2016) was the earlier stage of student nurse training as this suggests that education and training provided early in the course is key to shaping the attitudes of students and in turn, the cognitions and behaviours of nurses following professional registration. However, given that much of the problem of poor PPE practices among nurses in Saudi Arabia is evident among those already registered and operating within and outside of hospital
settings, ongoing education and training are likely to be key in addressing the issue on a meaningful scale but this would need to account for the attitudes of nurses that may be engrained from a much earlier period of training. This could present a considerable challenge for ongoing educationalists concerned with PPE training given that approaches may need to adapt interventions that are effective in achieving cognitive and behavioural change, which have observed mixed efficacy in generic terms across the evidence base (Chauhan et al., 2017; Ryan, 2009). However, other research has found that educational interventions can be effective in improving PPE knowledge and practices among registered nurses with PPE adherence rates improving by more than 20% (Chhapola and Brar, 2015; Salama et al., 2013). Importantly, Salama et al. (2013) also showed that improved compliance with hand hygiene guidelines among healthcare workers operating in a Kuwaiti intensive care unit was associated with significant improvements in the rate of nosocomial infections, bacteraemia’s, and respiratory tract infections. This highlights the clinical value of PPE adherence in protecting patient safety, as well as the safety of other health workers and visitors to hospitals where infectious pathogens can prevail.

Whilst improved education and training of nurses may help to address most of the problems of poor PPE guideline compliance within Saudi Arabia, such interventions are unlikely to attain desirable adherence rates in the absence of behavioural change initiatives, as indicated by Randle et al. (2013), interventions designed to address patient hygiene practices. Indeed, in a randomised controlled trial (the ACCOMPLISH study), Erasmus et al. (2011) sought to investigate the impact of a theory-based and multi-component strategy designed to improve PPE compliance. The intervention was reported to be underpinned by self-regulation theory; a theory that assumes changes in behaviour need to be goal-directed, to progress individuals towards achieving an overall objective, and involved the provision of physical PPE and improving the visibility and access to PPE within healthcare departments, providing interactive team workshops to demonstrate good PPE practices, providing supportive education and ensuring monitoring of performance through observation and feedback. Based on a large cohort of healthcare workers recruited from across 16 hospitals in the Netherlands, the authors found that the intervention program was associated with significant improvements in PPE compliance according to congruence with WHO guidelines (p<0.05), as well as near-significant reductions in the prevalence of healthcare-associated infections (p=0.07), as compared to baseline. The intervention effects revealed that the use of self-regulation theory through multiple experiential and educational components not only improved PPE compliance but in turn, led to meaningful reductions in nosocomial infection rates, which suggests that
future intervention strategies to improve PPE adherence in Saudi Arabia are likely to benefit from a similar approach.

Also supporting the value of theory-based interventions in improving PPE compliance behaviours have been the findings of a recent Cochrane review (Gould et al., 2017). Based on 26 studies comprising 14 randomised trials, two cohort studies and 10 time-series analyses with the majority of evidence having been sought from varied health professionals working in both hospital and long-term care facilities, the authors found that multi-modal interventions underpinned by behavioural change theories were effective in improving PPE compliance rates and pathogen colonisation and infection rates. However, given that most studies were affected by various systematic biases, certainty in the evidence was low, and thus, clouding inferences whether such interventions should be employed in Saudi Arabia. Several other trials, that are evaluating the impact of various interventions to optimise PPE compliance among nurses and other healthcare workers, are ongoing with the results eagerly awaited as these may help to inform initiatives to enhance PPE compliance among local nurses (Huis et al., 2011; Teesing et al., 2020).

As previously noted, interventions designed to improve PPE knowledge and practices among healthcare workers tend not to eliminate nosocomial infections and this may be because a proportion of infections are transmitted between patients themselves; those who can ambulate and come into proximity or even contact with others (Landers et al., 2012). Indeed, Haverstick et al. (2017) conducted a quasi-experimental before-and-after study to explore the impact of a hand hygiene intervention that was designed to improve patients’ awareness and knowledge of infection transmission and practices of hand hygiene. Following education provided by trained nurses and based on observations of patients admitted to a cardiothoracic ward in the United States, the authors showed that there was a decrease in the incidence of nosocomial infections with a significant correlation demonstrated between patient hand hygiene practices and the rates of vancomycin-resistance enterococci and methicillin-resistant Staphylococcus aureus infections (both p<0.01). Moreover, patients included in the study reported that the intervention improved the extent and intensity of hand hygiene education provided by nurses, thus, further suggesting that nurses in Saudi Arabia may need to adopt greater proactivity in educating patients concerning infection control precautions (Haverstick et al., 2017). Improvements in nosocomial infection rates secondary to patient-education initiatives and increases in infection control practices have also been supported in a recent systematic review of 10 studies, although much of the informing evidence observed a moderate to high risk of bias due to most commonly, a lack of a control group, and various
other systematic biases (Srigley et al., 2016). However, to improve the problem of patient-patient transmission of infective pathogens, Landers et al. (2012) suggest that nurse-led educational interventions should be provided in keeping with the principles of person-centredness as this approach is likely to optimise infection control compliance behaviours through ensuring information is tailored to suit the learning needs of individuals. In addition, the authors imply that the provision of patient education requires considering individuals’ most valued needs, to inform the timing of interventions to optimise infection control practices as the provision of information at times of illness or distress is unlikely to be effective (Landers et al., 2012).

Indeed, it may be that nurses themselves also require education and training initiatives to be tailored to suit their varied individual needs and in overcoming common barriers to attendance and completion of professional development opportunities as has been apparent across issues, such as time pressure and short staffing (RCN, 2019; Al-Mutair, 2015). In Saudi Arabia, there have been growing concerns surrounding the quality of ongoing education and training provided to nurses with issues having been recognised at the management, system, and social levels (Alghamdi et al., 2019). The cited authors conducted a qualitative study of three nursing educators and four educational leaders involved in the professional development of the profession and identified information within four key themes showing that Saudi culture, educational issues, working conditions and organisational problems are protracting issues with proficiency across the profession and issues with staffing levels and nurse turnover. Specifically, the Saudi culture was perceived to still be restricting the number of women entering nursing education at the undergraduate level and in turn, this affected the number of native nurses operating within hospitals; a reflection of the high abundance of overseas nurses in the nation continues to rely upon to meet the care demands of the growing service user population (Alboliteeh et al., 2017). The cultural impact upon women in Saudi Arabia was suggested to be so suppressed as to induce fear in respondents concerning entry into the nursing profession and such findings highlight the wider social issues of women in professional roles, which requires tackling by the Ministry of Health through national campaigns and incentive provision (Alghamdi et al., 2019). Aside from cultural problems, expert nurse educationalists in the interviews of Alghamdi et al. (2019) also revealed that the management of the nursing profession was poor and had resulted in the educational content being poor and congruence with the needs of healthcare systems lacking. In addition, a large proportion of nurses encountered problems with understanding information due to language
barriers with overseas educationalists, as well as limited access to resources, which impaired the ability to consolidate information or expand upon knowledge through self-research. Finally, respondents stated that the nursing profession lacked sufficient authority, representation, and leadership, which meant that the needs of nurses working towards registration and operating in frontline practice were neglected as compared to other areas of the medical profession. Whilst qualitative research tends to be discredited for issues of researcher subjectivity and other biases, the findings reported by Alghamdi et al. (2019) can be considered trustworthy due to the use of techniques to enhance credibility, dependability, and confirmability. Such findings hold value to the implications this study is likely to impart upon the nursing profession as whilst it was clear from the results that nurses’ intentions to comply with PPE guidelines receive complex influences, improving the problem will initially require resolution of sociocultural and educational issues affecting nurse staffing levels and proficiency in practice.

8.11 Implications for Local PPE Guidelines

Aside from the numerous recommendations for current and future nursing practice in Saudi Arabia, the findings of this study have some important implications for current PPE guidelines. Presently, the Ministry of Health national guidelines for infection prevention and control published in 2013 and titled: The Infection Prevention and Control Manual, currently are relatively detailed and based on the WHO’s standards for preventing the transmission of infective pathogens in health settings (Ministry of Health, 2013; WHO, 2009a). However, the guidelines fail to provide specific clinical and patient-related indications to inform the wearing of PPE, and this is likely to have generated uncertainty among the local nursing profession regarding PPE usage and selection and in turn, created mistrust, fear and anxiety concerning the risk of pathogen transmission due to misinformed PPE donning and doffing. Moreover, the guidelines are extensive, and this is likely to have obstructed nurses in finding the correct information to inform PPE use in current practice, particularly given the issue of short staffing and time pressures nurses continue to encounter within Saudi Arabia (Alluhidan et al., 2020). Furthermore, the guidelines are somewhat outdated given that they were published eight years ago and, to the author’s best knowledge, have not been revised in the interim, which is likely to have exacerbated nurses’ concerns about and trust in said guidelines. Therefore, it is strongly recommended that the current Ministry of Health guidelines for infection prevention and control are overhauled. Three major changes are needed and should comprise: 1) reducing the extent of content within the guidelines to derive more succinct and user-friendly information to help improve the timeliness of finding recommendations to inform
PPE use, 2) ensuring the guidelines are updated given the latest research evidence and other accepted international guidelines, as well as providing key sections on PPE use during endemic and pandemic infections, such as MERS and COVID-19, and 3) ensuring the guideline content provides specific clinical and patient-related indications for specific PPE use including both donning and doffing procedures. In addition to these former changes, it is also recommended that the current guidelines are frequently reviewed and updated on an annual basis, to prevent the content from becoming repeatedly outdated and misinforming PPE practices, which would present an avoidable risk to patients and staff safety. An important aspect of content missing from current guidelines that should be included in future updates should be recommendations concerning patient and relative education in hand hygiene and the wearing of PPE in situations where it is needed to protect persons from infectious disease. Finally, it may be useful for the current Ministry of Health guidelines to be converted into various electronic formats, to permit easier access to recommendations, such via a smart phone application, which would be increasingly simple and convenient for nurses to access and follow during shifts within and outside of inpatient settings (Huang et al., 2021).
Chapter 9. Conclusion

9.1 Relevance and Significance of the Findings

This is one of the first surveys to utilise the IBM model and has used a sufficiently valid and reliable instrument to measure the factors influencing PPE guideline adherence among a representative and large sample of nurses working in two hospitals in Saudi Arabia. The research had some key implications for current nursing practice and PPE guidelines with potential to contribute to improvements in practice due to elicitation of the factors shaping PPE behaviours in the present time of the COVID-19 pandemic. Ultimately, this study showed that nurses’ attitudes (positive and negative evaluations of self-performance of a behaviour), and to a lesser extent, subjective norms (perceptions of others’ expectations to comply with a behaviour) and perceived behavioural control (perceived ease and difficulties in performing a behaviour), influenced PPE behaviours and thereby, influence the infectious risks to patients admitted to Saudi hospitals. Indeed, some pathogens have marked virulence factors and in turn, endemic and pandemic potential, as has been the case with MERS and COVID-19, which are increasingly transmissible and are likely to incur much greater morbidity and mortality, than compared to other nosocomial infections. Thus, in the current context, this research has highlighted the factors that influence nurses PPE practices, which subsequently, influences the risk of nosocomial infections and infectious outbreaks within hospital settings. Indeed, nurses are a profession that should be concerned with upholding patient safety, staff wellbeing and continuously engaging in continuous quality improvement processes to ensure the provision of the best and safest possible care. However, as the evidence has identified a range of factors influencing PPE adherence among nurses with most being readily modifiable, nurses can become aware of such factors and take actions to help improve compliance rates and in turn, patient, and staff safety.

Whilst most change management initiatives encounter considerable resistance in health settings, due to varied issues of stakeholder resistance, incongruent cultures, and ineffective leadership, it should be easier for change agents to remedy the barriers to PPE adherence among nurses given the COVID-19 pandemic, which has markedly increased vigilance among the health professions regarding the appropriateness and stringent use of PPE in keeping with evidence-based research. Not only does this study hold value in improving clinical outcomes in the current and near-future about the novel and endemic viruses, such as COVID-19, but it also has relevance to improving outcomes from general nosocomial infectious, which can confer serious morbidity and seldom, mortality. Moreover, this research
has highlighted ongoing sociocultural issues that influence nursing practice both directly and indirectly, with the Saudi culture still driving problems of native nurse staffing levels and protracting racism between native and non-native persons. Furthermore, the evidence has also found that organisational issues of hospital culture and insufficient education and training of nurses are an ongoing problem, as is the poor specificity of infection control guidelines, which must be revised and provided in succinct and more accessible formats to help guide current PPE practices given time pressures and high service user demand. Finally, there is a clear and imminent need for policy change/revision in Saudi Arabia concerning infection prevention and control and it is indeed, the Ministry of Health’s responsibility to lead change and monitor progression in this regard. An updated policy is needed to align the recommendations with those utilised in the western world as such policies appear to be some of the most effective, worldwide (Alslamah and Abalkhail, 2022). However, as previously described, a reform of current policy needs to overcome various barriers to effective policy deployment and its success. These barriers include, but are not limited to, suboptimal resourcing, services, and infrastructure in supporting effective infection prevention and control. These hindering factors span across technical guidelines, human resourcing, infection surveillance, laboratory support, environmental services, monitoring and evaluation of performance and integration with other health services including public health (Alslamah and Abalkhail, 2022).

9.2 Recommendations for Future Research

Although the findings of this study have some key implications for current nursing practice and infection control guidelines, which must be considered in efforts to help improve patient and staff wellbeing from infectious disease, there are a few recommendations for ongoing research related to both persistent knowledge gaps and the limitations of this study. Firstly, as the survey relied upon eliciting the factors influencing PPE adherence among nurses by using the IBM, it was evident that this only accounted for 62% of the variance in nurses’ intentions to comply with PPE guidelines ($R^2=0.623$). Therefore, follow-on research needs to explore the other factors influencing PPE use among nurses, particularly as these barriers may prevent meaningful improvements in PPE practices in the future should they remain unidentified and unaddressed. Such research may be plausible by conducting a similar survey but utilising different theories to that of IBM. It would also be useful for this research to be repeated among a cohort of nurses working in a different region of Saudi Arabia, to confirm whether the factors influencing PPE adherence are shared across the nation and to detect those that are
not. Furthermore, patients and staff would also benefit from research exploring the factors influencing PPE adherence across other health professions, including doctors, nursing assistants and other allied professionals, to establish whether interventions to improve adherence are likely to be effective outside of nursing. In addition, it would be important for future research to investigate whether nurses’ intentions to comply with PPE guidelines fall congruent with actual PPE practices given that intentions to use PPE cannot be assumed to translate into actions.

9.3 Concluding Statement

In conclusion, this study, to the author’s best knowledge, was the first to explore the factors influencing PPE adherence among nurses working in Saudi Arabian hospitals based on the IBM. Through recognising that a significant relationship exists between nurses’ intentions to comply with PPE guidelines and their attitudes, behavioural beliefs/outcome evaluations, subjective norms, perceived behavioural control, normative beliefs/motivations to comply, and control beliefs/control belief power, and accounted for 62% of the variance in intentions, it can be concluded that such factors are barriers and direct threats to the safety of patients, patients’ relatives and staff members. Therefore, by addressing as many of the barriers to PPE adherence as possible, this research has found the most plausible means to improving PPE practices and in turn, outcomes related to infectious disease. In the current and prior contexts of endemic infections, such as MERS and COVID-19, the evidence and recommendations should not be dismissed as this may lead to worsening morbidity and mortality across the local population. Improving PPE practices to prevent such outcomes may be achievable through the deployment of a multi-modal intervention based on behaviour change theory.
Appendices

Appendix 1. Phase One Qualitative Interview Questions.
Concerning the personal protective equipment policy. Please provide detailed responses for the following questions? The more you can explain and express your thoughts, the more helpful your responses will be.

1. What do you believe would be the advantages of following the personal protective equipment policy?
2. What do you believe would be the disadvantages of following the personal protective equipment policy?
3. Are there any local issues related to the use of personal protective equipment?
4. Is there anything else you associate with your own views about [following the personal protective equipment policy]?
5. Who do you think would approve or encourage you to follow personal protective equipment policy?
6. Are there infection prevention and control monitoring measures in place to detect poor compliance with personal protective equipment policy?
7. Do you receive regular education and training regarding personal protective equipment?
8. Who do you think would disapprove or discourage you from following personal protective equipment policy?
9. Is there anything else you associate with other people’s views about [following the personal protective equipment policy]?
10. What factors or circumstances enable you to follow personal protective equipment policy?
11. What factors or circumstances make it difficult or impossible for you to follow personal protective equipment policy?
12. Are there any other issues that come to mind when you think about [following the personal protective equipment policy]?
13. What do you know about PPE?
14. What do you believe were the necessary skills required to comply with PPE?
15. How often are you using PPE with your patient?
16. Is the PPE available, and the location in visible place and easy access?
Appendix 2. Survey constructed based on the findings of the content analysis.

Part I: Instructions:

The questionnaire is designed to measure your perceptions towards adhering the PPE recommendations. You will be asked questions which make use of rating scales with seven places. Next to each question is a seven-point rating scale. You need to circle a number in the place on the scale that best describes your opinion.

For example, if you were asked to rate the statement "The weather in Riyadh" on such a scale, the seven-point rating scale would be interpreted as follows:

Bad: ___1___:___2___:___3___:___4___:___5___:___6___:___7___:Good

extremely quite slightly neither slightly quite extremely

If you think the weather in Riyadh is quite good, then you would circle the number 6, as follows:

The weather in Riyadh is:

Bad: ___1___:___2___:___3___:___4___:___5___:___6___:___7___:Good

If you think the weather in Riyadh is extremely bad, then you would circle the number 1, as follows:

The weather in Riyadh is:

Bad: ___1___:___2___:___3___:___4___:___5___:___6___:___7___:Good

Direct Measures: Attitudes

1. In my opinion regarding the prevention of infectious pathogens to or between patients, following the PPE policy is:
   a. Not beneficial for patient safety: 1__2__3__4__5__6__7__: Beneficial for patient safety
   b. Obstruct patient recovery: 1__2__3__4__5__6__7__: Promote patient recovery

2. Adhering to PPE policy is:
   a. Hard: 1__2__3__4__5__6__7__: Easy
   b. Uncomfortable: 1__2__3__4__5__6__7__: Comfortable

3. When used correctly, I believe wearing PPE prevents exposures:
   Ineffectively: 1__2__3__4__5__6__7__: Effectively

a. Direct Measures: Subjective norms

4. Other nurses expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time
5. Doctors expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time
6. Clinical managers expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time
7. Other healthcare staff expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time
8. Patients expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time
9. Patients’ relatives or friends (visitors) expect me to comply with PPE policy:
   Not at all: 1__2__3__4__5__6__7__: All the time

Direct Measures: Perceived Behavioural Control

10. I can obtain PPE if I want to:
    Disagree: 1__2__3__4__5__6__7__: Agree
11. It is my personal decision whether or not to use PPE:
    Disagree: 1__2__3__4__5__6__7__: Agree
12. Using PPE is guided my own decisions/judgement:
    Disagree: 1__2__3__4__5__6__7__: Agree
13. It is up to the decisions/judgement of other clinical staff whether or not I use PPE
    Disagree: 1__2__3__4__5__6__7__: Agree

Direct Measures: Intentions

14. To what extent do you intend to comply with the PPE policy within the next one month of your nursing practice?
    Not at all (0%): 1__2__3__4__5__6__7__: Completely (100%)
15. In your daily practice for the proceeding one month, to what extent do you plan on following the PPE policy?
    Never (0% of the time): 1__2__3__4__5__6__7__: Always (100% of the time)
16. How determined are you to comply with the PPE policy in the next one month of your practice?
    Not at all (0%): 1__2__3__4__5__6__7__: Completely (100%)

Indirect Measures: Behavioural Beliefs and Outcome Evaluation

Behavioural Beliefs

17. Following the PPE policy protects myself, patients, staff, and other persons from infectious disease
    Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
18. I am confident that wearing PPE protects myself, patients, staff, and other persons from infectious disease
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
19. Wearing PPE will lower infection rates in hospital
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
20. Wearing PPE will reduce length of stay in hospital
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
21. Wearing PPE will lower mortality due to hospital-acquired infections
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree

**Outcome Evaluation**

22. Utilising PPE in accordance with guidelines would make me a better nurse.
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
23. Utilising PPE in accordance with guidelines would make me feel safer.
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
24. Utilising PPE in accordance with guidelines would make patients feel safer.
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
25. Utilising PPE in accordance with guidelines would demonstrate that I care about the hospital service users.
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree

**Indirect Measures: Control Belief Strength and Control belief Power**

**Control Beliefs**

26. How varied is the compliance with PPE wearing among nurses in your local department?
   Not varied: 1__2__3__4__5__6__7__: Markedly varied
27. Access to PPE is affected by the nationality (Saudi versus non-Saudi origin) of nurses?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
28. After using PPE, do nurse managers make you feel guilty, fearful, or anxious about using up PPE stocks?
   Never: 1__2__3__4__5__6__7__: Always
29. The culture within your department or hospital prioritises correct PPE use.
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
30. To what extent do you feel that your role as a nurse is under-appreciated by nurse managers?
   Never: 1__2__3__4__5__6__7__: Always

**Control Belief Power**
31. Following PPE policy requires sufficient support and role appreciation from hospital administration staff
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
32. Following PPE policy requires sufficient support and role appreciation from doctors?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
33. Following PPE policy requires sufficient support and role appreciation from nurse managers?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
34. Following PPE policy requires a blame-free culture regarding the use of PPE stocks?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
35. A non-judgemental and blame-free culture/environment would make PPE compliance easier
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
36. Staff using negative comments to induce fear or anxiety would prevent me from following PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
37. Using PPE will reduce the racism I experience at work because it will be harder for others to see what race I am
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
38. Knowing that PPE is poorly available affects PPE policy compliance?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
39. Knowing that PPE is of poor-quality affects PPE policy compliance?
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
40. A lack of reactivity among nursing managers to address nurses concerns about PPE or patient safety affects compliance with PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
41. Excessive paperwork makes it difficult to comply with PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
42. Ambiguity among PPE guidelines make it difficult to follow PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
43. Insufficient nurse staffing makes it difficult to comply with PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
44. Insufficient nurse education about the PPE and clinical importance of PPE (impact upon outcomes) makes it difficult to comply with PPE policy
   Strongly disagree: 1__2__3__4__5__6__7__: Strongly agree
45. Allergies to PPE compromise patient and other staff members safety?
46. A lack of regular training or education in PPE use has compromised patient or staff members
safety in my local department
Never: 1__2__3__4__5__6__7__: Significantly compromised

Indirect Measures: Normative Beliefs and Motivation to Comply

Normative Beliefs

47. How supportive are nursing managers of you wearing PPE?
   Not supportive: 1__2__3__4__5__6__7__: Completely supportive

48. How supportive are doctors of you wearing PPE?
   Not supportive: 1__2__3__4__5__6__7__: Completely supportive

49. How supportive are other nurses of you wearing PPE?
   Not supportive: 1__2__3__4__5__6__7__: Completely supportive

50. Do you feel that laboratory tests provide reliable information to inform the wearing of PPE?
   Not reliable: 1__2__3__4__5__6__7__: Highly reliable

51. To what extent do senior nurses or other staff act as role models for PPE use and therefore
    influence your PPE practice?
   Never: 1__2__3__4__5__6__7__: Always

52. How much of problem to patient safety do you feel limited access to PPE has caused?
   Not a problem: 1__2__3__4__5__6__7__: Significant problem

53. How much of problem to patient safety do you feel short of stocksto PPE has caused?
   Not a problem: 1__2__3__4__5__6__7__: Significant problem

54. To what extent is your nursing practice compliant with local PPE guidelines?
   Not at all: 1__2__3__4__5__6__7__: Complete compliance

55. To what extent do you feel other nurses PPE practice complies with local guidelines?
   Not at all: 1__2__3__4__5__6__7__: Complete compliance

Motivation to Comply

56. To what extent is PPE compliance monitored?
   Not at all: 1__2__3__4__5__6__7__: Sufficiently regularly

57. To what extent are your raised concerns about PPE addressed?
   Never: 1__2__3__4__5__6__7__: Always

58. Should you have concerns about patient safety due to PPE related issues, to what extent are
    actions taken to resolve the problem?
   Never: 1__2__3__4__5__6__7__: Always

59. It is another staff members’ responsibility to ensure you comply with PPE guidelines
Strongly disagree: 1              2              3              4              5              6              7: Strongly agree

60. Clinical emergencies negate the need to wear PPE
   Strongly disagree: 1              2              3              4              5              6              7: Strongly agree

61. Do you agree that patients’ thoughts and reactions to PPE can influence nursing adherence to PPE?
   Strongly disagree: 1              2              3              4              5              6              7: Strongly agree

Part 2. Demographics

Please note that this survey is anonymised and therefore, any details you provide will not be traceable or identifiable to you specifically. Please answer the following questions by providing responses to free text spaces or circling the appropriate answer.

1. Nursing Position/Department __________

2. Age __________

3. Gender: male, female

4. Nationality: Saudi, other (please specify) __________

5. Duration of nursing experience __________

6. Education: diploma, bachelor’s

7. degree, Master’s degree, other (please specify)

END OF SURVEY – THANK YOU

Appendix 3. Tests of normality.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>p-value</th>
<th>Skewness Statistic</th>
<th>SE</th>
<th>Kurtosis Statistic</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intentions</td>
<td>0.776</td>
<td>278</td>
<td>0.340</td>
<td>-1.526</td>
<td>0.146</td>
<td>1.998</td>
<td>0.291</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>p-value</th>
<th>Skewness Statistic</th>
<th>SE</th>
<th>Kurtosis Statistic</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes</td>
<td>0.963</td>
<td>278</td>
<td>0.090</td>
<td>-0.670</td>
<td>0.146</td>
<td>0.921</td>
<td>0.291</td>
</tr>
<tr>
<td>Subjective Norms</td>
<td>0.882</td>
<td>278</td>
<td>0.078</td>
<td>-1.052</td>
<td>0.146</td>
<td>0.530</td>
<td>0.291</td>
</tr>
<tr>
<td>Perceived Behavioural Control</td>
<td>0.955</td>
<td>278</td>
<td>0.157</td>
<td>0.524</td>
<td>0.146</td>
<td>-0.395</td>
<td>0.291</td>
</tr>
<tr>
<td>Behavioural Beliefs and Outcome</td>
<td>0.822</td>
<td>278</td>
<td>0.357</td>
<td>-1.728</td>
<td>0.146</td>
<td>3.763</td>
<td>0.291</td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Controls Beliefs and Control Belief Power</td>
<td>0.962</td>
<td>278</td>
<td>0.230</td>
<td>-0.718</td>
<td>0.146</td>
<td>0.505</td>
<td>0.291</td>
</tr>
<tr>
<td>Normative Beliefs and Motivations to Comply</td>
<td>0.974</td>
<td>278</td>
<td>0.170</td>
<td>0.267</td>
<td>0.146</td>
<td>0.758</td>
<td>0.291</td>
</tr>
</tbody>
</table>

**Appendix 4. Summary of multicollinearity testing (predictor variables v. dependent variable)**

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Attitudes</td>
<td>0.520</td>
<td>1.922</td>
</tr>
<tr>
<td>B: Subjective Norms</td>
<td>0.611</td>
<td>1.635</td>
</tr>
<tr>
<td>C: Perceived Behavioural Control</td>
<td>0.910</td>
<td>1.099</td>
</tr>
<tr>
<td>E: Behavioural Beliefs and Outcome Evaluation</td>
<td>0.369</td>
<td>2.526</td>
</tr>
<tr>
<td>F: Controls Beliefs and Control Belief Power</td>
<td>0.715</td>
<td>1.398</td>
</tr>
<tr>
<td>G: Normative Beliefs and Motivations to Comply</td>
<td>0.772</td>
<td>1.295</td>
</tr>
</tbody>
</table>
Specify Information (TPB)

Develop interview questions according to the theory
Content & wording
Response format

Revise

YES
Pilot test (2 participants) to assess feasibility

NO

Final draft

Semi structure interview (open end questions, and administration Exploratory test (9-12 participants)

some interviews were in Arabic, I translated to English then I asked 2 senior nursing member to translate Arabic to English and English to Arabic as was same meaning

- I showed the content analysis to the interview participants as they agree about the themes

Validaty/ face- content- from expert nursing and infection control
construct from my supervisor
Pilot / 43) participant, 10% from participant
Reliability / internal consistency-test re-test (one week)

Analysis

Appendix 5
Appendix 6. Logistic Regression

Frequency statistics show that total 278 participants participated in the study and among them 27 participants from Diploma, 241 participants from Bachelor, 10 participants from Master in terms of education, 49 participants are male and 229 participants are female in terms of gender, 137 participants from ICU and 141 participants from Non-ICU in terms of Department, 96 participants from Saudi and 182 participants from Non-Saudi in terms of nationality, 48 participants have experience from 1 to 5 years and 230 participants have experience for more than 6 years, and 208 participants are aged between 35 and less and 70 participants are aged between 36 and more.

<table>
<thead>
<tr>
<th>Classification Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observed</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Predicted</strong></td>
</tr>
<tr>
<td>CA Intention</td>
</tr>
<tr>
<td>Percentage Correct</td>
</tr>
<tr>
<td>Less Complaince</td>
</tr>
<tr>
<td>More Complaince</td>
</tr>
<tr>
<td>Intention</td>
</tr>
<tr>
<td>Less Complaince</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>75</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>More Complaince</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>203</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>Overall Percentage</td>
</tr>
<tr>
<td>73</td>
</tr>
</tbody>
</table>

a. Constant is included in the model.
b. The cut value is .500

Figure 23: Classification Table Source: Primary study
The above data shows compliance has a significant impact on the behavioural intentions of the nurses and compliance is also very much capable to predict the intentions as well.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>S. E.</th>
<th>Wald</th>
<th>Sig.</th>
<th>Score</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct attitude</td>
<td>0.996*</td>
<td>0.135</td>
<td>54.298</td>
<td>0.00</td>
<td>81.838*</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Indirect attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.164*</td>
<td>1</td>
<td>0.00</td>
</tr>
<tr>
<td>Direct SN</td>
<td></td>
<td></td>
<td>49.538*</td>
<td>1</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect SN</td>
<td></td>
<td></td>
<td>6.072*</td>
<td>1</td>
<td>0.014</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct PBC</td>
<td></td>
<td></td>
<td>0.673*</td>
<td>1</td>
<td>0.412</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect PBC</td>
<td></td>
<td></td>
<td>25.076*</td>
<td>1</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>21.474*</td>
<td>1</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>4.202*</td>
<td>1</td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>2.555</td>
<td>1</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td>9.953*</td>
<td>1</td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience</td>
<td></td>
<td></td>
<td>1.189</td>
<td>1</td>
<td>0.275</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department</td>
<td></td>
<td></td>
<td>0.281</td>
<td>1</td>
<td>0.596</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Statistics</td>
<td>122.393*</td>
<td></td>
<td></td>
<td>13</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 24: Classification Table Source: Primary study

Direct attitude, Indirect attitude, Direct SN, Indirect SN, Indirect PBC, age, Gender, and Nationality are significantly capable of predicting the behavioural intentions of the nurses. Whereas, Education, Direct PBC, experience, and department are not statistically significant in predicting the behavioural intentions of the nurses.
The Chi-square score is 140.634, df score is 13, and p value score is 0.000 in the Omnibus test and Chi-square score is 6.148, df score is 8, and p value score is 0.631 in Hosmer and Lemeshow test. So, the study model is statistically significant in the Omnibus test but is not statistically significant in Hosmer and Lemeshow test.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
<th>B</th>
<th>95% C.I. for EXP(B)</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct attitude alpha .727</td>
<td>0.397*</td>
<td>0.577*</td>
<td>0.000</td>
<td>0.85*</td>
<td>0.24</td>
<td>12.51</td>
</tr>
<tr>
<td>Indirect attitude alpha .921</td>
<td>0.999*</td>
<td>0.3</td>
<td>11.36</td>
<td>1</td>
<td>0.00</td>
<td>2.72</td>
</tr>
<tr>
<td>Direct SN alpha .928</td>
<td>0.114</td>
<td>0.15</td>
<td>0.545</td>
<td>1</td>
<td>0.46</td>
<td>1.12</td>
</tr>
<tr>
<td>Indirect SN alpha .832</td>
<td>0.155</td>
<td>0.26</td>
<td>0.355</td>
<td>1</td>
<td>0.55</td>
<td>1.17</td>
</tr>
<tr>
<td>Direct PBC alpha .767</td>
<td>0.1</td>
<td>0.12</td>
<td>0.719</td>
<td>1</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Indirect PBC alpha .912</td>
<td>0.564*</td>
<td>0.23</td>
<td>5.878</td>
<td>1</td>
<td>0.02</td>
<td>1.76</td>
</tr>
<tr>
<td>Age</td>
<td>-1.31*</td>
<td>0.63</td>
<td>4.266</td>
<td>1</td>
<td>0.04</td>
<td>0.27</td>
</tr>
<tr>
<td>Gender</td>
<td>0.388</td>
<td>0.71</td>
<td>0.296</td>
<td>1</td>
<td>0.59</td>
<td>1.47</td>
</tr>
<tr>
<td>Education</td>
<td>-2.46</td>
<td>2.75</td>
<td>0.801</td>
<td>1</td>
<td>0.37</td>
<td>0.09</td>
</tr>
<tr>
<td>Nationality</td>
<td>-0.11</td>
<td>0.63</td>
<td>0.032</td>
<td>1</td>
<td>0.86</td>
<td>0.89</td>
</tr>
<tr>
<td>Experience</td>
<td>0.52</td>
<td>0.56</td>
<td>0.863</td>
<td>1</td>
<td>0.35</td>
<td>1.68</td>
</tr>
<tr>
<td>Department</td>
<td>-0.45</td>
<td>0.4</td>
<td>1.271</td>
<td>1</td>
<td>0.26</td>
<td>0.64</td>
</tr>
<tr>
<td>Constant</td>
<td>9.76</td>
<td>3.47</td>
<td>7.93</td>
<td>1</td>
<td>0.01</td>
<td>0</td>
</tr>
</tbody>
</table>

Dependent Variable: Intention (alpha .875)

* Statistically significant

Logistic Regression summary

Source: Primary Survey
Logistic Regression summary shows that Nagelkerke R Square is 0.577 with a significance level of 0.000 which means the model can explain 57.7% variance of Intention and the relationship is statistically significant. Direct attitude, indirect attitude, and Indirect PBC are positively related to Intention and the relationship is statistically significant. Direct SN, Indirect SN, Experience, and Gender are also positively related to Intention, but the relationship is not statistically significant. Age is negatively related to Intention and the relationship is statistically significant. Whereas Direct PBC, Education, Department, and Nationality are negatively related to Intention and the relationship is not statistically significant.

**Appendix 7. Outputs of validity & reliability testing.**

Table 15. Intraclass correlation coefficients for attitude items (n=6).

<table>
<thead>
<tr>
<th>Survey Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PPE policy and patient safety</td>
<td>0.43</td>
<td>*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. PPE policy and patient harm</td>
<td>-</td>
<td>0.30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. PPE policy and patient recovery</td>
<td>-</td>
<td>-</td>
<td>0.52</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. PPE adherence difficulty</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.35</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. PPE adherence comfortability</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.62*</td>
<td>-</td>
</tr>
<tr>
<td>6. PPE exposure effectiveness</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.55**</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01

Table 16. Intraclass correlation coefficients for behavioural beliefs and outcome evaluation items (n=9).
<table>
<thead>
<tr>
<th>Survey Items</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. PPE policy and protection from infection</td>
<td>0.55**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>19. PPE confidence in protection from infection</td>
<td>-</td>
<td>0.30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20. PPE lower infection rates</td>
<td>-</td>
<td>-</td>
<td>0.73**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>21. PPE reduce length of stay</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.70**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>22. PPE will reduce mortality</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.36</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>23. PPE and better nursing</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.65**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01

Table 17. Intraclass correlation coefficients for subjective norms items (n=6).

<table>
<thead>
<tr>
<th>Survey Items</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Other nurses’ expectations to comply with PPE</td>
<td>0.57**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Doctors expectations to comply with PPE</td>
<td>-</td>
<td>0.34</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Managers expectations to comply with PPE</td>
<td>-</td>
<td>-</td>
<td>0.54**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Other staff expectations to comply with PPE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.39*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8. Patients expectations to comply with PPE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.38*</td>
<td>-</td>
</tr>
<tr>
<td>9. Visitors expectations to comply with PPE</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.52*</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01

Table 18. Intraclass correlation coefficients for normative beliefs and motivation to comply items (n=17).
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.7 **</td>
<td>0.6 **</td>
<td>0.45 *</td>
<td>0.5 *</td>
<td>0.7 **</td>
<td>0.35</td>
<td>0.4 **</td>
<td>0.7 **</td>
<td>0.7 **</td>
<td>0.6 **</td>
<td>0.3</td>
<td>0.6 **</td>
<td>0.5 **</td>
<td>0.6 **</td>
<td>0.5 **</td>
</tr>
<tr>
<td></td>
<td>6 **</td>
<td>6 **</td>
<td></td>
<td>5 *</td>
<td>7 **</td>
<td></td>
<td>4 **</td>
<td>8 **</td>
<td>1 **</td>
<td>5 **</td>
<td>6 **</td>
<td>1 **</td>
<td>6 **</td>
<td>3 **</td>
<td>4 **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Table 19. Intraclass correlation coefficients for perceived behavioural control items (n=5).**

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Confidence in adherence to PPE</td>
<td>0.51*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11. Access to PPE</td>
<td>-</td>
<td>0.51*</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12. Personal decision to use PPE</td>
<td>-</td>
<td>-</td>
<td>0.50*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13. Judgement to inform PPE use</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.80**</td>
<td>-</td>
</tr>
<tr>
<td>14. Judgement other staff to guide PPE use</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.62**</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01

**Table 20. Intraclass correlation coefficients for control beliefs and control belief power items (n=19).**

|                         | 2  | 7  | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
|-------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 27. Variance in PPE compliance | 0.33 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 28. PPE use guided by nationality | 0.50* |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 29. Guilt regarding PPE use |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0.78** |
| 30. Culture supportive of PPE |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0.42* |    |    |    | 0.4*
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>31.</td>
<td>Under-appreciation</td>
<td>0.56 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>PPE use requires support from admin staff</td>
<td>0.44 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>PPE use requires support from doctors</td>
<td>0.44 *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>PPE use requires support from nurse managers</td>
<td>0.54 **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>PPE use requires blame-free culture</td>
<td>0.21</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>36.</td>
<td>Blame-free culture improve PPE adherence</td>
<td>0.49 *</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>37.</td>
<td>Negativity compound PPE use</td>
<td>0.70 **</td>
<td></td>
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</tr>
<tr>
<td><strong>38. PPE reduces racism</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>39. Poor availability PPE impairs use</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>40. Poor quality PPE impairs use</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.42</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>41. Poor manager reactivity to safety impedes PPE use</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>42. Excess Paperwork impedes PPE use</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 21. Intraclass correlation coefficients for nurses’ intentions items (n=3).

<table>
<thead>
<tr>
<th>Survey Items</th>
<th>15</th>
<th>16</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Extent of intentions to comply with PPE</td>
<td>0.71**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16. In proceeding month, intentions to comply</td>
<td>-</td>
<td>0.69*</td>
<td>-</td>
</tr>
<tr>
<td>17. Determination to comply with PPE over proceeding month</td>
<td>-</td>
<td>-</td>
<td>0.61*</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01
Appendix 8: IRB of Tabouk region

Principal Investigator: HANADI DAKHILALLAH
Protocol Title: Using the Integrative Behavioural Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE) in hospitals in, Saudi Arabia: a PhD research proposal with contextual focus upon emerging RNA viruses.

IRB Protocol No: TU-077/020/043
IRB Review Type: Expedited
IRB Review Action: Approved

Dear HANADI
The Institutional Review Board (IRB), General Directorate of Health Affairs, Tabuk Region [Registration No. H-07-TU-077] has recently reviewed your research protocol along with all relevant documents, and an ethical approval has been granted for the protocol.

Date of IRB approval: July 01, 2020
Standard conditions of this approval are:
1. The researchers shall conduct the research strictly in accordance with the proposal submitted and granted ethical approval, including any amendments made to the proposal required by the IRB-Tabuk.
2. The researchers shall be responsible for preserving confidentiality of the participants' data.
3. The principal investigator shall provide the IRB-Tabuk with a periodic report of the research every six months, and a final report when the project is complete.
4. The periodic/final report shall contain all the details of the research and its phases.
5. The IRB-Tabuk shall conduct periodic monitoring/follow-up of the project to ensure the consistency with the approved research protocol.

Head of Institutional Review Board
General Directorate of Health Affairs, Tabuk

Dr. Ghormalin Saullah Alghamdi

Fax: 0144229956
Email: irb-tabuk@moh.gov.sa
Appendix 9: University of Edinburgh IRB

Dear Hanadi Dahiallah,

Application for Ethical Approval

Reference: NURS50
Project Title: Using the integrative Behavioral Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE) in hospitals in Saudi Arabia: a PhD research proposal with contextual focus upon emerging RNA viruses

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 12th August 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 Anonen

Administrative Secretary
School of Health in Social Science
Appendix 10: Consent form

Participant Information Sheet

Using the Integrative Behavioural Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE) in hospitals in Saudi Arabia: a PhD research proposal with contextual focus upon emerging RNA viruses

My name is Hanadi Dakhilallah, a Doctoral student in Nursing Studies at the University of Edinburgh. I am doing a Doctoral research project to investigate perceptions and beliefs towards compliance with personal protective equipment use and policy among a multicultural nursing workforce in hospitals in the north of Saudi Arabia. This research is in fulfilment of the requirements for the degree of PhD in Nursing.

You are invited to take part in a research study. To help you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish. Contact us if there is anything that is not clear, or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

This project is being undertaken as part of the PhD program in nursing at the School of Health in Social Science, University of Edinburgh. This doctoral studentship is supervised by Dr. Sheila Rodgers, and Dr. Jennifer Tocher in Nursing Studies, School of Health in Social Science, University of Edinburgh, UK. The purpose of this project is to understand factors related to nurses’ behaviors and intentions to comply with personal protective equipment policies in the Tabouk region of Saudi Arabia.

This project involves interview questionnaires using open-ended questions in order to elicit information about beliefs towards compliance with the personal protective equipment policy among the multicultural nursing workforce at Tabouk region hospital and from the result of the elicitation study will construct the
questionnaire. The researcher requests your assistance with this project, which aims to help to ensure the quality and safety of nursing care.

<table>
<thead>
<tr>
<th>Why have I been invited to take part?</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are being asked whether you would like to participate in this study because registered nurses constitute the largest professional group employed in Tabuk region hospitals. The selection of participants for this study focuses on all qualified post probation nurses working in all department that performing personal protective equipment will be being asked to participate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do I have to take part?</th>
</tr>
</thead>
<tbody>
<tr>
<td>No, it is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. Deciding not to take part or withdrawing from the study will not affect the healthcare that you receive, or your legal rights.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What will happen if I take part?</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you decide to participate you will answer some questions within the interview regarding beliefs towards compliance with personal protective equipment practice. This should take 60 minutes for the interview. Completing a questionnaire will take around 20 to 30 minutes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is there anything I need to do or avoid?</th>
</tr>
</thead>
<tbody>
<tr>
<td>You do not need to do or avoid anything</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are the possible benefits of taking part?</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are no direct benefits to you taking part in this study, but the results from this study might help to improve practices with PPE and the healthcare of patients in the future.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are the possible disadvantages of taking part?</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are no risks attached to your participation in this study.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What if there are any problems?</th>
</tr>
</thead>
<tbody>
<tr>
<td>If you wish to make a complaint for any reason, if you have any concerns regarding any aspect of your involvement or if you feel that you have been placed</td>
</tr>
</tbody>
</table>
at risk, please contact the lead supervisor Dr. Sheila Rodgers s.rodgers@ed.ac.uk.

**What will happen if I don't want to carry on with the study**

You have the right to participate or not, and you will be able to withdraw from the research at any time without giving a reason and without any consequence, even after you have agreed to take part.

**What happens when the study is finished?**

This project will abide by the terms of the Data Protection Act. All the information collected during the study will be kept confidential and will be stored in accordance with strict privacy protection procedures. The results of this study will not contain personal identifying information (i.e., the data will be anonymous). All data will be kept securely in a password-protected form by the researcher, and only others who are involved in the data analysis will be eligible to access the data. The research data will be retained for a period of 5 years in accordance with the data protection policy at School of Health in Social Science, University of Edinburgh.

**Will my taking part be kept confidential?**

All the information we collect during the course of the research will be kept confidential and there are strict laws which safeguard your privacy at every stage. For details on what data will be held about you and who will hold and store this information, please refer to the Data Protection Information Sheet.

**What will happen to the results of the study?**

This study will be written up as a PhD thesis then for publication in journals and conferences and we will notify the participants by displaying and circulating information in the hospitals. You will not be identifiable from any published results.

**Who is organizing and funding the research?**

The study is being funded by myself as a PhD study.

**Who has reviewed the study?**
The study proposal has been reviewed by IRB committee Tabouk region
IRB protocol No: TU-077/020/043
- School of Health in Social Science Research Ethics Edinburgh University
  Reference: NURS050

**Researcher Contact Details**
If you have any further questions about the study, please contact
  Name: Dakhilallah Hanadi
  E-mail:

**Independent Contact Details**
Name: RODGERS Sheila
  E-mail:
  Name: TOCHER Jennifer
  E-mail:

**Complaints**
If you have any concerns about the study, please contact Professor Matthias Schwannauer, Head of School, School of Health in Social Science, hos.health@ed.ac.uk.
If you wish to make a complaint about the study, please contact the University of Edinburgh Research Governance Team at cahss.res.ethics@ed.ac.uk.
For general information about how we use your data go to:
https://www.ed.ac.uk/records-management/privacy-notice-research
To submit a formal complaint to the university, please go to:
https://www.ed.ac.uk/files/imports/fileManager/WEB%20Complaint%20Form.pdf
Consent Form

Using the Integrative Behavioural Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE) in hospitals in Saudi Arabia: a PhD research proposal with contextual focus upon emerging RNA viruses

Please initial box

1. I confirm that I have read and understand the information sheet (DD MMM YYYY and Version Number) and the Data Protection Information Sheet (DD MMM YYYY and Version Number) for the above study. I have had the opportunity to consider the information, ask questions and have had these questions answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my medical care and/or legal rights being affected.

3. I understand that data collected about me during the study may be converted to anonymized data.

4. I agree to my anonymized data and/or tissue being used in future studies.

5. I agree to my interview being audio/video recorded.

6. I agree to my audio/video recorded interview being transcribed by a third-party contractor.

7. I agree to take part in the above study.

   Yes   No

____________________________   ______________________   ______________________

Name of Person Giving Consent   Date   Signature

____________________________   ______________________   ______________________

Name of Person Receiving Consent   Date   Signature

1x original – into Site File; 1x copy – to Participant; 1x copy – into medical.
Online consent for questionnaire

Using the Integrative Behavioural Model to explore the factors influencing nurse adherence towards personal protective equipment (PPE) in hospitals in, Saudi Arabia: a PhD research proposal with contextual focus upon emerging RNA viruses

Please complete this short survey. There are no right or wrong answers. Your responses to this survey will help us explore the factor that influence nursing behavioral intentions toward perform the personal protective equipment policy of infection prevention & control in Saudi Hospitals

I declare that I have been informed of the nature of the study, its purpose, and its duration

- I voluntarily agree to participate in this research study.
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I have had the purpose and nature of the study explained to me and I have had the opportunity to ask questions about the study.
- I understand that I will not benefit from participating in this research.
- I understand that all information I provide for this study will be treated confidentially.
- I understand that in any report on the results of this research my identity will remain anonymous.
- I understand that if I inform the researcher that myself or someone else is at risk of harm, they may have to report this to the relevant authorities
  - they will discuss this with me first but may be required to report with or without my permission. I understand that I am free to contact any of the researcher to seek further clarification and information.
**Researcher:**
We confirm that no pressure was applied to participant to agree to take part in the study and that we are willing to answer any additional questions if required.

Name: DAKHILALLAH Hanadi E-mail
Name: RODGERS Sheila E-mail:
Name: TOCHER Jennifer E-mail:

By completing this survey, you are consenting to participate in this study.
Appendix 11. Examples of inductive coding.

<table>
<thead>
<tr>
<th>First code</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Raw Data</strong></td>
<td>&quot;Following the PPE, will protect the patient, ourselves and our family from infection&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Personal protective equipment which important for protecting ourselves and our patients from infection&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Equipment used to protect ourselves and patients from infection&quot;</td>
</tr>
<tr>
<td></td>
<td>&quot;Personal protective equipment using to save us and patient&quot;</td>
</tr>
<tr>
<td><strong>Deletions</strong></td>
<td>&quot;Using PPE where appropriate elicited feelings that both staff and patients were protected from infectious disease&quot;</td>
</tr>
<tr>
<td><strong>Reasoning</strong></td>
<td>Repetition</td>
</tr>
<tr>
<td><strong>Initial Code</strong></td>
<td>Focus on providing high-quality care</td>
</tr>
<tr>
<td><strong>Definition</strong></td>
<td>This code emerged from data concerning participants’ responses that were positive in relation to the provision of high-quality care. In the context of PPE use, nurses held positive views about how PPE adherence could protect patients and staff from infectious diseases.</td>
</tr>
<tr>
<td><strong>Revised Code</strong></td>
<td>Contentedness with providing high-quality care</td>
</tr>
<tr>
<td><strong>Theme</strong></td>
<td>Prioritising patient care and safety</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second code</th>
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<tbody>
<tr>
<td><strong>Raw Data</strong></td>
<td>&quot;Not always available [PPE], if there will be in a small amount in the storeroom and the rest in a closed room, if we need extra PPE we have to</td>
</tr>
</tbody>
</table>
request and wait for the head nurse to authorise its release

"Head nurses sometimes count it every morning, then threaten us, about why we used more"  

"I'm using it according to patient condition and availability of the equipment as they are calculating the equipment and not giving us more than one per shift"

| Deletions | "Ability to access and provide patient care with senior staff when needing to use PPE during the care of patients with invasive devices"

**Reasoning**  
Repetition of the issue

**Initial Code**  
Availability to staff

**Definition**  
This code emerged from data related to participants' needs and valuing of other staff members' support. This was support regarding care provision. In infection control contexts, support was valued in performing important practices, such as caring for patients with invasive devices

**Revised Code**  
Supportive feelings

**Theme**  
Cultures that fail to advocate the best infection prevention and control practices
References


NMC. 2018. *The Code: Professional standards of practice and behaviour for nurses and midwives* [Online]. Available at:
Noble, H. and Smith, J. 2015. Issues of validity and reliability in qualitative research. Evidence Based Nursing, 18, 34-35. Available at: https://ebn.bmj.com/content/ebnurs/18/2/34.full.pdf [accessed: 05/11/2020]


Savulescu, J. 2021. Good reasons to vaccinate: mandatory or payment for risk? *Journal of Medical Ethics*, 47, 78-88. Available at: http://jme.bmj.com/content/47/2/78.abstract [accessed: 21/04/2021]


