THESIS presented for the Degree of M.D. by Jessie Anne Scott, M.B., Ch.B., D.P.H.

on

A Study of Pigmentation in Relation to Disease in Children.

A STUDY IN PIGMENTATION IN RELATION TO DISEASE IN CHILDREN.

INTRODUCTORY.

Those who have opportunities of passing under review large numbers of individuals composing any given population cannot fail to be struck by the varying types encountered differing in physical characteristics and mental constitution. During the course of school medical inspection I had opportunities of making such observations amongst a considerable body of children who may fairly be regarded as being representative of the districts considered, if not typical of the child population of London.

The immediate object of medical inspection being the discovery of disease, it followed that attention was first directed to the possibility of finding a correlation between certain physical characters and particular morbid processes. The study of pigmentation as evidenced in the colour of the hair and iris was the subject selected, since it was possible to obtain the data readily by direct observation, independent of any co-operation on the part of the individuals observed.

SOURCE OF DATA.

The materials were collected by myself in the course of inspection carried out in the autumn and winter months of 1911-12 in the districts of Central Hackney in north-east London, and in Bermondsey and Rotherhithe, south of the Thames.

METHODS ADOPTED.

Verbal methods of colour classification were used comparable with those of Beddoe and the Anthropometric Committee of the British Association.

SCHEME OF CLASSIFICATION OF HAIR COLOUR.

1 Red.	All shades which approach more nearly to red than to brown, yellow and flaxen.
2 Fair.	Yellow, flaxen and golden.
3 Light Brown.	
4 Medium Brown.	
5 Dark Brown.	
6 Black.	

A division of the lighter browns into light and medium was made in order to obtain a point at which if necessary a general division of the whole could be made into light and dark groups.

SCHEME OF CLASSIFICATION OF EYE COLOURS.

1 Light.	Blue, all shades, bluish grey, light grey, lightest green.
2 Neutral.	All shades not included under Light or Dark.
3 Dark.	Brown, dark brown or black.

It was found more useful on account of the comparatively small total number of observations, to include pure blue and dark blue eyes in the light division, rather than to create a separate category.

Beddoe (1) points out that the mere categorical representation of blonde and brunette types does not bring out ethnological facts nearly so distinctly as does his factor the Index of Nigrescence. This is obtained by substracting the number of red and fair-haired individuals from the dark-brown haired together with twice the black-haired. From the gross index, a net or percentage index is arrived at. Similarly the Iris Index is obtained by substracting the number of light-eyed from that of the dark-eyed persons. These indices will be referred to frequently in the course of this paper.

A classification of material was made according to sex, and again into senior and junior age groups. It was expected that the latter division would show the well-known change in the direction of darkness occurring with

increasing age, and that it might prove useful by giving evidence of the operation of a genetic factor. Measles has been shown(2) in the school standards to have rendered 60 per cent of children immune, practically all having been exposed to the risk of infection while in the Infants departments. In scarlet fever 45 per cent of attacks occur under five years; in whooping cough 96 per cent of deaths, and in diphtheria 53 per cent of deaths are below that age. (3) The Junior Group, aged three to seven, were from the Infants departments; the Seniors, aged eight to thirteen from the Standards.

Those morbid processes of childhood selected for record were such as are found to be present in sufficiently large numbers to be of statistical value. Cases of, for instance, pulmonary tuberculosis, were too rare to be adduced as evidence in support of any theory of selection. The presence of hypertrophied adenoid tissue about the upper respiratory tract as evidenced by adenoids, enlarged tonsils, cervical glands, or by signs of bronchial glands, was recorded as one defect where such evidences occurred singly or collectively in one individual. Dental caries, the minor signs of rickets, respiratory disease other than phthisis, and organic disease of the heart yielded a considerable body of material.

The infectious diseases history was noted for each case. Statistics compiled from histories obtained during medical inspection are liable to considerable error. The

parent's statement is not invaribly reliable, and in the absence of the parent the word of elder children has to be accepted. I have not at hand a record of the percentage of parents who attended during the period when the materials were being collected, but would place it roughly at from 60 to 70 per cent. It is probable that in some 10 per cent of cases the history is wanting or doubtful. The zymotic diseases investigated were measles, whooping cough, chicken-pox, scarlet fever and diphtheria.

GENERAL OBSERVATIONS ON THE HISTORICAL ASSOCIATIONS, SANITARY INDUSTRIAL & SOCIAL EVOLUTION OF THE DISTRICTS STUDIED.

The important factor of social environment always warrants careful study in view of its potency in working changes in a stock by selection. Racial characters themselves must be the outcome to a great extent of certain surroundings, particular soils, climates or geographical features. Traits gradually acquired from long exposure to given conditions persist and transmitted. In order to gain some perspective in a review of the environmental agencies obtaining in London generally and in those areas in particular where my enquiries were conducted, it will be useful to make some mention of their history, and briefly to discuss their sanitary, industrial and social evolution.

The London of the Elizabethan period is seen to have extended little beyond the area now known as the "City". Beyond the city gates whose names still remain, Bishopsgate, Moorgate, Aldersgate and the rest, was open country. On the south side of the river there was little more than a fringe of houses. Much interesting topographical information may be gleaned from the pages of Herball, a botanical work published in 1597 by Gerard. A reference to Hackney occurs, describing it as a "village neere London". Two centuries later this village is mentioned by Maitland as "excelling all other villages in the Kingdom, and probably on earth in the riches and opulence of its inhabitants". This seems to have been the zenith of the fortunes of Hackney, for since then the locality has tended to become poorer and more crowded. The reasons for this change are closely associated with the growth of London's trade, commerce and industry. Charles Booth (4) frequently refers to the centrifugal movement of city populations. As people begin to prosper the tendency is for them to move further out. Thus in Hackney during the last half century there has been a constant flitting, and each class as it moved has been replaced by a slightly poorer and lower one. The census of 1871 showed a marked increase in population, but the last Registrar General's

Return shows that a slight diminution is now taking place.

Early topographical description of the south side of the Thames is again gleaned from Gerard. The present district of Bermondsey was the site of the mansion and grounds of the Earls of Sussex, and was surrounded by fields and woods. In earlier times still a fine old abbey formed a stately landmark. It is difficult now to imagine that these pastoral scenes could ever have existed where now the vast characterless and invertebrate south London district spreads its network of dingy streets in a sordid succession of artisan cottages, tenements and slums; missions, public-houses, docks, warehouses and factories. The population of Bermondsey now consists mainly of a struggling artisan class, containing a considerable population drawn from the lowest dregs of humanity. The worst elements occur towards the riverside where they intermittently engage in casual labour. The Cockney Irishman occurs here - an easy-going type who seldom reads, sometimes works, and frequently is found living upon the earnings of his women-folk. A considerable proportion of women are employed extra-domestically at varied forms of work. Some are engaged at factories, some at sweated outwork, others as charwomen or even woodchoppers. Bermondsey has long been the home of the tanning industry, and this still provides occupations for many. In the more respectable

EAST LONDON & HACKNEY.

Showing proportion of population of E. London & Hackney born outside London.

districts the occupations may be described generally as commercial and industrial.

The great impetus to British trade and commerce which occurred in the earlier part of the 19th century resulted in marked changes in the distribution of the population of London. The "city" became entirely a business centre, and this fact determined the displacement of the old population outwards to new suburbs, and dominated housing and sanitary arrangements. In 1851 the population of the city was only 128,000 as compared with the 2½ millions inhabitating the metropolis. At this time the increase due to immigration was very great, constituting indeed 37 per cent of the population (5). The districts particularly under review shared in the general increase. That of Hackney has been mentioned, while a correspondingly large numerical gain occurred south of the Thames. The constitution of this immigrant population has a direct bearing on the subject of this paper, since it brought in new blood, chiefly from the agricultural counties.

Charles Booth has aptly classified immigrants into "drift" and "current". The former class includes the flotsam and jetsam from other parts drifting in in the hope of finding an easy means of subsistence. Current immigration is an influx of the courageous and enterprising

who are attracted to the sources of industry and employment. This type of incomer would be expected to enhance the vitality of the population if he proves himself able to survive under urban environment. Some mention needs to be made of progress in sanitary affairs. Early in the 19th century, the housing conditions and sanitary state of the metropolis almost baffled description. Practically no local government existed outside the city, so that the remedy of existing evils was the business of no one. The Thames, into which all sewage was discharged, was itself little better than a foul sewer. Open ditches conveyed the sewage in many districts - including Bermondsey, Rotherhithe and Hackney - to the river, and formed potent fever foci. The water supply was often badly polluted. Overcrowding had reached its maximum Tenement houses abounded, associated with airless alleys, courts and cul-de-sacs. No sanitary conveniences were provided in such buildings. Trade nuisances were common in many districts, and especially prevalent in Rotherhithe, Bermondsey and Hackney. The sanitary chaos of this period is reflected in the infantile mortality rates. More than half the children born were dying within the first year of life. In Bermondsey in 1850, 506 deaths out of 983 were under five years. From this period onward sanitary legislation began to take

definite form . The appointment of medical Officers of Health able to make use of the new legislative machinery resulted in a gradual but complete sanitary revolution. Bermondsey still possesses the highest infantile mortality rates in London, but has made some progress towards improvement in this respect. The environment which was responsible for the elimination of infants in such large numbers could not fail to act deleteriously on the survivors. It is probable that reinforcement by immigration supplied new vitality to an enfeebled population.

PIGMENTATION AND URBAN SELECTION.

Mayr in Bavaria first demonstrated the fact which had been earlier commented on by Beddoe, that city populations had a distinct brunette tendency. This has been shown by subsequent observers to obtain in nearly all large cities. Tocher (6) finds in Scotland that Glasgow is significantly darker than the general population. In 1890 Ammon of Carlsruhe promulgated the theory, since known as Ammon's law, that the Teutonic race shows a special aptitude for city life. A study of the facts, however, proves that of the three physical characters taken, viz: long-headedness, tall stature, and blondness, the two former only find partial support. The evidence in favour of brunetteness rather than blondness in towns

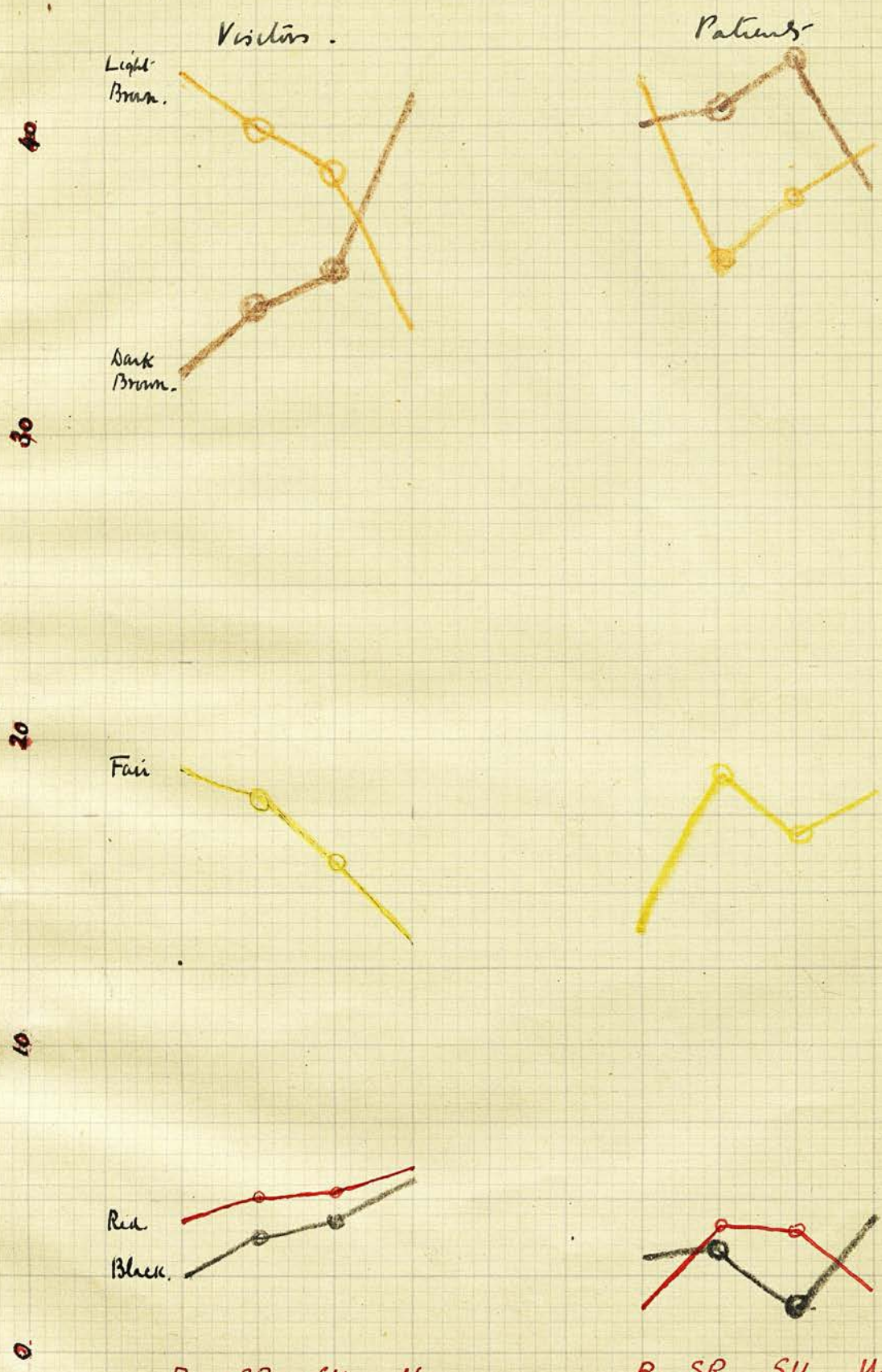
is conclusive, as is shown by the following table:-

City populations are fairer in	No difference between town and country in	City populations are darker in
Metz (children) Switzerland (adults of chief towns)	Most of the smaller Continental towns.	Germany (except Metz) Cities of the Rhine Valley (adults) Bavaria Austria Italy British Isles Boston, U.S.A. Baden.

Another method employed by Ammon in considering the long-headedness of city populations is that of division into classes: urban when the parents and persons observed were of city birth, semi-urban when the parents were immigrants from the country, and semi-rural when the individuals, though born in the country, had emigrated to the towns. A fourth group may be added comprising persons born and living in the country. This classification may usefully be applied in relation to pigmentation.

A study under these headings of visitors to London hospitals showed that there was a progressive increase of dark traits passing from rural to urban groups. This increase was not so well shown in a corresponding record of hospital patients. The total number of observations, however, was not large enough to be more than suggestive.

Hair colour.

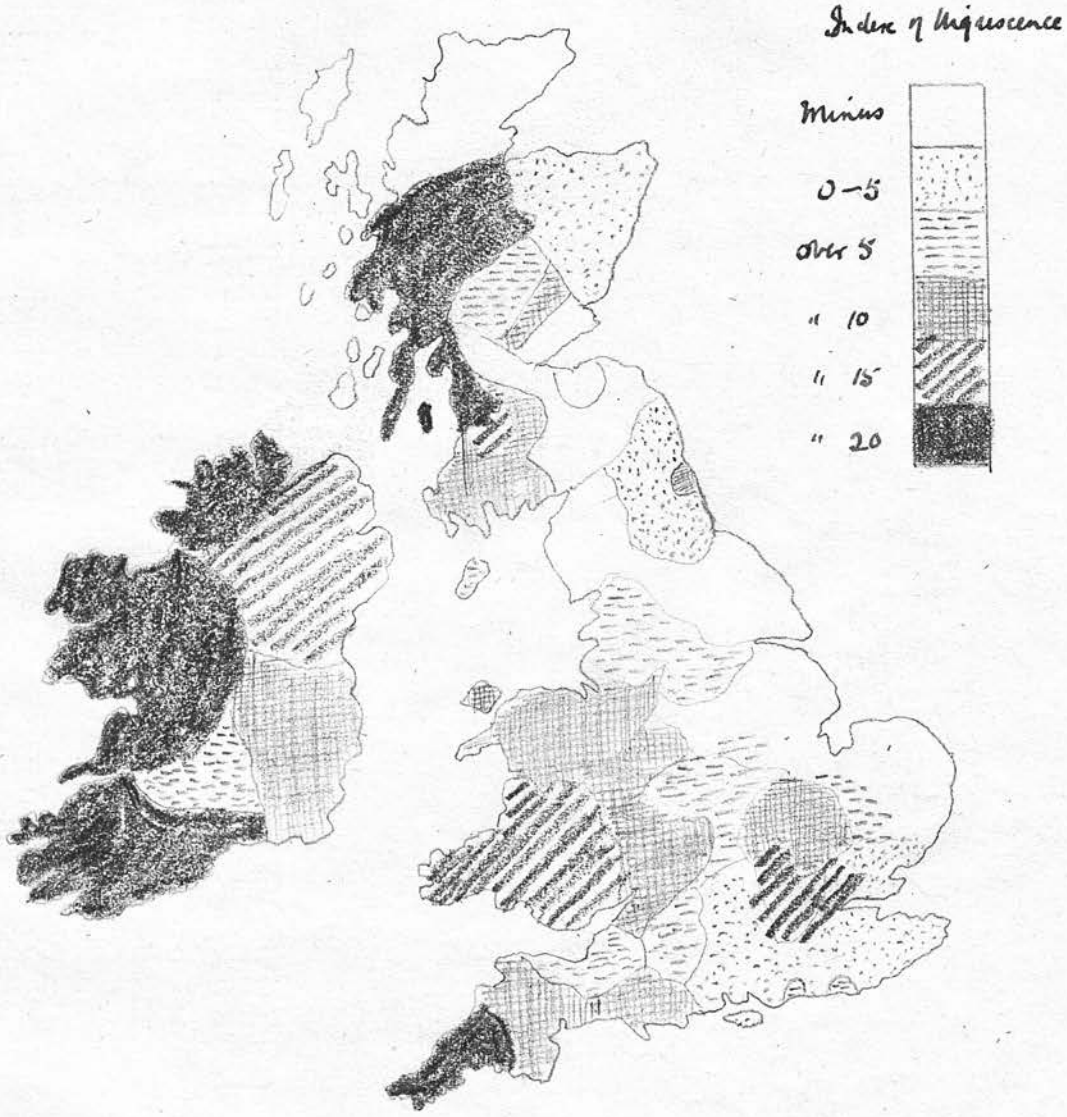


Percentage Frequency of each hair colour among visitors and patients classed in groups, according to length of city residence.
R, rural SR, Semi-rural SU, Semi-urban U. urban.

It would appear prima facie from the foregoing evidence that blonde types possess a lower vitality and offer less resistance to the exhausting conditions of the city life Beddoe finds in Bristol that dark-haired children are more tenacious of life. Mention should be made of the fact that in most European towns the richer classes are the fairer. These classes are not exposed to the same deleterious environmental conditions as the mass of the city population. They are well-fed, well housed, and spend a large period of each year away from the towns. It would seem, on the whole, that in the cities a genetic factor is in operation, which acts in the direction of elimination of the weaker or blond element.

THE GEOGRAPHICAL DISTRIBUTION OF PIGMENT IN GREAT BRITAIN.

Beddoe's great work (1) dealing with the anthropolgy of the British Isles was published in 1885. Following this came the results of national pigmentation surveys on the Continent. Virchow's census of Prussian school-children, set on foot shortly after the close of the Franco-Prussiam war, was published in 1886. Ranke followed Virchow. In Italy similar work was done by Levi and in Sweden by Retzius. The first pigmentation survey in the British Islands of a national character was that undertaken by Tocher under the direction of the Committee of the Pigmentation Survey of School children



British Isles.
Map showing relative brunetness.
(from Beddoe)

in Scotland. The results were published in 1908 (6).

Ripley (7) observes that, though the insular position of the British Islands has to some extent been protective against invasion, yet when invasion did occur, it invariably led to assimilation of the newcomers. The effect of successive invasions has thus resulted in a greater uniformity amongst racial components. Ethuic distinctions have thus become reduced mainly to a matter of feature and relative blondeness. Broadly considered, blonde traits predominate in the north of Scotland, in Cumberland and Westmoreland and along the east and south coasts of Great Britain from the Tay to the Hampshire Avon. Brunette traits predominate on the west and south-west of Scotland and Ireland, Wales and the Devonian peninsula. A peculiar island of brunettes is also found immediately to the north of London. Intermediate characters occur in the marches between the preceding groups, and in Limerick and Tipperary in Ireland.

The distribution of iris colour is a little different, dark eyes being more common in Perthshire, Limerick and the south of Great Britain. The dark-haired areas of Scotland and Ireland present light eyes, while in Wales, the west of England, and the brunette enclave north of London, dark hair and eyes increase together. The fair area of south-eastern England shows a relative

increased frequency of dark eyes. It appears from the maps of the index of nigrescence that blond traits are concentrated in the more fertile river valleys and along the continental edge of Britain; the brunette on the ocean margin and in the watersheds and such areas , as until recent times, were comparatively difficult of access.

Comparisons of mortality statistics with the distribution of pigment bring out some points which would appear to indicate a racial tendency to disease.

PIGMENTATION AND DISEASE.

It has been pointed out even amongst the lower animals that colour has some relation to constitution. Horse breeders have found that light coloured animals are high-spirited but irritable and delicate. Dark horses are more phlegmatic in temperament, but have much staying power.

Constitution and heredity, before the discovery of microbes as infective agents, were probably given an undue prominence as etiological factors in disease. At the same time evidence has been produced that certain infectious diseases have a selective action, and that other diseases not known to be of bacterial origin have a predilection for certain types. There is not as yet a large body of proof bearing on the subject of pigmentation and disease,

and much of what is at hand is capable of explanation on other grounds.

Cancer and gout have long been discussed in this connection; tuberculosis perhaps most of all. Beddoe (8) expresses his belief in a special predilection of this disease for the dark Gaelic and Kymric stocks. Reference to disease maps of England shows that the mortality from phthisis increases from east to west, and that Wales suffers more than Cumberland. Beddoe quotes in support of his view the American census returns for 1900. The phthisis mortality list is headed by the Irish. Other agents such as alcoholism, city life and unhealthy occupations, may have contributed to this result, but would stillleave room for the racial hypothesis.

Amongst Jews the tuberculosis death rate is said to be low; but here against racial resistance must be placed a consideration of their careful habits, and avoidance of strenuous occupations.

Baxter(9) from an examination of the statistics of the American Civil War, found that blond types are markedly inferior, particularly in their liability to pulmonary tuberculosis, urinary and circulatory diseases. Dark types presented a higher percentage of cases of chronic rheumatism and cancer. It must be observed, however, that Baxter's classification, was a very loose

one, distinguishing only light and dark types, and including all his observations in one or other category. The results are therefore of doubtful value.

From data obtained from the French recruiting service, those departments having the most tall, long-headed, blond types were found to yield the highest phthisis mortality. There is no proof, however, that the blond complexion, per se, has a direct relation to pulmonary tuberculosis. Beddoe finds the distribution of the disease about the same amongst blonds as in the general population. The typical phthisical person is, in his opinion, a tall person with blue eyes and dark hair, though among the upper classes the tall frail blond type is susceptible.

Cancer is found by Beddoe to be more common amongst brunettes. In support of this may be mentioned the greater prevalence of the disease in the Alpine races than in the Tuetonic. Statistics per standard millions in England and Wales show a maximum incidence in North Wales, Cumerland Warwick, Bedford and Cambridge. In some of these areas brunette traits predominate.

Mental disease seems to select dark types. Mania, according to Beddoe, is commoner in blonds, melancholia in brunettes. He finds too that in the blond Orkney and Shetland Islands it is the dark members of the community who suffer from nervous diseases. Epilepsy is said to have a high index of nigrescence. A greater frequency of

black hair has been noted in the Metropolitan asylum at Claysbury than occurs in the general population. Tocher (10) finds that lunacy is correlated positively with light eyes, and to a less degree with dark hair; negatively to red hair and to a less degree to dark eyes. The observation of Karl Pearson (11) may be cited here, that the loss of superficial pigment is one of the marks of senility. He suggests that this may accompany a loss of internal pigment, e.g. in the brain. Ophthalmic investigation reveals a high percentage of incomplete albinism in the eye of the insane. The Japanese mouse which has complete albinotic eyes and a habit of spinning may be mentioned in association with the existence of a type of idiot who rotates like a top. Histologically pigment is found in skin and hair, the choroid and iris, the perilymphatic spaces of the internal ear, the nuclii, substantia nigra, and grey matter of the brain, and in the suprarenal bodies. All these structures , with the exception of the pigmented tissues of the eye, internal ear, and suprarenal cortex, are of ectodermal origin, and even these are closely associated with ectoderm. A further investigation of this point may bring out some relation between pigment and vital functions. The partially albinotic cat with white hair and blue eyes is deaf, and histologically the walls of the perilymph chamber lack pigment(11).

Pigment is present in hair in increasing quantity passing from red through fair up to black. Some types of red hair are entirely devoid of pigment granules, and it is known that red hair occurs in excess in albinotic stocks. Such stocks are found to produce an excessive proportion of imbecility, idiocy and deaf-mutism.

It cam be shown that throughout Europe red hair occurs most frequently along the boundary zones between fair and dark populations, and may represent the mean of a cross between the two. This appears to be borne out on the Welsh borders. Evidence has been adduced showing the effects of acute rheumatism and its sequelae on the fair and red-haired. A reference to mortality statistics shows high mortality rates from these diseases in those counties adjoining Wales which are found also to contain a large percentage of red hair.

The distribution of suicide, according to Morselli, varies almost directly with the amount of Teutonic blood in the population. This is corroborated in France, but it must also be remembered that the blond areas of France are those most affected by alcoholism, which has a close relation to suicide.

Church (7) records exceptional prevalence of acute rheumatism in Whitehaven and Isle of Man. These are the two fairest and most purely Norwegian districts of England. Corroboration of this is found in the records of the number

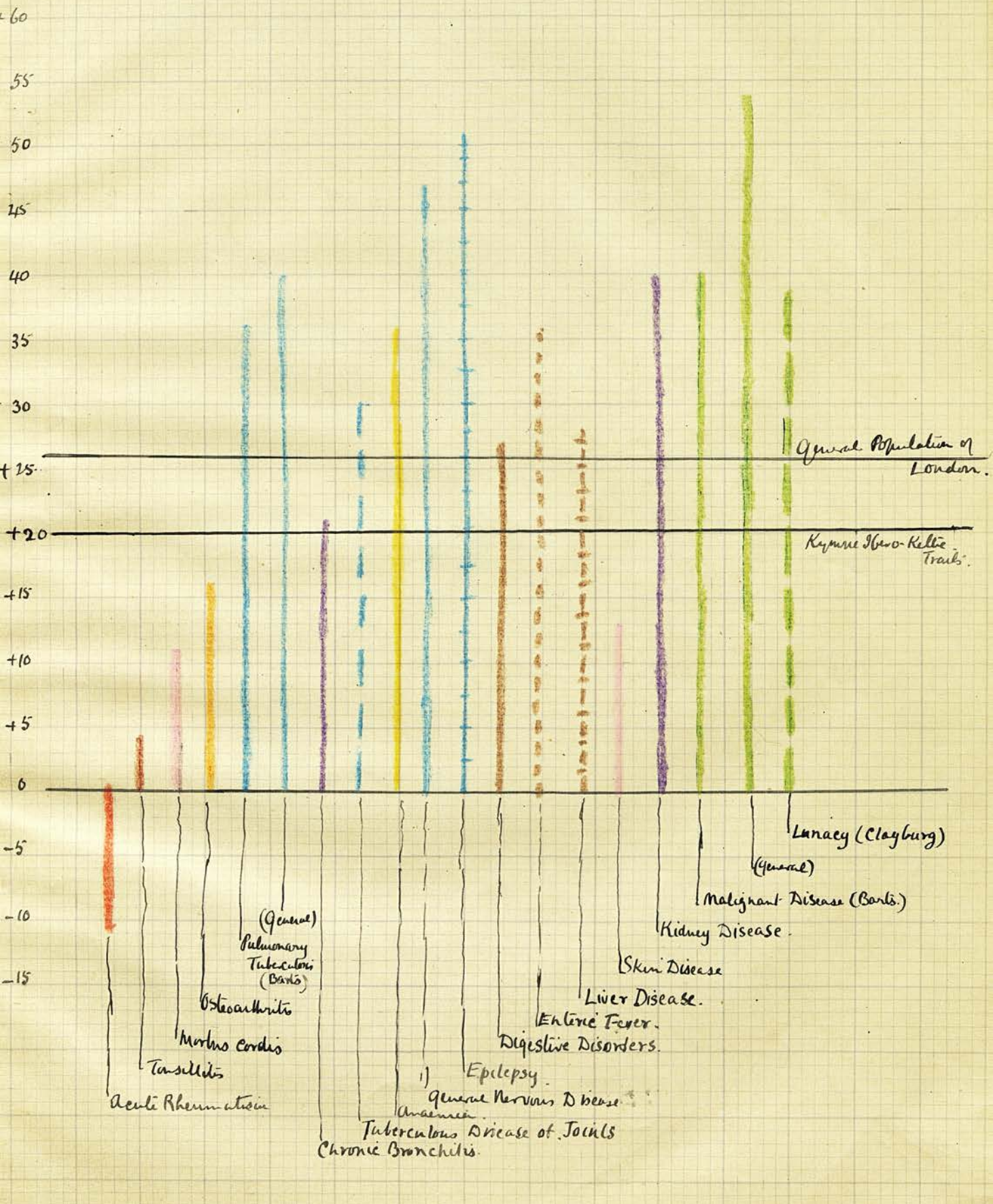
of omissions to Fever Hospitals of cases of acute rheumatismin similar districts. Disease maps shew a slightly higher rate of mortality from circulatory disease in the blond areas of Cumberland, Westmoreland and Northumberland than in Wales. Wiltshire with a largely Saxon population has a high mortality.

From statistical material gleaned from a number of sources, it is possible to show diagrammatically by means of the index of nigrescence and iris index the pigment relation of the number of diseased groups. The diagram of nigrescence on page 20 brings out the high colour indices in the case of lunacy, nervous disease including epilepsy, pulmonary tuberculosis and malignant disease already referred to, showing by contrast the low figure in acute rheumatism. The iris indices do not show quite the same relations. Here malignant disease and pulmonary tuberculosis stand slightly lower than acute rheumatism in the direction of lightness.

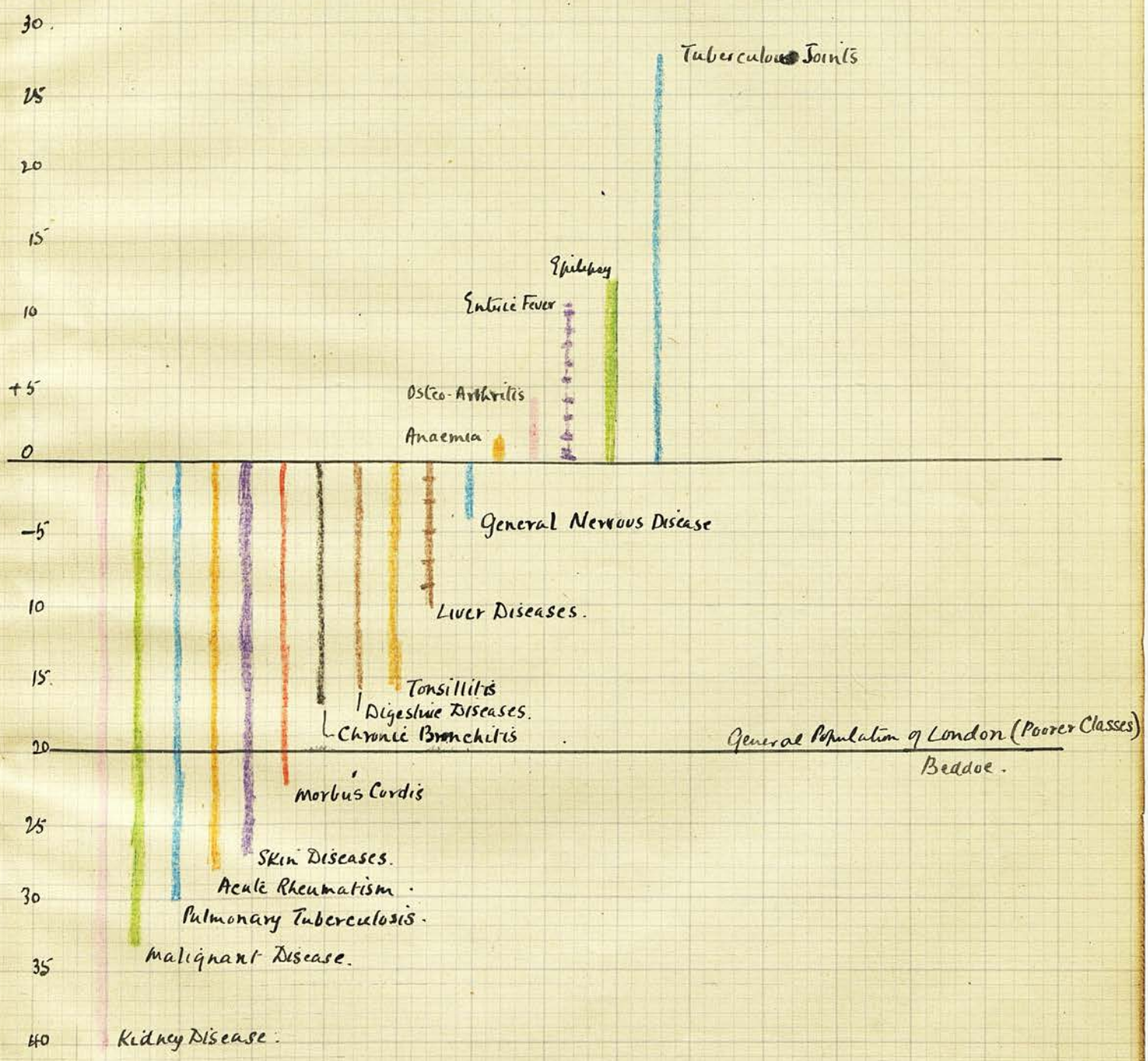
Cardiac disease has a comparatively low index in both tables.

The infectious diseases have lately been studied in connection with colour. Macdonald (12) recorded the pigmentation of some 3535 children in Glasgow Fever Hospitals, from point of view of susceptibility to and recuperative power from

Percentage Index of Negrescence.



Percentage Iris Index.



the exanthems and arrived at some striking conclusions. He finds the medium hair and medium eyed child much more liable to infection than dark haired and dark eyed, the fair and light eyed occupying an intermediate position. As regards recuperative power, the dark haired are superior, medium haired being intermediate while medium and dark eyes are better than light and blue eyes. Combining hair and eye colours, pure brunette types recovered better than the pure blondes, medium types occupying an intermediate position. In general he finds that the closer the type approaches the fair, the less is its resistance and recuperative power, and that the medium haired, medium eyed and light eyed, appear to be undergoing adverse selection. There are possibilities of a certain amount of error in Macdonald's work, arising chiefly from the fact that Tocher's figures for Glasgow were introduced thereby bringing in the chance of differences due to the personal equation. Error from this source may prove to be not inconsiderable whether mere verbal classifications be used or the more elaborate methods of standard glasses and pigmentation meters.

Following Macdonald's publication came that of Saunder's (14) dealing with material from school medical inspection in Birmingham. Again the infectious diseases were considered, but here no proof could be obtained of any definite correlation

with pigmentation. Such slight fluctuations as occurred, were not shown by mathematical tests to be greater than might result from random sampling.

Miss Elderton (13) attempted to correlate height and weight with pigmentation in Glasgow children, using records from Tocher's survey and the school schedules containing particulars of measurements of the same children. Hair and eye groups were taken separately and in various combinations, but in no case was any substantially significant relation demonstrated.

Results of personal observations. -

My own observations are too limited in number to be put forward with any assurance. I gathered complete records of only 2384 children. The population from which these were drawn, were in the main homogeneous. In Hackney a small proportion of Jewish children was included, but their number was too small to affect broad results.

Reference to Tables I. and II.* will show the distribution of hair and eye colour amongst all ages and according to sex and age. It will be seen that the school population is a blonde one, the girls having a slightly lower index of nigrescence, than the boys. The expected difference between the senior and junior group in the direction of darkening with seniority, is found, but this apparently

* Appendix.

THE UNIVERSITY *of* EDINBURGH

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has no other significance than that of increasing age. Tables III. and IV. showing the incidents of infectious disease in hair and eye colour groups, are similarly negative. No substantial difference is brought out in any group. The girls would appear to have a higher attack rate, both in junior and senior groups. Tables IV. and V. show the percentage frequency of the hair and eye colour in the infectious diseases compared with the general percentage colour distribution of the total children examined. These again, are characterless coinciding almost completely with the general distribution. Fluctuations in the red group are not to be regarded as having any significance since the total number of red haired individuals examined, was only 100.

Table VII. similarly shows greatest comparative fluctuations in the red group which should be discounted for the reasons mentioned. It may be suggested tentatively from Table VII. in corroboration of the evidence of other observance that morbus cordis favours the blonde type though in these tables the incidence in the red group is - coincidentally perhaps - nil. The fair and light brown percentages are somewhat above the level of the general school population.

Dental caries has no apparent colour selection. The red group perhaps accidentally, shows a good figure for general nutrition. Table VIII. is the only one presenting any point of interest. Rheumatism and Chorea are more prevalent in the brunette group. This is contrary to practically accepted opinion, namely that acute rheumatism selects blonds. It may be thought that Chorea cases altered the result, but I am able to state that the number of cases of Chroea included was a very small one and fairly evenly distributed as regards pigment groups. It may be noted that any general division of the hair colour scheme into light and dark groups only still further serves to neutralise the results.

Conclusions. -

From the considerable body of evidence brought forward in the early part of this paper, it can be asserted that there is more than a prima facie evidence of relation between pigment and morbid states.

Pulmonary tuberculosis, nervous diseases and malignant disease occur in greater proportions in association with brunette traits.

The rheumatic group of diseases on the whole, selects blondes.

Certain zymotic diseases appear to act in the direction of elimination of fair types.

Conclusions from the study of the School population. -

The small numerical bulk of the observations detracts considerably from the value of slight existing evidences of specialising disease.

Negative results have been obtained in the case of all the infectious diseases.

Negative results have been obtained in respiratory disease, disease of adenoid tissue, rachitis and dental caries.

There are slight evidences of blonde selection in morbus cordis.

Rheumatism and its allies, contrary to usual belief, shows a slight predilection for brunettes, probably fortuitous.

The red haired group has a tendency towards better nutrition, probably fortuitous.

The material studied has been shown to have been drawn from communities subject to considerable environmental vicissitudes. These communities seem to have been recruited largely from without. They therefore represent a population well mixed as regards racial elements.

The general conclusion then is that though in certain circumstances, colour may be corelated with morbidity, in this school population there is no obvious relation between pigmentation and disease.

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APPENDIX.

Table I shewing the distribution of hair colour.

Hair Colour.	All Ages, Boys & Girls.			Boys all Ages.			Girls, all Ages.		
	Numbers.	Percentage.		Numbers.	Percentage.		Numbers.	Percentage.	
Red.	100	4·1	Percentage Index of Nigrescence.	44	3·9	Percentage Index of Nigrescence.	56	4·4	Percentage Index of Nigrescence.
Fair.	644	27·0		285	25·6		359	28·1	
Light Brown.	370	15·5		192	17·2		178	13·9	
Medium Brown.	757	31·7		390	35·1		367	28·8	
Dark Brown.	513	21·5		200	18·0		313	24·6	
Total.	2384	100	-9·6	1111		-11·5	1273	100	-7·9

Hair Colour.	Boys & Girls Aet 8–13			Boys & Girls Aet 3–7					
	Numbers.	Percentage.		Numbers.	Percentage.				
Red.	62	3·6	Percentage Index of Nigrescence.	38	5·5	Percentage Index of Nigrescence.			Percentage Index of Nigrescence.
Fair.	416	24·4		228	33·3				
L. Brown.	229	13·4		141	20·6				
M. Brown.	572	33·6		185	27·0				
D. Brown	422	24·8		91	13·3				
Total	1701	100	-3·2	683	100	-25·5			

Table II shewing the distribution of eye colour.

Iris Colour.	All Ages, Boys & Girls.		Percentage Iris Index.	Boys, all Ages.		Percentage Iris Index.	Girls, all Ages.		Percentage Iris Index.
	Numbers.	Percentage.		Numbers.	Percentage.		Numbers.	Percentage.	
Light.	1373	57·5		647	58·2		726	57·0	
Neutral.	383	16·0		176	15·8		207	16·2	
Dark.	628	26·3		288	25·9		340	26·7	
Total.	2384	100	-32·2	1111	100	-32·3	1273	100	-30·3

Iris Colour.	Boys & Girls Aet 8–13		Percentage Iris Index.	Boys & Girls Aet 3–7		Percentage Iris Index.
	Numbers.	Percentage.		Numbers.	Percentage.	
Light.	958	56·4		415	60·7	
Neutral.	300	17·5		83	12·1	
Dark.	443	26·0		185	27·0	
Total.	1701	100	-30·4	683	100	-33·7

Table III shewing the incidence of infectious disease in eye colour groups.

Eye Colour.	Group.	Number of Children Examined.	Measles.		Whooping Cough.		Chicken-pox.		Scarlet Fever.		Diphtheria.	
			Cases	%	Cases.	%	Cases.	%	Cases.	%	Cases.	%
Light.	Boys & Girls. Aet 8–13	958	783	81·7	443	46·2	370	38·6	133	13·8	38	3·9
	Boys & Girls Aet 3–7	415	267	64·3	143	34·4	112	26·9	17	4·0	5	1·2
	Boys & Girls. All ages.	1373	1050	76·4	586	42·6	482	35·1	150	10·8	43	3·1
Neutral.	Boys & Girls. 8–13	300	248	82·6	145	48·3	117	39·0	28	9·3	12	4·0
	Boys & Girls. 3–7	83	43	51·8	24	28·8	17	20·4	3	3·6	3	3·6
	Boys & Girls. All ages.	383	291	75·9	169	44·1	134	34·9	31	8·0	15	3·9
Dark.	Boys & Girls. 8–13	443	367	82·8	194	43·5	191	43·1	64	14·4	13	2·9
	Boys & Girls. 3–7	185	121	65·4	72	38·9	43	23·2	8	4·3	2	1·0
	Boys & Girls. All ages.	628	488	77·7	266	42·3	234	37·2	72	11·4	15	2·3

Table IV showing percentage incidence of the infectious diseases in the hair colour groups.

		Measles.		Whooping Cough.		Chicken pox.		Scarlet Fever.		Diphtheria.	
		Boys.	Girls	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.	Boys.	Girls.
Fair	aet 8–13	89.4	93.5	47.6	62.0	42.8	45.4	14.7	15.1	4.6.	3.3
	aet 3– 7	71.3	78.7	29.5	48.5	25.0	31.4	6.8	6.6	3.4	.9
Red.	aet 8–13	90.9	96.8	47.3	50.0	45.0	46.8	10.5	25.0	10.5	6.2
	aet 3– 7	62.5	72.2	37.5	33.3	6.2	33.3	12.5	0.0	6.2	0.0
Light Brown	aet 8–13	95.0	99.9	46.5	47.4	40.2	47.4	22.7	14.2	6.8	3.0
	aet 3– 7	71.4	74.5	47.3	50.9	31.5	43.6	5.2	1.8	0.0	0.0
Medium Brown	aet 8–13	88.0	94.5	50.8	62.8	44.1	53.0	11.3	16.0	1.7	8.0
	aet 3– 7	77.6	73.1	49.3	34.9	35.8	25.3	3.7	1.5	0.0	1.6
Dark Brown	aet 8–13	89.7	94.6	51.9	51.6	50.7	48.1	19.3	15.0	3.8	2.9
	aet 3– 7	82.7	70.4	45.7	31.8	28.5	29.5	5.7	6.8	5.7	4.5

Table V. showing percentage frequency of hair colour in the infectious diseases.

Hair Colour.	General Distribution of Hair Colour.	Measles.	Whooping Cough	Chicken pox.	Scarlet Fever.	Diphtheria.
Red.	4.1	4.0	3.6	3.6	4.7	6.8
Fair.	27.0	26.5	27.3	25.1	26.3	24.6
Light Brown.	15.5	15.5	14.5	14.4	15.3	12.3
Medium Brown.	31.7	31.3	32.9	32.8	27.5	34.2
Dark Brown.	21.5	22.5	21.4	23.8	25.9	21.9
Percentage Index of Nigrescence.	-9.6	-8	-9.5	-4.9	-5.1	-9.3

Table VI shewing percentage frequency of eye-colour in the infectious diseases.

Eye Colour.	General Distribution of Eye Colour.	Measles.	Whooping Cough	Chicken-pox.	Scarlet Fever.	Diphtheria
Light	57.5	57.4	57.4	56.6	59.2	58.9
Neutral	16.0	15.9	16.5	15.7	12.2	20.5
Dark	26.3	26.6	26.0	27.5	28.4	20.5
Iris Index (percentage)	-31.2	-30.8	-31.4	-29.1	-30.8	-38.4

Table VII. showing percentage frequency of hair colour in the different defects.

Hair Colour.	General Distribution of Hair Colour.	Hypertrophied Adenoid Tissue.	Defects.					
			Rickets.	Respiratory Disease.	Bronchitis.	Valvular Disease of Heart.	Bad Teeth.	Bad Nutritio
Red.	4.1	3.4	2.7	6.1	6.0	0.0	4.2	2.7
Fair.	27.0	27.5	28.7	25.6	24.0	29.0	25.4	26.7
Light Brown.	15.5	16.0	17.0	16.5	19.3	19.3	15.8	16.3
Medium Brown.	31.7	31.4	30.6	30.4	29.0	32.2	32.7	31.3
Dark Brown.	21.5	21.4	20.5	21.1	21.6	19.3	21.7	22.8

Table VIII shewing percentage frequency of hair colour in Morbus Cordis, Rheumatism and Tonsilitis.

Hair Colour.	General Distribution of Hair Colour.	From data obtained during medical Examination.	From Data obtained from history of previous illness.	
		Organic Heart Disease.	Rheumatism & Chorea.	Tonsilitis.
Red.	4.1	0.0	0.0	4.1
Fair.	27.0	29.0	23.5	20.8
Light Brown.	15.5	19.3	14.7	13.5
Medium Brown.	31.7	32.2	32.3	36.1
Dark Brown.	21.5	19.3	29.4	26.1