

T H E S I S.

An Investigation into the Incidence of
Iron Deficiency Anaemia in the Adult
Population of a Rural District in England
in the Year 1950.

A U T H O R.

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PREAMBLE.

The investigations recorded in this thesis were initiated as a result of a report sent to the Surveyor of the Clun Rural District Council, Shropshire, by Professor W. G. Fearnside, M.A., F.R.S., F.G.S., M.I.M.E., Senior Geological Consultant to the National Coal Board.

Professor Fearnside had been asked to investigate the suitability of a site in the Snailbeach district for the erection of a new housing estate. In his report he had stated that in his opinion the site was unsuitable, because the tenants would be exposed to lead poisoning from the slag heaps deposited by the old mines in the area; and that the anaemia which past doctors in the area had believed to be present, was in all probability due to lead intoxication.

It was decided that the best way to establish or disprove the existence of a high incidence of anaemia in the Snailbeach and surrounding area, was to make a survey of the local inhabitants, taking into account such factors as age, sex, parity, and length of stay in the district.

As the investigation proceeded, it became evident that any anaemia present was due to Haemoglobin deficiency. The literature, however, contained no figures on which to base a comparison of the incidence of iron deficiency anaemia, as it affects unselected individuals in a rural area in England.

The inquiry was therefore extended to include the whole area covered by this Practice, which is practically unopposed, with only slight mingling at the periphery with adjoining Practices, and which is on the whole representative of any rural district in the country.

The final results therefore represent the incidence of iron deficiency anaemia in the area.

MATERIAL INVESTIGATED.

The Practice consists of approximately 5,000 persons. Basing our calculation on the Census of 1891, it is estimated that 628 per thousand of population are aged 16 years and over.⁽¹⁾ On this estimate about 3140 people aged 16 years and over live in the Practice area.

Of these, 1,000 individuals have been examined and their Haemoglobin levels estimated. This is considered a fair sampling of the population of the Practice, and should give a reasonably accurate indication of the incidences investigated.

The lower age limit of 16 years was chosen because it has been shown by Williamson⁽²⁾ that the Haemoglobin /

Haemoglobin concentration reaches its adult level at about 16 years, and that up to the 15th year there are no sexual differences in the Hb. Level. There was no upper age limit, the oldest person being 89 years.

The investigation was strictly limited to those who were resident within the area, temporary residents being excluded, as were also pregnant women, (since there would not be sufficient numbers available in the period of the investigation) and any case suffering at the time from an acute infection, or from any condition that might cause a temporary disturbance of the Hb.-Plasma ratio, such as dehydration.

In order to make the survey as comprehensive as possible, its purpose was explained to all patients seen in the course of the daily routine, and to their relatives and attendants. They were then asked to give a specimen of their blood. A number of specimens were taken in the Surgery and at houses visited, but many homes were deliberately visited for the specific purpose of taking samples. There were not more than ten refusals altogether, and it was thus considered that the material used was in no sense selected, the criteria being that they resided in the district, that they were 16 years of age or over, and, in the case of women, that they were not pregnant. Women who had borne children were not examined until at least two months after childbirth.

These methods largely eliminated the risks of selection attached to using volunteers, who might volunteer, for instance, because they thought they were anaemic, or had once been told that they were.

The area lies to the SOUTH-WEST of SHREWSBURY, and is one of typical English Countryside, the people being engaged mostly in agriculture and its associated crafts.

The main villages are Pontesbury, and further South, Minsterley, leading on to Hope Valley, on the East side of which lie the ancient mining villages of SNAILBEACH, BOG, STIPERSTONES, PENNERLEY and TANKERVILLE. These mining villages together make up the Heath Ward.

The area is rich in mineral content, and indeed in the British Museum there is a Roman pig of lead, weighing 171 pounds, inscribed in raised letters "IMP. HADRIANI. AUG:

A.D. 117-138"

which was excavated from Snailbeach in 1851.

These lead mines were worked from 1779, until, with /

with cheap foreign lead flooding the mineral market, they were eventually closed in 1910. Authorities agree, however, that they are not exhausted. The white slag hillocks which can still be seen all along this area speak of the activity of past generations. It is the presence of these deposits, and their possible danger to the community, which lead to the present investigation.

Near the surface these mines also produced Barytes, a Sulphate of Barium, the mining of which caused many cases of Silicosis in the district.

TECHNIQUE.

In each case approximately 2 C.C.s of Venous blood was withdrawn from the Median Basilic Vein, by a dry sterile syringe. Brief pressure by a rubber tourniquet or by the rolled up sleeve was applied where necessary to bring the vein into prominence. The blood was immediately transferred to a $\frac{1}{2}$ ounce rubber-stopped bottle containing crystals from 0.1ml of Wintrobe's Solution, and the bottle was shaken vigorously. A separate syringe and needle were used for each person. In 100 cases in the Heath Ward area two blood slides were also made.

The Haldane Haemoglobinometer was used, the colour of the tube being within the tolerances allowed in the British Standard Specification, B.S. 1079: 1942.

All instruments were tested at the National PHYSICAL LABORATORY, TEDDINGTON, LONDON. The results given are those reached after applying the N.P.L. Correction factor. This was found by plotting on a graph the figures for observed and corrected readings supplied by the Laboratory.

Carbon Monoxide was obtained from a cylinder of Coal Gas supplied by the Liverpool branch of the National Coal Board. This cylinder contained 150 cu. feet of compressed gas, which was sufficient for well over 1,000 estimations.

Each specimen was examined personally by the author on the day of withdrawal, artificial lighting being used. There are obvious advantages in a survey of this kind being carried out by a single individual.

Blood films were stained by Leishman's staining method.

Red cell counts were done on a Neubauer Stage.

An attempt was made to eliminate bias by numbering the specimens instead of writing the names on the bottles, since the knowledge of whose specimen was being /

being tested might easily bias in favour of an already formed clinical impression.

Some authors have found diurnal variations in the Haemoglobin level as great as 17%. (Short)(47).

McCarthy and Van Slyke (48) found variations up to 11% in the course of the day.

However, according to Walters (49), there is practically no variation in the Haemoglobin throughout the day during complete inactivity, and no doubt the differences noted by the above authors are in fact due to differences in the amount of activity of the subjects.

It has also been shown by Marshall (3) that excessive activity immediately before samples were taken might result in a difference of 12 to 18% in the reading. He therefore recommended twenty minutes recumbency before specimens were taken.

Kaltreider & Meneely (4) and Smith & Kumpf (46), also showed that exercise caused haemoconcentration, with an increased Hb. reading.

In the present investigation the possibility of these errors was largely eliminated by the fact that most patients nowadays have to wait some time before being seen by their Medical Attendant in Surgeries, and when patients were seen in their homes they would have recovered from the effects of any exercise they may have been engaged in, by the time the purpose of the visit was explained to them, and preparations made for the withdrawal.

All samples were taken during the Summer months, thus avoiding any differences, due to extremes of temperature, such as have been reported by certain workers e.g. Bazett et al (5).

RESULTS.

In this survey one came in contact with more women than men - 661 women compared to 339 men.

This is partly accounted for by the fact that women were more likely than men to be at home when houses were visited for the purpose of taking samples. Also, quite apart from their own complaints, women attend surgeries more frequently than men, for example to escort their children who need attention.

Further, it would appear from the Registrar General's figures (6) that more women than men suffer from illness or injury - 73.1% compared to 61.7%.

One result of this more frequent contact with females /

females than with males just noted, is that the proportion of sick men to the total number of men seen is likely to be higher than the proportion of sick women to the total number of women seen.

As already indicated, since the purpose of the Survey was to discover the amount of anaemia in the area, nobody was excluded on health grounds, unless they had a temporary disturbance such as an acute infection or a recent blood loss.

This accounts for the cases of Carcinoma, Pernicious Anaemia and other diseases included. While every effort was made to avoid "seeking out" such cases, the results would be vitiated if they had been excluded, and important conclusions - e.g. the significance of iron-deficient anaemia in the male - would not have been reached.

It is evident that other surveys must also have included some cases, for example, of malignant disease, and hence also of other causes of anaemia; indeed, in Davidson's (7) Aberdeen survey, there was a higher incidence of malignant disease in males than in the present survey.

It follows that although in the present survey a number of pathological conditions were known to exist which might influence the Haemoglobin level, the material nevertheless is suitable for comparison with other surveys such as, for example, the Aberdeen survey, inasmuch as they both contain a number of cases which might cause a "secondary" anaemia.

MALES.

The average Haemoglobin for the 339 males was 100.8%.

Table I shows the Haemoglobin Range in the different age groups in Adult Males.

TABLE I.
Hb. Range in 339 Males in
Different Age Distributions.

Age Group.	Number.	Haemoglobin Range %.									
		20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110+
16-24	43								11	24	8
25-34	58							1	8	41	8
35-44	64						2	1	10	41	10
45-54	66					1	2	4	13	34	12
55-64	50	1				1		9	10	21	8
65+	58			1	1	1	1	7	15	27	5
TOTAL	339	1		1	1	3	5	22	67	188	51

In this series, 11 males had a Haemoglobin level below 80% - i.e. 3.2% - and 7 of these 11 men had definite organic disease, while the remaining 4 showed an anaemia which was unexplained except as a simple hypochromic anaemia responding to iron. In fact, with the exception of these 4 cases, all males with a Haemoglobin value below 85% had some form of organic disease, as will be seen from Case List I.

CASE LIST I.
18 Males with Haemoglobin below 85%.

<u>Case No.</u>	<u>Hb. Reading.</u>	<u>Associated Disease.</u>
670	77	Pernicious Anaemia.
438	83	Rheumatoid Arthritis. (Subacute stage)
503	73	Nil.
299	77	Carcinoma of Bronchus.
130	52	Pernicious Anaemia.
180	44	Nil.
310	28	Pernicious Anaemia.
40	83	Silicosis.
99	80	Haemorrhoids.
1	71	Nil.
46	83	Silicosis.
985	66	Carcinoma of Colon.
60	83	Silicosis : Haemorrhoids.
498	83	Recurrent Pleurisy: ? T.B.
2	62	Pulmonary T.B.
585	60	Carcinoma of Caecum.
330	75	Nil.
9	83	Active Duodenal Ulcer.

Indeed, if the 18 cases referred to in Case List I had been excluded as not being "normal", it will be /

be found that the average Haemoglobin for the remaining 321 men is 102.6%, and the Standard Deviation is 6.8. This is assuming that the 4 cases with unexplained anaemia below 80% would not have been included in any "normal" series, since clinically they were quite obviously anaemic.

The following is a brief outline of these 4 cases.

(1) T.G. 84 years of age. Hb. 44%.
RBCs. 4,000,000.
CI. 0.55.

Films showed hypochromia with many "ring" forms, and no organic disease was discovered. After a course of Tabs. Ferrous Sulph. Co. the Haemoglobin rose to 92% and RBC's to 4,450,000. He remains well 9 months later.

(2) K.S. 44 years of age. Hb. 73%.
RBC's. 4,360,000.
CI. 0.8.

Film - hypochromic anaemia. He had "slight" piles six months before. No organic disease was found on examination, including X-Rays. He responded well to iron.

After Treatments. Hb. 110%.
RBC's. 5,070,000.

(3) P.R.H. 72 years of age. Hb. 75%.
RBC's. 5,300,000.

Films showed hypochromia with normal shape. Patient had worked in lead mines for many years, and had had several blood examinations for lead poisoning in the past with negative results. His record card shows him to have been anaemic at the age of 21 years. Clinically there was no evidence of organic disease, and the man had no symptoms.

After treatment with Tabs. Ferrous Sulph. Co. a further count showed the Hb. level to be 106%.

(4) T.C.S. 48 years of age. Hb. 71%.
Roadman. RBC's. 5,000,000.

Films showed hypochromia only. He was anaemic as a youth, gave no history of blood loss, and there was no obvious cause clinically. According to himself he was "always anaemic".

After treatment the Haemoglobin level rose to 98%.

None of these cases belonged to the Snailbeach area, but cases 3 and 4 belonged to another part of Heath Ward.

These four cases, out of a total of 339 males conformed clinically to the picture of hypochromic anaemia. In K.S., no doubt the "piles" initiated the /

the anaemia, which was not made good until iron therapy was instituted, even with ample farm produce such as was available to him.

T.G. was probably undernourished as he had "not been eating" for months.

In cases 3 and 4, no explanation was found for the anaemia.

No doubt a number of these cases of hypochromic anaemia are cured by iron therapy in general practice and so do not reach hospital. However, the ~~instance~~^{existence} of such an entity in males in no way relieves the practitioner from taking all necessary steps to exclude organic disease; and in men this diagnosis should only be accepted when X-Rays and other investigations have eliminated particularly malignant disease, and when the response to iron is dramatic. Thus, in F.S., X-Rays were completely negative, but as the response to iron was slow, repeated physical examinations were made, until a mass was detected in the caecum, and following removal of the carcinoma, Hb. recovery has been rapid.

Similarly in the case of E.L.H., he was finally discharged from hospital as "much improved" with no diagnosis made, since the original suspicion of malignant disease was not confirmed by X-Ray. But he made no response to iron therapy, and soon the tell-tale ascites^{and} enlarged liver only too easily foretold his early demise.

On the other hand, K.S. strongly suggested a carcinoma of the stomach, but the response to iron therapy (instituted after the negative X-Ray findings) was rapid and clinically obvious.

Similarly T.G., with negative clinical findings, and considering himself too old "to bother with X-Rays" responded quickly and clinically, obviously to iron therapy.

On comparison between the rest of the practice and the Heath Ward area one finds that 64 men from Heath Ward were examined, and of these 64, 9 were less than 85%, i.e. 14% of the Heath Ward males examined were less than 85%, and 9 men out of the remaining 275, i.e. 3.3%, were less than 85%. Statistically this might be held to be significant since the observed difference (10.7) is more than twice the standard error of the difference (4.5). However, with the low figure of 64 for one group it might be considered that $2\frac{1}{2}$ times the standard error of the difference would be a more accurate measure of significance.

But even if the figures are accepted as significant from an arithmetical point of view, it is plain that the two groups are not suitable for comparison /

comparison of the incidence of anaemia, since in the Heath Ward group, another factor, namely organic disease, has increased the incidence of anaemia in the group.

This will be seen if we refer back to Case List I where the following belonged to the Heath Ward Area.

No. Case.	Whether in Snailbeach Area.	Hb.	R.B.C.	Assoc'd Disease.	Sequel to Therapy.
1. T.C.S.	No.	71.	5,000,000	Nil.	98%
2. R.D.	Yes.	62.	4,600,000	T.B. Lung.	86%
3. F.B.H.	Yes.	83.	4,450,000	Active D.U.	Awaiting X-Ray.
4. M.R.	Yes.	83.	4,700,000	Silicosis.	Not Available
5. E.L.H.	Yes.	66.	4,200,000	Carcinoma Bowel.	Died.
6. E.P.	Yes.	83.	4,700,000	Silicosis. Haemorrhoids.	Died.
7. B.S.B.	Yes.	83.	5,400,000	Recurrent Pleurisy. ?T.B.	98%
8. F.S.	No.	60.	4,000,000	Carcinoma Caecum.	Operation 104%
9. P.R.H.	No.	75.	5,300,000	Nil.	106%

It will be seen that only in cases 1, 9, and possibly 4, is there no adequate explanation for the anaemia. The films in each case showed no evidence of any blood disorder other than hypochromia, and the response to iron as indicated in the last column confirms that the anaemia is one of iron deficiency. In Case 4, the patient unfortunately was not available for the final examination, but was stated to be "feeling better".

Thus the majority of the cases of Anaemia in Heath Ward males are shown to be due to organic disease, and two of the three men whose anaemia was of unexplained origin, did not live in the Snailbeach area of Heath Ward.

If we exclude those cases with an obvious organic cause for the anaemia, we find the following figures for cases below 85%.

Heath Ward.		Remainder of Practice.
71%	(Not Snailbeach)	73%
75%	" "	44%
83%	(Snailbeach)	83%
		80%

From this it will be seen that of the cases unassociated with organic disease, 3 were from the Heath Ward and 4 from the rest of the practice, while of those cases below 80%, two were from Heath Ward (neither from Snailbeach) and two from the rest of the practice.

It cannot be concluded from these figures that there is significantly more anaemia in males in the Heath Ward or the Snailbeach portion of it, than in the rest of the practice.

NULLIPAROUS GROUP.

There were 227 women in the nulliparous group, with ages ranging from 16 to 79 years. 135 were in the age group 16-44 years, the remaining 92 being in the 45 plus age group. The average Haemoglobin reading for the whole group was 90% and the Standard Deviation was 10.7.

Table III shows the H_aemoglobin Range in the different age groups.

TABLE III.

Hb. Range in 227 Nulliparous Women in Different Age Distribution.

Age Group.	Number.	Haemoglobin Range.									
		20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110+
16-24	72	-	-	-	-	1	5	22	29	15	-
25-34	28	-	-	-	-	-	1	17	7	3	-
35-44	35	-	-	-	-	2	5	8	12	8	-
45-54	38	-	1	-	2	1	3	6	17	8	-
55-64	23	-	-	-	-	1	2	9	6	5	-
65+	31	-	-	-	1	1	3	7	15	3	1
Total.	227.	-	1	-	3	6	19	69	86	42	1

Table IV shows the number and percentage of cases below 80% Hb. and below 70% Hb. in the different age groups.

TABLE IV.

AGE GROUPS.							
	16-19	20-29	30-39	40-44	45-54	55-64	65+
Total No. in Group.	39	48	27	21	38	23	31
Number below 70%	1	0	1	1	4	1	2
Percentages below 70%	2.6	0	3.7	4.8	10.5	4.3	6.4
Number below 80%	2	5	4	3	7	3	5
Percentages below 80%	5.2	10.4	14.8	14.4	18.4	12.9	16.1.

In the nulliparous group there were 47 with Hb. value below 85%. i.e. 20.7%, 29 with Hb. value below 80%. i.e. 12.8%. of whom 19 were in the "moderate anaemia" group (70% to 79%), i.e., 8.4%, so that 10 women had Hb. values below 70% in this class; i.e., 4.4% can be regarded as severely anaemic, and of these 10, three were in the age group 16-44 years.

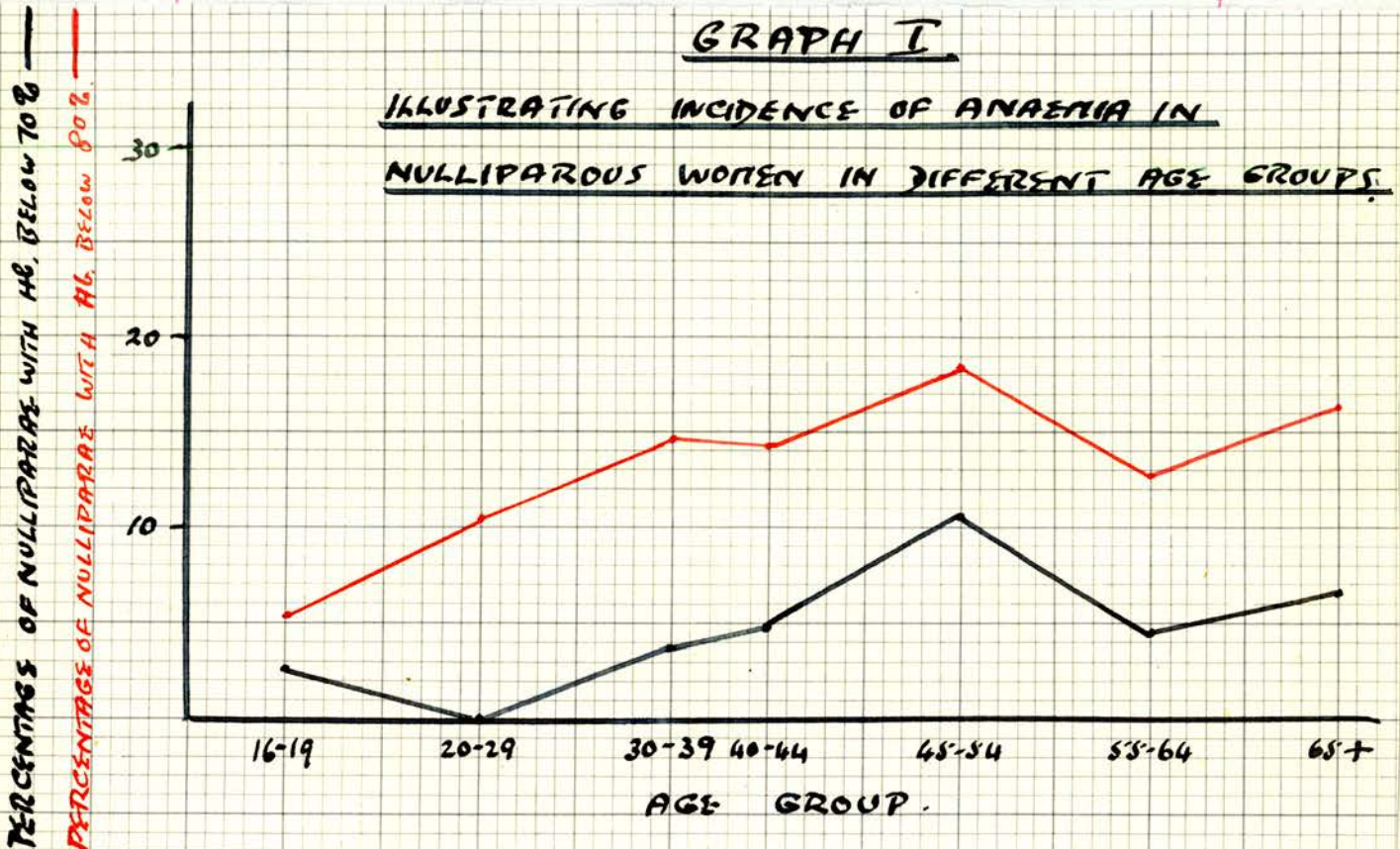
Of the 47 nulliparous women with Hb. values below 85%, 22 were in the age group 16-44 years, i.e. 16.3% of this age group. The remaining 25 were in the age group 45 plus, i.e. 27.1%. The observed difference between these is 10.8%, and the Standard Error of the Difference is 10.8%^{6.7}, so that the difference in the amount of anaemia in these two age groups is not significant.

Table IV appears to show a rise in the incidence of severe anaemics (i.e. below 70%) and of cases below 80% as age increases in nulliparae up to the menopause.

Graph /

Graph I illustrates this apparent rise.

GRAPH I.



However, in spite of this apparent trend as seen in Table II and illustrated in Graph I, it must be admitted that the numbers in each group are small, and, indeed, the Standard Error of the Difference between the percentage of cases below 70% in the 16-19 age group and in the 45-54 age group is 5.5, and the observed difference is 7.9. Thus these differences could have arisen by chance, and /

and the most that can be said is that the figures do not disprove the claim that anaemia incidence increases with age.

Included in this group there were 31 women from the Heath Ward. Of these 6 had Hb. figures below 85%, i.e., 19.3% of the Heath Ward women. As already stated, there were 47 nulliparous women with Hb. figures below 85% out of the total of 227, so that, ~~Ex~~cluding the Heath Ward women, in the rest of the practice there were 41 nulliparous women with Hb. values below 85% out of a total of 196, i.e., 20.9%

Thus there is no significant difference in the amount of anaemia in nulliparous women from Heath Ward area, compared with nulliparous women from the rest of the practice.

PAROUS WOMEN.

434 parous women were examined of whom 222 were in the age group 16-44 years and 212 in the age group 45 plus years.

In the 16-44 age group the average Haemoglobin was 87.6% and the Standard Deviation 8.9.

In the older age group the average Haemoglobin was 89% and the Standard Deviation 9.7.

The Standard Error of the Difference between the two means is 0.88 and as the observed difference is 1.4% the difference is not statistically significant.

A total of 108 parous women had a Haemoglobin value below 85%. i.e., 24.9%

63 parous women had Hb. below 80%, i.e. 14.5%
24 parous women had Hb. below 70% i.e. 5.5%

Table V. compares these figures with those for nulliparous women.

Table V.
Proportion of Parous and Nulliparous Women with different degrees of Anaemia.

Hb. Level	Parous	Nulliparous
Below 85%	24.9%	20.7%
Below 80%	14.5%	12.8%
Below 70%	5.5%	4.4%

The observed difference between the percentage of cases below 85% Hb. in the two groups is 4.2% and the Standard Error of the Differences is 3.3, so that if the age factor is ignored, the figures obtained do not show a significant difference in the amount of anaemia in parous compared with nulliparous women.

If we now divide the Parous women into the two age groups 16-44 and 45+, we find the differences compared with nulliparous in Table 6.

Table 6.
Proportion of Parous Women in 16-44 and 45+ age groups and Nulliparous with different degrees of anaemia.

	Parous		Nulliparous.
	16-44	45+	
% Below 85%	28.2 (222)	25.1 (212)	20.7
% Below 80%	16.2	12.6	12.8
% Below 70%	5.4	5.6	4.4

Thus, while there would appear to be more anaemia in the 16-44 parous group compared with the 45+ parous group, the observed difference between the percentage of cases below 85% Hb. in these two groups is 3.1, while the Standard Error of the Difference is 4.2. These results therefore are insufficient evidence that there is more anaemia in Parous women below the age of 45 years than in Parous women over /

over this age.

If we compare the 16-44 parous women with the whole group of nulliparous women, the observed difference in the percentages below 85% Hb. is 7.5 and the Standard Error of the Difference is 4. i.e. the difference is not statistically significant.

On the other hand if we compare the 16-44 parous women with the 16-44 nulliparous women we find that in this nulliparous group 16.3% had Haemoglobin values below 85%, while of the corresponding Parous group 28.2% were below 85%. The observed difference is 11.9% and the Standard Error of the Difference is 4.3. This difference is therefore significant, and there is more anaemia as measured by cases below 85% Hb. in Parous women under the age of 45 years than in nulliparous women of the same age group.

Table 7 shows the percentage of Parous women with Haemoglobin below 70% and of those with Haemoglobin below 80% in the different age groups.

Table 7.
Percentage of Parous Women below 80% and below 70% in the Different Age Groups.

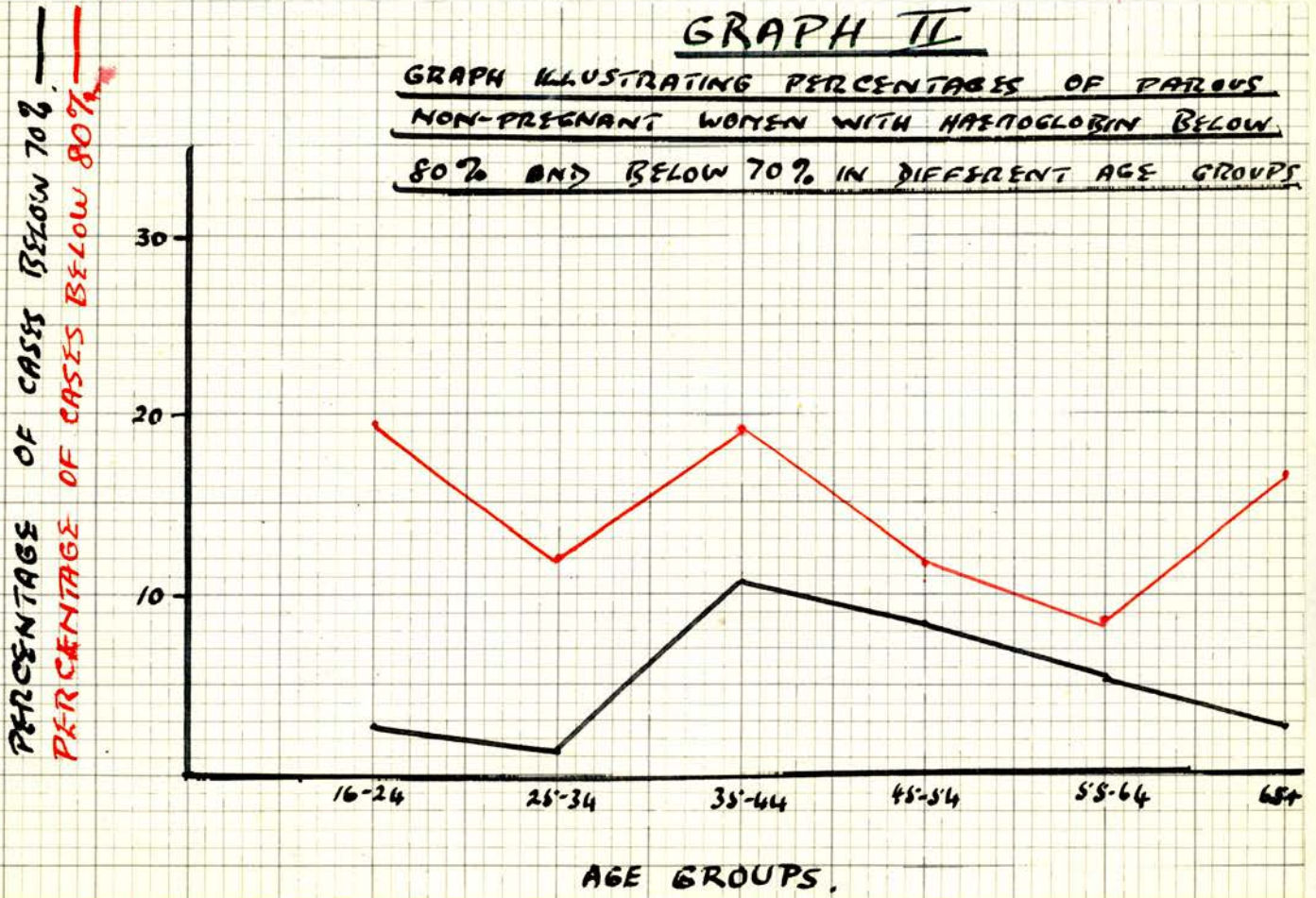
	Age Group.					
	16-24	25-34	35-44	45-54	55-64	65+
Total No. in Group	36	92	94	84	58	70
No. below 80% Hb.	7	11	18	10	5	12
% below 80% Hb.	19.6	12	19.1	11.9	8.6	16.8
No. below 70% Hb.	1	1	10	7	3	2
% below 70% Hb.	2.8	1.1	10.6	8.3	5.2	2.8

Graph II illustrates these figures.

GRAPH II. (over)

GRAPH II

GRAPH ILLUSTRATING PERCENTAGES OF PAROUS
NON-PREGNANT WOMEN WITH HAEMOGLOBIN BELOW
80% AND BELOW 70% IN DIFFERENT AGE GROUPS



It is seen that in the age groups 16-24 and 35-44 the incidence of cases below 80% is approximately equal. In the age group 25-34 the incidence is 12% i.e. the observed difference from the earlier age group is 7.6%. But since the Standard Error of the Difference is 7.4, these apparent differences could have arisen by chance.

If we now consider the percentage of cases below 70% Hb., it is seen that between the age groups 16-24 and 35-44 the observed difference is 7.8%. The Standard Error of the Difference is 4.2., so that even these differences are not statistically significant.

Table 8 shows the relationship between incidence of Anaemia and parity.

Table 8.
Table of Hb. levels grouped according to
Parity in Age Groups 16-44 yrs.

Hb. Level	P.0	P.I	P.II	P.III+
Below 85%	15.5%	22.6%	26.9%	35.6%
Below 80%	10.4%	11.3%	15.4%	20.5%
Below 70%	2.2%	-	3.8%	9.9%
Total No. in Group.	135	69	78	72

There appears to be a steady increase in incidence with increase in parity, at least for the groups below 85% and 80%. But, for example, 15.5% of Para 0 and 22.6% of Para I have Hb. values below 85%. The observed difference is 7.1, and the Standard Error of the Difference is 5.9. Similarly, between Para I and Para III+ the observed difference is 13%, and the Standard Error of the Difference is 7.5. These figures therefore are not statistically significant, and larger numbers in each group are needed to eliminate chance as a possible explanation of the apparent increase in incidence of anaemia with /

with increase in parity.

Further, older women are also more likely to have a larger number of children as is shown in Tables 9 and 10.

Table 9.
Parity in relation to Age Group.

Parity.	Number of Mothers in Age Groups		
	16-24	25-34	35-44
1	20	35	14
2	14	36	29
3	2	10	26
4		6	7
5		3	8
6+		2	10
Total.	36	92	94

The average number of children "per mother" is shown in Table 10.

Table 10.
Average Number of children "per mother."

	Age Group.		
	16-24	25-34	35-44
Total No. of children from Group	54	188	282
No. of Mothers.	36	92	94
Average per Mother.	1.3	2	3

Table 11 shows, in the different age groups, the average Haemoglobin, the incidence of cases below /

below 80% and of cases below 70%, in relation to parity. No column is provided for the age group 20-24 as there were no women with parity greater than 3 in this age group.

Table 11.

The average Haemoglobin, and the amount of anaemia, in Para 1-3 and Para 4+ women, in different age groups.

Age Group	25-29		30-34		35-39		40-44	
	1-3	4+	1-3	4+	1-3	4+	1-3	4+
No. of Cases.	42	2	42	9	34	16	32	9
Average Haemoglobin	88.7	92.5	91.5	87.1	88.1	86.3	88.3	89.4
% c Hb. below 70%	2.4%	-	-	-	5.9%	25%	9.4%	11.1%
% c Hb. below 80%	16.7%	-	7.1%	11.1	11.8%	37.5%	15.6%	33.3%

It would appear from this table that ⁱⁿ the older age groups the incidence of anaemia is greater in those women with the higher parity. However, the figures are too small for this to be a reliable conclusion, and, in terms of statistics, the differences are not significant, since even in the 35-39 age group, where the observed difference is 25.7, the Standard Error of the Difference is 13.3. The most that can be said is that, owing to the small number of cases in the different groups, the apparently higher incidence of anaemia in women with higher parity, could have arisen by chance.

If we compare the incidence of anaemia in Parous women in the Heath Ward with that of Parous women in the rest of the practice the following figures appear:-

Parous women below 85% = 108 out of total of 434.

Parous women from Heath Ward below 85%

= 30 out of total of 91.

i.e. for the rest of the practice, 78 out of a total of 343 (22.7%) had Hb. below 85%.

From Heath Ward 30 out of 91 parous women had Haemoglobin values below 85%. i.e. 32.9%

The observed difference is 10.2% and the Standard Error /

Error of the Difference is 5.4, so that the difference is not statistically significant, assuming significance to be represented by twice the Standard Error of the Difference. In other words the apparently higher incidence of anaemia in the parous women of Heath Ward could have arisen from chance sampling.

The fact remains, however, that a high proportion of the parous women of Heath Ward had low Haemoglobin values. There was no corresponding drop in the red cell counts of the 49 specimens examined, films were scrutinized for the presence of punctate basophilia but did not show this phenomenon, and a therapeutic test was applied by prescribing iron in the form of Tab. Ferri Sulph (N.F.)

The following list shows the effect of iron therapy on the Haemoglobin level in the more severe cases of anaemia in the Heath Ward.

Table 12.

Case No.	Original Hb.	Hb. after Therapy.	Comment.
1.	75	88	
2.	58	96	
3.	62		Did not take Tabs.
4.	78	96	
5.	74	98	
6.	74		Lost contact.
7.	79	96	
8.	73	90	Became pregnant
9.	68	78	? persisted with treatment.
10.	78	96	
11.	62)	Sisters. Did not take Tablets.	"always anaemic" Ulcerative Colitis.
12.	75)		
13.	52	96	
14.	79	98	
15.	77	90	
16.	79	98	

Thus it is seen that the response to iron therapy was marked in all cases where the patient had persisted with the treatment, supporting the view that these women were suffering from an anaemia due to iron deficiency.

Of the 30 Parous women from Heath Ward with Haemoglobin values below 85%, 23 had lived in the same district all their lives and 4 of the remaining 7 for over six years. It was therefore impossible to relate length of stay in the district to anaemia in these women.

In the large majority of parous women examined, no organic cause was discovered to account for the anaemia found. In a number of cases, the women believed that they had been anaemic since some past event such as a post-partum haemorrhage or an operation. There was, however, no clear-cut association noted between anaemia and organic disease such as was demonstrated in males, and, indeed, many did not think that they were anaemic, or that they were any different from what they had always been.

If we take the women with Haemoglobin below 80% we find that the following clinical conditions were present as possible causes - the number of cases of each condition being indicated in brackets.

Haemorrhoids (3)	Pernicious Anaemia (2)
Ulcerative Colitis (1)	Operation (1)
Post partum Haemorrhage (1)	Chronic Infection (2)
Miscarriage (1)	Menorrhagia (1)
Carcinoma of Bowel (1)	
Nasal Haemorrhage (2)	

On the other hand a number of women with haemorrhoids had Haemoglobin figures above 90%, one woman with a resected Carcinoma of Bowel had a Hb. reading of 90%, the operation referred to was a double Mastoidectomy done 6 months before, and the post partum haemorrhage occurred nine months previously.

It would therefore appear that in this group of women, while blood loss may initiate a hypochromic anaemia, it is found in only a small proportion of cases, and in only some of these would it be accepted as causative.

It may therefore be said that the Parous women in this survey are representative of the women in the district.

Incidence of Koilonychia.

There were 19 people with Koilonychia in the survey /

survey, of whom 3 were males. The majority of the females had low Hb. levels as the following list will show.

List of Hb. values associated with
Koilonychia in females.

86% (Had iron therapy).
81
62
67
81
60
52
95
47
91 (Having iron).
52
79
38
91 (Goitre).
66
60.

Of the 3 men with Koilonychia, F.M. is a labourer, 66 years of age, who had "bad nails" for about 8 years. Hb. 91%. His Hb. responded to iron therapy and his nails healed with typical ridge formation. Some months later however, he returned asking for more tablets as the nail condition had returned. The Hb. was now 104%. On this occasion, however, very large amounts of iron failed to effect a cure of the nails.

A.B. a retired farmer, aged 65 years, had Koilonychia for "a few years." He was suffering from Diabetes Mellitus when first seen. Hb. 102%, R.B.C's, 5 million. Stabilization on diet and insulin had no effect on the nails; some months later he began taking iron tablets and soon the advancing ~~ridge~~ ridge of healthy nail appeared and his Koilonychia gave place to normally formed nails.

The 3rd. case, A.N. a schoolmaster aged 63 years, had Koilonychia most of his life, more marked on the forefingers of both hands. Hb. 100%. There was no response in the nails to iron therapy.

It will be seen that in two of these three men the Hb. was normal, before iron therapy was begun.

Two women also had Hb. values within the normal range (i.e. 95% & 91%).

H.R. aged 67 years, Para O, had Koilonychia, she thinks, "for years." Long and continuous iron therapy had no effect on the nail condition. R.B.C's. /

R.B.C's. 5,100,000.

quite

M.R., 58 years, Para. 4. has a large nodular ~~factor~~ in a non-toxic stage. Hb. 91%. There was no response in the nail condition to long-continued iron therapy.

Discussion.

While great advances have been made in this century towards understanding the nature and incidence of the various types of anaemia, the anaemic state has been recognised for many hundreds of years. Indeed, the earliest writings, including the Hippocratic Collection of 400 B.C., contain references to a condition which was probably chlorosis, and it is recognised in subsequent writings by a variety of descriptive terms such as "De Narbo Virginio", "White Fever" and "Love Sickness."

According to Immermann (8) (Cyclop. of Pract. of Med.) and Osler (9) (A system of Pract. Med.), Duncan was the first to compare the depth of colour of normal blood under standard conditions with that of patients suffering from chlorosis. He demonstrated that the *intensity* of colour of the latter was 1/3 that of normal blood, while the number of red cells were deficient in pigment. *was unaltered, i.e. Hay* When he found that the red cells of chlorotics settled more slowly than normally, he concluded that this was owing to a reduction of the heaviest constituent of corpuscles - i.e. their iron colouring matter.

According to Garrison (10) (An introduction to the History of Medicine), the nature of this iron-containing pigment, which we call Haemoglobin, was discovered in 1851 by Funke.

More accurate study followed Gower's invention of a Haemoglobinometer in 1878, and Hayem, according to Fowler (11) (Ann. of Med. Hist.) introduced the term "valeur globulaire" to ~~express~~ express the Hb. per cell - the fore runner of our present day mean cell haemoglobin concentrations.

The therapeutic use of iron for a variety of complaints also dates back to ancient times; for in the older pharmacopoeia it is referred to as Mars. Iron rust dissolved in wine, steel filings and water, in which a sword had rusted, were favourite prescriptions of our forebears.

Garrison (12) (p.271) gives the credit to Sydenham for being the first to introduce steel tonics /

tonics for chlorosis. "I order the patient to take, for 30 days, some remedy drawn from Mass. Nothing else succeeds better on such occasions..... The pallor disappears and once again the face is rosy and ruddy."

According to Warren (13) (B.M.J. 1950, 1.1204) an anonymous book published in London in 1769 called "Compendium of Physic & Surgery" recommended "steel waters" and "simple filings of iron" for the treatment of chlorosis.

In 1831, Bland announced his formula and dosage of a preparation of iron which he used successfully in the treatment of chlorosis.

Chlorosis has largely disappeared today as the present study shows, but it is interesting to surmise on whether it now appears in a later age group, as Nutritional Hypochromic Anaemia; a phenomenon which we see taking place in other conditions such as Poliomyelitis and the Primary ~~F.B. Focus.~~ **FOCUS.**

According to "the Lancet" (14) "iron deficiency anaemia must be one of the commonest diseases in women, and is more common in men than is supposed." While Waldenström (15) reports that "iron deficiency is by far the most common and the most important deficiency in ~~Sweden~~ today.

It was felt that the problems presented by the proposed housing estate in Snailbeach gave one an opportunity to assess the incidence of this iron deficiency in the population.

As emphasised earlier, every effort has been made to avoid selection of any kind, thus hoping to obtain a true indication of the amount of anaemia in the practice, and for this purpose, the introduction of the National Health Service afforded a much more ready access to homes.

In the Haemoglobin survey carried out by the Medical Research Council (16) in 1943, an excellent estimate has been made of the Haemoglobin levels in different sections of the community, but, relying on volunteers, and testing only selected groups, no estimate can be made of the amount of iron deficiency in a community from these figures. Furthermore the readings were made by general observers. The present survey was not open to these objections.

Similarly, in the Aberdeen survey of 1935, a selected group of people were investigated, namely, the poorer class people of Aberdeen, and, in the case of married women, such as attended clinics etc.

It is apparent that the full significance of the figures in the various surveys can only be assessed when /

when it is made clear what constitutes a "normal" individual. Thus Price-Jones' (17) definition of a "healthy" man, was a man "who said he was well, and was doing his work properly." It is obvious that such a definition might include men with organic disease, and indeed at least two men in the present survey with Haemoglobin below 70% would be considered normal by this definition.

On the other hand, Davidson, Fullerton and Campbell (7) found four cases of "severe organic disease" out of a total of 93 men examined. It is not unreasonable to assume that a group of men which included 4.3% of cases of organic disease would also include a number of cases with other minor affections, such as piles, for instance, which would partly account for the anaemia.

It is therefore considered that the present survey deals with a group of people corresponding to the Aberdeen group, at least as far as males are concerned, and that these two surveys, are suitable for comparison of the incidence of anaemia in the two areas concerned. As was pointed out earlier, however, the Aberdeen survey purposely confined itself to a selected group of women, and from this point of view it is felt that the figures of the present survey are more representative of the community at large.

On the other hand, this being so, the results, indicating as they do a lesser degree of anaemia than in Aberdeen, must be interpreted in the light of the above, inasmuch as the better Haemoglobin values are due partly to the fact that the proportion of "poor class women" is smaller in this survey.

In the case of the M.R.C. Survey, 0.9% of males were below 80% and 0.2% of males were below 70%, so that it is unlikely that there was much organic disease in this group of men. In other words, their figures are less likely to be influenced by organic disease, and are more representative of a community from which cases of organic disease have been excluded.

The usual figures for "normal" give no indication of the variability that may occur in a "normal" population, as was demonstrated in the Medical Research Council Special Report Series (16). According to this report "it would appear reasonable to accept a mean figure of the order of 105 (or above) as satisfactory in men." "The normal mean value should probably not be lower than 98" for women (figures expressed as percentages Haemoglobin). There is, however, a wide range above and below these figures. As Davidson et al say /

say, "the range of normality extends 10% above and below the average findings in normal individuals."

Males.

The figures given by Price-Jones were 105.4% for 1 group of 100 normal men, and 104.7% for another group of 90 men.

These values for the normal are low compared to those found by some foreign observers, especially in Buenos Aires, India, and America. The most ready explanation of this was that the difference was due to differences of technique; Price-Jones therefore went to America himself and as a result of his observations there he concluded that the Haemoglobin levels of the students he examined in America were higher than those of London students. He attributed this difference to the comparatively large number of closed cars in America leading to a "slow chronic poisoning in which oxygen pressure is constantly being slightly reduced, and the bone marrow responds by producing a relative polycythaemia."

Such an explanation would not apply in the country, nor indeed is it likely that it could be argued for London today.

In this connection it is interesting to note the observations of Wills (19) et al, who found that the mean Haemoglobin is higher in London than in the country. Evidently, also, in the past, a country lass was considered less likely to develop a severe anaemia as may be gathered from Isaac Walton's lines, quoted by Fowler (20).

I married a wife of late

 But oh! the green sickness
 Soon changed her likeness
 And all her beauty did fail.
 But 'tis not so
 With those that go
 Thro' frost and snow
 As all men know
 And carry the milking-pail.

In contrast to these figures, Jenkins & Don (21) (~~J. Hyg. 1933: 33: 36~~) found that the average Hb. for 118 men was 115% Haldane and for 116 women it was 100%. Their material consisted of small samples taken in various parts of this country including London.

Davidson et al in Aberdeen found that their average normals corresponded more to the figures of Price-Jones, as indeed do those in the present survey, where only 51 males out of 339 had a Haemoglobin /

Haemoglobin level 110+, and only 8 females out of 661.

Widdowson & McCance (22) found an average Haemoglobin of 102% in 42 men of professional and artisan class, while Sinclair found an average value of 98% in 60 men of an Oxford Survey, and an average value of 99% in 50 male students. According to the Medical Research Council Report, the corrections applied to this latter figure bring the mean to 106.3%.

A survey on medical students in Edinburgh by Davidson et al (24) gave an average of 105.7% (corrected). They also found a mean value of 100.5% in 123 factory workers in Edinburgh.

In a mobile survey, Meiklejohn (25) found a mean value of 100% in 27 men from Accrington, and a mean value of 91% in 23 men of Merthyr Tydfil.

Marshall estimated the Hb. level in blood donors, all of whom were considered to be in good health, and none of whom had donated blood before. He obtained the following figures:-

100 males	mean Hb. 100%
65 women (after reproduction period)	" 84%
220 women (in reproduction period)	" 82%

The M.R.C. Report found a mean of 102.4% in single men and 102.1 for married men.

In a survey of Hb. levels in a North Carolina population in 1940-45, Milan & Muench (27) (J. Lab. Clin. Med.) found a mean figure of 14.25 gm for 611 white men aged 12 years and over. Converted to Haldane's scale this corresponds to 103.2%.

It will be seen that apart from the students, all the above groups fell short of the mean figure of 105% given by Price-Jones.

On the other hand, in America, Wintrobe (18), in an analysis of nearly 700 individuals, found average values of 115% for the males in his survey.

In the present survey it was seen that if we excluded the 18 cases in which organic disease might be held to have been a factor in causing the anaemia, the average Hb. for 321 adult men was 102.6%, practically the same figure, in fact, as was found in the M.R.C. Survey, and this in spite of the fact that the present survey included a number of other cases of disease of various kinds. Even if all cases with organic disease are included, the mean value was 100.8%. This group includes men with various types of chronic illness such as rheumatoid arthritis, peptic ulcer, haemorrhoids, and a host of other minor disorders.

When /

When these figures are compared with those of Davidson^F & Campbell, whose average for 93 adult males is 97%, it must be remembered that the present series contain several cases of organic disease, as described. Also in the Aberdeen series, there were 4 cases out of 93 with Hb. less than 80%. all of whom were found to be suffering from severe organic disease - i.e., 4.3% of the cases suffered from organic disease.

On the other hand, in the M.R.C. Survey, only 0.9% of the whole male sample were below 80%, whereas in the present survey, 11 out of 339 were ~~more than~~ ^{below} 80% (i.e. 3.2%) and 6 were ~~more than~~ ^{below} 70% (i.e. 1.7%), compared with 0.2% in the M.R.C. Survey. However, as shown earlier, severe anaemia in males has almost always an organic basis, and if these organic cases are excluded, only 4 occurred ~~more than~~ ^{below} 80%, and 1.2% below 80% without any detectable organic basis.

Darby and Milan (28) in another American survey found that only 2 out of 200 adult males (1%) had unexplained values below 12 gms (86.9% Haldane). 75.2% fell within the group 90-109, and a further 15.1% were 110 +. There were in fact 9.7% below 90% compared to 7.4% in the M.R.C. Survey, and 16.1% in the Aberdeen series.

Youmans (29) (~~Amer. J. Med. Sc. 1950: 219: 30~~) in a group of 1200 persons in a rural population in Middle Tennessee, found that 3% of males in the 16-20 age group, and 3.6% in the 21 + age group, had Hb. levels below 12 gms per cent (i.e., 86.9% Haldane), while only 2 males (i.e. 1%) both in the 21 + age group fell below 80%.

The M.R.C. report further noted a slight fall in the mean Hb. level after the age of 50 years. This corresponds to the fact, as shown in the present survey, that the majority of cases ~~more than~~ ^{below} 90%, and also of cases of organic disease, occur in this age group.

On comparing the figures in the present survey with those in previous surveys, it is reasonable to conclude that there is but little anaemia in adult males in this area, and anaemia plays but a small part in any low Hb. findings in the area.

Females.

Price-Jones obtained a mean figure of 98.3 on 100 healthy women students and nurses aet. 19-33.

Mackay (30) found a mean value of 84% in female medical students and nurses, and a mean value of 94% in a group of adolescent factory girls. In a group of 209 poor mothers she found a mean of 87.2%.

Wintrobe (18) found an average figure of 100.8% (Haldane) in adult American women.

Nulliperae.

Davidson Fullerton and Campbell in 1935 found an average /

average Hb. of 89.7% in 50 nulliparae aet 18-29. However, since it has been shown that the incidence of anaemia rises with age and this group were all aged between 18 and 29, it may be concluded that the average level of Hb. in poor class nulliparae of all ages in Aberdeen was considerably lower than 89.7.

Milan and Muench (27) found that 5% of white women in their survey fell below 81%.

Wills et al (19) (~~J. Hyg. Camb. 1942: 42: 505~~) found that the mean for London students and nurses was higher than that for country students and nurses.

The M.R.C. Survey found a mean of 93.7% for all women in their survey, and a mean of 94.3% for nulliparae.

i.e. for nulliparous group -

M.R.C. Survey.	Mean value	-	94.3%
Davidson's Series	" "	-	89.7%
Present Survey	" "	-	90.0%

If we compare the figures of the incidence of anaemia in these three surveys in the age group under 30, we find as follows:-

	M.R.C. Survey.	Aberdeen Survey.	Present Survey.
% <i>Below</i> above 80%	5.1%	16%	8%
% <i>Below</i> above 70%	1.1%	6%	1.1%

It is evident that in this younger age group, although the mean value in the present survey is 90.8, compared with 94.7 in the M.R.C. Survey, and 89.7 in Aberdeen, there is no more severe anaemia here than in the M.R.C. Survey, and considerably less cases below 80% than in Aberdeen.

It is clearly demonstrated from these figures that, for practical purposes, chlorosis is no longer a major problem.

The incidence of anaemia rose in nulliparae as age advanced, according to the figures of this survey. In this connection, Davidson's findings suggested that "an iron deficiency anaemia may arise in nulliparous females in this (poor) social class with advancing age", but the small figures available in the older age groups did not warrant a definite conclusion.

In the nulliparous group of the present series, there appears to be a rise in the incidence of cases below 80% from 5.2% in the 16-19 age group to 18.4% in the 45-54 age group, but the drop after this age is /

is not so apparent as in, for example, Fullerton's series (31). It may well be that this is because these older women, suffering from the lassitude associated with anaemia, are less likely to attend clinics than their more active neighbours, or than younger women with more direct responsibility to their children, and so escaped inclusion in Fullerton's series. Such women would have been reached by being visited in their homes in the present survey.

Parous Women.

The average Haemoglobin for parous women in this Survey was 87.6% in the 16-44 age group, and 89% in the 45 + group. These figures are well below the normal standard stated by Price-Jones, and below the mean obtained in the M.R.C. Survey for parous women under 50, which was 90.8%. On the other hand, in the Aberdeen group of 603 parous women, under 45, the mean was 81.3%. According to the M.R.C. Survey Report, this last figure is uncorrected, but is considered to be "at most 2% too high".

Thus the mean value in the present survey is 7-8% higher than in the corresponding Aberdeen group.

The following table shows the comparison between the incidence of anaemia in the different age groups in Aberdeen and in the present survey.

TABLE 13.

Comparison between the incidence of anaemia in Aberdeen and present series, in different age groups.

Hb. Level.	Age Group 16-44 years.		Age Group 45 + years.	
	Davidson's Series.	Present Survey.	Davidson's Series.	Present Survey.
Below 85%	48%	28.2%	36%	25.1%
70-79%	17%	10.8%	9%	7.1%
Below 70%	16%	5.4%	10%	5.6%
Total No. in Group.	603.	222.	112.	212.

In Davidson's series of 603 women there were 48% with Hb. below 85%.

In the present series of 222 women there were 28.2% with Hb. below 85%.

The /

The difference between these two is 19.8% and the Standard Error of this difference is 3.6, so that this difference is significant. This means that there was considerably more anaemia in the Aberdeen parous women of the 16-44 age group than in the women of the corresponding group of the present series.

Table 14 compares the incidence of anaemia in the three surveys.

TABLE 14.

Percentages of 16-44 parous women with anaemia in three surveys.

Hb. level.	Davidson.	M. R. C.	Present.
Below 80%	33%	12.5%	16.2%
Below 70%	16%	4.6%	5%.

It is seen that the figures of the present survey are close to the M.R.C. figures, and there is less than half the amount of anaemia in the present series that there was in Aberdeen in 1935.

In London, Mackay (30) found that 31.6% of 209 poor mothers had Haemoglobin values below 85% - a slightly higher incidence than in the present survey, but lower than Aberdeen.

It is also evident from the present figures that there is more anaemia in parous women of this district under 45 years of age than in nulliparous women under 45 years of age.

Both Table 8 and Table 11 would appear to support the view that the incidence of anaemia increases with parity, although, as remarked earlier, it is possible that these figures could have arisen by chance. The M.R.C. survey also found that there was a "small but consistent decline in mean Haemoglobin" as the number of pregnancies increased, but whether, as they say, this is due to the cumulative effect of several pregnancies, or to the fact that with a larger family, the mother gets a poorer diet, is impossible to determine on the evidence available.

In the 45+ age group of parous women, the average Hb. was 89%, being slightly higher than in the younger age group, and slightly lower than in the nulliparous group. On the other hand, it is considerably lower than the M.R.C. Survey figure for this group, namely, 93.5, and higher than the Aberdeen figure of 86.7.

On comparing the Aberdeen figures with the present ones for the incidence of anaemia in the 45+ age /

age group, we find as follows:- Davidson's series of 112 women had 36% below 85% Hb. The present series of 212 women had 25.1% below 85% Hb.

The difference is 10.9% and the Standard Error of the Difference is 5.4, so that this difference is significant, and there is less anaemia in the 45 + parous women of the present series than in the corresponding group of the Aberdeen series.

TABLE 15.

Comparison of the incidence of anaemia in the three surveys for parous women in 45 + age group.

Hb. level.	Davidson.	M. R. C.	Present.
Below 80%	19%	6.6%	12.6%
Below 70%	10%	1.8%	5.6%

In this age group it is seen that there is approximately twice as much anaemia as in the M.R.C. Survey, and about half the amount of the Aberdeen Survey. Again, it is noted, as in nulliparous women, that there is a considerable amount of anaemia in this age group.

However, in the interpretation of these figures, it has to be remembered that authors such as Newman and Gitlow (50) found Haemoglobin averages of 10% to 20% lower in those over 60 years of age than in young adults. To what extent this can be attributed to lack of activity, and to degenerative processes, it is difficult to say.

The investigations carried out in this survey failed to support the view that any in the community were suffering from anaemia due to lead poisoning. Other clinical conditions usually associated with the toxic effect of lead absorption, such as lead colic, lead palsy, and lead encephalopathy have been unknown in the district.

The main sources of danger in Snailbeach from this point of view were considered to be the slag heaps and the various water supplies. The water supplies have been chemically examined at repeated intervals for lead, and on only one occasion was there any lead pollution found, in the autumn of 1949. This was in the "Boat Level", half-way up the valley, 2 to 3 miles from Snailbeach, and here the lead was in suspension and not in solution. Dust from the slag heaps at Snailbeach has been found to contain about /

about 7% of lead, but here again it is in the form of Galena, which is the insoluble Lead Sulphide.

Another suggestion raised was that the pitch blende known to be in the district might give rise to radio-active poisoning. Numerous experiments by enthusiastic amateurs seemed to show that water from the higher mines had a toxic effect on fish, even to the extent of consuming the animals without any trace being left. Stories by old miners that they had often seen rats going into the mines but had never seen any come out, lent colour to these experiments. The matter was put on a more scientific basis, however, by a visit in the summer of 1950 from Dr Blaney, of Harwell, who visited the mines with a Geiger counter. He ~~obtained~~ ^{obtained} slight reactions in the most southerly mines - the Gritt and Pennerly mines - but none in Snailbeach, so that the likelihood of this being a cause of anaemia is very remote.

The possibility of worm infestation being a cause of anaemia was considered, and stools from five anaemic cases examined microscopically. All were negative for *Diphyllobothrium latum*.

At one time it was thought that vitamin deficiency might be held responsible for causing anaemia. However, the part played by vitamin deficiency, especially vitamin C. in blood formation is still in doubt; indeed, Crandon, Lund and Dill (51) showed that in a man with artificially induced scurvy there was no anaemia even after ~~v~~ ^vsections amounting to 10 pints of blood.

"Sway back", a paralytic condition noted in Australia by Bennetts and Beck (32) as occurring in pregnant ewes, and associated with anaemia, was unknown to local farmers in the district. This condition was found to be prevented and cured by giving the ewes copper. It was to exclude such a remote possibility as this that the N.F. Tab. ~~Fe~~ ^{Fe} Sulph. was prescribed to our anaemic patients in Heath Ward instead of the more usual Tab. Ferri. Sulph. Co. which contains Copper Sulphate. Ferr

The possibility remains that organic disease, and particularly malignant disease, is more common in the Snailbeach area than in the rest of the practice.

Relevant death statistics for the period 1935-45 were as follows:-

HEATH WARD.

	Snailbeach Portion.	Remaining Portion.
Population (1945)	213.	178.
No. of deaths from cancer.	7.	1.
% of deaths from cancer.	21.8%	3.8%

The observed difference here is 18 and the Standard Error of the difference is 3.2, so that this difference is significant, and there would appear to be more cancer deaths in the Snailbeach Portion of the Heath Ward than in the rest of the Ward. It will be noted that the higher incidence of cancer deaths occurs in that part of Heath Ward in which the Geigy counter failed to give any reactions.

Since these all occurred in one practice, they are not open to the usual objections levelled against comparisons of cancer death rates - namely, differences in the certification of death. However, as the majority of "other causes" were probably not verified by post-mortems, the figures of comparison are likely to be inaccurate.

It is felt that the response to iron demonstrated clearly that this was the factor missing. There is no doubt also that the similarity between the types of women affected with anaemia in this survey (particularly those from Heath Ward) and in the Aberdeen series is significant - the poorer class parous women. For it is to be noted that since the mines closed in 1910, the area has been regarded as a depressed area, partly because the men had no work, and partly because so many, now dead, were victims of silicosis. Indeed, of the few remaining silicotics in the area, only one is receiving a pension, and this, no doubt, is also a factor in producing an anaemia which is undoubtedly nutritional in origin.

In the Aberdeen investigation referred to so frequently, it was concluded that "the physiological demands for iron (were) not satisfactorily supplied by the diets of many of the poorest classes" and that the term nutritional anaemia was justified. Furthermore, according to Fullerton et al (45) the adult figures were substantially the same in 1943 as in 1935.

On the other hand, the results of this survey do not give ground for the view that the people of the practice as a whole are anaemic, or undernourished. Indeed, considering the number of cases of organic disease included in this survey, it is reasonable to conclude that no ill-effects such as could be measured by Haemoglobin levels have resulted in the community from the prolonged rationing to which the people have been subjected.

In this connection it would appear from the report of the Medical Officer of the Greater London Red Cross Transfusion Service (33) that there is a greater incidence of mild anaemia in Great Britain than there was pre-war. Indeed, this report evoked an extensive correspondence, much of it, however, of a political nature. It should be remembered that previous workers, such as Dobbs (58) found the Haemoglobin levels of London students and nurses higher than those in the country - a finding which would possibly have been explained by Price-Jones as due to "slow chronic poisoning" by Carbon Monoxide. Were such an explanation tenable, it could be that in more recent years /

years London levels would fall as a result of the restrictions in motoring which have resulted from petrol rationing, etc. On the other hand, as pointed out by Milan and Muench (52) "a study of the distribution of Haemoglobin levels in a population may furnish important information regarding its nutritional status".

As was also pointed out by Davidson and Leitch (34) it is not uncommon for anaemia to be associated with a poor diet.

These workers quoted the studies of Werdinus in Sweden who showed that where the diet of the people consisted chiefly of milk and cereals, anaemia is common in adults, especially women. They also referred to the work of Orr and Gilks (35) (M.R.C. Sp. Rep. 1) who compared the incidence of anaemia in two tribes in Kenya. Orr and Gilks showed that the diet of the Kikuyu male, although adequate in protein, contains little meat (only on ceremonial occasions) while the staple diet of the Masai tribe consists of meat, milk and blood. The incidence of anaemia in the Kikuyu males was 47.8% compared to 11.7% in the Masai males.

Similarly, Taylor, Chhuttani and Kumar in an investigation of 40 meat eaters and 42 vegetarians in a desert garrison found that in meat eaters the average Haemoglobin was 15.44 gms.% compared to 14.32 gms.% in the vegetarians.

Davidson and Leitch concluded from their observations that "anaemia due to a deficient diet is common in both animals and humans. It is the cause of much loss of health and efficiency in adults, and a factor of first importance is deficiency of iron".

On the other hand, to quote the same authors, "while an adequate intake of iron will restore health when the diet is deficient in iron alone, it will not do so if the diet be otherwise inadequate. The addition of iron to a poor diet, while improving the condition with regard to anaemia, cannot be expected to restore complete health. Conversely, even minor degrees of malnutrition due to diet will tend to be associated with anaemia, since poor diets are usually low in iron. Hence, although iron treatment cures nutritional anaemia, complete health requires a well-balanced diet".

This fact might indeed be used as an argument against fortifying bread with iron, since the higher Haemoglobin which might result could give a false sense of security with regard to the nutritional state.

As the M.R.C. Survey points out, that Haemoglobin levels vary with the family income has been clearly shown in the past by a number of workers such as Spence (36), Fullerton (37), Reid and Mackintosh (38) and McCance et al. (39).

This is no doubt related to the fact that foods which contain iron and other haemopoietic substances are, with the exception of cereals, the more expensive.

The M.R.C. further considered that the relatively high levels in their survey might be due to the higher iron content of national bread, as suggested by Davidson (41).

From /

From the figures presented in this survey, it appears that in males, anaemia is not a serious problem. In females, the parous women particularly, but also women in the older age groups, are more likely to suffer from anaemia. There is no reason to believe that the amount of anaemia in the community is greater than a similar survey would have shown before the Second World War.

With regard to the cases of Kailonychia, it is interesting to note that Waldenstrom (42) in 1938 drew attention to the possibility of iron deficiency occurring in the absence of anaemia and resulting in Kailonychia. He described 3 such women, 2 of whom were pregnant, in whom there was "no anaemia" and whose nails were cured by large doses of iron.

In 1945, (43), referring to a group of similar cases with "no anaemia", he found that the serum iron was low in these cases of what he calls "latent sideropenia", and noted the resultant effect of iron treatment on the epithelial tissues, and on the serum iron level, while having no effect on the Hb. He thought it probable that "this ~~investigation~~ of the serum iron may be necessary for the growth of these epithelial cells".

normalisation

Waldenstrom studied the serum levels in a rural population and concluded that there were three combinations of serum-iron and Haemoglobin level which may arise. They were as follows.

1. Low serum iron + low Haemoglobin = iron deficiency, a pathological state which may be cured by iron and which is common in rural districts.
2. Normal serum iron + low Haemoglobin = anaemia which is refractory to iron.
3. Normal Haemoglobin + low serum iron = epithelial symptoms, which may be an indication for iron treatment, i.e. latent sideropenia.

In the present series, two women and two men had Kailonychia with a Haemoglobin level within the normal range, but only the diabetic men would conform to the picture described by Waldenstrom in group 3. There was no suggestion of trauma in any of these cases, and in two cases the figures quoted were equivalent to those obtained by samples sent to hospital for confirmation.

According to Davidson and Fullerton (44) E.M.J. 1938, new series 112) "fully developed kailonychia probably does not occur in the absence of a co-existing nutritional anaemia" and "the principal factor responsible for the nail changes is lack of iron."

It is possible as suggested by Wintrobe (59) and Cooke & Lutz (60) that the frequent occurrence in women could be related to the combination of a much higher incidence of anaemia in the female sex, and occupational exposure to the toxic effect of soda during the process of washing. This would explain the frequent occurrence in the fingers compared /

compared to the toes.

While the present survey shows no cause for alarm at the incidence of anaemia in the population, it is evident that the health of the people could be improved by the more frequent recognition by doctors of cases of anaemia, especially in women, and its early treatment. The cure of hypochromic anaemia is so readily available and bestows such benefits on the patients that the small amount of time involved in a Hb. estimation is well worth while and should be an every day routine in general practice.

In males, particularly, a figure below 85% unless there is clear cut evidence of the cause, calls for the ~~e~~xclusion of malignant disease. In women, under present circumstances, this ideal will not be realised, but serial estimations will not only put treatment on a scientific basis but will assist the practitioner in singling out more quickly those cases requiring further investigation.

SUMMARY /

SUMMARY AND CONCLUSIONS.

The Haemoglobin levels were investigated by Haldane's Method in one thousand adults in the summer of 1950.

Every effort was made to ensure that the sampling was representative of the whole community. For this purpose a large proportion of the specimens were obtained by making direct visits to houses.

The whole investigation, including all the readings, was carried out personally by the author.

A subsidiary purpose of the investigation was to investigate the possible existence of an anaemia peculiar to one district in the practice, namely the disused lead mining area known as Heath Ward.

Results are divided into three groups - Males, Nulliparous females and Parous females.

Males. The average Haemoglobin for this group was 100.8%. If all ill patients are excluded (mostly with organic disease of one form or another) the average Haemoglobin for the remaining 320 men is 102.6%.

Eleven males had figures below 80%, and in 7 of these there was definite organic disease. The remaining 4 conformed to the picture of a hypochromic anaemia without apparent cause, and responding to iron therapy. Apart from these 4 cases, all males with Hb. below 85% had an organic disease to account for the anaemia.

Organic disease should always be suspected in males when the Haemoglobin falls to 85%, and even with negative findings, should still be suspected if there is no dramatic response to iron therapy.

There was no evidence of any serious amount of anaemia in males in the districts unrelated to organic disease.

Nulliparous group. 227 women were examined. The average Haemoglobin for the group was 90%. 20.7% of these women had Hb. values below 85% and 12.8% below 80%, while 4.4% were below 70%. The figures appear to show an increase in incidence with advancing years up to the Menopause, but the numbers are inadequate for statistical verification.

There was no significant difference in the amount of anaemia in the Heath Ward district compared to the rest of the practice.

Parous Women. 434 were examined, 222 in the age group 16-44 years, and 212 in the 45 + age group. The average Haemoglobins for these two groups were 87.6% and 89% respectively.

24.9% of Parous women had a Hb. value below 85%, 14.5% were below 80%, and 5.5% below 70%.

There /

There is much more anaemia in the under 45 parous women than in the same age group of nulliparous women.

The figures showed a steady increase in incidence of anaemia with increase in parity : there were insufficient numbers in each group to eliminate chance as a possible explanation.

A high proportion of parous women in Heath Ward are anaemic: i.e. 32.9% compared to 22.7% for the rest of the practice. This difference however is not statistically significant. This anaemia is due to iron deficiency, and was cured by iron therapy.

As the population are fairly static, no relation could be drawn between the degree of anaemia and the length of stay in the district.

In parous women, organic disease does not play such a prominent part in causing anaemia, as was noted in males.

Koilonychia was present in 19 people, including 3 males. The Haemoglobin was normal in 2 of the males and in 2 of the females. In one of these males, a diabetic, the Koilonychia was cured by iron therapy.

The history of anaemia and of iron therapy is briefly reviewed.

The results are compared particularly with the Aberdeen Survey of 1935, and the Medical Research Council Survey of 1943. On the whole the results fall in between these two, and reasons are given for regarding the figures of the present survey as more representative of the community at large.

While the figures show no cause for alarm, there is a large amount of anaemia in the country which could be readily cured.

There was no evidence that any special type of anaemia occurred in Heath Ward, and any increase in incidence is believed to be due to social conditions. The Death Rate for Heath Ward suggests a higher Death Rate from Cancer in the Snailbeach portion than in the rest of the ward, but owing to lack of postmortems, this cannot be confirmed.

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