The epidemiology of the haemoglobin level – a study of 1057 subjects in general practice

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Summary: A prospective survey of the level of haemoglobin (Hb) has been carried out in 1057 subjects (607, 57.4% women) over the age of 40 randomly selected from the age-sex register of a North London group practice. Mean Hb levels were $15.04 \pm \text{s.d. } 1.41 \text{ g/dl}$ in men and $13.54 \pm \text{s.d. } 1.32 \text{ g/dl}$ in women ($P < 0.001$). In men, Hb levels did not differ between the ethnic groups represented, but women of Mediterranean origin had significantly lower Hb levels than other women ($P < 0.001$). There was no social class difference in Hb levels. Women under age 50 had significantly ($P < 0.001$) lower Hb levels than older women. Smokers had significantly higher Hb levels than non-smokers ($P < 0.002$) and there was a weak correlation with numbers of cigarettes smoked (men $r = 0.07$, $P = 0.07$; women $r = 0.14$, $P < 0.001$). Haemoglobin levels correlated with diastolic blood pressure in both men ($r = 0.07$, $P < 0.05$) and women ($r = 0.23$, $P < 0.001$). Thirty eight subjects (3.6%), 25 women and 13 men, were found to be anaemic (Hb $< 11.5 \text{ g/dl}$ in women or $< 12.5 \text{ g/dl}$ in men). Anaemia could be confirmed in only six of 19 subjects in whom repeat levels were measured. Screening for anaemia did not uncover any serious disease.

Introduction

No study of the levels of haemoglobin (Hb) in the general population of the UK has been published since 1972 when Elwood *et al.*¹ reported a comparison in 450 women and 385 men of Asian, Welsh and English origin.

We have performed a general practice-based study in which a randomly selected sample of subjects over the age of 40 were screened for diabetes, hypertension and anaemia.² In this paper we report the findings of the haemoglobin levels in this population.

Subjects and methods

The Islington Diabetes Survey was conducted between July 1983 and July 1984 at a purpose-built group practice of 4 partners on a housing estate in North Islington. Of the 10788 registered patients, 3485 (32.3%) were over 40 years of age. A random sample of 1908 of these subjects, stratified by sex and age, was selected from the age-sex register for screening. The subjects were invited to attend the practice for a screening examination which included an abbreviated

75 g glucose tolerance test, blood pressure measurement using random zero sphygmomanometer, and haemoglobin estimation. Levels of haemoglobin (Hb), of blood glucose and of glycohaemoglobin were performed on a fingerprick blood sample, obtained without stasis. All the tests were performed in the morning and the subjects were fasting prior to the glucose load 2 hours before the sample.³ Blood was taken into an EDTA capillary tube (Sarstedt Ltd., Leicester, UK) and within 24 hours the haemoglobin level was estimated colorimetrically by conversion to cyanmethaemoglobin using a Coulter haemoglobinometer (Coulter Electronics Ltd., Luton, Beds., UK) which was calibrated daily using Coulter 4C Plus Normal Coulter Counter Cell Control (Coulter Electronics Ltd., Luton, Beds., UK). The inter-assay coefficient of variation was 0.2%. Duplicate testing of 20 samples at 0 h and 24 h demonstrated no effects of the delay in assay on haemoglobin levels. Blood glucose was estimated using a glucose-oxidase method (Technicon I, Technicon Laboratories, Basingstoke, Hampshire, UK) and glycohaemoglobin by an agar gel electrophoretic method (Corning Medical Ltd., Halstead, Essex, UK). Subjects with Hb $< 12.5 \text{ g/dl}$ (men) or $< 11.5 \text{ g/dl}$ (women) were classified as anaemic but at the general practitioners' request, all subjects with levels $< 11.5 \text{ g/dl}$ were advised to contact their general practitioner for follow-up.

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Statistical analysis was performed using a SPSS package, and employed linear regression analysis or Spearman rank correlation for non-parametric data, and Student's *t*-test (with appropriate allowance for multiple comparisons) and analysis of variance. Results are expressed as mean $\pm$ s.d. (number of subjects).

Results

Of the 1908 selected subjects, 38 were known diabetics and were excluded from screening, 176 had been removed from the practice list by the Family Practitioners Committee and 50 had died. Of the 1644 eligible subjects, 1084 (65.9%) were examined, and Hb levels were available on 1057 (97.5%). Of these, 607 (57.4%) were women. The subjects studied were representative of the total practice population in terms of gender and place of residence, but as expected the younger and older age groups were somewhat under-represented.

The mean Hb level was 13.54 ± 1.32 g/dl (607) in women and 15.04 ± 1.41 g/dl (450) in men ($P < 0.001$). Frequency distributions are shown in Figure 1.

In men there was no significant difference in Hb levels in subjects of Afro-Caribbean origin, of Mediterranean origin (predominantly Greek-Cypriot), or of Asian origin compared to those of Northern European origin (Table I), but women of Mediterranean origin had significantly lower Hb levels ($P < 0.001$) than other women. This difference remained significant ($P < 0.05$) when different smoking habits and age group were taken into account by analysis of variance. Five Afro-Caribbean subjects were identified as having sickle cell trait (4.8%) and one subject, of Mediterranean origin, thalassaemia trait (0.9%).

Smokers had significantly higher Hb levels than non-smokers (2-way analysis of variance $P < 0.002$) and the difference remained significant ($P < 0.02$)

Figure 1 The distribution of haemoglobin levels (g/dl) in men and women.

when age differences between smokers and non-smokers were taken into account. This difference was also seen by comparison using Student's *t*-test in women but not in men (Table II). There was a weak correlation between the number of cigarettes smoked and Hb

Table I Mean level of haemoglobin (g/dl) according to ethnic group.

	Men	Women
Total	15.04 $\pm$ 1.41 (450)	13.54 $\pm$ 1.32 (607)
(a) North European	14.97 $\pm$ 1.45 (340)	13.49 $\pm$ 1.37 (481)
(b) Afro-Caribbean	15.17 $\pm$ 1.40 (51)	13.44 $\pm$ 1.38 (53)
(c) Mediterranean	15.12 $\pm$ 1.70 (48)	12.76 $\pm$ 0.89 (58)
(d) Asian	16.15 $\pm$ 1.25 (9)	13.52 $\pm$ 2.14 (10)
Analysis of variance	$P > 0.2$	$P < 0.03$
Student's <i>t</i> -test North European vs others	$P > 0.25$	Student's <i>t</i> -test Mediterranean vs others $P < 0.001$

Table II Effects of smoking on haemoglobin level (g/dl)

	Men	Women
Smokers	15.13 ± 1.37(191)	13.79 ± 1.34(200)
Non-smokers	14.98 ± 1.44(259)	13.41 ± 1.30(407)
Student's <i>t</i> -test	$P > 0.25$	$P < 0.001$

levels (men $r_s = 0.07$, $P = 0.07$; women $r_s = 0.14$, $P < 0.001$).

Haemoglobin levels were higher in women over the age of 50 than in younger women (Table III) but there was no significant linear relationship of Hb levels with age in men. There was no correlation of Hb level with social class in either sex. In both sexes Hb levels correlated weakly with diastolic blood pressure (men $r = 0.07$, $P < 0.05$; women $r = 0.23$, $P < 0.001$), but there was no relationship between Hb level and body mass index or alcohol intake in either sex ($r = -0.03$ to 0.07 , $P > 0.10$). Moreover the relationship between Hb level and diastolic blood pressure remained significant when analysed with body mass index and alcohol consumption included in a multiple regression analysis (men: F change = 23.97, $P < 0.001$; women: F change = 4.68, $P < 0.05$). In women Hb levels correlated with 2-hour blood glucose ($r = 0.08$, $P < 0.05$) and with glycohaemoglobin ($r = 0.08$, $P < 0.025$) but these relationships were not found in men ($r = -0.01$, $P = 0.38$ and $R = 0.06$, $P = 0.12$, respectively).

One hundred and eight subjects (10.2%) complained of fatigue; their mean level of haemoglobin did not differ from those without this symptom (14.41 ± 1.50 g/dl vs 14.15 ± 1.57 g/dl, respectively, $P = 0.09$).

Thirty eight subjects (3.6%) were found to be anaemic (25 women, 4.1%; 13 men, 2.9%). Of the 25 women who were requested to see their general

practitioner for a repeat Hb measurement, 13 had repeat Hb levels recorded in their notes within 6 months of the screening examination. Seven of these values were normal; of these, 6 had received no treatment and the seventh, whose anaemia was already under investigation, had been started on replacement vitamin B12 therapy for pernicious anaemia. Four women still had levels between 11.0 and 11.4 g/dl, of whom one had received iron therapy (no reason given in her notes) and three had not been considered in need of further investigation or treatment. The remaining two women, both with menorrhagia, whose Hb levels had been repeated, were still anaemic despite being treated with iron. Two women with no repeat Hb level recorded in their notes were currently attending hospital out-patient clinics (one for menorrhagia, one for osteoarthritis) where a recent level may have been checked. Eight other women had not had a repeat Hb level recorded in their notes and two women's notes could not be found.

Of the 13 men with Hb levels less than 12.5 g/dl, five had levels > 11.5 g/dl and were therefore not referred to their GP. Six subjects, one of whom was receiving regular vitamin B12 injections for pernicious anaemia, were retested and all had normal Hb levels. Of the remaining two subjects, one was attending a hospital haematology clinic for monitoring of long-term anticoagulant therapy after a retinal vein thrombosis, and one had died of previously diagnosed malignant disease.

Table III Mean level of haemoglobin (g/dl) according to age group

	Men	Women
Age		
40–49	15.12 ± 1.31 (167)	13.29 ± 1.27 (189)
50–59	15.16 ± 1.22 (107)	13.73 ± 1.26 (153)
60–69	14.97 ± 1.43 (94)	13.45 ± 1.30 (124)
70–79	14.90 ± 1.82 (67)	13.78 ± 1.40 (98)
80+	14.37 ± 1.51 (15)	13.66 ± 1.47 (43)
Analysis of variance	$P > 0.20$	$P < 0.01$
Linear correlation	$r = -0.07$, $P = 0.06$	$r = 0.11$, $P < 0.005$
	Student's <i>t</i> -test > 80 versus < 80 $P = 0.10$	Student's <i>t</i> -test > 50 versus < 50 $P < 0.001$

Discussion

Previous studies of the normal haemoglobin level in subjects in the UK have shown ranges of 13.3–14.0 g/dl in women and 14.6–15.4 g/dl in men^{1,4,5,6} depending on the population and on the method of venesection.⁷ An epidemiological association between haemoglobin levels and blood pressure does not appear to have been previously reported. A recent study of cardiac function and blood pressure in 40 patients with haematological disease has reported a significant positive correlation of systolic and diastolic blood pressure with haemoglobin levels, a relationship mediated by changes in peripheral resistance with variations in haematocrit.⁸ There have been previous reports of higher levels of haemoglobin in smokers.^{9,10} The correlation between levels of glycohaemoglobin and those of haemoglobin has also been previously described,^{11,12} and possibly relates to the increased oxygen affinity of the glycosylated haemoglobin. No consistent racial or social class difference in haemoglobin levels has been described.^{1,13} Larger studies have described a decline in haemoglobin levels in the elderly.¹⁴ Our failure to do so may reflect the fact that a study large enough to detect a 0.5 g/dl difference in haemoglobin levels between 2 groups would require 142 subjects in each group for a power of 80%, using a 5% level of significance. Campbell *et al.* found a lower haemoglobin level in women under the age of 45 than in older women.⁵

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