Haematological condition of the San (Bushmen) relocated from Namibia to South Africa

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A cross-sectional study was undertaken to assess the haematological condition of the San (Bushmen) relocated from Namibia to South Africa. We studied 238 subjects — 145 men and 93 women; none of the women was pregnant. We performed full blood counts and estimations of serum vitamin B_{12}, folate, ferritin and erythrocyte folate concentrations. The mean haemoglobin concentration among the men was 14,7 g/dl and 19 (13%) were anaemic; among the women it was 13,8 g/dl and 18 (19%) were anaemic. Thirteen (9%) of the men and 22 (24%) of the women had low concentrations of serum ferritin, and 38 (26%) of the men and 22 (24%) of the women had erythrocyte folate concentrations of less than 270 nmol/l. Three (2%) men and 4 (4%) women had serum vitamin B12 concentrations of less than 120 pmol/l. Eighty-one (56%) of the men and 76 (82%) of the women had eosinophilia, probably because of parasitic infections. It would appear from this and previous studies that prolonged exposure of these hunter-gatherers to a Western lifestyle has resulted in a high prevalence of anaemia, caused by low iron and folate intakes, complicated by alcohol consumption.

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While following their traditional hunter-gatherer way of life, the San (Bushmen) maintained a remarkably healthy haematological condition.[1] Their diet included fruit, roots, nuts and tsama melon (which provided folate), meat (which provided sufficient iron and vitamin B_{12}) and not much alcohol. There had always been parasitic infections due to poor hygiene,[1] but the relatively good general health of the San while following this way of life is well documented.[2]

In recent times, however, the way of life and pattern of health of the San have changed as they were gradually forced to leave their traditional hunting grounds and turn to other ways of living. For instance, at Tsumkwe in Bushmanland, Namibia, the authorities provided permanent housing and some employment. During the hostilities in Namibia and Angola many of the men joined the army as soldiers. These factors led to the gradual adoption of a Western lifestyle. There was a reduction in the intake of meat and vitamins, accompanied by increased consumption of alcohol.[3,4] In 1979 a follow-up examination of the San at Tsumkwe was done.[3] These people were genetically and linguistically similar to those studied in 1969.[1] It showed a prevalence of anaemia of 10% among men and 16% among women. This was associated with a deficiency of folate and iron in their diet. More recently O'Keefe *et al*.[5,6] described the social, economic and physical plight of the modern San.

In March 1990, at the end of the hostilities in Namibia, those San soldiers and their dependants who chose to, were relocated to a camp at Schmidtsdrif, near Kimberley, South Africa, under the aegis of the South African Defence Force. The men continued to serve as soldiers and the families were temporarily housed in tents (Fig. 1). All of these people belong to the !Kung group of San. About half of them originated in southern Angola and belong to the Vasekela clan; the remainder belong to the Barakwena clan of Namibia. The Vasekela are more homogeneous than the Barakwena, who have interbred with other ethnic groups in Namibia.

In October 1990, we conducted a study of these relocated people under the auspices of the Hans Snyckers Institute, as part of a general survey of their state of health. The study was done at the end of the winter in which the group arrived at Schmidtsdrif, when few vegetables had been planted and there was not yet outside employment for family members. Subsequently, however, conditions improved considerably. The aim of this study was to assess the haematological condition of this group of San, to compare our findings with those of previous studies, and to make recommendations about their health. We hope to continue monitoring this population.

Fig. 1. Women fetching water. These women were waiting near a water tanker. Rows of tents, the temporary accommodation, can be seen in the background.

A study of dietary intake was conducted simultaneously by the Nutrition Research Group of Potchefstroom University under Professor H. H. Vorster. A validated food frequency questionnaire was used to assess 20 individuals and showed that most of the food was bought at a defence force store. Two or three meals were eaten daily, consisting

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of maize, supplemented with small portions of meat, canned fish or vegetables. Fresh fruit was eaten once or twice weekly. After pay-day there was liberal eating, leaving very little money for food later in the month. There was a high mean intake of sucrose, 1 157 g/d (standard deviation 88,3). The intake of vitamins B_6, C, D and E was below the recommended daily allowance. The diet was semi-Western and more varied than that of other San, but not always balanced. Alcohol intake varied from low to high (personal communication — H. H. Vorster).

Subjects and methods

Of a total of 4 300 people 605 were male soldiers, 450 civilian men, 1 400 women and 1 845 children. Blood was drawn from 332 fasting adults (i.e. 14% of all adults) who gave informed consent (see Fig. 2). We restricted our study to the 145 men (older than 14 years) and 93 women (older than 14 years) on whom we had complete haematological data. None of these women was pregnant. Most of the men and some of the women underwent physical examinations, the findings of which will be reported elsewhere. Of the 174 subjects whose tribe was known, 48 (28%) were Barakwena and 126 (72%) Vasekela. The median age of the group of 238 was 25 years (range 14 - 92 years); that of the men was 24 years (range 16 - 57 years) and that of the women 29 years (range 14 - 92 years). Information on age was obtained from their identification documents and, for the older folk, by reference to important historical events.

Fig. 2. Soldiers waiting for blood tests.

We collected 5 ml of blood from the subjects' antecubital veins in test tubes containing ethylenediaminetetra-acetic acid (EDTA) and a further 7 ml in plain tubes. Serum was removed from the clotted specimens and frozen on the same day. The other specimens were kept at 4°C during the 4-hour journey to the laboratory in Bloemfontein and also subsequently until the tests had been completed. Full blood counts and automatic white cell differential counts were performed on the EDTA specimens within 24 hours of collection, by means of a Technicon H1 blood cell analyser. Blood films were prepared and examined manually. Erythrocyte folate concentrations (Simultrac-SNB Radioassay kit, Becton-Dickenson) were also assayed on blood in EDTA. Vitamin B_{12}, folate (both assayed with the Simultrac-SNB Radioassay kit, Becton-Dickenson) and ferritin (Ferritin Radioimmunoassay kit, Amersham) concentrations were assayed on serum. Serum g-glutamyl transferase (GGT) activities were measured with a Technicon SMAC multi-channel analyser at the Department of Chemical Pathology, University of Pretoria.

We used the World Health Organisation criteria[7] for anaemia. The indices suggestive of anaemia (at sea level) are a haemoglobin concentration below 13 g/dl for adult men and haemoglobin concentration below 12 g/dl for non-pregnant adult women. The altitude of Schmidtsdrif is 1 100 m above sea level. The cut-off concentration for haemoglobin needs to be raised by 0,2 g/dl for the first 1 000 m above sea level.[8] We therefore adjusted our limits to 13,2 g/dl for men and 12,2 g/dl for women.

Statistical methods

We summarised continuous variables in terms of means and SDs (as well as medians and ranges where distributions were skewed), and categorical variables by frequencies and percentages. To investigate the association between different variables, the variables were categorised into groups reflecting low/normal/high values. We determined the strength of the associations by relative risks with 95% confidence intervals (CIs) from two-by-two tables. We compared the results of this and two previous studies by calculating the differences in prevalence, with 95% CIs.

Results

Because the results of the Vasekela and Barakwena groups were similar, we combined the two for purposes of analysis. We used the reference ranges of the Department of Haematology, Bloemfontein, for judging whether concentrations were low or raised.

Anaemia (Table I)

The adjustment of the WHO cut-off concentrations for altitude only resulted in the inclusion of 1 more man and 1 more woman in the groups with anaemia. We divided the women into the following age groups: those under 20 years, 20 - 50 years (both groups in the reproductive age) and those above 50 years (post-menopausal).

Thirteen (68%) of the 19 anaemic men had microcytic anaemia. All 4 anaemic women under 20 years old had microcytic anaemia. Six of the 10 anaemic women aged between 20 and 50 years, and 3 of the 4 over 50 years had microcytic anaemia.

There were no cases of macrocytic anaemia among subjects of either sex. Among the men, the median GGT activity was 22 IU/l (range 10 - 182) and 17/145 (12%) had activities greater than 43 IU/l. Among women the median GGT activity was 16 IU/l (range 2 - 73) and 4/93 (4%) had activities greater than 43 IU/l. There was no significant association between GGT activities and macrocytosis.

Serum ferritin concentrations (Table II)

We again divided the subjects according to age and sex, in order to examine the effect of reproduction and age on the iron stores. There was a strong association between low ferritin values and anaemia in both men and women. The relative risk of a low serum ferritin concentration in anaemic individuals, compared with non-anaemic individuals, was 7,7 (95% CI 2,9 - 20,6) in men and 4,2 (95% CI 2,2 - 8,1) in women. The latter association remained when women were stratified by age. Total white cell count or eosinophil count did not alter the association in either men or women. Four of the 145 men (3%) and 1 of the 93 women (1%) had raised ferritin concentrations, but these were not associated with increased serum GGT activity.

Serum vitamin B_{12} concentrations (Table II)

The vitamin B_{12} concentrations were higher among women than among men. Eight (9%) of the 93 women had raised concentrations.

Erythrocyte folate concentrations (Table II)

Erythrocyte folate concentrations were generally low in both sexes. There was no association between low folate concentrations and anaemia in either men or women. In men the relative risk of anaemia (individuals with low folate relative to those with normal folate concentrations) was 0,75 (95% CI 0,23 - 2,1) and in women the relative risk was 0,92 (95% CI 0,34 - 2,5).

Table I. Red cell results

	Men	Women			
	(*N* = 145)	< 20 years (*N* = 15)	20 - 50 years (*N* = 62)	> 50 years (*N* = 16)	Total (*N* = 93)
Haemoglobin (g/dl)					
Mean (SD)	14,7 (1,6)	13,4 (1,9)	13,8 (2,0)	13,9 (1,9)	13,8 (2,0)
Adjusted WHO criteria[7,8]	< 13,2	< 12,2	< 12,2	< 12,2	< 12,2
No. (%) reduced	19 (13)	4 (27)	10 (16)	4 (25)	18 (19)
Red cell count ($\times 10^{12}$/l)					
Mean (SD)	5,2 (0,5)	5,0 (0,4)	4,9 (0,6)	4,9 (0,4)	4,9 (0,5)
Packed cell volume (l/l)					
Mean (SD)	0,5 (0,0)	0,4 (0,0)	0,4 (0,1)	0,4 (0,1)	0,4 (0,1)
Mean cell volume (fl)					
Mean (SD)	88,4 (6,9)	82,8 (7,5)	87,8 (8,5)	88,3 (7,7)	87,1 (8,4)
No. (%) < 80 fl	17 (12)	6 (40)	8 (13)	3 (19)	17 (18)
No. (%) > 100 fl	5 (4)	0 (0)	2 (3)	0 (0)	2 (2)
Mean cell haemoglobin (pg)					
Mean (SD)	28,6 (2,7)	26,9 (3,6)	28,3 (3,3)	28,3 (3,3)	28,1 (3,4)
Mean cell haemoglobin concentration (g/dl)					
Mean (SD)	32,3 (1,4)	32,3 (1,7)	32,2 (1,5)	32,0 (1,6)	32,2 (1,5)

Table II. Serum ferritin, serum vitamin B_{12} and erythrocyte folate concentrations

	Men	Women			
	(*N* = 145)	< 20 years (*N* = 15)	20 - 50 years (*N* = 62)	> 50 years (*N* = 16)	Total (*N* = 93)
Serum ferritin concentration (mg/l)					
Reference range	17 - 230	14 - 150	14 - 150	14 - 150	14 - 150
Mean (SD)	71,1 (62,0)	22,6 (19,6)	37,5 (30,3)	54,8 (49,8)	38,1 (34,5)
Median	47	14	26	35	26
Range	1 - 361	1 - 57	1 - 128	5 - 194	1 - 194
No. (%) reduced	13 (9)	7 (47)	12 (19)	3 (19)	22 (24)
Serum vitamin B_{12} concentration (reference range: 120 - 720 pmol/l)					
Mean (SD)	338,5 (137,7)	371,7 (215,7)	448,8 (235,8)	392,1 (241,4)	426,6 (235,8)
Median	317,3	322,4	400,3	309,5	377,8
Range	83 - 797	164 - 1 003	100 - 1 431	104 - 972	100 - 1 431
No. (%) reduced	3 (2)	0 (0)	2 (3)	2 (13)	4 (4)
No. (%) raised	2 (1)	1 (7)	5 (8)	2 (13)	8 (9)
Erythrocyte folate concentration (reference range: 270 - 1 950 nmol/l)					
Mean (SD)	363,5 (154,4)	361,2 (105,9)	438,3 (226,2)	457,0 (303,0)	429,1 (229,5)
Median	337,6	346,7	397,7	410,2	398,8
Range	32 - 977	204 - 564	129 - 1 321	113 - 1 534	113 - 1 534
No. (%) reduced	38 (26)	5 (33)	15 (24)	2 (12)	22 (24)

Table III. White cell results

	Men	Women			
	(*N* = 145)	< 20 years (*N* = 15)	20 - 50 years (*N* = 62)	> 50 years (*N* = 16)	Total (*N* = 93)
White blood cells (reference range: 4,0 - 11,0 × 10^9/l)					
Mean (SD)	7,6 (2,5)	8,3 (2,1)	8,1 (2,4)	8,2 (1,6)	8,2 (2,2)
No. (%) raised	11 (8)	2 (13)	7 (11)	0 (0)	9 (10)
Neutrophils (reference range: 1,6 - 8,0 × 10^9/l)					
Mean (SD)	3,9 (2,0)	4,4 (1,5)	4,1 (1,7)	4,3 (1,1)	4,2 (1,6)
No. (%) raised	6 (4)	0 (0)	2 (3)	0 (0)	2 (2)
Eosinophils (reference range: 0,04 - 0,45 × 10^9/l)					
Mean (SD)	0,66 (0,52)	0,90 (0,54)	0,99 (0,58)	0,89 (0,57)	0,96 (0,58)
No. (%) raised	81 (56)	12 (80)	53 (86)	11 (69)	76 (82)

White blood cells (Table III)

Fifty-six per cent of the men and 82% of the women had eosinophilia. There was no association between eosinophilia and anaemia. In men with eosinophilia, the relative risk of having anaemia was 0,88 (95% CI 0,38 - 2,0); in women it was 1,1 (95% CI 0,36 - 2,0). A survey of stool specimens from subjects aged 9 - 16 years was undertaken at Schmidtsdrif shortly before our study.[9] Of 53 specimens, 48 (90,6%) contained the hookworm, probably only *Necator americanus*, 25 (47,2%) *Strongyloides stercoralis*, 42 (79%) *S. fuelleborni*, 9 (17%) *Trichuris trichiura* and *Taenia* spp. 1 (2%). Calculations of eggs per gram showed the following: 2 - 3 870 hookworm eggs, 2 - 2 988 embryonated eggs, 2 - 1 512 larvae and 1 - 18 *Trichuris* eggs.[9]

Discussion

The study has certain limitations, despite the large number of subjects. The state of iron nutrition could not be assessed fully as serum iron and transferrin concentrations were not measured. We did not take smoking into consideration when evaluating anaemia and did not examine stool specimens from the adult subjects.

Microcytic anaemia predominated and showed a strong association with low serum ferritin concentrations, in both men and women. Since there was no association with other factors, the main cause of anaemia must be iron deficiency. Firstly, at the time of our study the subjects' diet was deficient in fresh vegetables and fruit, which are expensive, and especially protein. The families arrived during the winter of 1990, and we undertook the study a few months later during early spring, when the weather was still cold, and they had not yet planted vegetables. The low intake of protein and vitamins is reflected in the proportion of subjects with low ferritin and folate concentrations. Secondly, there is the factor of chronic blood loss caused by *S. stercoralis* and perhaps hookworm (*N. americanus*) infections. Thirdly, anaemia in women was most prevalent in those younger than 20 years, probably because San women usually bear children soon after their menarche. The postmenopausal women (older than 50 years) had the highest mean haemoglobin concentration of the three age groups of women. The higher prevalence of anaemia in women than in men is to be expected because women lose blood through menstruation and childbearing.

The consumption of alcohol by men (reflected in the 12% with raised GGT activity) probably explains why their concentrations of folate were lower than those of the women. There was no association between anaemia and raised activity of serum GGT, although the individuals with raised activity tended to have an increased mean cell volume.

In contrast, the vitamin B_{12} concentrations were adequate. Fernandes-Costa and Metz[10] showed that vitamin B_{12} concentrations in black subjects are higher than those in whites. The concentrations were possibly higher in the women because black women are known to have high concentrations of transcobalamin II.[11]

If we extrapolate from the stool specimens collected from children shortly before our study,[9] our subjects probably had a high prevalence of intestinal parasitic infections. We ascribe the high prevalence of eosinophilia to these parasites, as there was no other obvious cause. In this arid terrain, chlorinated water had to be brought to the tents by army tankers. There was no water-borne sewage at that stage, and many people preferred the traditional way of defaecating in the open veld to using the pit toilets. This habit encourages the transmission of intestinal infections. The difference in prevalence of eosinophilia in men and women (56% v. 82%) has yet to be explained, but may be caused by differences in the personal habits and physiology of the sexes. Gunders *et al.*[12] clinically diagnosed cutaneous leishmaniasis in 2 women at Schmidtsdrif. Such infections may have caused eosinophilia. It would have been interesting to examine the relationship between parasite infection and the haematological condition of individual subjects. Clinically, there were many respiratory infections, but there was no association between anaemia and a raised white cell count. The raised ferritin concentrations in 4/145 men (3%) must be interpreted with caution; they may have been spuriously high because of infections and alcohol intake.

The studies of Metz *et al.*[1] in 1969 at Dobe, Botswana, and Fernandes-Costa *et al.*[3] at Tsumkwe, Namibia, in 1979 were conducted on related !Kung San groups. As our group was relocated from the Tsumkwe area, we felt justified in comparing the three studies (Table IV). Iron deficiency anaemia remains a problem among women, but there has

not been a significant change since 1979. Reduced concentrations of folate are prevalent. The study by Evans *et al.*[9] in 1990 showed that a large proportion of stool specimens were positive for parasites. Our study showed a high prevalence of eosinophilia (Table IV).

Table IV. 95% CIs for the difference in prevalence between our study and the two previous studies

	1969[1] Dobe*	1979[3] Tsumkwe*	1990 Present study
Anaemia			
Men			
Prevalence (%)	6/38 (16)	7/72 (10)	19/145 (13)
95% CI	–15,5 - 10,1	–5,4 - 12,2	
Women			
Prevalence (%)	7/113 (6)	13/95 (14)	18/93 (19)
95% CI	4,0 - 22,3	–4,9 - 16,3	
Reduced serum vitamin B_{12} concentrations			
Men			
Prevalence (%)	0/34 (0)	1/72 (1)	3/145 (2)
95% CI	–2,5 - 4,4	–2,9 - 4,2	
Women			
Prevalence (%)	0/109 (0)	2/95 (2)	4/93 (4)
95% CI	2,0 - 8,4	–2,8 - 7,2	
Reduced erythrocyte folate concentrations			
Men			
Prevalence (%)	3/36 (8)†	10/72 (14)	38/145 (26)
95% CI	6,4 - 29,4	1,6 - 23,0	
Women			
Prevalence (%)	7/110 (6)†	9/95 (10)	22/93 (24)
95% CI	7,5 - 27,1	3,7 - 24,6	
Reduced serum ferritin concentrations			
Men			
Prevalence (%)	1/37 (3)‡	0/72 (0)	13/145 (9)
95% CI	–0,7 - 13,3	4,3 - 13,6	
Women			
Prevalence (%)	15/108 (14)‡	2/85 (2)	22/93 (24)
95% CI	–1,1 - 20,6	12,1 - 30,5	
Eosinophilia§			
Prevalence (%)	65/160 (41)	43/167 (26)	157/238 (66)
95% CI	15,6 - 35,0	31,3 - 49,2	
Stool parasites§			
Prevalence (%)	8/18 (44)	9/40 (23)	49/53 (93)[5]
95% CI	24,0 - 72,0	55,2 - 84,7	

* Pregnant women were excluded from our calculations.
† Serum concentrations were measured in this study.
‡ Transferrin saturation < 16%, as ferritin concentrations were not measured in this study.
§ In these cases men and women were combined in the previous studies, so that we could not distinguish gender-based differences.

There seems to be a deterioration in the haematological condition of the San as they adopt a more Western way of life (Table IV). At present few San can exist in the hunter-gatherer state, and that with difficulty. Our survey identified a number of causes for concern among settled San, especially poor iron and folate intakes. Nevertheless, the prevalence of anaemia compares favourably with that in some other parts of Africa.[13] A supply of fortified cereal blend supplements was suggested as a strategy to combat malnutrition, because animal products are expensive.[14] However, the South African Medical Services launched a campaign to improve the health of these people who had been living under conditions of war until a few months previously. By the time of a subsequent visit in March 1991, the situation at Schmidtsdrif had already improved: women had found employment on neighbouring farms, families were planting and buying vegetables, a number of new buildings were under construction and the Medical Services had been active. A craft industry had been established. The officers in charge of the settlement are particularly concerned about the welfare of their people, probably making this one of the few groups of San with a secure future. If the deleterious aspects of westernisation, especially the altered diet, can be contained, the health of these people is bound to improve. The future of other Bushmen, however, may be bleak,[6] except in areas such as Bushmanland, Namibia, where the Ju/'hoan Bushman Development Foundation[15] is helping them maintain an independent way of life.

We intend to publish our follow-up study shortly.[16]

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