HAEMOGLOBIN LEVELS OF PREGNANT RURAL WOMEN

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AS PART of a comprehensive care programme (1949–1952) to pregnant women and their families on two co-operative agricultural settlements (a Moshav Shitufi and a Kibbutz)[1, 2, 3] an attempt was made to examine the haemoglobin and blood smear of 80 consecutive pregnant women (who went to term) once in each trimester and again at the six-week postpartum examination. Fifty of the women from the Moshav Shitufi were studied intensively, while the results of the 30 from the Kibbutz will be used mainly for comparative purposes.

Although the group was a relatively small one, the results partly fill the gap in the Israeli literature of haemoglobin values in pregnant women between the work of Sadovsky in 1946[4] to that of Sadovsky,[5] Izak,[6] Guggenheim,[7] Strauss,[8] and Rachmelewitz[9] from 1953 to 1960.

This intervening period between 1947 and 1952 included the period of the War of Independence (1948) and the rationing which followed it for a number of years.

Forty-seven of the 50 Moshav women were born in Europe or in English-speaking countries, the other three being born in Israel of European-born parents. The group's median age was 23.2 years, and the mean 24.2 years. With one exception, they were all having their first or second babies (table I). Of the 47 immigrants, 43 arrived between the years 1948–1952, the other four having entered before the state became independent.

The group were all members of a rural settlement, living by the same basic principles of co-operative living.[1] Their physical living conditions were very uniform and economically the differences were extremely small, these being due mainly to the differences in the material objects the individuals brought with them on joining the settlement. They worked from 4–8 hours per day for the settlement, depending on whether they had any other children, and on their month in pregnancy. The work could be divided into jobs which were: (i) mainly sedentary, e.g. clerical, sewing; (ii) physically active, e.g., shepherdess, communal kitchen and work in the vegetable field; (iii) an in-between group, e.g., nursery school teacher, nurse, etc.

TABLE I

DISTRIBUTION OF THE PREGNANT 'MOSHAV' WOMEN BY AGE, PARITY AND PLACE OF BIRTH

Place of birth	*Age up to and including 24 years*		*Age 25 years or over*			*Total*
	Parity		*Parity*			
	0	*I*	*0*	*I*	*IV*	
British Isles ..	3	1	4	1	—	9
South Africa ..	12	1	5	2	—	20
United States ..	2	1	1	3	—	7
Europe	3	1	3	3	1	11
Israel	3	—	—	—	—	3
Total ..	23	4	13	9	1	50
	27		23			50

The educational standard of the group tended to be higher (table II) than the general standard for women in the country.

TABLE II

DISTRIBUTION OF EDUCATIONAL LEVEL

Completed elementary school only	7	50
Partial or complete high school	34	
Nursing or teaching diploma	4	
University graduates	5	

In this type of co-operative society *status* is of the 'achieved', rather than of the 'ascribed' type, and in order to classify them by social status a simple scoring system was worked out, whereby each girl was given points depending on her membership of key committees; her influence among her peers; her influence due to her job and as reflected by her husband's status. On this basis, eight of the group (having 11 pregnancies in this period) were judged to have a high status, and their blood values were analysed and compared to the rest of the group (*see* table V).

The period under review was marked by strict food rationing, in order to meet the demands of the large immigration. Generally speaking, the settlements during this period had a better diet than the townspeople, as they farmed their own produce; but the 'Moshav' settlement in question only started working their barren fields in July 1949, so that, even towards the end of the period (1952), they were not eating appreciably better than the urban population, with the possible exception that milk was more freely available.

The range of quantities consumed by the group was very small except in the amount of bread. This was not reflected in the weight gain, because generally speaking, the large bread eaters were the more active women. The other difference between the women was in the amount of the fluids consumed.

Methods

(*a*) *Laboratory:* During the woman's periodic prenatal check-up in each trimester and six-weeks postpartum, capillary blood was checked by the same examiner for:

1. *Haemoglobin*—using a Sahli haemoglobinometer standardized to that of the Central Kupat Cholim laboratory in Haifa.* This is an acceptable procedure by World Health Organization standards.[10]
2. *Blood smear*—examination with measurement of diameter of red cells, using a micrometer disk-gauge in the eye-piece of the microscope. Five hundred cells were counted and measured after calibrating the disk for the tube length and lens.[23]
3. *Erythrocyte counts* were done on most women but are generally recognized as being far less reliable than the first two examinations.

These simple procedures plus a clinical appraisal are regarded by some[11] as being sufficient for an accurate diagnosis of anaemia, although the author was keenly aware of the need for further detail—unavailable at that time in that area.

(*b*) *Treatment:* In addition to the general prenatal programme,[1] all women were put on tabs. ferr. sulp. (0.25 G.) three times per day after meals from their fourth month onwards (when they were past the nausea and vomiting stage). In those whose stools did not turn black, the dose was increased, but the vast majority kept to the three per day.

As soon as it was realized how low the general haemoglobin values were, *milk* (up to 1 litre/day) was made available to every pregnant woman, although the average amount consumed was in the region of 500–600 ml. per day, and thus contained as much protein as a medium helping (100 G.) of meat or chicken. One woman (with macrocytic anaemia) received a course of six injections of crude liver extract. The ascorbic acid obtained from fruit was certainly adequate during the citrus season (winter), but probably fell short of recommended amounts in other seasons. The egg ration was four per week for pregnant women, as compared to the two for non-pregnant adults.

*Director: Professor Hirsch.

Results

The most striking feature was the *low haemoglobin values* throughout pregnancy. There were only ten women of the 50 who did not drop below 10 grams of haemoglobin at any stage of pregnancy. As 10 grams is the figure which has been recommended as the border line, below which a pregnant woman is considered anaemic, irrespective of country or climate,[10] *percentage of anaemic women* in this group reached 80.

There was no one *type of anaemia* (based on the classification in table III) which was completely predominant.

TABLE III
DISTRIBUTION OF TYPE OF ANAEMIA AMONGST 50 WOMEN

Criteria	*Macrocytic hyper-chromic*	*Normocytic normo-chromic*	*Microcytic hypo-chromic*	*' Mixed forms '*	
Colour index ..	1.2– 2.0	0.8– 1.2	0.4– 0.8	0.8–1.2	0.4–0.8
Cell diameter ..	8.0–10.0	7.0– 8.0	6.0– 7.0	6.0–7.0	7.0–8.0
No. of women	1	12	16	21	

Of the 30 veteran women of the neighbouring settlement, 14 were found to have had at least one examination below 10 grams of haemoglobin, i.e. *46.7 per cent anaemic* by this standard.

Analyses of the haemoglobin distribution by *age* of women, *parity*, *status* and *education*, revealed no significant associations (tables IV and V).

Country of birth and *period of gestation:* An analysis of variance was carried out on 139 haemoglobin readings obtained from 46 pregnant women (three Israeli born women and one other were omitted). These readings were grouped according to period of gestation and the woman's country of birth. The results of this analysis are shown in table VI which shows that the *effect of period of gestation is highly significant*; the theoretical value for F (3,138) at $P \leq 0.01$ is 3.9. The effect of country of birth is not significant.

From table VII it can be seen that there is in fact little variation due to country of origin; the range in the overall mean Hbs is only 0.4 mg. per cent (9.4–9.8 mg. per cent). Except for those women born in England, who showed an initial fall in the group mean during the second trimester, the Hb in all groups rose throughout pregnancy and postpartum, so that the mean rise was 0.9 mg. per cent (9.3–10.2 mg. per cent). This rise was most marked in those

TABLE IV

HB. TRIMESTER DISTRIBUTION BY AGE OF WOMEN (UNDER 25 AND 25 AND OVER), AND PARITY (0 AND 1)

Under 25 years								*Age*	*25 years and over*							
I		*II*		*III*		*P–P*		*Trimester*	*I*		*II*		*III*		*P–P*	
0	*1*	*0*	*1*	*0*	*1*	*0*	*1*	*Parity*	*0*	*1*	*0*	*1*	*0*	*1*	*0*	*1*
								Hb values								
—	—	2	1	—	—	—	—	8.0 — 8.4	—	3	1	1	—	—	—	—
3	—	2	—	2	2	1	—	8.5 — 8.9	1	2	2	1	1	—	—	—
1	—	3	1	2	—	1	—	9.0 — 9.4	3	1	3	2	2	1	3	1
4	1	3	1	1	1	2	—	9.5 — 9.9	1	2	4	2	1	1	—	—
3	2	7	—	5	—	4	—	10.0 — 10.4	3	—	3	1	3	1	3	1
1	—	3	—	4	—	6	1	10.5 — 10.9	—	—	1	—	4	1	2	1
—	—	—	—	2	—	2	—	11.0 — 11.4	—	—	—	—	—	—	1	—
—	—	1	—	—	—	1	—	11.5 — 11.9	—	—	—	—	—	—	3	—
—	—	—	—	—	—	1	—	12.0 — 12.4	—	—	—	—	—	—	1	—
12	3	21	3	16	3	18	1	Total	8	8	14	7	11	4	13	3
								Mean Hb.	9.6	9.1	9.6	9.3	9.4	10.0		
9.7		9.7		10.0		10.6			9.3		9.5		9.9		10.6	

TABLE V
Hb trimester distribution by A. status, and B. education

Trimester	I		II		III		IV	
	No. of women	*Mean Hb.*	*No. of women*	*Mean Hb.*	*No. of women*	*Mean Hb.*	*No. of women*	*Mean Hb.*
A. High status women	7	9.0	11	9.5	8	9.9	8	10.4
All women	31	9.3	46	9.4	35	9.9	35	10.2
B. University women (highest educational group)	5	9.5	5	9.7	5	9.8	4	10.7
Elementary school (lowest educational group)	(3	10.0)	7	10.1	6	10.1	5	10.9

TABLE VI
Analysis of variance

	Degrees of freedom	*Sums of squares*	*Mean square*	*F (3,138)*
Between countries	3	3.317	1.108	1.68 N.S.
Between periods	3	24.022	8.007	12.17*
Error	132	86.902	0.658	
Total	138	114.241		

TABLE VII

MEAN HAEMOGLOBINS BY PERIOD OF GESTATION AND COUNTRY OF BIRTH
(Figures in parentheses represent the number of estimations on which the mean is based)

		All countries	*Europe*	*U.S.A.*	*England*	*S. Africa*
By period of gestation:	I	9.3 (29)	9.5 (5)	8.5 (4)	9.5 (6)	9.3 (13)
	II	9.4 (43)	9.5 (9)	9.3 (7)	9.0 (7)	9.6 (20)
	III	9.9 (33)	10.0 (6)	9.8 (5)	9.7 (8)	10.0 (14)
	IV	10.2 (34)	10.3 (6)	10.0 (5)	10.2 (8)	10.6 (15)
By country of birth:		9.7 (139)	9.7 (26)	9.4 (21)	9.6 (29)	9.8 (62)

TABLE VIII

THE RESULTS OF THE STATISTICAL PROBABILITIES P ($\chi^2(4)$ = — 2 logee) OF THE ASSOCIATION BETWEEN LENGTH OF GESTATION AND HAEMOGLOBIN VALUES

Trimesters	*I and II$_{(n)}$*	*II and III$_{(n)}$*	*III and Postpartum$_{(n)}$*
(*a*) Paired comparisons	0.295 (27)	0.23 (33)	0.004 (29)
(*b*) Two sample test	0.578 (19 & 4)	0.238 (2 & 13)	0.206 (6 & 6)
(*c*) Pooled test: p	0.40 – 0.50	0.025 – 0.050	0.005 – 0.010

of American origin where the group mean rose from 8.5–10.0 mg. per cent (1.5 mg. per cent).

Length of gestation: To test the association between the length of gestation (by trimesters) and the haemoglobin values, a regression coefficient might be employed. But as the vast majority of women had more than one examination, there is a great deal of 'dependence' between the results so that statisticians frown on using a method by which the results are not independent of each other.

The statistical method therefore used was one by which the absence of differences between the four observations (those in trimester I, II, III and postpartum) was tested against the alternative of values increasing with time. Each successive pair of observations (trimesters I and II; II and III; III and P–P) were tested separately using two t–tests. One for the women for whom both observations were available (paired comparisons) (*a* in table VIII), another for the two sets of women for each of whom only one of the observations was available (two-sample test) (*b* in table VIII). The probabilities for the two t–tests were then pooled (*c* in table VIII) by the usual —— logee p transformation, giving a chi-square variable with four degrees of freedom from which the final probability was obtained.[14]

The final line of table VIII gives the p (probability) values obtained by pooling the two tests. In the last two comparisons, the chance of obtaining the differences in haemoglobin that were found is less than 1/20 (i.e. $P \leq 0.05$) i.e. the *rise in haemoglobin found between the second, third and fourth periods is significant.* It is not significant between the first and second periods.

From table VII, it can be seen that for all groups these increases were 0.1, 0.5 and 0.7, which is all in keeping with this finding.

Morbidity during pregnancy: Seven of the group had 'threatened abortions', one had numerous 'extrasystoles' during the last few weeks of pregnancy, while one developed and completely recovered from poliomyelitis during her third month. (The child at birth was found to be normal.) 'Tiredness', with and without exertion, was a common complaint, especially during the humid summer afternoons, while 15 came to the physician because of swollen ankles towards the end of the day in summer. 'Muscle cramps' at night were also common. There were no cases of toxaemia; no cases of hepato- or splenomegaly; mild signs of nutritional imbalance were seen on the tongue, lips and skin. Skin irritation in pressure areas from excess sweating was very common, especially in the summer.

Results of the births: There was one stillbirth; one premature delivery, and one forceps delivery. All the others had normal, 'natural birth' deliveries. There were no haemorrhages (postpartum or others) among the group.

Everyone breast fed—unfortunately there was no systematic investigation of the infants' haemoglobins.

Repeated pregnancies: Five women had two pregnancies during this period, and their haemoglobin during the second trimester in each pregnancy was compared. It is interesting to note how the mean haemoglobin of the group dropped by 1.0 grams (table IX).

TABLE IX
HAEMOGLOBIN VALUES IN SUCCESSIVE PREGNANCIES
(BOTH DURING TRIMESTER 2)

	1	*Pregnancy*	*2*
	G per cent		*G per cent*
R.L.	9.0		9.5
E.G.	10.5		9.0
S.M.	10.0		9.0
N.O.	10.7		9.3
S.H.	11.5		9.5
	10.3	Mean	9.3

Discussion

The low haemoglobin values could be due to:

1. Techniques of examination, i.e. the instrument and the examiner. Precautions to guard against these hazards were that the instrument was standardized in the Haifa laboratory, being compared with other instruments and methods there, as well as having some bloods examined both on the settlement, and a duplicate examination in Haifa. The results of the latter did not show more than ± 0.4 G. difference. Whatever ' bias ' the examiner had it remained constant throughout the whole period. Thus it is reasonable to assume that neither the instrument, nor the examiner, were major factors in the low values.

2. The values being truly ' low ', this being a reflection of a general state in the country, or a state of affairs peculiar to this particular settlement. Unfortunately, the only survey during this period, Strauss[29] did not include pregnant women, but the impression of other physicians with whom I discussed the matter was that there was a great deal of anaemia. The comparison with the 30 pregnant women from a nearby settlement who had been in Israel for a longer period was therefoıe of great interest. The amount of anaemia they exhibited (47 per cent below 10 G.) was high, but significantly lower than the 50 Moshav pregnant women (80 per cent below 10 G.). The guarded conclusion would seem to be that, in addition to the high proportion of anaemia among the pregnant women of the country, those of this settlement had perhaps an even higher percentage.

The results of the type of anaemia (cf. previously) left the impression that in addition to the ' universal ' iron deficiency, other factors were playing important roles, thus the high proportion of ' mixed forms ' of anaemia.[6, 9, 19]

The iron-deficiency state which was probably present in all the women was investigated from a number of directions.

1. *Food and soil:* Specimens of the soil and food (eggs and vegetables) were sent for analysis to an agricultural school, and their reports indicated no special deficiency of iron or other elements in the samples

2. *The diet:* During the period 1949–1952, there was controlled rationing in the country, and the national balance-sheet (table X) showed, that while the figures were far below those of the ' developed ' countries (e.g. U.S.A.—animal proteins in 1951–1952 was 61 G./day), they were more than others (e.g. in Italy in 1951–1952, 21 G./day/capita of animal protein were consumed; in Turkey, 15/day; and in India, 6 G./day/capita).

TABLE X
NATIONAL FOOD BALANCE SHEET[12] DAILY VALUES

Period	*Iron (mg.)*	*fat (G.)*	*Total protein (G.)*	*Animal protein (G.)*	*Calories*
1949/50 ..	15.0	73.9	83.9	32.2	2,610
1950/51 ..	15.8	74.4	88.2	33.7	2,677
1951/52 ..	15.8	68.2	84.9	26.2	2,706

However, when discussing individual consumption, national balances can be very misleading. During the same period, family surveys were carried out[13, 29], which indicated certain differences with national figures. The four main discrepancies are shown in table XI.

The dietary histories of the individual pregnant women tended to show figures not too far off the above ones (usually on the lower side) except for milk, which was taken in average quantities of 500–600 ml. per day, double the national and family survey figures. (On the kibbutz, more animal protein and vegetables were available.)

TABLE XI
CONSUMPTION PER CAPITA PER DAY (IN GRAMS)

	Family survey	*National*
Standard bread ..	208	287
Citrus ..	462	287
Milk (fluid)	259	198
Fresh fish ..	12	7
Iron ..	11.0 mg. (33 per cent had less than 10 mg.)	15.0 mg.

The recommended daily intake for pregnant women (in second half of the pregnancy) of 'normal' activity in a temperate climate is 15 mg. iron,[27] so the above dietary figure would suggest that it was *unlikely* that the iron-deficiency state was due to a *gross absolute deficiency* of iron, animal protein, ascorbic acid, vit B_{12} or folic acid. However, the American recommended figures are for temperate climates, so that for the hot, humid climate here, with its increased sweating (cf. later) the relative dietary deficiency probably became fairly marked in respect of the body's needs.

3. *Absorption of iron:* Neither diseases nor drugs could be held responsible for possible lack of absorption of iron in the food. Although a fair amount of cereals were eaten, it is doubtful if the phosphates and phytates available combined with the iron in such amounts as to make most of the latter non-absorbable.[10]

4. *Excretion of iron:* One of the striking features of these women was the amount they sweated, leading to skin irritations in skin folds and pressure points. The increased metabolic rate of pregnancy, added to a hot, humid climate which they were not used to, added up to profuse sweating. If, as is suggested, the desquamated epithelial cells in sweat contain iron, this might have been an important source of iron loss in these women, as the amount of sweat lost was considerable.

5. *The state of the women before pregnancy:* It was clinically apparent that the group of pregnant women had been well nourished before immigration, and five of them had been volunteer blood donors in South Africa. During the few years before immigration, their Hb had never dropped below 13.0 G. in the examination directly preceding the taking of blood. These five did not differ from the rest of the women in their haemoglobin values during their pregnancies.

6. Loss of iron during cooking was not an important factor, as very little meat and fish were prepared.

7. The only real check we had as to whether the women were taking their iron pills, was the frequency with which they came for repeat prescriptions of 30 tablets. Judging by this, the vast majority of women were taking what had been prescribed.

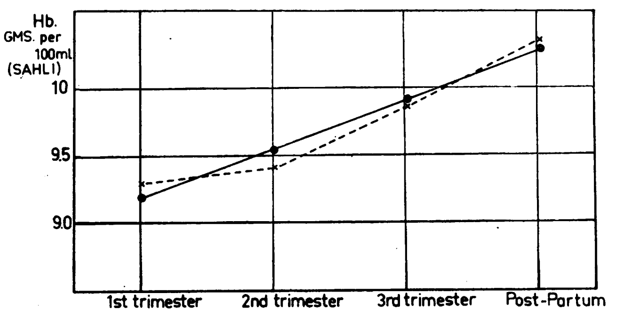
Response to treatment

The literature abounds with statements to the effect that there is a ready response of microcytic hypochromic anaemias to iron therapy, despite the fact that "dietary deficiency of iron alone is rarely a cause of anaemia"; similarly, there are many reports,[15, 17, 20] showing the improved response to anaemic pregnant women receiving iron as against those who did not. The longer the period of iron therapy, the greater the effect. This effect is increased when various types of animal protein is added to the iron.

With this background of information, the group were given iron in the form of ferrous sulphate, and increased milk as an added source of protein (cf. previously)—meat and fish being, to all intents and purposes, unavailable. The iron was started early in pregnancy, usually during the fourth month, and continued right into the lactating period.

As a clinician, it was frustrating to give the accepted form of treatment in quantities which were theoretically sufficient, and to find that the haemoglobin in 43 per cent of cases in the third trimester did not even reach 10 G. per cent, while 51 per cent were between 10–11 G. per cent, and only two women went over 11 G. per cent.

Despite this poor clinical response, it is interesting to note that the haemoglobin values in the third trimester were significantly elevated from those of the first and/or second (cf. earlier and figure 1). This is quite contrary to expectations, as reflected by the ' physiological ' parabolic curve during pregnancy, in which there is a drop of approximately 12 per cent in the Hb level from the 5th–8th week to the 32nd–34th week, with a subsequent upswing (of ± 3–4 per cent) by the 39th week.[16, 17]



Note: Continuous line: Fitted regression
Interrupted line: Group means for comparison
Regression coefficient and standard error $=0.185 \pm 0.032$

Figure 1. Regression of haemoglobin on length of gestation

Thus the treatment given produced, or helped to produce, a statistically significant increase in haemoglobin levels in the third trimester, although the levels reached were clinically disappointing. Yes, disappointing from what one expected, judging by the literature. However, if the objective of the treatment is to improve the health of the women and reduce complications, then the objective was apparently achieved (cf. below).

Lack of complications

Among others, the work of Sadowsky and Berkowici in Jerusalem,[21] has shown a much higher percentage of forceps delivery, postpartum haemorrhage, and puerperal morbidity among pregnant women with haemoglobin less than 10 G. per cent, as compared to those over 10 G. per cent.

The group studied had one forceps delivery, and one caesarian section. *No postpartum haemorrhages* were recorded despite the low haemoglobin values. Why?

Suggested factors reponsible for the anaemia

Of the multiple interrelated and interacting factors producing the anaemia, it is suggested that the following are among the most mportant.

1. One of the factors existing in the country in general at that time was a mild to moderate absolute *dietary deficiency* of animal protein and perhaps iron—if judged by American standards for temperate climates.

2. The anaemia in this coastal region with its hot, humid climate, was most probably considerably aggravated by the *excessive sweating*. The improved techniques used by Foy and Kondi[24] showed that up to 6.0 mg. or more of iron per litre can be lost in cell-rich sweat, which in tropical climates may reach 11 litres of sweat per day.[24] These figures are perhaps not out of reach of the women, whose metabolic activity is increased during pregnancy, magnifying or exaggerating the effect of the climate.

3. Even if we accept the foregoing suggestions, it still leaves unanswered the question as to why anaemia was so much more prevalent among the 50 female newcomers as compared to the 30 veteran residents. The tentative hypothesis which comes to mind would be:

The women, being recent immigrants, all experienced a drastic change of geophysical as well as social environment. The hot, humid climate and the harder physical work (compared with that to which they had been accustomed), together with the mental adjustment which was necessary, probably acted in two main directions:

(*a*) There was a considerable increase in sweating with consequent loss of iron (cf. above), and an increase in blood volume due to the adaptation process. "The most important factor in the adaptation to heat is an *increase in blood volume* . . . increases of up to 30 per cent have been recorded."[25] Both the loss of iron and the increased blood volume would influence the degree of anaemia.

(*b*) While there is general agreement that the *essential substances for blood formation* are iron, vitamin B_{12}, folic acid, pyridoxine, etc., the fact that the *controlling factors of haematopoiesis* probably reside in the endocrine organs, as well as there being an erythroporetic-stimulating factor (ESF—erythroporetin) in the plasma is not so widely known or accepted. " On firmer ground is the evidence that certain hormones are involved in the control of haemoporesis, particularly those of the gonads, the thyroid, adrenal cortex and anterior pirtuitary."[23]

Some, too, believe that the basic changes might be related to alterations in cellular metabolism, which in turn, might be controlled by the endocrines.[26] Further, there seems to be suggestive evidence that hot climates alter the endocrine metabolism[22] with a probable decrease in the activity (and therefore production) of the bone marrow. Interestingly, these hormonal changes were different for new arrivals and veteran residents.[22] (The clinical experience of seeing the alteration in the rhythm and amount of blood loss during menstruation of young women in the first 3–9 months after immigration is very common.)

Following this line of thought a little further, it was noted that among the 50 women, five went through two pregnancies during this period, with a drop of 1.0 G. per cent in their mean haemoglobin from the first to the second pregnancy.

Putting the above together, it would seem that, like many other biological processes, the reaction of these women to their new conditions might be shown graphically by a curve (figure 2), with the suggestion that the majority of the 50 women were somewhere along the AB section, whereas the 30 veteran women were probably between B and C.

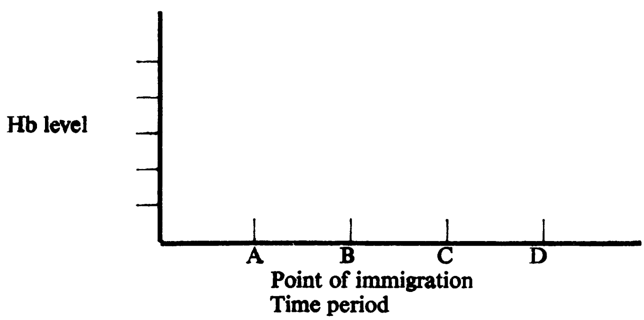


Figure 2. Hypothetical Hb curve after immigration.

The hypotheses can be summarized to the effect that (i) the high proportion of anaemia among pregnant women in the coastal region during those years, was due mainly to a relatively deficient diet with an increased loss of iron due to sweating, thus in effect increasing the level of iron deficiency, and (ii) it is further suggested that the relative increased amount of anaemia among the 50 recent immigrants was due to their pregnancy occurring in the early phase of their adaptation to the new geophysical conditions which affected their endocrine control of haemoporesis, leading to decreased production; this, together with the increased loss of iron through sweating, plus an increase in blood volume, aggravated the blood picture.

The treatment with iron and milk raised the haemoglobin values in the third trimester, but the fact that the Hb stayed (with two exceptions) below 11 G. per cent was proabbly due to the non-treatment of the other factors, or to the fact that the amount of iron and protein recommended in temperate climates is probably insufficient under subtropical conditions, just as it is inadequate under tropical conditions.[28]

Summary

1. Hb erythrocytes and blood smears of two groups of women in rural communities were periodically examined during pregnancy.

2. All the examinations were performed by the same method and the same examiner.

3. The one group of 50 women were all recent arrivals in Israel from English-speaking and European countries, while the other group of 30 kibbutz women in the same age group, were all of European origin, but had been in Israel for at least 3–5 years longer than the first group.

4. The results of the Hb estimations showed a very high percentage of anaemia (below 10 G. per cent Hb on one examination). Eighty per cent among the group of 50 recent arrivals and 47 per cent among the 30 more veteran women.

5. The predominant type of anaemia was the mixed or dimorphic type, with the microcytic hypochromic and normocytic normochromic types following close behind.

6. It is tentatively suggested that the major interrelated factors in the production of anaemia or pregnancy in this rural region were:

(*a*) Relative dietary deficiency of animal proteins and iron, and
(*b*) Increased loss of iron through the considerable increase in sweating.

In addition to these general factors, the anaemia of the 50 recently immigrated women was aggravated by:

(*c*) The increased plasma volume as a result of the acclimatization process, and
(*d*) The effect of the hot, humid, unaccustomed climate and increased physical work, on the endocrine output, resulting in decreased production by the bone marrow.

7. The women were put on tabs. ferrous sulphate from their fourth month of pregnancy, and increased milk. The clinical response from the point of view of Hb estimations was much less than expected, but resulted in a statistically significant rise of Hb in the third trimester, and gratifyingly, an extremely low rate of compli-

cations, with no haemorrhages.

A corollary of the above suggestions might be that the amounts of iron and protein recommended for pregnant women under temperate conditions, should be increased considerably in subtropical climates.

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