Variation of the Hemoglobin Level with Age and Sex

Article *in* Blood · November 1954

DOI: 10.1182/blood.V9.10.999.999 · Source: PubMed

3 authors, including:

Ward Hawkins
Los Alamos National Laboratory
16 PUBLICATIONS **243** CITATIONS

SEE PROFILE

Emily Speck
York St John University
5 PUBLICATIONS **155** CITATIONS

SEE PROFILE

Variation of the Hemoglobin Level with Age and Sex

By W. W. Hawkins, Eirlys Speck and Verna G. Leonard

THE HEMOGLOBIN CONCENTRATION of the blood is widely used as an aid in assessment of the state of health. A sound factual basis is therefore necessary for establishing the trend of hemoglobin values in relation to age and sex. This is most important when borderline states must be considered, as in nutrition surveys. Within only about the last decade have surveys been adequate in number and extent to provide reliable figures on this aspect of hematology. In this respect children from six years of age upward and young women have received most attention. The state of knowledge concerning hemoglobin levels in some population groups is, however, still unsatisfactory.

Altitude probably need not be considered as a factor affecting hemoglobin levels in localities where most surveys have been done.[1] Little is known concerning the possible importance of other geographic factors.

Tables 1, 2, and 3 summarize hemoglobin values which have been reported for individuals from 4 to about 100 years of age mostly within the last ten years, particularly from Canada, the United States, and Great Britain. The methods used were sufficiently similar to justify comparison of these values with one another and with those reported in this survey.

In tables 2 and 3 the values given by Wintrobe[2, 3] are typical of those usually considered as characteristic of men and women throughout adult life. The other values for adult people in these tables are, however, generally lower. The sex difference is of the same magnitude as that shown by Wintrobe, but it is smaller among older people. A difference between men and women in the trend of hemoglobin values in late adult life has been remarked upon in reports of the last few years. Evidence has been provided that there is little or no change in the hemoglobin of women with advancing age, but that a decrease occurs in men.[4-6]

The work reported here was undertaken in order to extend information on the hemoglobin levels of individuals from 6 years of age upward. We wished particularly to obtain sufficient data on adult people to allow comparison of values before and after middle age, and to indicate the degree of the sex difference among older adults. Such information could be of fairly wide interest and use, because significant differences would not be likely to exist between hemoglobin levels among the people of Halifax and those in many other localities in Canada, the United States, and possibly some other countries, particularly at sea level.

Subjects and Methods

The survey was done on 1308 male and 1424 female subjects between the ages of 9 and 98 years. It was carried out between November 12, 1952, and May 22, 1953. The youngest sub-

From The Maritime Regional Laboratory, National Research Council of Canada, Halifax, N. S.

Submitted December 9, 1953; accepted for publication February 9, 1954.

We must thank Dr. E. Gordon Young, the Director of this Laboratory, for advice during the course of this survey, and for help in preparing the material for publication.

TABLE 1.—*Hemoglobin Levels among Children*

Age	No. of subjects	Hgb (Gm. %, av.)	Locality	Ref.
6–13	—	13.3–13.6	Great Britain	19
4–14	493	13.2	Great Britain	20
6–14	1483	12.8	British Columbia	14
—	3575	12.8	Florida	12
5–11	1456	13.3	Saskatchewan	15
5–15	200	12.5	Hamilton, Ont.	10
5–16	518	12.4	East York, Ont.	10
8–13	515	13.1	Louisiana	21
7–14	358	13.5	Michigan	8
7–14	1669	13.6	Saskatoon, Sask.	9
6	297 boys	13.1–13.8	England	13
10	329 boys	13.5–14.0	England	13
14	550 boys	14.3–14.7	England	13

TABLE 2.—*Hemoglobin Levels among Men*

Age	No. of subjects	Hgb (Gm. %, av.)	Locality	Ref.
12–19	—	13.8	Great Britain	19
15–19	—	14.2	Great Britain	19
16–25	137	15.1	Hawaii	22
—	111	15.8	Cleveland	23
17–23	25	15.9	Philadelphia	24
17–25	411	15.2	Boston	25
19–28	77	16.2	Sydney	26
19–30	51	15.6	Norway	27
16–59	539	16.0	U. S. A. and Europe	2, 3
—	245	15.7	Great Britain	13
—	175	16.0	Lima	28
50–79	60	13.8	Canada	11
50–97	330	14.0	Winnipeg	6
60–94	50	14.1	St. Louis	5
60–98	41	13.9	Scotland	4
65–80	73	13.1	U. S. A.	29
69–91	50	12.6	U. S. A.	30
60–104	160	14.3	U. S. A.	31

jects were studied during the early part of the winter, and the adults later in the winter and in the spring.

With the help of the Halifax School Medical Service, six schools were chosen which would provide children 6 to 14 years old from a variety of socio-economic groups. Subjects were drawn from each grade in each school.

Those from 14 to 20 years of age were students in high schools, hospitals, colleges, and universities, so that at least the oldest among them would be expected to have a better than average socio-economic background.

There was a wide variety of adult subjects. There were some invalids among them, but any with disorders likely to affect the hemoglobin were excluded. Some were residents of old folks' homes. Many were members of clubs and societies, including some of the better known welfare groups. In general the adults were more healthy and in a better socio-economic class than those usually studied in surveys of this kind.

Capillary blood from a puncture of the finger tip was used. A sample of 20 cu. mm. was taken into a calibrated Sahli pipet, and collected in a few milliliters of water in a test tube

TABLE 3.—*Hemoglobin Levels among Women*

Age	No. of subjects	Hgb (Gm. %, av.)	Locality	Ref.
12–19	—	12.8	Great Britain	19
15–19	—	13.6	Great Britain	19
12–19	258	12.2	Minnesota	32
—	48	13.0	Cleveland	23
15–22	44	13.6	Mississippi	33
17–21	1080	12.0	Toronto	10
17–24	4550	13.4	North central U. S. A.	34
17–22	161	13.8	Amherst, Mass.	35
17–25	52	13.2	Lincoln, Neb.	36
17–26	352	13.8	Saskatoon, Sask.	1
18–23	25	13.5	Philadelphia	24
17–68	403	14.0	U. S. A. and Europe	2, 3
19–30	60	14.1	Norway	27
17–86	275	13.2	Lincoln, Neb.	36
—	480	13.8	Great Britain	13
50–79	64	12.7	Canada	11
50–97	175	13.6	Winnipeg	6
60–90	50	13.7	St. Louis	5
60–98	48	13.2	Scotland	4
65–80	27	12.5	U. S. A.	29
66–104	50	11.7	U. S. A.	30

marked at 10 ml. At the laboratory this was treated with ferricyanide and cyanide, diluted to the 10 ml. mark with water, and the optical density read at 540 mμ in a Coleman model 14 spectrophotometer. This is an application of the cyanmethemoglobin method for the determination of hemoglobin described by Collier.[7] It was standardized against blood of which the hemoglobin concentration had been determined from the iron content and oxygen capacity.

RESULTS

The hemoglobin values arranged according to age for each sex are presented in table 4 and figure 1.

Among the children 6 to 14 years old the values increased with age from an average of about 13 Gm. per 100 ml. of blood among the youngest to about 14 Gm. among the oldest. Up to about 12 years of age there was possibly a tendency for higher values to occur among the girls, but after that they were higher among the boys. The average value for both boys and girls 6 to 14 years of age was the same, 13.5 Gm. per 100 ml. It may be of interest to note that many of the girls had started to menstruate at about 11 years of age. An examination of the distribution of hemoglobin values among these children showed that 40 per cent of them were between 13 and 14 Gm., 31 per cent of them being higher and 28 per cent lower. No doubt this slight positive skewness was a reflection of the tendency toward higher values with increasing age.

In the subjects between 14 and 20 years of age the hemoglobin values decreased slightly among the girls, and increased rather markedly among the boys. In the latter the average value at 20 years of age was 5 per cent higher than that at 14 years, and represented essentially the highest value shown by male subjects. In individuals 15 to 20 years of age inclusive, the average hemoglobin value

TABLE 4.—*Variation of Hemoglobin Levels with Age and Sex among Representatives of the Population of Halifax*

Age	Males				Females			
	No. of subjects	Hgb. (Gm. per 100 ml. of blood)			No. of subjects	Hgb. (Gm. per 100 ml. of blood)		
		Range	Av.	S.D.		Range	Av.	S.D.
6	66	11.3–14.8	12.8	0.81	53	11.4–14.7	13.2	0.69
7	45	10.7–14.5	13.1	0.91	60	11.4–15.3	13.2	0.89
8	55	11.2–15.1	13.3	0.91	42	11.1–15.7	13.1	0.99
9	45	11.9–15.1	13.5	0.80	60	11.2–15.7	13.4	0.92
10	78	11.8–16.0	13.5	0.81	62	11.7–15.2	13.3	0.90
11	56	11.4–15.3	13.4	0.91	57	11.6–17.0	13.7	1.15
12	51	12.0–16.4	14.1	1.01	56	11.5–15.9	13.7	0.79
13	48	12.2–15.8	14.0	0.91	66	11.3–15.4	13.7	0.87
14	66	12.2–16.5	14.3	1.12	93	11.4–16.3	13.5	1.07
15	109	11.4–17.4	14.4	1.05	154	10.5–15.7	13.3	0.98
16	119	11.7–17.5	14.5	1.13	169	8.0–15.9	13.0	0.98
17	83	11.1–17.1	14.8	1.17	104	7.4–15.3	13.2	1.13
18	52	12.8–16.9	15.0	1.05	57	10.6–15.4	12.9	0.82
19	39	12.8–16.5	14.9	0.96	44	10.3–14.3	12.8	0.87
20	19	12.8–17.5	14.9	1.08	21	11.3–14.1	13.2	0.75
21–30	83	12.1–18.0	15.1	1.22	44	9.0–14.4	12.7	1.14
31–40	23	12.3–17.5	14.6	1.35	39	11.0–16.2	13.2	0.92
41–50	23	11.8–16.8	14.7	1.26	39	10.2–16.5	13.2	1.30
51–60	65	8.1–16.9	14.4	1.31	41	9.6–16.3	13.1	1.32
61–70	81	8.4–17.4	13.9	1.59	55	7.7–15.6	12.9	1.33
71–80	71	8.9–17.1	13.4	1.59	71	8.3–16.1	13.0	1.45
81–90	28	8.9–15.8	12.4	1.73	33	11.1–15.4	13.0	1.24
91–100	3	8.9–14.3	11.2	2.18	4	10.6–12.6	11.4	0.95
6–14	510	10.7–16.5	13.5	1.00	549	11.1–17.0	13.5	0.96
15–20	421	11.1–17.5	14.6	1.12	549	7.4–16.3	13.2	1.04
21–94					326	8.3–16.5	13.0	1.29
21–98	377	8.1–18.0	14.1	1.65				
6–94					1424	7.4–17.0	13.3	1.07
6–98	1308	8.1–18.0	14.0	1.23				

for males was 14.6 Gm. per 100 ml., and for females 13.2 Gm., a difference of 10 per cent. The distribution of values also reflected the sex difference: 98 per cent of the males had levels between 12 and 17 Gm., and 81 per cent between 13 and 16 Gm.; 99 per cent of the females had levels between 10 and 16 Gm., and 93 per cent between 11 and 15 Gm.

In the case of those above 20 years of age the averages of 14.1 Gm. for men and 13.0 Gm. for women can hardly be compared with the values in tables 2 and 3 because differences in age ranges are involved. Among the women the average value of 12.7 Gm. for those in the third decade of life was lower than any of those shown in younger yearly age groups. The averages for decades thereafter differed very little. Among the men the average value of 15.1 Gm. for those in the third decade was higher than that in any younger yearly age group or in any succeeding decade. Decreases in hemoglobin values among

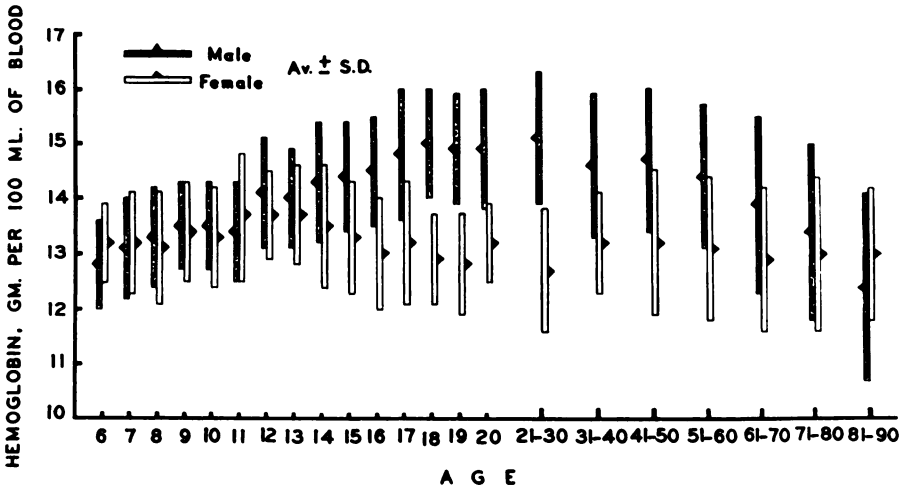

FIG. 1.—The trend of hemoglobin values with age and sex among representatives of the population of Halifax. Averages and standard deviations are shown.

the men were progressive and more marked after the fifth decade. Among men values were considerably higher than among women up to about 70 years of age, but thereafter the differences became much smaller, and in the ninth decade values among men tended to be lower than those among women. Hemoglobin values in men between 20 and 60 years of age were typically between 14.5 and 15 Gm. per 100 ml., the higher values occurring among the younger subjects. In women they were typically about 13 Gm. The difference between these values and those in tables 2 and 3 are greater in the case of men than of women.

DISCUSSION

The average hemoglobin value of 13.5 Gm. per 100 ml. of blood for Halifax children 6 to 14 years old is among the highest which have been reported for this age group. Our results agree with some others[2, 8, 9] in indicating that between these ages the hemoglobin increases from 13 to 14 Gm. per 100 ml. Other investigations have indicated the same increase with age, but lower values.[10-12] A trend toward higher values than ours in boys 6 to 14 years old has been reported from England.[13]

The question of what hemoglobin level represents anemia in children is important. An answer is of course not possible, but speculations may be made. Pett, Hanley, and Perkins[14] on the basis of the distribution of hemoglobin values among a group of over a thousand children in British Columbia, suggested that those which fell below 11.9 Gm. per 100 ml. could represent anemia. Pett and Hanley[15] deduced the same value as the lower limit of normal from the examination of children 5 to 11 years old in Saskatchewan. Our data on the Halifax children were analyzed as follows. The values were distributed among six class intervals falling between 12 and 17 Gm., with the two extremes omitted out of the total of 999 (10.7 Gm. for one boy and 17.0 Gm. for one girl). They were arranged in a histogram. A smooth curve was drawn through the middle of the top of each bar of the diagram, and extended to the axis on which the hemo-

globin values were represented. This curve showed a slight positive skewness. Its limits were at 11.1 Gm. and 16.8 Gm., which were also the limits of the range of values among the 997 subjects who were considered. Such a procedure would therefore appear to be of little use in an attempt to define the anemic level. The distribution was such, however, that 5 per cent of the children had hemoglobin levels below 12 Gm. per 100 ml. of blood, and 87 per cent between 12 and 15 Gm. This information might be of more use in thinking about anemic levels.

The average hemoglobin value of 13.2 Gm. per 100 ml. of blood for young women 14 to 20 years of age in Halifax was within the range of average values for young women in Canada, the United States, and Great Britain which are shown in table 3. Very few of the comparable groups represented in this table include girls as young as 14, and many include some older than 20. If there is a tendency toward decrease of hemoglobin values in young women between those ages, then the average value for these Halifax subjects would compare favorably with those for others in more nearly the same age range. The decrease in hemoglobin values which we observed within this age group has been noted in other surveys.[1, 10, 11] Average hemoglobin values among Halifax women in each decade of life between 20 and 90 years were 12.7 to 13.2 Gm. per 100 ml., indicating a virtual leveling off at about the age of 20. Values obtained by Pett and Ogilvie[11] on women in various parts of Canada also indicated a leveling off through the middle years of life.

The average hemoglobin value of 14.6 Gm. per 100 ml. of blood for Halifax young men, 15 to 20 years of age inclusive, was lower than most of those reported on comparable groups (table 2). From 20 to 30 years of age, however, values tended to be high compared to those in the five preceding years, and increases among males in this period of life would be expected, so that this group of Halifax subjects probably would compare more favorably with those of more nearly the same age range. This is supported by the fact that for those 17 to 25 years old the average hemoglobin value was higher, 14.9 Gm. per 100 ml. The hemoglobin values found by Pett and Ogilvie[11] among Canadian subjects showed increases from an average of 13.2 Gm. in boys 13 to 14 years old to 13.9 Gm. in those 17 to 19, and 14.5 Gm. in young men from 20 to 30. This last value was the highest which those authors found in males in any decade of life. Young men in this age group in Halifax also showed the highest average hemoglobin value of any of the male subjects, but it was essentially the same as that which was reached at the age of 17 and maintained into the 20's.

In the Halifax subjects, 15 to 20 years of age inclusive, the hemoglobin values, expressed as minus and plus one standard deviation, ranged between 13.5 and 15.7 Gm. per 100 ml. for the males, and 12.2 and 14.2 Gm. for the females. The values were so distributed that between 95 and 100 per cent of the males showed 12 Gm. per 100 ml. and over, and the same proportion of the females 10 Gm. and over. These figures might be of use in attempts to define anemic levels.

The small degree of variation in hemoglobin values among women after about 20 years of age was remarkable. The highest values among females were shown

by those between 10 and 14 years of age. There was no evidence that the menopause affected the hemoglobin level.

In men the progressive increase in hemoglobin through childhood and youth resulted in the highest values being shown in the 20's, when the lowest values were shown by women. This was followed by a fall, possibly a leveling off between 30 and 50, then progressively decreasing values. The decreasing difference in hemoglobin values between men and women with advancing age therefore appeared to be the result of decreasing levels in men. This trend in hemoglobin values in men after middle age has been indicated in the results of previous surveys[4-6] which have been referred to above, and the material of this report supplies further evidence for it.

Whether or not it has any connection with hemoglobin, it might be of interest to note that there is a difference between the sexes in the concentration of iron in the liver, but it varies with the species.[16, 17] In rats it is higher in females, and this may be associated with sex hormones.[16, 17] In the case of humans, men have the higher liver iron.[18]

Summary

During the winter and spring of 1952–53 a survey of hemoglobin values was made in Halifax among 1308 male subjects 6 to 98 years of age, and 1424 female subjects 6 to 94 years of age.

Among children 6 to 14 years old the values increased from about 13 to about 14 Gm. per 100 ml. of blood, and there were essentially no differences between the sexes. The average value for both the boys and the girls was 13.5 Gm.

In girls between 14 and 20 years of age the hemoglobin values decreased slightly, reaching about 13 Gm. per 100 ml. In boys of corresponding ages there was an increase to about 15 Gm. In both sexes these values were attained at about 20 years of age, and remained characteristic of the third decade of life. They were essentially the lowest and the highest shown respectively by the female and the male subjects of any age group.

Hemoglobin values in men between 20 and 60 years of age were typically 14.5 to 15 Gm. per 100 ml., the higher values tending to occur among the younger men. After the fifth decade there were progressive and marked decreases to an average of 12.4 in men between 80 and 90 years of age.

In women from 20 years of age onward the average hemoglobin values remained near 13 Gm. per 100 ml.

Summario in Interlingua

Es presentate un studio statistic del valores hemoglobinic obtenite durante le hiberno e primavera de 1952/53 a Halifax in Nova Scotia ab 2732 individuos—1308 masculin de etates ab 6 a 98 annos e 1424 feminin de etates ab 6 a 94 annos.

In juvenes inter 6 e 14 annos le valores cresceva ab circa 13 a circa 14 g per 100 ml de sanguine. In iste gruppo de etate nulle differentia essential esseva constatate inter le sexos. Le valor medie pro pueros e pueras esseva 13,5 g.

In pueras inter 14 e 20 annos de etate le valores de hemoglobina decresceva levemente usque a circa 13 g per 100 ml de sanguine. In pueros del mesme etates

il habeva un accrescimento usque a 15 g. In ambe sexos iste valores esseva attingite al etate de circa 20 annos. Illos remaneva typic durante le tertie decade del vita e representava respectivemente le minimo e le maximo inter le gruppos de etate del duo sexos.

Le valores de hemoglobina in masculos inter 30 e 60 annos de etate esseva typicamente 14,5 a 15 g per 100 ml de sanguine. Le valores plus alte tendeva a occurrer in le individuos plus juvene. Post le quinte decade il habeva progressive e marcate decrescimentos usque al valor medie de 12,4 pro homines inter 80 e 90 annos de etate.

In feminas post 20 annos de etate le valores medie de hemoglobina persisteva presso a 13 g per 100 ml de sanguine.

REFERENCES

[1] Hawkins, W. W., Barsky, J., and Collier, H. B.: Hemoglobin levels among Saskatchewan college women. Canad. M. A. J. *58:* 161, 1948.

[2] Wintrobe, M. M.: Clinical Hematology, Philadelphia, Lea & Febiger, 1951.

[3] —: Blood of normal men and women. Erythrocyte counts, hemoglobin and volume of packed red cells of 229 individuals. Bull. Johns Hopkins Hosp. *53:* 118, 1933.

[4] Olbrich, O.: Blood changes in the aged. Edinburgh M. J. *54:* 306, 1947.

[5] Shapleigh, J. B., Mayes, S., and Moore, C. V.: Hematologic values in the aged. J. Gerontol. *7:* 207, 1952.

[6] Jefferson, D. M., Hawkins, W. W., and Blanchaer, M. C.: Hematological values in elderly people. Canad. M. A. J. *68:* 347, 1953.

[7] Collier, H. B.: The standardization of blood hemoglobin determinations. Canad. M. A. J. *50:* 550, 1944.

[8] Kaucher, M., Moyer, E. Z., Harrison, A. P., Thomas, R. U., Rutledge, M. M., Lameck, W., and Beach, E. F.: Nutritional status of children. VII. Hemoglobin. J. Am. Diet. A. *24:* 496, 1948.

[9] Hawkins, W. W. and Kline, D. K.: Hemoglobin levels among seven to fourteen year old children in Saskatoon, Canada. Blood *5:* 278, 1950.

[10] —, Leeson, H. J., and McHenry, E. W.: Hemoglobin levels in Canadian population groups: children and young women. Canad. M. A. J. *56:* 502, 1947.

[11] Pett, L. B. and Ogilvie, G. F.: Hemoglobin levels at different ages. Canad. M. A. J. *58:* 353, 1948.

[12] Anderson, R. K. and Sandstead, H. R.: Nutritional appraisal and demonstration program of the U. S. Public Health Service. J. Am. Diet. A. *23:* 101, 1947.

[13] Berry, W. T. C., Corwin, P. J., and Magee, H. E.: Hemoglobin levels in adults and children. Brit. M. J. *1:* 410, 1952.

[14] Pett, L. B., Hanley, F. W., and Perkins, E.: Hemoglobin levels of children in British Columbia. Bull. Vancouver M. A. *22:* 128, 1946.

[15] — and —: A nutrition survey among school children in British Columbia and Saskatchewan. Canad. M. A. J. *56:* 187, 1947.

[16] Widdowson, E. M. and McCance, R. A.: Sexual differences in the storage and metabolism of iron. Biochem. J. *42:* 577, 1948.

[17] — and —: The effect of dosage on sexual differences in the iron metabolism of rats. Biochem. J. *53:* 173, 1953.

[18] Lapicque, L.: Une vielle donnée perdue de vue: le foie de la femme contient deux fois et demie moins de fer que celui de l'homme. Compt. rend. Soc. de biol. *141:* 214, 1947.

[19] Medical Research Council: Special Report Series No. 252: Hemoglobin levels in Great Britain in 1943 (with observations upon serum protein levels). London, H. M. Stationery Office, 1945.

[20] MacKay, M. M., Wills, L., and Bingham, K.: Economic status and the hemoglobin level of children of men in the fighting services and of civilians. Brit. M. J. *1:* 711, 1946.

[21] McBee, M., Moschette, D. S., and Tucker, C.: The hemoglobin concentrations, eryth-

rocyte counts, and hematocrits of selected Louisiana elementary school children. J. Nutrition *42:* 539, 1950.

[22] HAMRE, C. J. AND AU, M. H.: Hematologic values for normal healthy men 16 to 25 years of age. J. Lab. & Clin. Med. *27:* 1231, 1942.

[23] MYERS, V. C. AND EDDY, H. M.: The hemoglobin content of human blood. J. Lab. & Clin. Med. *24:* 502, 1939.

[24] BELK, P., CURTIS, E., AND WILSON, M. K.: Erythrocyte counts, hemoglobin, and erythrocyte volume in normal young men and women residing in the eastern U. S. Am. J. Clin. Path. *6:* 487, 1936.

[25] HEATH, C. W.: The hemoglobin of healthy college undergraduates and comparisons with various medical, social, physiologic, and other factors. Blood *3:* 566, 1948.

[26] WARDLAW, H. S. H.: The concentration of hemoglobin in the blood of normal men. M. J. Australia *2:* 103, 1941.

[27] LINNEBERG, L. L. AND SCHARTUM-HANSEN, H.: Blodets hemoglobinmengde og de rode blodlegemers antall og volum hos friske menn og kvinner. Norsk. Mag. for Laeg. *96:* 832, 1935.

[28] HURTADO, A., MERINO, C., AND DELGADO, E.: Influence of anoxemia on the hematopoietic activity. Arch. Int. Med. *75:* 284, 1945.

[29] FOWLER, W. M., STEPHENS, R. L., AND STUMP, R. B.: The changes in hematological values in elderly patients. Am. J. Clin. Path. *11:* 700, 1941.

[30] NEWMAN, B. AND GITLOW, S.: Blood studies in the aged. The erythrocyte in the aged male and female. Am. J. M. Sc. *205:* 677, 1943.

[31] MILLER, I.: Normal hematologic standards in the aged. J. Lab. & Clin. Med. *24:* 1172, 1939.

[32] LEICHSENRING, J. M., DONELSON, E. G., AND WALL, L. M.: Studies of blood of high school girls. Am. J. Dis. Child. *62:* 262, 1941.

[33] HAWORTH, M., MOSCHETTE, D. S., AND TUCKER, C.: Hemoglobin values, plasma vitamin A and carotene levels in young women on institutional diets. J. Am. Diet. A. *27:* 960, 1951.

[34] OHLSON, M. A., CEDERQUIST, D., DONELSON, E. G., LEVERTON, R. M., LEWIS, G. K., HIMWICH, W. A., AND REYNOLDS, M. S.: Hemoglobin concentrations, red cell counts, and erythrocyte volumes of college women of the north central states. Am. J. Physiol. *142:* 727, 1944.

[35] GUTOWSKA, M. S. AND ELLMS, E. B.: Nutritional status of women students. J. Am. Diet. A. *22:* 763, 1946.

[36] CHALOUPKA, M., LEVERTON, R. M., AND DIEDRICHSEN, E.: Serum iron and hemoglobin values of 275 healthy women. Proc. Soc. Exper. Biol. & Med. *77:* 677, 1951.

1954 9: 999-1007

Variation of the Hemoglobin Level with Age and Sex

W. W. HAWKINS, EIRLYS SPECK and VERNA G. LEONARD

Blood (print ISSN 0006-4971, online ISSN 1528-0020), is published weekly by the American Society of Hematology, 2021 L St, NW, Suite 900, Washington DC 20036.