# HEMOGLOBIN *Level and* DIETARY INTAKE *of Adults*

*By* LEONORA MIRONE, PH.D.*

SINCE THE Second World War nutrition programs have received increased emphasis throughout the United States. Because nutrition programs similar to those in other sections of the country were activated in the South, and because of the commonly held belief that hemoglobin levels are low and dietary habits poor in this region, it appeared that a hemoglobin level and dietary intake survey would be of value in pointing out the extent of the nutritional problem which might need greater study.

## EXPERIMENTAL PROCEDURE

A sample of capillary blood for hemoglobin was obtained from 535 adults by pricking the finger of healthy volunteers with a spring lancet. The subjects were not examined clinically and the adjective "healthy" was used to denote that the participants showed no symptoms of illness and that they considered themselves healthy. The hemoglobin was determined by the oxyhemoglobin method;[1] the calibration factor was obtained by the Ponder[2] modification of the Wong Method. Two 0.02 ml. samples of blood were taken in calibrated pipettes. The blood was added to 5.0 ml. of 0.007 *N* $NH_3$ (0.04 ml. ammonia solution, sp. gr. 0.88, to 100 ml. with distilled water). Duplicate readings were made in a Klett-Summerson photoelectric colorimeter and the average of the two readings, agreeing within 0.5 Gm., was recorded for each sample.

The participants, residents of Georgia, were instructed to record the food intake on the United States Public Diet Record Form.[3] Food Value Tables for Calculation of Diet Records[4] and Taylor's[5] Food Tables were used to calculate the calories, animal protein, vegetable protein, fat, carbohydrate, calcium, phosphorus, iron, thiamine, riboflavin, niacin, and ascorbic acid intake for each individual. One hundred and thirty-nine men and 396 women volunteered to participate in the study.

From the Nutrition Department, School of Home Economics, University of Georgia, Athens, Ga.

* Associate Professor of Nutrition Research.

## RESULTS AND DISCUSSION

### *Hemoglobin*

The mean weight, height, age, and hemoglobin level for the men and women is shown in Table I. The average hemoglobin concentration for the men was comparable to that reported by Andresen and Mugrage[6] for men in Colorado; Heilmeyer and Hausold,[7] for men in Germany; and Jenkins and Don[8] for men in England. Likewise, the average hemoglobin concentration for the women was comparable to that reported by Osgood[9] for women in Oregon; Gargiulo,[10] for women in Argentina; Jenkins and Don,[8] for women in England; and Sankaran and Rajagopal,[11] for women in India. It would appear, therefore, that the average hemoglobin values for men and women in Georgia are in accordance with averages reported in other parts of the world.

### *Weight*

Since weight in relation to age, height, and sex has long been held to be one indication of nutritional status, it appeared of interest to investigate whether underweight was associated with low hemoglobin levels. The percentage of underweight or overweight for each participant was calculated from the tables published by the Metropolitan Life Insurance Company.[12] The subjects were classified into 3 groups, namely: those 10 per cent or more underweight, those within 10 per cent of the normal weight, and those 10 per cent or more overweight, according to these criteria. As

TABLE I

Average Mean Weight, Height, Age, and Hemoglobin Level

| Subjects | Weight | Height | Age | Hemoglobin | |
|---|---|---|---|---|---|
| | | | | Range | Average |
| | *lb.* | *in.* | *yr.* | *Gm./100 ml.* | *Gm./100 ml.* |
| Men | 164.5 | 70.1 | 28.8 | 13.04 – 18.23 | 16.13 ± 0.09 |
| Women | 126.2 | 64.1 | 27.1 | 10.39 – 16.83 | 13.99 ± 0.05 |

shown in Table II, underweight occurred at all hemoglobin levels, and there did not appear to be a close relationship between weight and hemoglobin values. Thus, it appears that underweight is not necessarily associated with low hemoglobin values. In a similar comparison study, Sheets and Barrentine[13] found no association between underweight and low hemoglobin values. Noteworthy is the fact that 23.8 per cent of the men were overweight as compared to only 9.1 per cent of the women. The proportion of overweight men in this study was significantly high. Thus, it indicated a need for stressing the hazards associated with overweight in nutrition programs.

### *Dietary Intake*

The mean calorie, protein, carbohydrate, and fat intake of the participants is shown in Table III. The mean caloric intake of 2817 for men and 2081 for women was not significantly different from the Recommended Allowances of the National Research Council.

It was not surprising to find that the mean total protein intake for men was 96 Gm., with an average of 68.8 per cent of the total protein in the form of protein of animal origin. Stare and Davidson[14] reported that before rationing of food in the Second World War, it was not uncommon for persons to ingest daily 150 Gm. of protein chiefly of animal origin. Likewise, Cuthbertson[15] reported that for men the average protein intake varied from 30 to 121 Gm., with 68.5 per cent of the total protein coming from animal sources. The percentage of protein of animal origin to the total protein for women was similar to that of the men, namely 68.1 per cent.

Although the National Research Council does not specify the recommended dietary allowance for carbohydrate and fat, it is customary in planning diets to allow 50 to 60 per

TABLE II

Relationship between Hemoglobin Values and Weight

| Hemoglobin | Subjects | | Underweight, 10% and over | | Normal weight | | Overweight, 10% and over | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| *Gm./100 ml.* | | | | | | | | |
| | | | | Men | | | | |
| 13.00–14.49 | 8 | 7.1 | 2 | 25.0 | 5 | 62.5 | 1 | 12.5 |
| 14.50–16.49 | 73 | 51.8 | 14 | 19.2 | 43 | 58.9 | 16 | 21.9 |
| 16.50–18.49 | 58 | 41.1 | 6 | 10.3 | 36 | 62.1 | 16 | 27.6 |
| TOTAL | 139 | 100.0 | 22 | | 84 | | 33 | |
| AVERAGE | | | | 15.8 | | 60.4 | | 23.8 |
| | | | | Women | | | | |
| 10.00–12.99 | 59 | 14.9 | 27 | 45.8 | 27 | 45.8 | 5 | 9.6 |
| 13.00–13.99 | 134 | 33.8 | 45 | 33.6 | 81 | 60.4 | 8 | 6.0 |
| 14.00–14.99 | 147 | 37.1 | 43 | 29.3 | 91 | 61.9 | 13 | 8.8 |
| 15.00–16.99 | 56 | 14.2 | 13 | 23.2 | 33 | 58.9 | 10 | 17.9 |
| TOTAL | 396 | 100.0 | 128 | | 232 | | 36 | |
| AVERAGE | | | | 32.3 | | 58.6 | | 9.1 |

TABLE III

Mean Calorie, Protein, Carbohydrate, and Fat Intake

| | Calorie | Animal Protein | Vegetable Protein | Total Protein | Carbohydrate | Fat |
|---|---|---|---|---|---|---|
| | | | Men | | | |
| Recommended allowances | 3000 | — | — | 70 | — | — |
| Mean intake, Gm. | 2817 | 66 | 30 | 96 | 309 | 133 |
| Standard error of mean | 69.78 | 2.21 | 0.98 | 2.37 | 10.10 | 3.80 |
| Standard deviation | 823 | 26 | 12 | 28 | 119 | 45 |
| Intake as calories | | 264 | 120 | 384 | 1236 | 1197 |
| Intake as per cent of total calories | | 9.38 | 4.26 | 13.64 | 43.88 | 42.49 |
| | | | Women | | | |
| Recommended allowances | 2400 | — | — | 60 | — | — |
| Mean intake, Gm. | 2081 | 47 | 22 | 69 | 224 | 101 |
| Standard error of mean | 29.06 | 0.79 | 0.40 | 0.94 | 3.57 | 1.68 |
| Standard deviation | 578 | 16 | 8.0 | 19 | 71 | 33 |
| Intake as calories | | 188 | 88 | 276 | 896 | 909 |
| Intake as per cent of total calories | | 9.03 | 4.23 | 13.26 | 43.06 | 43.68 |

TABLE IV

Mean Mineral and Vitamin Intake

| | Calcium | Phosphorus | Iron | Thiamine | Riboflavin | Niacin | Ascorbic Acid |
|---|---|---|---|---|---|---|---|
| | *Gm.* | *Gm.* | *mg.* | *mg.* | *mg.* | *mg.* | *mg.* |
| | | | Men | | | | |
| Recommended allowance | 1.0 | — | 12 | 1.5 | 1.8 | 15 | 75 |
| Mean intake | 1.09 | 1.65 | 16.82 | 1.69 | 2.28 | 17 | 96 |
| Standard error of mean | 0.05 | 0.04 | 0.43 | 0.05 | 0.08 | 1.76 | 15.60 |
| Standard deviation | 0.65 | 0.57 | 5.07 | 0.62 | 1.04 | 6.59 | 58.19 |
| | | | Women | | | | |
| Recommended allowances | 1.0 | — | 12 | 1.2 | 1.5 | 12 | 70 |
| Mean intake | 0.82 | 1.2 | 12.2 | 1.2 | 1.6 | 12.1 | 84 |
| Standard error of mean | 0.02 | 0.02 | 0.19 | 0.04 | 0.05 | 0.21 | 2.72 |
| Standard deviation | 0.37 | 0.37 | 3.77 | 0.79 | 0.95 | 4.21 | 54.03 |

cent of the total calories from carbohydrate sources and 25 to 35 per cent from fat sources. As shown in Table III, the percentages of carbohydrate and fat consumed by the subjects are about equal, and both are higher than 40 per cent. This raises the question as to what role, if any, the equal ratio of fat and carbohydrate plays in obesity. Is fat *per se* or the origin of the fat (animal or plant) the more important contributing factor in obesity? Does the human organism metabolize and store fat of animal and of plant origin in the same manner? At present we cannot answer these questions, but it is hoped that future research will elucidate these problems.

It may be seen in Table IV that the mineral and vitamin intakes were well within the recommended allowances, with the exception of calcium. In the case of the men the calcium recommendations were just met, but among the women the calcium intake was somewhat lower than the recommended allowance. This finding is in agreement with Maynard's[16] belief that calcium may be deficient in many United States dietaries. However, recent, work appears to indicate that the calcium requirement may have been set too high.

## Summary

A survey of 535 "healthy" adults in Georgia was made. The average hemoglobin level for the 139 men and 396 women was 16.13 ± 0.09 Gm. and 13.99 ± 0.05 Gm. per 100 ml. of blood, respectively. These values are well within the normal accepted standard for adults.

No close relationship was found between the

overweight and underweight distribution and hemoglobin levels. Therefore, it would appear that underweight is not necessarily associated with low hemoglobin values.

The calorie intake of this sample was not significantly different from the Recommended Allowance of the National Research Council. The protein intake was above the recommended allowance for both men and women and about two thirds of the total protein was of animal origin. The fat intake was high; over 40 per cent of the calories were derived from fat. This may indicate a very important factor in obesity. Curiously, 23.8 per cent of the men and only 9.1 per cent of the women were overweight. The mineral and vitamin intakes were well within the recommended allowance, with the possible exception of calcium in the case of the women.

The dangers associated with obesity and the provision for high nutritive diets of low caloric value are the factors to be stressed in nutrition education programs.

## Acknowledgments

I am grateful to Miss E. Merle Wade, Mr. John J. Donovan, Jr., and Miss A. Marie Townsend for technical assistance.

## References

1. Szigeti, B.: Estimation of oxyhaemoglobin and of methaemoglobin by a photoelectric method. *Biochem. J.* 34: 1460, 1940.
2. Ponder, E.: Errors affecting the acid and alkali hematin methods of determining hemoglobin. *J. Biol. Chem.* 144: 339, 1942.
3. Eads, M. G., and Meredith, A. P.: Nutrition studies. *Pub. Health Rep.* 63: 777, 1948.
4. Food Value Tables for Calculation of Diet. U. S. Public Health Service, Federal Security Agency, Washington, D. C., 1947.
5. Taylor, C. M.: *Food Value in Shares and Weights.* The Macmillan Co., New York, 1942.
6. Andresen, M. I., and Mugrage, E. R.: Red blood cell values for normal men and women. *Arch. Int. Med.* 58: 136, 1936.
7. Heilmeyer, L., and Hausold, I.: Der Hämoglobingehalt gesunder Männer und Frauen, eine Studie zur Definition des relativen Massystems der Hb—bestimmung und zur Aufstellung des normalen Färbeindex. *Deut. Arch. f. Klin. Med.* 179: 94, 1936.
8. Jenkins, C. E., and Don, C. S. D.: The hemoglobin concentration of normal English males and females. *J. Hyg.* 33: 36, 1933.
9. Osgood, E. E.: Normal hemotologic standards. *Arch. Int. Med.* 56: 849, 1935.
10. Gargiulo, A.: Hemoglobina sanguínea normal en personas de las provincias de Córdoba y San Luís. *Rev. Soc. argent. de biol.* 12: 156, 1936.
11. Sankaran, G., and Rajagopal, K.: Haemotological investigations in South India. Part I. The estimation of haemoglobin. *Indian J. Med. Research* 25: 741, 1938.
12. Cooper, L. F., Barber, E. M., and Mitchell, H. S.: *Nutrition in Health and Disease.* 10th ed., J. B. Lippincott, Philadelphia, 1943, p. 661.
13. Sheets, O., and Barrentine, M. W.: Hemoglobin concentration and erythrocyte counts of the blood of college men and women. *J. Am. Dietet. A.* 20: 521, 1944.
14. Stare, F. J., and Davidson, C. S.: Protein: Its role in human nutrition. *J. A. M. A.* 127: 985, 1945.
15. Cuthbertson, D. P.: Quality and quantity of protein in relation to human health. *Nutrition Abstr. and Rev.* 10: 1, 1940.
16. Maynard, L. A.: Translating dietary allowances into foods and diets. *J. Am. Dietet. A.* 25: 18, 1949.

## Resumen

*Nivel de hemoglobina y dieta en los adultos*

En Georgia se hizo un estudio de 535 adultos "saludables." El nivel promedio de hemoglobina en 139 hombres y en 396 mujeres fué 16,13 ± 0,09 y 13,99 ± 0,05 gm. por 100 ml. de sangre, respectivamente. Estos niveles se encuentran dentro de los límites normales del standard aceptado para adultos. No se encontró relación directa de los niveles de hemoglobina con el peso del individuo. Por lo tanto, parece que la disminución de peso no va necesariamente asociada con niveles bajos de hemoglobina.

La ingestión calórica de este grupo no fué significantemente diferente de la cantidad recomendada por el Consejo Nacional de Investigación. La ingestión de proteínas fué mayor que la cantidad recomendada tanto en hombres como en mujeres y cerca de las dos terceras partes de proteína fué de origen animal. La ingestión de grasa fué elevada; más del 40 por ciento de las calorías provenían de las grasas. Este puede constituir un factor muy importante en la obesidad. Singularmente, 23,8 por ciento de los hombres exhibían

sobrepeso, observandose este hecho en solo 9,1 por ciento de las mujeres. La ingestión de vitaminas y minerales estaba dentro de las cantidades recomendadas, con la posible excepción del calcio en el caso de las mujeres.

Los peligros asociados con la obesidad y la provisión de dietas altamente nutritivas de bajo valor calórico son los factores en los cuales debe ponerse énfasis en los programas educativos nutricionales.

---

### *Doctors and Dignity*

"We become more conscious of our dignity as we grow older. Not that I think we have more real dignity now. In fact, we may have less of it in our character and thoughts since we joined in the battle of existence than we had in the fellowship of youth. Whether this is so or not, we certainly regard good lusty humour as unbecoming on important occasions, and there are many occasions which we consider important—or at any rate we feel important on so many occasions. Perhaps this is as it should be—although I do think that the wise clown has as much dignity as the sombre fool; but feeling ourselves important so often, we are leaving humour out of our lives more and more, and I believe greatly to our detriment."
—W. J. Saxton in an Address to the Queensland Branch of the British Medical Association. *The Medical Journal of Australia* II (15): 553–554, 1953.

---

### *Old Saying—New Meaning*

"The old phrase of derision, 'He has a fat chance,' has become applicable with striking reality to the twenty-five million members of our community who are overweight and are, therefore, *poorly* fed."
—Charles Glen King. *Journal of the American Dietetic Association* 30: 15, 1954