nutrition survey

Nutritional status of a population sample in Macon County, Alabama[1,2]

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ABSTRACT A nutrition survey was conducted in Macon County, Alabama, with a population sample of 102 individuals, 76% of whom were black. Three 24-hr dietary recalls were obtained for each participant and 24 nutrients and energy were calculated for each combined 3-day intake. Serological and hematological analyses of blood were performed. Dietary calculations indicated that intakes of calcium, vitamin B_{12}, calories, and iron were lowest within the population sample. Blood analyses did not confirm the calculated inadequacies of dietary calcium, vitamin B_{12}, or iron. Body weight data did not support the calculated inadequate energy intakes. Serum analysis indicated a folic acid deficiency. Mean intakes of energy and macronutrients were higher in nonblacks than in blacks; for most vitamins and minerals, the same was true. The lower calcium intakes among blacks than among nonblacks in the growing years exceeded the differential in energy intakes. Higher serum vitamin B_{12} levels in blacks than in nonblacks were observed but not explained. *Am. J. Clin. Nutr.* 29: 94-104, 1976.

The present study was undertaken to assess the nutritional status of a representative sample of the population in the county in which Tuskegee Institute is located. While many generalizations have been made about hunger and malnutrition in the Southern United States, data inclusive of dietary intakes, biochemical values, and clinical parameters for a population sample are not usually offered to substantiate such statements.

Methods

Data collection

In the summer of 1971, four questionnaires were developed for recording information pertaining to residents of Macon County. These were concerned with: *1*) health screening—historical data; *2*) demographic information; *3*) physical examination; and *4*) dietary information. Except for the physical examination, information for the completion of questionnaires was obtained by a nutritionist who interviewed participants in their homes.

Three 24-hr recalls of food intake were obtained from each participant. The mother, or another adult, provided information for preschoolers. In no instances were these obtained on consecutive days. All interviews were completed between September 1971 and January 1972.

In December 1971, each participant in the population sample came to John A. Andrew Memorial Hospital, Tuskegee Institute, for a physical examination, at which time urine and blood samples were donated.

A home visit to obtain a fecal specimen was made to each participant during the 3-week period after physical examination.

Description of sample

The population sample consisted of 41 families, or 102 individuals—20 preschool children, 27 adolescents, and 55 adults. Six of the adults were over 65 years of age (Table 1). Racial constituency of the population sample was 76% black and 24% nonblack; 39% was male and 61% female. According to the 1970 Census (1), 12% of the Macon County population was below 6 years of age, 15% was in the adolescent age range, and 61% was adult; 80% was black and 19% was nonblack; 48% was male and 52% was female. Hence, the Macon County population sample consisted of a larger percentage of preschool-

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ers and adolescents and a smaller proportion of adults than was characteristic of the total county population. Ethnic constituency was similar, but the experimental population had fewer males and more females than was recorded in the Census.

Selection of sample

Participants were selected through use of a two-stage area sample of Macon County citizens. In collaboration with the Social Science Department of Tuskegee Institute, the county was subclassified in terms of *1*) a probability selection of area segments, and *2*) a probability selection of people within the area segment covering all age ranges. Area segment maps had been prepared 2 years previously by personnel in the Social Science Department. Initially, information was gathered relative to household constituency and willingness to participate. All persons who were willing and either 2 to 5 years of age, 13 to 18 years, or 19 years and over constituted three pools from which random samples were chosen. The enlistment of white rural participants was difficult and randomness was not maintained in this segment of the sample. The area segment maps showed all houses in Macon County and racial composition therein. There were encountered instances in which houses had been vacated since the maps were constructed and in which racial composition had changed; nevertheless, this was a useful model.

Participants were informed directly, or indirectly via the physician authorized by the participant, of any abnormal test results. In addition, a letter was sent to each participant's home address, informing him of his blood type.

Clinical and biochemical assessments

Macon County is predominantly rural, and in order to guarantee a reasonably good participation rate, round trip transportation was provided between the participant's home and the site of the physical examination. The examinations were conducted over a 3-day period by physicians with the assistance of nurses, student nurses, and laboratory technicians. In addition, a representative from Consolidated Biomedical Laboratories, Inc., Columbus, Ohio, supervised the collecting, labeling, and packaging of samples for the major battery of serological and hematological analyses, and a member of the Nutrition Department Faculty of the University of Alabama Medical Center supervised the handling of samples to be taken to Birmingham for vitamin analyses.

Tests performed on blood specimens by Consolidated Biomedical Laboratories included: *1*) executive profile consisting of glucose, urea nitrogen, total protein, albumin, alkaline phosphatase, serum glutamic oxaloacetic transaminase, lactic dehydrogenase, calcium, phosphorus, uric acid, total bilirubin, total cholesterol, T-4 Murphy-Pattee, triglycerides, white blood cell count, red blood cell count, hemoglobin, hematocrit, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, band neutrophils, segmented neutrophils, total neutrophils, lymphocytes, eosinophils, basophils, platelets; *2*) ABO blood grouping; *3*) sickle cell preparation; and *4*) serum iron and iron binding capacity. The Nutrition Laboratory of the University of Alabama Medical Center analyzed serum for ascorbic acid, folic acid, vitamin B_{12}, retinol, and β-carotenes. The Hema-

TABLE 1
Age and sex distribution in population sample

Age (years)	Sex: Male	Sex: Female	Total
2	2	3	5
3	2	1	3
4	2	5	7
5	1	4	5
Subtotal	7	13	20
13	3	2	5
14	4	3	7
15	6	1	7
16	1	4	5
18	1	2	3
Subtotal	15	12	27
19–35	5	15	20
36–45	1	8	9
46–55	7	6	13
56–65	2	5	7
66–75	3	0	3
76–85	0	3	3
Subtotal	18	37	55
Total	40	62	102

tology Laboratory of the Veterans Administration Hospital, Birmingham, Alabama, performed hemoglobin electrophoresis on blood specimens. Consolidated Biomedical Laboratories did routine urinalysis of urine specimens and examined feces for ova and parasites.

The amount of blood obtained from adolescents and adults was 30 ml and from preschoolers 10 ml. The lesser volume taken from preschoolers precluded the determination of certain items in the executive profile series, vitamin B_{12}, serum iron, and iron binding capacity.

Data analysis

The energy and nutrient content of the diets was calculated by a special computer program written by one of the authors (B. T.), using food values compiled by Bowes and Church (2). Food values for folic acid and vitamin B_{12} were obtained from USDA Handbook 29 and Home Economics Research Report 13 (3, 4), respectively. The computer was a Hewlett-Packard model 2000G. Quality of the dietary intakes was evaluated using the 1968 National Research Council (NRC) Recommended Dietary Allowances (RDA) (5).

Results

Demographic and socioeconomic characteristics

The size and distribution of families in the population sample are shown in Table 2.

Among the 41 families, five were welfare recipients and seven were Social Security recipients. Eighteen families received commodity foods. There were 23 rural and 18 urban families. Twenty-three families owned

TABLE 2
Size of families in population sample

Size of family	No. of families	% of families
1	2	5
2	4	10
3	11	27
4	6	14
5	4	10
6	6	15
7 or more	8	19

their homes and 18 were renting. Fifty-two percent of rural families and 61% of urban families were home owners.

Large families had a smaller income per capita than small families, and rural families had less income than urban ones. Forty-nine percent of the families spent less than $5 per week per capita for food, 44% spent $5 to 10, and 5% spent $10 to 15. Among the 18 families who received commodity foods, 15 utilized them daily whereas others did so approximately twice weekly.

Twenty-six families had gardens and 14 owned livestock. The food group purchased most frequently was meat by both garden owners (73%) and livestock owners (80%). Having a garden was not related to owning/renting but was related to rural/urban sites; 78% of rural families had gardens in contrast to 30% of urban families. Families with both gardens and livestock tended to spend more per capita for food than those with neither.

Vitamin supplements were used by approximately 50% of the families. There was a positive correlation between the use of vitamin supplements and the educational level of the mother. Seventy-five percent of all families used iodized salt. Three families practiced pica—two ate dirt and one ate raw starch. The frequency of eating meals at school varied inversely with food expenditure per capita.

Among the 28 families with both a mother and a father, 13 fathers and 18 mothers had completed a high school education.

The mean weekly family income for the total sample was $100.

Nutrient intakes

Although vitamin supplements were used by 18 of the 41 families, the pattern of use was irregular and no attempt was made to include vitamin supplements in the calculation of nutrient intakes.

Means and standard deviations for energy and nutrient intakes of the various age groups are shown in Table 3. Males between 13 and 85 years of age consumed more calories and macronutrients than did females. The nutrients of greatest variability in daily intake were vitamins A and B_{12} and folacin; in most instances, standard deviations exceeded means. Values for vitamin D, folacin, and magnesium were omitted from Table 3 because of incomplete nutrient data for many foods in the food composition tables. In Table 4 is shown a comparison of mean intakes with 1968 NRC RDA as standards for the several age groups.

When the total population sample was considered, the nutrient intake which most closely met the RDA was protein, followed by vitamins C and A. Mean intakes of essential amino acids (Table 3) were in excess of safe allowances for the age groups and sexes, with only three minor exceptions: mean intakes of phenylalanine were 72 to 100% of safe allowances, of methionine 80 to 100%, and of tryptophan 90 to 100%. Niacin data in Tables 3 and 4 include biosynthetic niacin derived from tryptophan. Among the B vitamins, the poorest intakes were of vitamin B_{12}, and the deficiency was most severe in late years of life. The dietary B_{12} inadequacy is more dramatically shown when individual intakes are examined (Table 4) than when group means are the criteria (Table 3).

In the total population sample, calcium was the dietary nutrient the intake of which was most inadequate, followed by calories, then iron. The lack of calories made questionable the favorable protein intake. Phosphorus intakes were higher than those for calcium; in many instances dietary phosphorus was almost twice the level of calcium (Table 3). This is related to the fact that most of the phosphorus was provided by nondairy, plant sources. The unavailability of adequate magnesium data for foods is particularly unfortunate in this study because of the low dietary calcium values and the physiological interrelationships of calcium and magnesium in the human body. Dietary sodium and potassium were present in abundance for all age groups.

TABLE 3
Dietary intakes based on 3-day records (exclusive of vitamin supplements)

Nutrients	2-5 years: Male and female (20)[a]	13-18 years		19-55 years		56-85 years	
		Male (15)	Female (12)	Male (13)	Female (29)	Male (5)	Female (8)
Energy (kcal)	1,494 ± 762[b]	1,874 ± 984	1,739 ± 854	2,265 ± 1,041	1,410 ± 705	1,473 ± 927	1,262 ± 477
Protein (g)	64 ± 34	87 ± 48	75 ± 44	114 ± 54	69 ± 35	71 ± 43	62 ± 25
Carbohydrate (g)	182 ± 112	199 ± 120	183 ± 87	244 ± 140	159 ± 93	172 ± 136	139 ± 78
Fiber (g)	2.8 ± 2.1	3.2 ± 2.7	2.7 ± 3.7	4.4 ± 4.3	2.6 ± 2.0	4.4 ± 4.9	3.1 ± 1.9
Fat (g)	60 ± 33	83 ± 45	80 ± 48	99 ± 48	59 ± 33	56 ± 30	54 ± 23
Polyunsaturated fatty acids (g)	3.2 ± 3.0	4.6 ± 3.8	5.9 ± 8.9	4.8 ± 3.5	4.0 ± 3.0	3.4 ± 1.8	4.2 ± 3.4
Thiamin (μg)	1,073 ± 653	1,378 ± 953	1,192 ± 804	1,892 ± 1,464	1,129 ± 861	1,119 ± 866	1,194 ± 952
Riboflavin (μg)	1,228 ± 813	1,628 ± 978	1,489 ± 1,149	2,201 ± 1,264	1,313 ± 1,071	1,281 ± 1,073	1,106 ± 450
Niacin (mg)	13 ± 9	18 ± 12	17 ± 14	23 ± 14	15 ± 10	13 ± 7	12 ± 6
Vitamin C (mg)	85 ± 78	68 ± 60	66 ± 75	115 ± 100	83 ± 81	84 ± 66	65 ± 52
Vitamin A (IU)	4,667 ± 5,651	5,048 ± 6,822	6,245 ± 12,428	11,560 ± 12,626	7,560 ± 9,095	11,035 ± 14,541	6,195 ± 5,895
Vitamin B_{12} (μg)	6 ± 19	5 ± 15	7 ± 23	31 ± 112	6 ± 15	0.6 ± 2	2 ± 3
Sodium (mg)	1,658 ± 1,076	1,906 ± 1,190	1,686 ± 1,026	2,368 ± 1,601	1,459 ± 1,080	1,673 ± 1,825	1,363 ± 900
Potassium (mg)	1,418 ± 875	1,794 ± 1,391	1,699 ± 1,337	2,382 ± 1,572	1,343 ± 861	1,521 ± 1,156	1,188 ± 627
Calcium (mg)	591 ± 408	755 ± 526	658 ± 489	894 ± 512	542 ± 448	477 ± 324	418 ± 230
Phosphorus (mg)	927 ± 531	1,227 ± 795	1,083 ± 700	1,535 ± 799	878 ± 532	865 ± 613	906 ± 548
Iron (mg)	9 ± 6	11 ± 7	11 ± 6	18 ± 12	12 ± 14	11 ± 9	10 ± 4
Tryptophan (mg)	494 ± 293	634 ± 379	648 ± 541	924 ± 554	506 ± 366	593 ± 373	474 ± 247
Phenylalanine (mg)	1,933 ± 1,075	2,473 ± 1,473	2,548 ± 2,162	3,692 ± 2,273	1,976 ± 1,351	2,455 ± 1,853	1,823 ± 900
Leucine (mg)	3,585 ± 2,042	4,463 ± 2,644	4,452 ± 3,591	6,598 ± 4,097	3,590 ± 2,547	4,330 ± 3,171	3,258 ± 1,743
Isoleucine (mg)	2,234 ± 1,312	2,821 ± 1,739	2,834 ± 2,343	4,209 ± 2,652	2,247 ± 1,653	2,784 ± 2,056	2,093 ± 1,130
Lysine (mg)	2,853 ± 1,910	2,523 ± 2,294	3,513 ± 2,992	5,840 ± 3,769	2,910 ± 2,409	3,566 ± 2,781	2,666 ± 1,751
Valine (mg)	2,415 ± 1,402	2,853 ± 1,723	3,056 ± 2,591	4,493 ± 2,770	2,416 ± 1,735	3,004 ± 2,199	2,265 ± 1,210
Methionine (mg)	910 ± 580	1,115 ± 674	1,117 ± 870	1,647 ± 1,042	910 ± 720	1,057 ± 662	848 ± 495
Threonine (mg)	1,756 ± 1,040	2,219 ± 1,364	2,210 ± 1,785	3,306 ± 2,092	1,794 ± 1,332	2,137 ± 1,571	1,724 ± 1,014

[a] Number of experimental subjects in parentheses. [b] Mean ± standard deviations.

If examined by age groups, the best nutrient intakes occurred in the 2- to 5-year age group, although calcium and iron were low. In adolescents, calcium, iron, and calories were low; in adults, calcium and calorie intakes were lowest.

Biochemical values

The standards selected to assess adequacy of biochemical and hematological parameters (6–8) are shown in Table 5. In instances in which standards specific for preschoolers and adolescents were not available, those for adults were used. Results for the executive profile and vitamin analyses are shown in Table 6.

Executive profile. Serum total protein and serum albumin were above the normal range, confirming adequacy of protein intakes calculated from dietary recalls despite the inadequacy of calculated energy intakes. Mean serum calcium levels approached the upper limit of the normal range, although dietary calcium was a limiting nutrient according to dietary recalls. Total cholesterol was elevated in 19- to 55-year-old males and in both sexes of the 56- to 85-year age group. Mean uric acid was elevated in both sexes over the age range 19 to 85 years. Means for all other measurements included in the executive profile, as shown in Table 6, were within the normal range.

Vitamin analyses. Consistent with dietary data, serum ascorbic acid means were above average, although two adolescents and five adults had serum values below 0.2 mg/ml. The most extensive nutrient deficiency, based on serum levels, was of folic acid. Mean serum folate for all age groups was low, considering 6 ng/ml as acceptable. If one considers the deficiency state to be below 3 ng/ml, all group means were above the deficiency level, but three preschoolers, four adolescents, and 14 adults had folate levels below 3 ng. One adult had a level of 20 ng folate/ml serum. In contrast to expectation based on dietary data, there were no individuals with a vitamin B_{12} level below 200 pg/ml, although there were seven adolescents and 16 adults who had levels above the upper limit of normal, three in excess of 2200 pg/ml. The significance of extremely high levels of vitamin B_{12} and folate is unclear. Except for the 2- to 5-year age group, mean retinol levels in serum were in the normal range, although eight adolescents and four adults had levels below 20 μg/dl; 13 of the 20 preschoolers had less than 20 μg retinol/dl. Only one of the 102 participants had a β-carotene level below 40 μg/dl.

Hematology. Hematological data are presented in Table 7. Except for white blood cell count, means for the various blood cells and erythrocyte indices were within the normal range. The mean white blood cell count in the preschoolers was higher than in other age groups, as expected; nevertheless, it was below the normal range for preschoolers. The mean white cell count for 56- to 85-year-old participants also was below the normal range. Total iron, iron binding capacity, and transferrin saturation were not determined in the

TABLE 4
Percentage of individuals whose intakes were 100% and 67% of NRC RDA

Energy and nutrients	2–5 years		13–18 years		19–55 years		56–85 years	
	100%	67%	100%	67%	100%	67%	100%	67%
Energy	50	80	15	48	19	38	8	31
Protein	90	100	78	89	74	86	54	92
Vitamin A	65	90	41	59	67	83	85	92
Vitamin C	85	95	60	78	74	79	62	92
Niacin	55	90	44	70	74	71	46	85
Riboflavin	75	100	48	63	42	67	31	54
Thiamin	75	100	44	59	41	64	38	69
Vitamin B_{12}	10	30	22	37	32	50	0	8
Calcium	30	45	11	33	24	50	8	23
Phosphorus	45	80	26	52	62	90	38	85
Iron	37	52	7	44	45	79	31	78

TABLE 5
Standards for serum biochemical and hemotological values

Serum constituent	Preschooler	Adolescent		Adult	
Glucose (mg/dl)					80–110
Urea N (mg/dl)			10–20		10–20
Total protein (g/dl)				male	6.3–7.1
				female	6.0–6.8
Albumin (g/dl)					≥3.5
Alkaline phosphatase (ng/ml)			150–360		30–85
Serum glutamic oxalo-acetate transaminase (ng/ml)					10–40
Lactic dehydrogenase (ng/ml)					100–225
Serum Ca (mg/dl)					8.5–10.5
Serum P (mg/dl)					3.0–4.0
Uric acid (mg/dl)				male	4.1–6.0
				female	3.1–5.0
Total bilirubin (mg/dl)					<1.2
Total cholesterol (mg/dl)					160–220
T-4 (Murphy-Pattee (μg/dl)					4–11
Triglycerides (mg/dl)					27–150
Total Fe (μg/dl)		male	≥60	male	≥60
		female	≥40	female	≥40
Fe binding capacity (μg/dl)			250–410		250–410
Transferrin saturation (%)		male	≥20	male	≥20
		female	≥15	female	≥15
Retinol (μg/dl)			≥20		≥20
β-carotenes (μg/dl)	≥40		≥40		≥40
Ascorbate (mg/dl)	≥0.3				≥0.2
Serum folate (ng/ml)					≥6.0
Vitamin B_{12}(pg/ml)					200–900
WBC (no./mm^3)	8–15 × 10^3				5–10 × 10^3
RBC (no./mm^3)	4–5 × 10^6			male	4.0–6.2 × 10^6
				female	4.0–5.5 × 10^6
Hb (g/dl)	≥10.0	male	≥12.0	male	≥12.0
		female	≥10.0	female	≥10.0
Hct (%)	≥31	male	≥37	male	≥37
		female	≥31	female	≥31
MCV (μ^3)	75–80		81		76–96
MCH (pg)	25–28		28		27–32
MCHC (%)	≥30		34		32–36
Band neutrophils (no./mm^3)	0.7 × 10^3		0.6 × 10^3		0.6 × 10^3
Segmented neutrophils (no./mm^3)	3.0 × 10^3		3.8 × 10^3		3.8 × 10^3
Lymphocytes (no./mm^3)	4.5 × 10^3		2.8 × 10^3		2.5 × 10^3
Monocytes (no./mm^3)	0.4 × 10^3		0.4 × 10^3		0.3 × 10^3
Eosinophils (no./mm^3)	0.2 × 10^3		0.2 × 10^3		0.2 × 10^3
Basophils (no./mm^3)	0.05 × 10^3		0.04 × 10^3		0.04 × 10^3

preschooler, but means for other age groups were within the normal range. Hemoglobin electrophoresis determinations indicated one AS type in the 2- to 5-year age group, three AS and two AC in the 19- to 55-year age group, and one AS in the 56- to 85-year age group. Considering the fact that 76% of the participants were black, the observed incidence of sickling trait, 9%, was less than expected.

TABLE 6
Serum biochemical values

Serum component	2–5 years: Male and female	13–18 years		19–55 years		56–85 years: Male and female
		Male	Female	Male	Female	
Executive profile						
Glucose (mg/dl)		102 ± 12[a]	102 ± 15	100 ± 9	107 ± 23	108 ± 39
Urea N (mg/dl)		13 ± 2	12 ± 4	18 ± 3	14 ± 4	18 ± 5
Total protein (g/dl)		7.8 ± 0.6	7.9 ± 0.5	7.5 ± 0.3	7.7 ± 0.5	7.6 ± 0.4
Albumin (g/dl)		5.3 ± 0.2	5.0 ± 0.4	4.9 ± 0.4	4.8 ± 0.5	4.6 ± 0.3
Globulin (g/dl)		2.5 ± 0.5	2.9 ± 0.4	2.6 ± 0.3	2.9 ± 0.5	3.1 ± 0.5
A/G ratio		2.1 ± 0.4	1.8 ± 0.3	1.9 ± 0.3	1.8 ± 0.4	1.5 ± 0.3
Alkaline phosphatase (ng/ml)		317 ± 150	96 ± 46	68 ± 31	65 ± 30	58 ± 15
Glutamic oxaloacetate transaminase (ng/ml)		28 ± 7	24 ± 7	28 ± 8	23 ± 9	29 ± 16
Lactic dehydrogenase (ng/ml)		163 ± 25	132 ± 17	147 ± 26	141 ± 31	157 ± 40
Calcium (mg/dl)		10.2 ± 0.4	10.0 ± 0.4	9.9 ± 0.4	9.9 ± 0.6	9.7 ± 0.3
Phosphorus (mg/dl)		4.7 ± 0.6	4.0 ± 0.6	3.8 ± 0.5	3.5 ± 0.5	3.6 ± 0.4
Uric acid (mg/dl)		6.0 ± 0.8	4.9 ± 0.6	6.7 ± 1.2	5.5 ± 1.7	6.1 ± 0.9
Total bilirubin (mg/dl)		0.48 ± 0.24	0.62 ± 0.45	0.45 ± 0.16	0.38 ± 0.25	0.38 ± 0.15
Total cholesterol (mg/dl)		192 ± 27	185 ± 34	238 ± 50	216 ± 44	264 ± 49
T-4 Murphy Pattee (μg/dl)		8.0 ± 0.9	9.1 ± 0.9	8.9 ± 2.1	9.3 ± 2.4	9.0 ± 1.4
Triglycerides (mg/dl)		104 ± 45	65 ± 31	140 ± 58	114 ± 75	144 ± 83
Vitamins						
Ascorbic acid (mg/dl)	0.9 ± 0.4	0.5 ± 0.4	0.7 ± 0.5	0.8 ± 0.8	0.7 ± 0.4	0.7 ± 0.6
Folic acid (ng/ml)	4.8 ± 1.6	3.8 ± 1.9	4.1 ± 1.3	4.2 ± 1.6	4.7 ± 3.3	4.6 ± 2.8
Vitamin B_{12} (pg/ml)		586 ± 152	1032 ± 594	782 ± 479	821 ± 371	779 ± 316
Retinol (μg/dl)	17 ± 8	21 ± 9	22 ± 8	33 ± 9	32 ± 14	45 ± 13
β-carotenes (μg/dl)	152 ± 64	144 ± 50	109 ± 43	175 ± 89	166 ± 80	256 ± 96

[a] Mean ± standard deviation.

TABLE 7
Hematology

Blood component	2–5 years: Male and female	13–18 years: Male	13–18 years: Female	19–55 years: Male	19–55 years: Female	56–85 years: Male and Female
White blood cells ($\times 10^3$/mm^3)	7.4 ± 2.2	6.4 ± 1.8	6.4 ± 1.1	6.2 ± 1.1	6.5 ± 1.6	4.9 ± 1.4
Red blood cells ($\times 10^6$/mm^3)	4.4 ± 0.5	4.8 ± 0.5	4.3 ± 0.5	5.1 ± 0.6	4.4 ± 0.3	4.6 ± 0.5
Hemoglobin (g/dl)	12.1 ± 0.8	13.9 ± 0.6	12.8 ± 1.3	14.9 ± 1.1	13.4 ± 0.9	13.7 ± 0.9
Hematocrit (%)	36.9 ± 2.1	42.7 ± 1.9	39.6 ± 3.8	45.8 ± 2.8	41.4 ± 2.8	42.4 ± 2.7
Mean corpuscular volume (μ^3)	83.8 ± 5.6	87.8 ± 7.2	90.9 ± 8.7	90.0 ± 7.9	92.3 ± 5.4	92.4 ± 6.8
Mean corpuscular hemoglobin (pg)	27.5 ± 2.6	28.6 ± 2.6	29.3 ± 2.9	29.4 ± 2.7	30.0 ± 1.9	29.8 ± 2.3
Mean corpuscular hemoglobin concentration (%)	32.3 ± 1.3	32.2 ± 0.6	31.9 ± 0.7	32.2 ± 0.6	32.1 ± 0.7	31.9 ± 0.6
Segmented neutrophils ($\times 10^3$/mm^3)	3.6 ± 0.7	3.6 ± 0.6	3.7 ± 0.4	3.5 ± 0.6	3.6 ± 0.7	2.6 ± 0.3
Band neutrophils (no./mm^3)	0	0	0	0	6.5 ± 26.0	0
Lymphocytes ($\times 10^3$/mm^3)	3.6 ± 0.7	2.6 ± 0.6	2.4 ± 0.4	2.2 ± 0.6	2.5 ± 0.6	2.0 ± 0.3
Monocytes (no./mm^3)	148 ± 148	128 ± 128	64 ± 64	124 ± 62	130 ± 65	98 ± 49
Eosinophils (no./mm^3)	370 ± 296	192 ± 128	192 ± 128	248 ± 248	130 ± 130	147 ± 98
Basophils (no./mm^3)	3.7 ± 14.8	19.2 ± 25.6	25.6 ± 32.0	18.6 ± 37.2	26.0 ± 39.0	98.0 ± 196.0
Total iron (μg/dl)		89 ± 18	77 ± 33	87 ± 20	81 ± 25	89 ± 20
Iron binding capacity (μg/100 ml)		360 ± 41	364 ± 58	326 ± 36	332 ± 37	320 ± 49
Transferrin saturation (%)		25 ± 5	22 ± 9	27 ± 8	24 ± 7	28 ± 7
Abnormal hemoglobin	1 AS			2 AS	1 AS, 2 AC	1 AS

Parasites

Fecal specimens were obtained from 91 of the 102 participants. These were examined for six types of parasites and ova. Results are shown in Table 8.

The 30 parasitic infections were observed in 22 individuals, four of whom had two types of parasites, and two of whom had three types. The 22 individuals with positive fecal specimens represented 16 families. Without regard to nature of parasitic agent, the rate of infection was one per 2.6 families, or one per 4.6 individuals. These results indicate the need for improvement in sanitary conditions of the home and its environs.

Discussion

Dietary intakes: national trends versus Macon County sample

According to a recent analysis of trends in food consumption (9), there has been a dcwnward trend in consumption of dairy products since 1957 to 1959. During the past 20 years the per capita consumption of meat, poultry, and sugar and other sweeteners has increased. Most intakes of participants in this study are consistent with national trends.

The 1965 survey by the USDA of family food consumption in the U.S.A. (10) indicated that the three nutrients most frequently below the RDA were calcium, vitamin A, and vitamin C. The nutrient the intake of which was lowest in the Macon County population was calcium. Wakefield and Merrow (11) observed inadequate intakes of calcium in 6- to 12-year-old children and Hampton et al. (12) reported that calcium intake was inadequate in diets of high school students. Jerome and Pringle (13) found calcium inadequate in intakes of southern families who had migrated to Wisconsin. The low calcium intakes in the Macon County population, accompanied by serum calcium levels which approached the upper limit of the normal range, confirm the previously reported observation that serum calcium level as the sole clinical index of malnutrition is unreliable until after body stores are exhausted and nutritional deficiency is advanced. Measurements of bone density along with normal serum cal-

TABLE 8
Prevalence of parasitic infections in population sample

Parasites	No. of positive cases
Entamoeba coli	14
Necator americanus	2
Endolimax nana	8
Entamoeba histolytica	3
Giardia lamblia	1
Iodamoeba bütschlii	2

cium values are necessary to assess the true calcium status in the body.

Although calcium intakes of the Macon County population paralleled those of the 1965 USDA survey, intakes of vitamins A and C were second only to protein in satisfying the respective RDA's. The second and third limiting dietary factors in the Macon County group were calories and iron, in this order. Since the RDA for iron in the female was increased in 1968, this may explain the appearance of iron among the three most limited nutrients in the present study. Over the 10-year period between 1955 and 1965, the USDA survey reported that the consumption of calories and calcium decreased while protein and iron increased (10).

Because folate values for several food items were unavailable, dietary folate data in the present study were not regarded as accurate reflections of the amounts eaten. However, blood folate levels substantiate that intakes were inadequate. Although folate is widely distributed in food, the fact that it is partially destroyed by cooking processes—which are lengthy in the hands of Southerners—contributes to decreased availability of the vitamin. Leevy et al. (14) reported that a low serum folate level was the most common vitamin deficiency in a low-income hospital population.

Energy intakes and height/weight observations

Obesity has been observed in a large segment of the American population (6). The observation that 77% of the Macon County sample population had less than the recommended energy intake and 51% had less than two-thirds of the recommended intake is perplexing in view of body weight data for this group.

Using the NRC body weights as standards (5), the mean body weights for the 37 females and 19 males in this study were 36 and 19 pounds over the NRC values. In the 13- to 14-year adolescent group mean body weights exceeded the NRC values by 25 pounds in males and 30 pounds in females; in the 15- to 18-year adolescent group, males had a mean body weight similar to the NRC value and females were 10 pounds over. Using heights published by NRC as standards, 13- to 15-year-old males were 4 inches taller and females in this age range were 2 inches taller than NRC values; above 15 years of age, observed heights in both sexes were similar to NRC values.

When body weight and height data were analyzed for differences between ethnic groups, using NRC values for adolescent and adult groups (5) and those of Garn et al. for preschool children (15), the differences were not significant. Black adolescent males, 13 to 19 years of age, were taller than nonblack males, nonblack females, or black females ($P < 0.05$). In the 19- to 55-year age group only, males in each ethnic category were taller than females ($P < 0.01$).

Distribution of dietary nutrients by ethnic and age groups

Among the 20 preschoolers, 12 were black and eight were nonblack, and among the 27 adolescents, 19 were black and eight were nonblack. In other age groups, the number of blacks constituted three-fourths of the total sample. This inequity in numbers of blacks and nonblacks in the several age groups was intentional in order to simulate ethnic constituency of Macon County, but the value of statistics in comparisons which follow is lessened by this inequity.

In the 2- to 5-year age group, nonblacks consumed 44% more calories, 36% more protein, 71% more carbohydrate, 133% more fiber, 16% more fat, 73% more sodium, and 55% more calcium than blacks. Only the differences in fiber ($P < 0.01$) and sodium ($P < 0.05$) consumption were significant. Although nonblack preschoolers consumed 44% more calories than blacks, the percentage of protein calories in diets was similar—18% for both black and nonblack children; the percentage of calories contributed by carbohydrate was higher in diets of nonblack children while the percentage of calories from fat was higher in diets of black children. Intakes of all vitamins and minerals were higher in diets of nonblacks than in those of black children; the differences were not significant.

In the 13- to 19-year age group, calories for nonblack males and females combined were 32% higher, protein 64%, carbohydrate 82%, fiber 100%, fat 44%, sodium 108%, and calcium 101% higher than for blacks. In this age group, vitamin A and folic acid intakes were higher (9 and 100%, respectively) in diets of blacks, while all other vitamins and minerals were higher in diets of nonblacks. Because of disproportionate sample sizes and degree of variability within subgroups, none of these differences were significant. While adolescent nonblack children consumed 32% more calories than blacks, each ethnic group consumed 18% protein calories; blacks consumed a smaller percentage of carbohydrate calories and a larger percentage of fat calories than nonblacks.

Analysis of data by sex for the adolescent age group showed no ethnic differences among females, but among the males nonblacks had larger intakes of protein ($P < 0.05$), carbohydrate ($P < 0.05$), sodium ($P < 0.05$), calcium ($P < 0.02$), phosphorus ($P < 0.05$), and vitamin D ($P < 0.01$).

For all subgroups in the population above 18 years of age, the only significant differences in nutrient intakes occurred in the 19- to 35-year old female subgroup; nonblacks had a larger mean niacin intake than blacks ($P < 0.05$).

In the total population sample, calcium intakes were 42% higher for nonblack females than for black females and 52% higher for nonblack than for black males. The largest ethnic differences in calcium intake, 50 to over 100%, occurred in preschool and adolescent age groups. The smallest ethnic differences, 5% and less, occurred in participants over 35 years of age. In each ethnic group, females consumed 30% less calcium than males. As a result of both ethnic and sex factors, black males and nonblack females had equivalent calcium intakes. The dietary questionnaire did not contain items that would provide the specific explanation for the large ethnic differences observed in calcium intakes during the growing years of life. One is tempted to speculate that economic level of the family is not the overriding determinant, as ethnic differences practically disappeared after age 35.

In the total population sample, iron consumption was 32% higher in nonblack males and 44% higher in nonblack females than in black male and female groups, respectively. Iron intakes were 25% higher in nonblack males and 35% higher in black males than in the corresponding female ethnic groups.

Although a trend is established by calcium and iron intake data, reflecting higher nutrient intakes for nonblacks than for blacks, the small sample sizes and inherent variation may have caused these differences not to be significant.

Serum hemoglobin and vitamin levels by ethnic and age groups

Hemoglobin. There were no differences in hemoglobin by either ethnic or sex groupings. However, in the adolescent group, black females had lower values than black males, nonblack males, or nonblack females ($P < 0.05$). In the 19- to 55-year and over 55 age groups, within each ethnic group males had a higher mean hemoglobin level than females ($P < 0.01$).

Vitamins. In preschoolers, there were no ethnic differences in serum ascorbate levels, but the levels were higher in females than in males ($P < 0.04$).

In the adolescent group, serum β-carotene levels were higher in blacks than in nonblacks ($P < 0.03$), and higher in the black male than in the black female ($P < 0.03$). Analysis of folate data for this age group by sex and ethnic groups indicated only one significant difference: nonblack males had a higher

TABLE 9
Serum vitamin B_{12} levels (pg/ml)

Age (years)	Black	Nonblack
13 18	874 ± 504	548 ± 149
19 55	835 ± 356	657 ± 260
56 85	911 ± 479	679 ± 0

serum folate level than nonblack females ($P < 0.03$).

The 19- to 55-year age group showed no difference in serum retinol levels by ethnic background, but the nonblack female had a lower serum retinol level than either the nonblack male or the black female ($P < 0.05$).

Most enigmatic among the data were those for vitamin B_{12}. This vitamin was 6 times higher in diets for nonblack preschoolers and 3 times higher for nonblack 13- to 85-year-old participants than for blacks in the respective age groups. Serum vitamin B_{12} values were not obtained for the 20 preschoolers, but for the remaining 82 subjects, serum vitamin B_{12} was 50% higher for the black male than for the nonblack male and 40% higher for the black female than for the nonblack female. A higher serum vitamin B_{12} for blacks was observed for each age group (Table 9), although the only significant diffference related to ethnic origin was for males 13 and 14 years of age ($P < 0.05$)—the mean values were 642 $\pm$ 131 pg/ml for blacks and 467 $\pm$ 155 for nonblacks. When serum vitamin B_{12} data were pooled and examined by sex, 13- to 18-year-old females had significantly higher levels of vitamin B_{12} (1,074 $\pm$ 573 pg/ml) than males (581 $\pm$ 122; $P < 0.01$); above 19 years of age, there were no differences related to sex.

We do not have an explanation for the observation that dietary vitamin B_{12} intakes were lower and serum vitamin B_{12} levels were higher in blacks than in nonblacks. Among the 23 participants previously mentioned who had serum vitamin B_{12} levels above 900 pg/ml, 22 were black. It should be noted that while Caucasians were the predominant nonblack group, also included were Middle Easterners, Far Easterners, and Oriental Jamaicans.

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