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# BODY MEASUREMENTS AND CREATININE EXCRETION AMONG UPPER AND LOWER SOCIO-ECONOMIC GROUPS OF GIRLS IN GUATEMALA[1]

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ANTHROPOMETRY is one practical approach to the assessment of the nutritional status in man. In Guatemala, anthropometric studies include those on Mayan Indians by Byers and La Farge (1931), Crile and Quiring (1939) and Goff (1948). In 1951, Mejicano Paiz (1951) measured children from the public schools of Guatemala City. More recently Méndez and Behrhorst (1963) conducted an anthropometric comparison of Indian and urban Guatemalan children. Only the study of Mejicano Paiz included girls. It was limited to measurements of height and weight in lower socio-economic group children 3 to 14 years old.

Creatinine coefficient (mg. excreted in 24 hrs/kg. body weight) has long been used as an index of the relative amount of muscle in an individual, because in the normal person the amount of creatinine excreted in 24 hours is a good measure of the quantity of skeletal musculature (Stearns *et al.*, 1958). Considerable skeletal musculature can be sacrificed during periods of protein deprivation to provide amino acids for gluconeogenesis and protein synthesis in the liver (Arroyave and Castellanos, 1961). It can be assumed, therefore, that protein requirements of other body tissues have been met, if the skeletal musculature is well maintained. Thus the skeletal musculature as measured through creatinine excretion can be a good indicator of the protein nutritional status of adults and children. Stearns *et al.* (1958) have summarized the results of a twenty five years work in a creatinine coefficient curve for well nourished Iowa children, 1 to 10 years of age. Talbot also

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used creatinine coefficient as an index of nutritional status in children (1938). Creatinine excretion per cm of height, however, gives a more accurate measure of a child's physical development than either his creatinine weight coefficient, or his weight-height relationship because it is not affected by the amount of adipose tissue (Daniels and Hejinian, 1929). In 1961 Arroyave and Wilson (1961) measured urinary creatinine excretion of children per cm of height under different nutritional conditions. The anthropometrical measurements and creatinine studies in Guatemala have been confined to either very small children or to adults. No data on girls have been reported.

The present study was designed to obtain information on body measurements and creatinine excretion of girls from representative samples of higher and lower socio-economic groups. It is hoped the data will add basic information needed towards determining reference values for the evaluation of nutritional status of girls in this region.

## MATERIALS AND METHODS

During June-August 1965, 448 girls representative of both upper and lower socio-economic groups in Guatemala were studied. For the upper socio-economic group, 230 girls in the age range of 7-17 years were examined in a private school (Monte María) in Guatemala City. They had Guatemalan parents, but none were identified as Indians. For the lower socio-economic group, 218 Mayan Indian girls of the same age range were selected from schools of Chimaltenango and its surrounding villages of Parramos, Zaragoza, San Andrés Itzapa, and Comalapa.

Measurements included weight, height, sitting height, biacromial and bicristal diameters, chest circumference, arm circumference and arm skinfold thickness as per the "Recommendations concerning body measurements for the characterization of nutritional status" (1956). The first group were measured in swim suits and the second in thin gowns. The reported values are the averages of two measurements. Weight was recorded to the nearest quarter pound and converted into kilograms. Height was recorded to the nearest mm. Sitting height was taken with the subject seated on a firm stool with horizontal surface, with her knees flexed and trunk in contact with the anthropometer at both scapular and sacral regions. Sternal height was taken with the subject standing, from the upper border of the sternum at the suprasternal notch to the ground.

Chest circumference at the xyphoid level was measured at maximum

inspiration and expiration and then mid-inspiration chest circumference was calculated. A pelvimeter was used for measuring the biacromial and bicristal diameters. The Lange skinfold caliper was used for measuring the skinfold thickness of the arm. The posterior aspect of the upper arm, midway between the acromion and the olecranon was the site of measurement. Arm circumference was measured at the same level.

For creatinine determination, 2-3 hour timed urine specimens were collected in the morning (8-11 a. m.), 61 from the upper socio-economic group and 76 from the lower and 24 hour creatinine excretion was calculated.

Although creatinine determinations were done the day of collection, as a further precaution hydrochloric acid was used as preservative. A mirco-method based on that of Clark and Thompson (1949) was used. Creatinine per cm height was calculated. Statistical significance between groups was determined by the "t" test.

## RESULTS AND DISCUSSION

### *Anthropometric Measurements*

Table 1 gives the total height and three linear segments calculated from sitting and sternum heights. Height, head and neck, trunk, and leg lengths are significantly greater in the urban groups. As shown in Fig. 1, the urban group falls within normal range when height is compared with INCAP standards (1952), but the rural group comes far below these values. Although the three segments of height are significantly greater in the case of the urban group, their ratios in relation to the height, not given in the table, are the same in both groups. In comparable boys, by contrast, Méndez and Behrhorst (1963) found head and neck, as well as trunk lengths to height ratios significantly greater, and leg length to height ratio significantly lower in the rural group.

The lateral measurements, biacromial and bicristal diameters, shown in Table 2, are significantly greater in the urban group; chest circumference, however, is not. Although bicristal diameters are greater in the urban group, the bicristal diameter to height ratios, not shown in the table, are consistently and significantly greater in the rural group.

The weight, arm skinfold thickness and circumference are given in Table 3, the urban group showing significantly higher values than the rural.

TABLE 1

*Body measurements of upper and lower socio-economic groups in Guatemala*

| GROUP | | YEARS OF AGE 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upper | Number | 20 | 16 | 20 | 22 | 19 | 26 | 22 | 23 | 18 | 21 | 23 |
| Lower | | 19 | 21 | 23 | 19 | 18 | 21 | 19 | 20 | 20 | 19 | 20 |
| | | | | | | Total height, cm | | | | | | |
| Upper | Mean | 121.0 | 124.1 | 131.2 | 135.6 | 140.8 | 147.8 | 152.4 | 157.4 | 156.5 | 156.8 | 159.1 |
| | S. D. | 6.4 | 7.0 | 5.9 | 6.3 | 7.9 | 4.8 | 8.4 | 5.6 | 6.5 | 5.4 | 4.6 |
| Lower | Mean | 106.6 | 113.4 | 116.7 | 121.0 | 129.6 | 135.0 | 134.3 | 139.3 | 143.3 | 142.8 | 143.5 |
| | S. D. | 5.0 | 3.5 | 3.6 | 4.5 | 8.0 | 4.0 | 6.0 | 5.3 | 6.3 | 3.4 | 4.5 |
| | | | | | | Head and neck length, cm | | | | | | |
| Upper | Mean | 25.0 | 25.1 | 25.9 | 26.2 | 26.8 | 28.0 | 27.6 | 28.0 | 28.2 | 29.4 | 29.8 |
| | S. D. | 1.3 | 1.3 | 1.2 | 1.8 | 1.3 | 1.4 | 2.6 | 2.5 | 2.5 | 1.4 | 1.4 |
| Lower | Mean | 22.5 | 23.0 | 23.2 | 24.1 | 25.0 | 25.9 | 26.2 | 27.4 | 27.1 | 27.3 | 27.5 |
| | S. D. | 1.5 | 1.2 | 1.1 | 1.1 | 1.5 | 1.4 | 1.6 | 2.6 | 1.5 | 1.1 | 1.4 |
| | | | | | | Trunk length, cm | | | | | | |
| Upper | Mean | 40.6 | 42.1 | 44.2 | 45.8 | 48.6 | 50.7 | 53.0 | 55.3 | 56.1 | 54.1 | 54.5 |
| | S. D. | 2.7 | 2.9 | 2.5 | 3.3 | 3.2 | 3.2 | 4.0 | 3.8 | 4.4 | 2.9 | 2.6 |
| Lower | Mean | 36.2 | 39.1 | 40.1 | 41.6 | 44.2 | 46.1 | 46.2 | 48.3 | 50.1 | 50.1 | 50.9 |
| | S. D. | 3.0 | 1.5 | 2.7 | 2.4 | 2.7 | 1.9 | 3.2 | 3.5 | 2.6 | 2.3 | 2.5 |
| | | | | | | Leg length, cm | | | | | | |
| Upper | Mean | 55.4 | 56.9 | 61.2 | 63.6 | 65.4 | 69.1 | 71.8 | 74.2 | 72.2 | 73.3 | 74.8 |
| | S. D. | 3.8 | 3.9 | 3.5 | 3.5 | 4.2 | 2.7 | 4.6 | 3.7 | 4.4 | 3.5 | 3.7 |
| Lower | Mean | 47.9 | 51.3 | 53.2 | 55.3 | 60.4 | 63.0 | 61.8 | 63.6 | 66.3 | 65.4 | 65.4 |
| | S. D. | 2.7 | 2.2 | 2.3 | 1.9 | 4.5 | 2.1 | 3.3 | 3.6 | 4.1 | 3.2 | 4.0 |

Also in Fig. 1 the weights of the two groups are compared to the INCAP standards (1952). As in the case of heights, weights of the urban upper socio-economic group fell within the normal range, while those of the rural lower economic group were below. When the data are plotted on the Wetzel Grid, both groups showed adequate rate of growth and weight for height. The physical status of both groups on this basis, therefore, appeared good. When chronological age is taken into consideration, however, the development curves of the Indian group are about 1½ years retarded, as compared to 2 years found by Méndéz

TABLE 2

*Body measurements of upper and lower socio-economic groups in Guatemala*

| GROUP | | YEARS OF AGE 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Biacromial diameter, cm | | | | | | |
| Upper | Mean | 26.6 | 27.3 | 28.2 | 29.0 | 30.9 | 32.1 | 33.6 | 34.2 | 34.4 | 33.7 | 33.9 |
| | S. D. | 1.6 | 1.7 | 2.2 | 2.2 | 2.1 | 1.5 | 1.7 | 1.7 | 1.5 | 2.0 | 3.9 |
| Lower | Mean | 24.5 | 25.6 | 26.2 | 27.3 | 28.8 | 29.7 | 29.9 | 31.0 | 32.7 | 32.9 | 33.2 |
| | S. D. | 1.0 | 0.9 | 0.9 | 1.2 | 1.6 | 2.0 | 2.6 | 1.5 | 1.3 | 0.9 | 1.2 |
| | | | | | | Bicristal diameter, cm | | | | | | |
| Upper | Mean | 19.7 | 20.2 | 21.4 | 22.1 | 22.7 | 23.8 | 25.9 | 26.2 | 27.4 | 26.8 | 27.8 |
| | S. D. | 1.3 | 1.1 | 1.1 | 1.0 | 1.9 | 1.6 | 2.3 | 1.8 | 2.8 | 1.3 | 2.8 |
| Lower | Mean | 18.1 | 19.3 | 19.6 | 20.4 | 21.6 | 23.4 | 23.9 | 25.3 | 25.4 | 26.5 | 26.8 |
| | S. D. | 1.1 | 0.8 | 0.7 | 0.8 | 1.3 | 2.0 | 2.2 | 1.6 | 1.4 | 1.8 | 1.1 |
| | | | | | | Chest circumference, cm | | | | | | |
| Upper | Mean | 60.0 | 60.6 | 63.0 | 64.6 | 66.5 | 67.7 | 70.7 | 71.6 | 73.5 | 70.1 | 70.6 |
| | S. D. | 4.7 | 3.7 | 4.7 | 4.3 | 5.0 | 4.6 | 5.0 | 6.1 | 3.9 | 4.2 | 5.8 |
| Lower | Mean | 58.2 | 59.7 | 61.6 | 63.2 | 65.7 | 67.7 | 68.9 | 70.8 | 74.9 | 76.3 | 77.7 |
| | S. D. | 2.2 | 1.8 | 2.4 | 3.1 | 3.2 | 3.2 | 3.9 | 3.6 | 3.8 | 3.1 | 3.1 |

TABLE 3

*Body measurements of upper and lower socio-economic groups in Guatemala*

| GROUP | | YEARS OF AGE 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Weight, Kg | | | | | | |
| Upper | Mean | 24.0 | 26.0 | 28.9 | 32.7 | 35.7 | 40.6 | 46.8 | 50.3 | 52.0 | 50.0 | 52.1 |
| | S. D. | 4.2 | 5.5 | 5.0 | 5.1 | 7.3 | 7.0 | 8.2 | 9.8 | 8.2 | 5.3 | 7.2 |
| Lower | Mean | 17.9 | 20.1 | 21.8 | 23.7 | 27.3 | 30.7 | 32.7 | 36.0 | 41.6 | 43.2 | 45.7 |
| | S. D. | 2.1 | 1.6 | 2.9 | 3.0 | 4.4 | 3.2 | 6.0 | 5.0 | 5.2 | 3.4 | 3.8 |
| | | | | | | Arm skinfold thickness, mm | | | | | | |
| Upper | Mean | 11.5 | 11.3 | 11.2 | 13.8 | 13.1 | 15.8 | 16.2 | 16.3 | 17.6 | 18.1 | 18.6 |
| | S. D. | 3.2 | 2.9 | 3.0 | 5.1 | 3.6 | 5.6 | 4.5 | 4.8 | 5.0 | 4.1 | 5.6 |
| Lower | Mean | 7.5 | 7.6 | 8.1 | 8.3 | 7.4 | 9.6 | 9.6 | 10.2 | 11.3 | 12.3 | 11.9 |
| | S. D. | 1.6 | 1.3 | 2.0 | 2.2 | 1.2 | 2.1 | 2.6 | 2.5 | 3.0 | 2.3 | 2.6 |
| | | | | | | Arm circumference, cm | | | | | | |
| Upper | Mean | 19.3 | 19.4 | 20.2 | 21.4 | 22.0 | 23.0 | 24.3 | 24.6 | 25.9 | 25.5 | 25.7 |
| | S. D. | 1.8 | 1.7 | 2.0 | 2.4 | 2.0 | 2.3 | 2.5 | 2.9 | 2.5 | 1.8 | 2.3 |
| Lower | Mean | 16.7 | 16.9 | 17.4 | 18.2 | 18.6 | 20.1 | 20.5 | 21.0 | 22.7 | 23.6 | 24.7 |
| | S. D. | 0.9 | 0.7 | 1.3 | 1.4 | 1.2 | 1.0 | 2.1 | 2.0 | 1.5 | 1.4 | 1.3 |

and Behrhorst (1963) for boys. This retardation is also reflected in the age of onset of menarche as discussed later.

It is difficult to say how far the differing anthropometric measurements in the two groups were due to racial differences. Although the

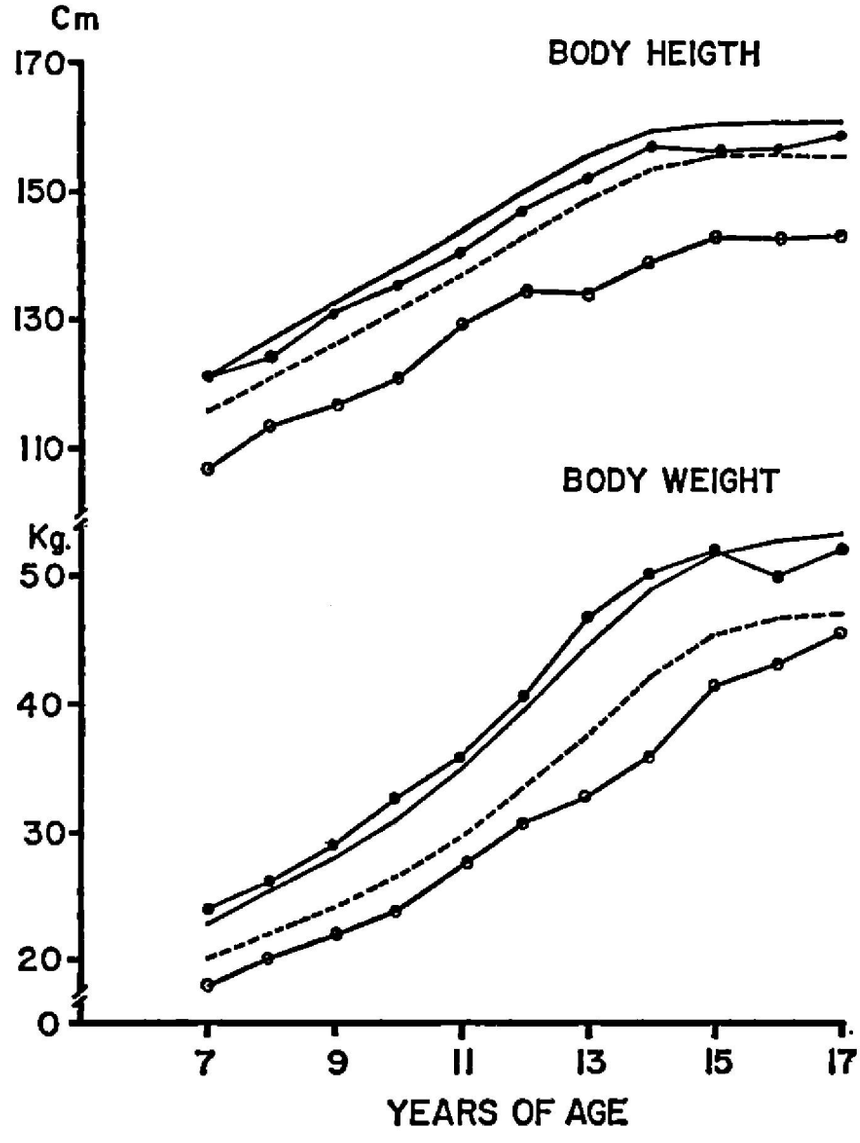


FIG. 1. HEIGHTS AND WEIGHTS OF THE TWO GROUPS AS COMPARED TO INCAP STANDARDS.

——— Reference mean; ----- One standard deviation below reference mean.

●——● Guatemalan urbans; o——o Guatemalan Indians.

potential stature of any individual is governed by heredity, environmental factors play an important role in determining actual stature. It is likely that for the most part the differences in anthropometric measurements were due to a synergism of poor nutrition and frequent infection. The diet of a rural Indian in Guatemala mainly consists

of corn and beans with the addition of some vegetables but very little meat or any other animal protein. The daily intake of rural Indians of the region is roughly as follows: calories, 2200; protein, 70 g (animal protein, 7 g); fat, 19 g; carbohydrates, 450 g (Flores, 1961). On the other hand, the diet consumed by the upper socio-economic group has adequate amounts of all nutrients required for good growth.

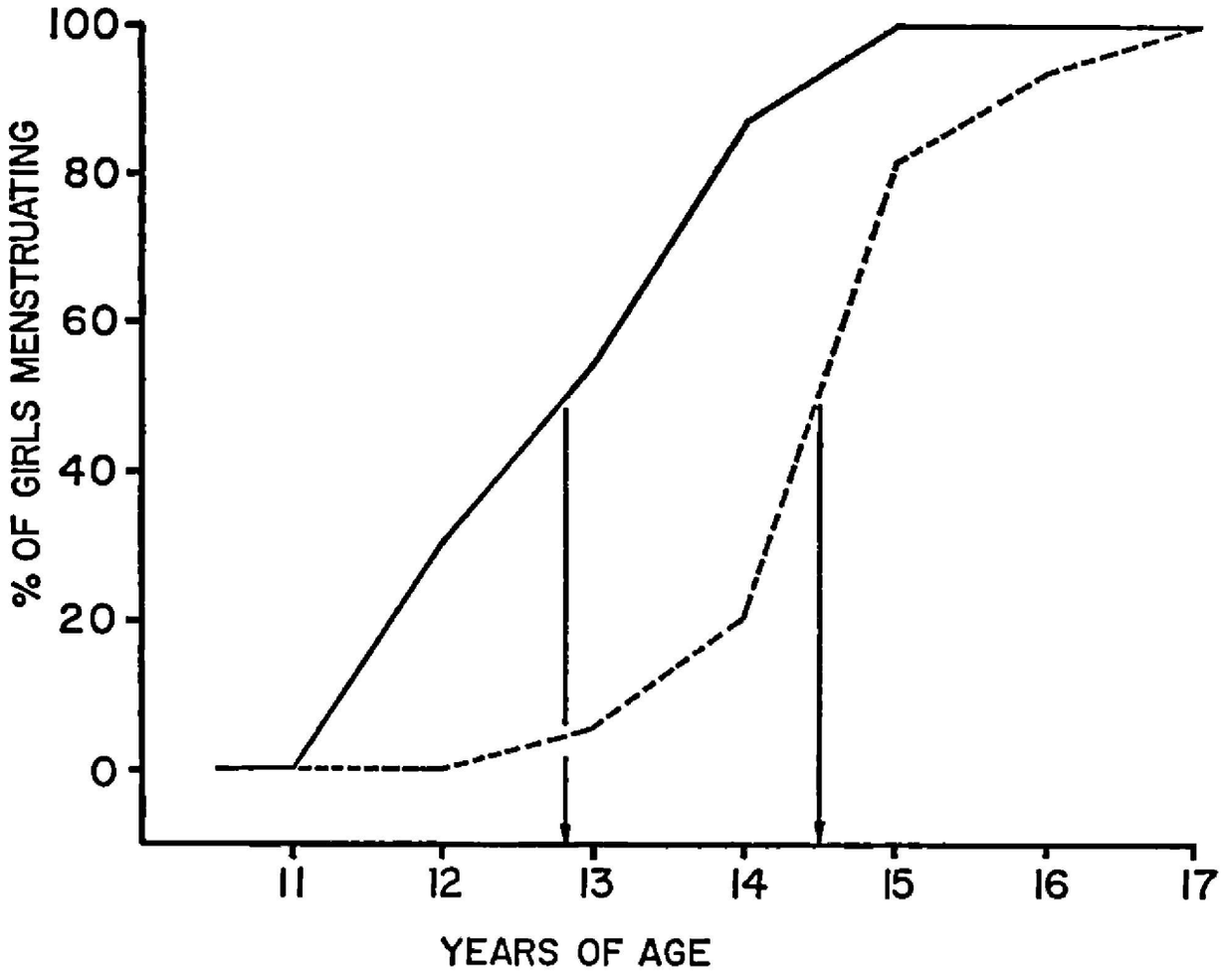


FIG. 2. PERCENTAGE OF GIRLS MENSTRUATING AT DIFFERENT AGE LEVELS IN THE TWO GROUPS. ——— Urban group; ----- Rural group.

*Menarche*

Subjects between 11 and 17 years of age were asked whether they were menstruating. Fig. 2 gives the percentage of girls menstruating at different age levels in the two groups. As it has been pointed out that the age at which 50% of the girls in a single year group had attained menarche fits well with the mean age calculated by probit analysis if the population is normally distributed by age, and sampling is random (Oettlé and Higginson, 1961), this point was selected for comparison.

The mean age for the upper urban socio-economic group was 12.8 years while that for the rural Mayan Indian group was found to be 14.5 years. Many views have been put forward to explain the menarchial variations in different groups like the effect of race, climate, geography, etc. Genetic factors affect individual cases, but nutrition is an important factor. Keys *et al.* (1950) have summarized many reports indicating that the onset of menstruation is delayed by periods of severe food shortage. Other observations like those on Bantu girls in Africa also show that groups with poorer nutritional status show a later mean age at menarche (Burrell *et al.*, 1961). The findings of this study are also consistent with the retardation of growth discussed before.

*Creatinine*

Table 4 summarizes data on urinary creatinine per centimeter of

TABLE 4

*Urinary creatinine excretion of upper and lower socio-economic groups in Guatemala*

| AGE GROUPS YEARS | URINARY CREATININE, MG/CM HT | | | | | | UPPER/LOWER RATIO |
|---|---|---|---|---|---|---|---|
| | UPPER | | | LOWER | | | |
| | N | Mean | S. D. | N | Mean | S. D. | |
| 7–8 | 14 | 4.2 | 1.2 | 15 | 3.7 | 1.2 | 1.13 |
| 9–10 | 8 | 4.5 | 0.8 | 16 | 3.2 | 0.6 | 1.41 |
| 11–12 | 13 | 4.8 | 1.0 | 21 | 4.6 | 1.2 | 1.06 |
| 13–14 | 9 | 6.2 | 1.1 | 12 | 4.5 | 1.0 | 1.37 |
| 15–16 | 11 | 6.0 | 0.8 | 9 | 5.1 | 0.9 | 1.18 |
| 17 | 6 | 6.2 | 1.6 | 3 | 5.6 | 0.2 | 1.09 |

height for the two groups. Although too much reliance cannot be put on the data due to limited numbers, values for the upper economic group were about 20% greater at all ages than those of the lower economic group. By this criterion, the upper socio-economic group had greater lean body mass and better nutrition.

## SUMMARY AND ABSTRACT

A comparison of anthropometric measurements and urinary creatinine per centimeter of height was done on representative samples of 230 upper and 218 lower socio-economic group girls 7 to 17 years of age in Guatemala. The former were of mixed, predominantly European,

origin and the latter principally Mayan Indian. Total height and its linear segments (head and neck, trunk and leg lengths), the lateral dimensions (biacromial and bicristal diameters), weight, arm circumference and skinfold thickness were significantly higher in the urban upper socio-economic groups. There were no significant differences in chest circumference and in head and neck, trunk, and leg lengths to height ratios. The bicristal diameter to height ratios were greater in the rural lower socio-economic group. Creatinine excretion per centimeter of height was higher in the urban group. The mean age of the onset of menarche was found to be 1½ years later in the rural lower socio-economic group, a difference which agrees well with the retardation in physical growth and development.

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