Growth and Development of Adolescent Girls From the Segou Region of Mali (West Africa)

Lisa R. Pawloski*

College of Nursing and Health Science, George Mason University, Fairfax, Virginia 22030

KEY WORDS adolescent girls; growth; development; puberty; menarche; height; weight; West Africa

ABSTRACT In Mali, adolescent girls face many physical stresses which, with a history of poor nutrition, can result in delayed growth and development. Despite the fact that adolescent girls encounter nutritional demands, most research in Mali has focused only on young children. This study examines anthropometric and reproductive data on 1,056 adolescent girls (aged 10–17 years) from the Segou Region of Mali. When compared to the reference population, the Malian girls exhibited poorer indicators of growth and development. Z-scores for height-for-age and weight-for-age were below 0 at all ages. Urban girls had better indicators of growth than rural girls. The body composition data show that the Malian girls have lower body fat than reference girls. Menarche was delayed by about 1.5 years compared to girls from the United States and Europe. Delayed growth and development may be due to many factors, including a history of undernutrition, poor socioeconomic status, and increased energy demands. Am J Phys Anthropol 117:364–372, 2002. © 2002 Wiley-Liss, Inc.

The nutritional status of a community is an important indicator of its quality of life. Examining growth and development using anthropometric analyses is a commonly used tool to assess nutritional status in developing countries. In such countries, growth and development can be affected because the body places higher priority on channeling energy and nutrient resources to fighting disease, maintaining basal metabolism, and providing energy for physical activity than on growth (Tanner, 1990). In an undernourished child, the tempo of growth is usually first affected, and “the undernourished child will slow down and wait for better times” (Tanner, 1990). Delayed growth is also associated with reduced cognitive development, and stunted women are at greater risk of delivering growth-retarded infants, which increases the infants’ risk of mortality (Martorell and Gonzalez-Cossio, 1987). Poor growth and development not only indicate poor nutritional status, but also increased susceptibility to disease, decreased energy expenditure, and reduced fertility. Thus, poor growth and development among populations may have many health implications.

Studies conducted by Dettwyler (1986, 1991) in Mali reveal poor growth and development among children under age 5 years. Dettwyler (1991) suggests these results may be due not only to poor socioeconomic conditions but also to traditional eating patterns, disease, consumption of bulky foods that are high in carbohydrates and low in other nutrients, and mothers’ feeding habits. Many other studies conducted by international development organizations and Malian government organizations also show poor growth and development among children less than five years (Coulibaly et al., 1996; Academy for Educational Development, 1991). However, little information is provided by these organizations to explain these poor indicators. Most studies attribute poor nutritional status to poor socioeconomic status, yet little ethnographic information is provided.

In Mali, while children under age 5 years have been shown to exhibit indicators of poor nutrition, few studies other than the current and that of Prazuck et al. (1989) have examined the nutritional status of adolescent girls. Other research in West Africa has reported poor nutritional status among adolescent girls (Simondon et al., 1998; Bénéfice and Cames, 1999; Bénéfice, 1992), but this work focused on anthropometric indicators and provided little ethnographic data to help explain the causes.

In Mali, adolescent girls are at risk for poor nutritional status because they encounter many physical stresses during adolescence and puberty. The

*Correspondence to: Lisa Pawloski, College of Nursing and Health Science, George Mason University, 4400 University Drive, Fairfax, VA 22030. E-mail: pawlosk@gmu.edu

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terms “adolescence” and “puberty” in this study both refer to physical growth and development as opposed to the term “adolescence,” which outside of the literature of human growth and development refers to certain behavioral and psychological changes.

While Malian adolescent girls are still growing, they must often assume essentially adult responsibilities in their daily lives, including marriage and childbirth. Adolescent girls also spend much of their day preparing meals, pounding millet, gathering firewood, hauling water, washing clothes, and taking care of children. The combined stresses of an adult workload, puberty, marriage, and pregnancy place great nutritional demands on the adolescent girl. These stresses can negatively affect her health and that of her children (Martorell and Gonzalez-Cossio, 1987; Frisancho et al., 1984).

The health of adolescent girls is a major concern in Mali because many of these girls are already having children. The 1996 Demographic Health Surveys (DHS) reported that close to 30% of girls ages 15–19 years have already had one child, and 50% of adolescents between ages 15–19 in rural regions are already pregnant (Coulibaly et al., 1996). The requirements for growth during adolescence are an important constraint on fetal development (Frisancho et al., 1980, 1984; Scholl et al., 1994), and infants born to very young mothers have a higher risk of being premature and of low birth weight, especially if the mothers are malnourished (Cameron, 1991; Martorell and Gonzalez-Cossio, 1987). Low birth weight is a major health concern because it is strongly associated with neonatal and infant mortality. Therefore, healthier adolescents become healthier mothers, and healthier mothers may in turn have healthier babies. Healthy mothers and babies are also culturally important in Mali because children play such an important role in society, and a woman’s worth is often based on whether or not she has surviving children.

This paper examines growth and development data on adolescent girls from both rural and urban areas in the Segou Region in Mali. It compares these data with well-nourished girls in the United States, and with data collected elsewhere in Mali and West Africa. The primary hypothesis to be tested is that when compared to healthy US girls, Malian adolescent girls will show indicators of poorer nutritional status. It is also hypothesized that the rural Segou girls will show indicators of poorer nutritional status when compared with the urban Segou girls.

**METHODS**

*Communities and participants*  

Anthropometric data and age of menarche were collected from adolescent girls in the town of Segou (population 326,000) and from five surrounding villages (Soke, population 1,751; Koila, population 2201; Dioro, population 8,068; Yollo, population 4,020; and Nonongo, population 1,462; Fig. 1) (Ministère du Plan, 1987). All of the research sites are located within the Segou administrative region. The Segou Region is located approximately 200 km north of the capital, Bamako, and is situated primarily along the Niger River.

The Segou Region was chosen because it is fairly homogenous in geography and environment, and the population is relatively homogenous in terms of ethnic composition, language, and religious affiliation. The town of Segou is the largest and wealthiest town in the region and serves as a major trading center between the northern towns and Bamako. The main industry in Segou is a textile factory. The town is equipped with electricity and running water, but most people cannot afford these services, and use community pumps. The town includes a hospital, a maternity clinic, several pharmacies, and a military base.

The five villages were selected after determining which were the most similar in size, ethnicity, distance from Segou, and receptiveness to outsiders conducting research in their communities. All of the villages were poorer than Segou and had little industry or business, few had schools or health centers, and none had electricity or running water. Most villagers were subsistence farmers.

The villages selected are primarily ethnically Bambara, and are relatively close in proximity to Segou. The closest village, Soke, is 10 km from Segou and the furthest village, Nonongo, 45 km. All of
the villages lie within 1 km of the Niger River except Nonongo and Yollo, which are about 35 km away from the river.

Mali is considered the third poorest country in the world by some standards, with an average per capita income of $280 per year (World Bank, 1993). Because there are few resources, a great deal of physical labor is required for people to survive. For example, Malians must grow and process their own food. Girls who do not attend school spend much of their day helping their mothers prepare meals, clean, take care of their siblings, and conduct many other physical tasks. In Nonongo, parents did not send their girls to school because they were needed at home. Many parents were even reluctant to have their daughters participate in the study for fear of not finishing the day’s work.

Concerning dietary practices, most girls reported eating three meals a day. Breakfast usually consisted of a piece of bread, or a millet porridge mixed with sour milk or pancakes made of millet, and coffee. A typical lunch or dinner meal included one small piece of meat, fish, or chicken that was combined in a sauce of leaves or a few boiled vegetables with a large serving of thick millet porridge or rice. In the villages, dinners and breakfast were often leftovers from the previous day’s lunch. Rice, which is more expensive than millet, was more commonly consumed in wealthier families.

Data collection methods and analysis

Anthropometric data. Anthropometric and reproductive data were collected during the hot season (February–May) of 1997. The anthropometric measurements were taken following the guidelines of Lohman et al. (1988). All measurements were done by the author and a trained research assistant. Measurements were taken inside an office or a classroom, where schools were available, or in a maternity clinic, health dispensary, meeting hall, or outside when necessary.

Weights were measured with girls wearing light clothing (wrap skirt and t-shirt) in pounds (and later converted to kilograms), using a standard bathroom scale placed on level ground. Heights were measured in centimeters using a movable field anthropometer (GPM, Seritex, Inc.) with the subject standing on level ground. Subjects did not wear shoes for the height and weight measurements. Body mass index (BMI) was calculated as weight (kg)/height (m)^2.

Subscapular and triceps skinfold measurements were measured in millimeters using a Lange skinfold caliper, and arm circumference measurements were taken in centimeters with a nonstretchable plastic-coated measuring tape. Arm circumference and skinfold measurements were taken on the left side of the body.

Upper arm muscle area (UMA) and upper arm fat area (UFA) were determined using the following equations (Frisancho, 1990): UMA = [(AC − π × Ts)^2]/(4π), where AC is arm circumference and Ts is triceps skinfold in centimeters, and UFA = UMA − UMA, where UAA = AC^2/4π.

Age at menarche. Age at menarche was determined using the status quo method. For this method, girls are asked for their date of birth and if they have begun to menstruate. The results allow for the construction of a frequency distribution which may be analyzed by probit techniques to estimate the median age of menarche (Cameron et al., 1994). The status quo method actually gives the age at which 50% of the girls have reached menarche.

Age. Previous nutritional research in Mali demonstrated difficulties in assessing the ages of children (Oshaug et al., 1994; Cashion, 1988; Dettwyler, 1986). Age is critical in growth and development studies in order to make comparisons with same-age individuals from reference populations. In Mali, most children do not know their age, and birthdays are not celebrated. In order to obtain the most accurate age information, birth records and family cards (or cartes de familie) were requested. Birth records were available for about 80% of participants. A calendar of local events was then used to double-check the age listed on the family card or the birth records.

Participants/clearance. In Segou, data were collected at schools in the Segou Coura district. In the villages, schools were only present in Dioro and Nonongo, and thus girls were recruited via the village chiefs and elders. Girls between ages 10–17 years were asked to participate. Permission and proper research clearances were obtained prior to visits in Mali from the Ministère des Enseignements Secondaire Supérieur et de la Recherche Scientifique and the Centre National de la Recherche Scientifique et Technologique; a Human Subjects Clearance was obtained from the Indiana University Human Subjects Committee.

Statistical analyses. Height-for-age and weight-for-age were calculated using Epi Info (Dean et al., 1995). The rest of the quantitative data were entered in SPSS for Windows (SPSS, Inc., 1997) so that statistical analyses could be conducted. Univariate analyses were used to examine the means and standard deviations and make comparisons with reference data. Bivariate analyses (one-way ANOVA) were used to assess the statistical relationships between two variables. Finally, probit analysis techniques were used to determine median age at menarche. All statistical analyses were done using SPSS (SPSS Inc., 1997), and graphics were developed using Microsoft Excel 97 (Microsoft Corp., 1996).

Reliability. A measurement reliability study was performed to determine intraobserver error. It was conducted by measuring and remeasuring a small sample of girls and then remeasuring about every thirtieth girl (n = 38). Technical error of measurement (Mueller and Martorell, 1988), coefficient of
relative variation (Jamison and Ward, 1993), and reliability (Fleiss, 1986) were determined and fell within acceptable ranges when compared with other research (Johnston, 1974). See Table 1.

Reference population. For this study, as with many studies in developing countries, there is no large local reference population available. Therefore, the best anthropometric reference data can be taken from populations of well-nourished individuals from the United States. For this study, heights and weights were compared with data utilized in the Epi-Info program created by the Centers for Disease Control (CDC). This program uses growth curves developed from the National Center for Health Statistics (NCHS) and the CDC, using data from the Fels Research Institute and US Health Examination Surveys (Dean et al., 1995). These growth curves are recommended by the World Health Organization (WHO) for international use. For the other anthropometric data (BMI, skinfolds, and circumferences), Frisancho (1990) was used.

RESULTS

Anthropometric data

Tables 2 and 3 show the mean anthropometric values by age for height, weight, height-for-age z-scores (HAZ), and weight-for-age z-scores (WAZ). Distance curves for HAZ and WAZ are shown in Figures 2 and 3. Age categories are calculated at the mid-year, so that the 11-year-olds included girls who were between ages 10.5–11.49 years. For the total sample of girls, HAZ and WAZ revealed poor growth compared to the reference population. Further, rural girls exhibit delayed growth when compared to urban girls in both HAZ (ANOVA, \( P < 0.03 \)) and WAZ (ANOVA, \( P < 0.01 \)). The HAZ values for all of the

<table>
<thead>
<tr>
<th>Measurement</th>
<th>TEM</th>
<th>CRV</th>
<th>R</th>
<th>Reference TEM</th>
<th>Reference CRV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>0.359</td>
<td>0.20</td>
<td>1.0</td>
<td>0.494</td>
<td>0.302</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>0.941</td>
<td>2.5</td>
<td>1.0</td>
<td>1.17</td>
<td>2.11</td>
</tr>
<tr>
<td>Subscapular skinfold (mm)</td>
<td>0.613</td>
<td>7.3</td>
<td>0.99</td>
<td>1.53</td>
<td>18.3</td>
</tr>
<tr>
<td>Triceps skinfold (mm)</td>
<td>0.90</td>
<td>9.6</td>
<td>0.89</td>
<td>0.80</td>
<td>6.75</td>
</tr>
<tr>
<td>Arm circumference (cm)</td>
<td>0.217</td>
<td>1.0</td>
<td>1.0</td>
<td>0.10–0.40</td>
<td>4</td>
</tr>
</tbody>
</table>

1 TEM refers to technical error of measurement and is determined by taking the square root of reliability (Mueller and Martorell, 1988).
2 CRV refers to coefficient of relative variation. CRV provides the magnitude of error relative to the size of the measurement, and is reported as a percentage (Jamison and Ward, 1993).
3 R refers to reliability. Reliability can be defined as the proportion of the variance of an observation due to between-subject variance in error free scores (Fleiss, 1986).
4 Lohman et al. (1988). Note that "R" values are not available.
5 Johnston FE (1974). Note that "R" values and reference CRV for the arm circumference data are not available.
Malian girls are below zero (Fig. 2). From ages 10–13 the curve declines, indicating that these girls are growing at a slower rate than the reference population. After age 13 the curve climbs, indicating that these girls are growing at a faster rate than the reference population. As with HAZ, the WAZ fall below the mean for the reference population. However, there is not as sharp an increase in WAZ after age 12 as there is in HAZ; the curve remains relatively flat between −0.8 and −1.4 z-scores for most ages.

BMI values can be used to identify the presence of protein energy malnutrition in adolescents, with a BMI of less than 15 in girls ages 11–13 years, and a BMI less than 16.5 in girls ages 14–17 years indicating the presence of protein energy malnutrition (Chew, 1994). The BMI values for the Segou girls do not reveal presence of protein energy malnutrition. BMI values are listed for the entire Segou sample as well as for both urban and rural samples in Table 4. BMI values for the entire Segou sample, the rural Segou sample, and the urban Segou sample, are significantly (P < 0.001) lower than the reference data. Further, rural Segou girls have lower BMI values than the urban Segou girls, and this difference is statistically significant (P < 0.01). However, when broken down by age, statistically significant differences were only seen at ages 12 (one-way ANOVA, P = 0.03) and 17 (one-way ANOVA P = 0.04).

Tables 2 and 3 list the mean anthropometric values for upper arm muscle area (UMA), upper arm fat area (UFA), upper arm muscle area z-scores (UMA), and upper arm fat area z-scores (UFAZ).
Z-scores for UMA and UFA are plotted in Figures 4 and 5. UMAZ for the total Malian sample remain below /H11002/0.5 from ages 10–17 years, and then rise close to the reference mean at ages 16–17 years. Further, the rural UMAZ appear closer to the reference population at most ages, but there is no statistically significant difference between the rural and urban UMAZ (one-way ANOVA, /H11005/P /H11021/0.10). The UFAZ (Fig. 5) show a fairly linear trend around a z-score of /H11002/1 that increases slightly to a z-score of /H11002/0.75 at age 17 for the total sample of Malian girls. The UFAZ of rural girls appear further from the reference population at most ages than the UFAZ of urban girls, and the rural-urban difference is statistically significant (one-way ANOVA, /H11005/P < 0.01).

Menarche

Using the status quo method, median age at menarche for Malian girls was 14.4 ± 0.42 years, which is older than girls in the US. For the rural sample, age at menarche was 14.7 ± 0.59 years, and for the urban sample it was 14.1 ± 0.61 years. No statistically significantly differences were found between the rural and urban girls (/H11005/P > 0.05).

Comparisons with anthropometric data collected elsewhere in Mali

Tables 4 and 5 compare anthropometric data of girls from the Segou Region with those of girls from other regions in Mali. From these data, it appears that both the 10- and 11-year-old girls living in rural villages in the Segou Region are slightly taller and heavier than the 10- and 11-year-old girls living in rural villages in southwestern Mali measured by Dettwyler (1991). However, because no standard deviation data are given, tests of statistical significance cannot be performed.

Data collected by Prazuck et al. (1989) for girls ages 15–17 years were taken from randomly selected rural villages all over Mali. The height data of Prazuck et al. (1989) are below the rural Segou girls’ data for ages 15, 16, and 17; however, these differences are only statistically significant at ages 15 and 17 years (/H11005/t = 2.5, /H110021/P < 0.01 and /H11005/t = 2.66, /H110021/P < 0.01, respectively).

Rural Segou BMI values are compared with the data of Dettwyler (1991) and Prazuck et al. (1989) in Table 4. The rural Segou data are similar to the data of Dettwyler (1991) and Prazuck et al. (1989), but because no standard deviation data are given, tests of statistical significance cannot be performed.

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**TABLE 4. Body mass index of urban and rural Malian adolescent girls compared to reference values**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>All Segou Region</th>
<th>Rural Segou, Mali</th>
<th>Urban Segou, Mali</th>
<th>US data (Frisancho, 1990)</th>
<th>Rural SW Mali¹</th>
<th>Rural, all Mali²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>10</td>
<td>111</td>
<td>14.6</td>
<td>1.5</td>
<td>56</td>
<td>14.6</td>
<td>1.6</td>
</tr>
<tr>
<td>11</td>
<td>151</td>
<td>15.3</td>
<td>1.6</td>
<td>88</td>
<td>15.3</td>
<td>1.4</td>
</tr>
<tr>
<td>12</td>
<td>154</td>
<td>15.5</td>
<td>1.8</td>
<td>82</td>
<td>15.2</td>
<td>1.7</td>
</tr>
<tr>
<td>13</td>
<td>149</td>
<td>16.4</td>
<td>2.2</td>
<td>80</td>
<td>16.1</td>
<td>1.8</td>
</tr>
<tr>
<td>14</td>
<td>165</td>
<td>17.4</td>
<td>2.6</td>
<td>101</td>
<td>17.2</td>
<td>2.6</td>
</tr>
<tr>
<td>15</td>
<td>116</td>
<td>18.5</td>
<td>2.5</td>
<td>57</td>
<td>18.5</td>
<td>2.3</td>
</tr>
<tr>
<td>16</td>
<td>141</td>
<td>19.2</td>
<td>2.4</td>
<td>79</td>
<td>19.2</td>
<td>2.6</td>
</tr>
<tr>
<td>17</td>
<td>69</td>
<td>19.6</td>
<td>2.3</td>
<td>26</td>
<td>18.9</td>
<td>1.9</td>
</tr>
</tbody>
</table>

¹ Dettwyler (1991). Values are only given for 10 and 11 year olds. Standard deviation values were not available.
² Prazuck et al. (1989). Values are only given for 15, 16, and 17 year olds.
TABLE 5. Height and weight of rural adolescent girls from Segou Region compared to other rural girls in Mali

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Rural Segou Region</th>
<th>Rural SW Mali&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Rural, all Mali&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>56</td>
<td>135.0</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>88</td>
<td>139.1</td>
<td>21</td>
</tr>
<tr>
<td>15</td>
<td>57</td>
<td>158.0</td>
<td>180</td>
</tr>
<tr>
<td>16</td>
<td>79</td>
<td>158.5</td>
<td>132</td>
</tr>
<tr>
<td>17</td>
<td>26</td>
<td>160.4</td>
<td>133</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>26.8</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>86</td>
<td>29.8</td>
<td>21</td>
</tr>
<tr>
<td>15</td>
<td>57</td>
<td>46.3</td>
<td>180</td>
</tr>
<tr>
<td>16</td>
<td>79</td>
<td>48.3</td>
<td>132</td>
</tr>
<tr>
<td>17</td>
<td>26</td>
<td>48.2</td>
<td>133</td>
</tr>
</tbody>
</table>

<sup>1</sup> Dettwyler (1991). Values are only given for 10 and 11 year olds. Standard deviation values were not available.
<sup>2</sup> Prazuck et al. (1989). Values are only given for 15, 16, and 17 year olds.

TABLE 6. Prevalence (%) of stunting (HAZ < −2)<sup>1</sup> among adolescents<sup>2</sup>

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Malian girls</th>
<th>Malian urban girls</th>
<th>Malian rural girls</th>
<th>Malian children&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Senegalese girls&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9.9 (n = 111)</td>
<td>9.1 (n = 55)</td>
<td>10.7 (n = 56)</td>
<td>19.0 (n = 40)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>11.9 (n = 151)</td>
<td>7.9 (n = 63)</td>
<td>14.8 (n = 88)</td>
<td>25.0 (n = 33)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>26.6 (n = 154)</td>
<td>25.0 (n = 72)</td>
<td>28.0 (n = 82)</td>
<td>46.6 (n = 88)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>25.8 (n = 149)</td>
<td>21.7 (n = 69)</td>
<td>28.8 (n = 80)</td>
<td>31.4 (n = 137)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>20.8 (n = 165)</td>
<td>18.8 (n = 64)</td>
<td>21.8 (n = 101)</td>
<td>21.5 (n = 121)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>10.3 (n = 116)</td>
<td>16.9 (n = 57)</td>
<td>3.5 (n = 57)</td>
<td>11.7 (n = 145)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>5.0 (n = 141)</td>
<td>4.8 (n = 62)</td>
<td>5.1 (n = 79)</td>
<td>15.4 (n = 91)</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>8.7 (n = 69)</td>
<td>9.3 (n = 43)</td>
<td>7.7 (n = 26)</td>
<td>0.00 (n = 26)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14.7 (n = 1,157)</td>
<td>13.5 (n = 540)</td>
<td>15.7 (n = 617)</td>
<td>23.2 (n = 698)</td>
<td></td>
</tr>
</tbody>
</table>

HAZ, height-for-age z-scores. n, sample size.
<sup>1</sup> Dettwyler (1991). Values are only given for 10 and 11 year olds.
<sup>2</sup> Simondon et al. (1998). Values are only given for 12–17 year olds.

DISCUSSION

Adolescent girls from both urban and rural areas in the Segou Region in Mali show delayed growth in weight and height when compared with reference girls; however, BMI values reveal no presence of protein energy malnutrition. Further, rural Malian girls have lower height-for-age, weight-for-age, and BMI values than urban girls. Comparing these girls’ data with those from Dettwyler (1991) and Prazuck et al. (1989), it appears that rural girls in the Segou Region are similar to their counterparts from other rural areas of Mali. However, the rural Segou girls are taller than the girls surveyed by Prazuck et al. (1989), heavier at age 15 years, and lighter at age 17 years.

Other researchers working in West Africa have also reported poor growth and development among adolescent girls. Garnier and Bénéfice (2001), Simondon et al. (1998), and Bénéfice and Camé (1999) found Senegalese adolescent girls’ heights and weights to also be below reference standards. Simondon et al. (1998) indicated that the prevalence of stunting (HAZ score less than −2.0) (Table 6) among adolescent girls ages 12–17 years was 23.2% (Table 4), which is greater than the prevalence of stunting among Malian girls. In the Segou Region, 13.5% of the urban girls, 15.7% of the rural girls, and 14.7% of the entire sample can be classified as stunted. For girls ages 10 and 11 years in rural southwestern Mali, 19% and 25%, respectively, can be classified as stunted (Dettwyler, 1991). These comparisons suggest again that Segou Region girls, while still exhibiting poor growth compared with the reference population, have better growth than other girls in Senegal and Mali.

The HAZ (Fig. 2) and WAZ (Fig. 3) growth curves appear to show evidence of catch-up growth, and thus suggest that individuals regain some childhood losses in growth because of environmental changes or other factors that are due to a population-specific pattern of growth. However, these curves most likely depict a delayed adolescent growth spurt. Further, since all of the anthropometric data fell below the reference means at all ages, these Segou girls most likely did not recuperate any overall growth losses. Only by looking at longitudinal data from these girls could evidence of catch-up growth be established.

Comparisons with adult data give more clues as to whether or not these girls might be able to recuperate from poor childhood growth. At age 17, mean height was 160.4 cm (159.2 cm for the rural girls and 161.1 cm for the urban girls), which is the same as the reported mean stature from adult women of all
ages in rural southern Mali (mean = 160.4) given by Dettwyler (1992). Further, at age 17, the mean weight was 50.6 kg (48.2 kg for the rural girls and 52.1 kg for the urban girls), and Dettwyler (1992) reported mean weight from adult women of all ages in rural southern Mali to be 53.4 kg, which is slightly higher than these data. The NCHS data report that the mean height of 17-year-old US girls is 163.1 cm, and their mean weight is 57 kg. Thus Malian women are still shorter and lighter than their US counterparts, which suggests that these girls have not fully recuperated from childhood losses in growth by age 17. Longitudinal studies done among adolescents in Africa reveal a pattern of growth that is slower, but more prolonged than that of the reference population, suggesting that African girls can recuperate some of their early childhood losses (Billewicz and McGregor, 1982; Cameron et al., 1994; Martorell et al., 1994), and that the Segou girls may be still growing.

Even if additional longitudinal data were to support the idea that these girls have been able to recuperate some of their early childhood losses, it would be difficult to ascertain if girls recuperated in growth because of an improvement in their overall nutritional status. As evidenced by ethnographic data (Pawloski, 1999), it appears that these girls are given greater responsibilities as they age, which might impair growth. Further, diseases such as measles can impair growth and development, and the disease histories of these girls have not been fully explored. Yet because they are older, they also have greater access to food. Malians eat out of a common pot, and because it is believed that older individuals should first receive the better-tasting, more nutrient-dense foods such as chicken and fish, older children are able to obtain nutritious foods more than younger children. Older girls have additional cooking responsibilities that often include tasting the meal, which also increases access to food. The body composition results show that Segou girls have less body fat than reference girls. Further, the rural girls have less fat mass than the urban girls, which is likely due to greater workloads among rural girls. Although the difference in fat mass was statistically significant between the urban and rural girls, the difference in muscle mass was not. The UMA z-score curve (Fig. 4) suggests a dramatic increase in upper arm muscle from ages 14–17 years. This might represent a kind of catch-up growth, or more likely the change in work patterns that adolescent girls go through. Older girls reported that they have more responsibilities, particularly if they are not attending school and have few sisters to help them. Examples of these kinds of activities include carrying wood, washing clothes, carrying water, pounding millet, and carrying children. Hence, as girls grow, they are responsible for more and more physical tasks, and as a result develop a greater arm muscle mass.

The rural Segou data show that while these girls developed a higher proportion of muscle mass, they still exhibit other growth indicators of nutritional stress. As shown by Bénifice (1992) and Garnier and Bénifice (2001), this stress can affect girls’ ability to work. Work is a very important part of a girl’s life in Mali, and nutritional stresses could affect her ability to perform her daily responsibilities. Further, physical work responsibilities can also lead to increased energy needs which, if not fulfilled, can lead to more problems associated with undernutrition.

Menarche was considerably delayed for the entire Segou sample when compared to data from the US. For Segou girls, the mean age of menarche was 14.4 years, and that for US girls is 12.8 years (Eveleth and Tanner, 1976). A more recent report found mean age of menarche among a cohort of girls from the US to be 11.4 years for African-American girls and 11.5 years for European-American girls (Wattigney et al., 1999). Age of menarche for Segou Region girls falls within the range of other recent data collected in West Africa. Pasquet et al. (1999) reported mean age of menarche among Yaounde girls from Cameroon to be 13.18 years (13.98 in suburban areas and 14.27 among rural girls), and Simondon et al. (1998) reported mean age of menarche among Senegalese girls to be between 15.6–17.2 years, which is much later than in many earlier reports from West Africa. Hence, when compared to US girls, Malians are considerably delayed in development, although they do appear to fare better than girls from rural Senegal.

CONCLUSIONS

The results reveal that overall, adolescent girls from the Segou Region exhibited delayed growth and development. When compared to US reference populations, adolescent girls fell below the mean for height-for-age, mean weight-for-age, and specific body composition measurements (arm fat area and arm muscle area). Further, urban girls were taller, heavier, and fatter than rural girls. Yet these data suggest that rural Segou girls appear to be better-off than their counterparts living in other areas of Mali. The delayed growth and development that are evident in girls from the Segou Region in Mali may be due to many factors, including a history of undernutrition, poor socioeconomic status, and increased energy demands. The Segou Region has a history of poor growth and development among young children as well as poor socioeconomic status (United Nations, 1994). While some evidence indicates these girls may be able to recuperate childhood losses in height, this hypothesis can only be answered definitively with further longitudinal studies and qualitative assessments.

LITERATURE CITED

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