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ABSTRACT

***Background*: Menarche is the age at first menstruation in a girl child. Values vary globally, influenced by factors that included gene, race, industrialization, and nutrition. Attainment of a critical weight before menarche had been hypothesized and found applicable in studies from different countries, Nigeria inclusive.**
***Objective*: To re-evaluate age of menarche in our practice using the prospective method of evaluation and establish if the critical weight hypothesis is applicable in our setting**
***Design*: Cohort of 63 secondary schoolgirls were longitudinally followed up for twenty-four months to obtain accurate age, weight and height at point of menarche.**
***Results*: Mean age at menarche in this study was 13.65(±1.26) years and the range was between 10 and 16 years. Similarly, the means and ranges for weight and height were 45.9(±0.90) [43.8-48.1] kilograms and 156.16(±1.77) [149-161]. Using logistic regression correlation, while accounting for other variables, demonstrated stronger correlation between age at menarche and weight than menarche and height.**
***Conclusion*: Study demonstrated leveling off of menarche at between 13 and 14 years in our practice and agreed with hypothesis of critical weight of between 45 and 46kg. The heights of our girls at menarche compared with global average of 155 and 156cm.**

INTRODUCTION

Menarche is the age at first menstruation in the life of a girl child (1,2). It denotes commencement of reproductive life in the milestone of the girl child or woman (3). The average age of menarche had continued to decline globally over the last two centuries in view of improvement in the standard of living and its attendant improvement in nutrition worldwide (2,4). Several studies and reviews of studies have tended to conclude that this decline of the years have now leveled off at a global average age of 12.8 years and a concept of early menarche (age less than 12 years) and late menarche (age more than 12 years (4-6). Improvement in nutrition brings about rapid increase in weight gains and spurts in heights thereby bringing about attainment of menarche early in the life (3,5,6). Comparisons of several studies of over last six decades have shown that weights and heights have more roles to play in the attainment of menarche than the age (7-11). Analyses of these weights and heights had led researchers to hypothesized that a critical weight and height need be attained before a girl child can reach her menarche (9-11). However there have been contrasting views as to which of the two (i.e. weight or height) is more critical in the determination of age of attainment of menarche (3,5,12). Several studies in the past and recent decades were however of the opinion that critical weight, more than for height, hypothesis is applicable in the attainment of menarche in girls (8-16) Global average for critical weight was put at 45.6Kg, and height at 156cm (4,7-13).

Menarche and Menopause study group of this study site undertook a study on menarche using the recall method about half a decade ago revealed mean age of menarche of 13.8 (±1.3) and the mean height and weight were 47.1kilograms and 158cm respectively (17). These differences may be as a result of the recall method of evaluating for menarche that has been commonly found to be at variance with data if method of study was prospective. The prospective method evaluates the real weight and height at the time of first menstruation (3). In order to evaluate applicability of this hypothesis in our environment a prospective method of evaluating for menarche was undertaken.

MATERIALS AND METHODS

Eight-seven schoolgirls with pre-menarcheal tell tale signs (that is, breast growth, and tuft of hairs in the

armpit) were selected from 7 middle grade public secondary schools in Sagamu, southwest Nigeria. Consent from them and their parents were obtained before they were recruited in the study. They were followed up by three monthly visits, or by phone messaging from either their parents or collaborating female teachers, to get at-point of menarche real weight and height. Both the weight and height were taken and recorded at the time of recruitment and at the point of menarche. The study was for a period of twenty-four months; July 2012 through to June 2014. The height was taken with the girls standing and backing a ruled wall on bare feet, heels put together and the toes separated at angle 450 and the head in Frankfort horizontal plane. Two height measurements were taken for every schoolgirl with a third taken if the first two were more than 0.5cm apart.

The weight was taken using commercial scale that had earlier been corrected to zero with the girls made to undress to underpants and put on a light cotton linen gown. Two weight measurements were taken for every schoolgirl, and a third necessary if the difference in the two was more than 0.3 kilogram apart.

Other data collected included age at first menstruation, religion, tribe, occupation of the parents, and the estimated family income as offered by any (or both) parents at interviews.

Analysis of data was made using HPSS version 17.0. Results were presented in numbers and percentages to describe categorical variables. Quantitative variable were described in mean, median, mode, standard deviation and range. Chi-square test was used to describe difference in means of age, height, and weight. Level of significance was considered at p-value <0.05. Correlations between menarche weight and height were determined with logistic regression.

RESULTS

At the end of the study period 24 schoolgirls had been excluded in the data due to failure to attain menarche during the 24 months period of follow-up, loss on follow-up arising from relocation and transfer to schools outside the study area, and decline to further participate by either the girls or their parents. Sixty-three schoolgirls participated fully in the follow-up and attained menstruation during the study period.

At recruitment the ages of the girls ranged between 9 and 14 years and the mean was 12.06 (±1.08) years. On completion of the study and attainment of menarche the ages ranged between 10 and 16 years and the mean was 13.65 (±1.26) years. Similarly, at recruitment the girls weighed between 38.5 and 45.2 kilograms and the mean was 42.03 (±1.89) kilograms. On attainment of menarche the girls weighed between 43.8 and 48.1 kilograms and the mean was 45.9 (±0.90) kilograms. The girls' heights at recruitment ranged between 150 and 155 cm and the mean was 152.8 (±1.42) cm. On attainment of menarche heights ranged between 149 and 161cm and the mean was 156.16 (±1.77) cm.

The peak weight velocity ranged between 0.40 – 4.30 kg/year and the mean was 2.50 (±0.95) kilogram per year. Similarly the peak height velocity ranged between .00 and 9.00 cm/year and the mean was 2.57 (±1.86) cm/year. The modal weight and height at menarche were 45.8 kg and 155cm respectively. Similarly the modal velocities of gain in weight and spurt in height during the study period were 3.0kg/year and 2.0cm/year, (Table 1).

Comparing the mean age at menarche in this study with that of global average (13.65 vs. 12.8; p <0.0001) demonstrated that mean age at menarche is still significantly higher than the global average. However, finding in this study compared to the works in the same environment by the same team about five years earlier (13.65 vs. 13.80; P= 0.351) appeared similar and showing no significant difference statistically.

About two-thirds of the schoolgirls at recruitment were below the age 15 years, and 80.9% of them had attained menarche in the same age range within the study period. Fifty-eight point seven percent of the girls are from Christian homes and 36.5% from Muslim homes, (Christian mean versus Muslim mean, 13.62 vs. 13.78; p = 0.640), demonstrating that religion played no role in menarche in this study. About 2/3 of either the mothers and fathers had no education and at best fairly educated up to secondary school levels. Less than 10% of the families could best be described as earning high income per month, 61.9% are poor income earners and 28.6% are middle-income earners. Comparing schoolgirls from low income earners with middle or high income earners (Low income families (n=39) versus middle income (n=18), [14.11 vs. 12.94; p = 0.001] or Low income families (n=39) versus high income families (n=6), [14.11 vs. 12.50; p<0.0001]. Comparison with middle-income families (n=18) and high income families (n=6) [12.94 vs. 12.50; p = 0.201], (Table 2).

Multivariate analysis of variable weights, heights, velocity of weight gain, and velocity of spurt in height revealed that the most significant of these is the weight, (p = 0.012). The mean, median and mode of weight at recruitment were 45.97, 45.90 and 45.80 respectively; suggesting attainment of weights between 45 and 46 kilograms is critical to attainment of menarche, (Table 4).

Similarly partial correlation, while correcting for other variables such as family income, weight and height velocities, was stronger for weight than height in this study; menarche vs. weight, -0.292; p = 0.025, and menarche vs. height, 0.113; p = 0.395.

Table1
Statistical Description of quantitative variables in the study population

Statistics	Age at Recrui -tment	Age at Mena -rche	Weight at Recrui -tment	Weight atMen -arche	Height at Recrui -tment	Height atMen -arche	Weight Velocity	Height Velocity
Total Number	63	63	63	63	63	63	63	63
Mean	12.06	13.65	42.03	45.97	152.65	156.25	2.50	2,57
Median	12.00	14.00	42.50	45.90	153	156.00	26	2.00
Mode	12	14	39.6	45.8	152	155	3.0	2.00
Std Deviation	1.076	1.259	1.89	.90	1.47	1.52	.948	1.86
Minimum	9	10	38.5	43.8	149	152	.40	.00
Maximum	14	16	45.2	48.1	155	161	4.30	9.00

Table 2
Socio-demographic characteristics of the secondary schoolgirls

Variable	Frequency (n)	Percentage (%)
Age of the schoolgirls at recruitment (Yrs)		
≤ 9	1	1.6
10-12	40	63.5
13-15	22	34.9
16-18		
Age of the schoolgirls at Menarche (Yrs)		
≤ 9	-	-
10-12	9	14.3
13-15	51	80.9
16-18	3	4.8
Religion		
Christianity	37	58.7
Islam	23	36.5
Others	3	4.8
Education of the mother		
Nil Education	5	7.9
Primary school education	9	14.3
Secondary school education	43	68.3
Tertiary school education	6	9.5
Education of the father		
Nil Education	3	4.8
Primary school education	10	15.9
Secondary school education	38	60.3
Tertiary school education	12	19.0
Family Income		
< 25000	1	1.6
25000 - 49999	38	60.3
50000 - 99999	18	28.6
> 100000	6	9.5

Table 3

Global Survey of Age at Menarche over the last three Decades by Parent AA and co-workers[a]

Country	Date	Mean age at Menarche (yrs)
Switzerland	1983	13.4
Belgium	1985	13.1
South Africa	1990	13.2
Japan	1992	12.6
Finland	1993	13.0
UK	1993	13.0
Italy	1995	12.0
Sweden	1996	13.2
Germany	1996	13.5
Thailand	1997	12.5
Hong Kong	1997	12.4
Denmark	1998	13.0
India	1998	12.1
Greece	1999	12.3
Cameroon	1999	13.2
Venezuela	2000	12.6
Netherlands	2000	13.2
USA	2001	12.5
Spain	2002	12.6
France	2006	12.6

Global average 12.8; Average in the 21st century 12.7

a Reference number 4.

Table 4

Multivariate Analysis of variance of Mean weight, height, weight velocity and height velocity at the attainment of age at menarche

Variables	Total sum of squares	F	Sig.
Weight at menstruation	50.824	3.061	.012
Height at menstruation	194.413	1.676	.144
Weight velocity	55.772	1.164	.338
Height velocity	245.214	1.535	.184

DISCUSSION

Of the three methods of evaluating for menarche (that is the status quo, recall/retrospective, and prospective) the prospective method applied in this study is more superior and closest to the exact for the real weight and height at the exact time of first menstruation (3). This accounted for the values in the weight and height obtained in earlier study that were at variance with the critical weight hypothesis and the global average for height at menarche (17,18,19). Our findings in this study demonstrated that the mean age at menarche in our environment has leveled off at between 13 and 14 years, which is still significantly different from the global average of 12.8years ($p<0.0001$). Global studies have revealed that other factors in the determinants of age at menarche included race, family set up, tribe, ethnicity, nutrition, season, and level of industrialization (1-5,15-20). Findings of mean weight of 45.97 (±0.90) kilograms and a median and mode of 45.90 and 45.80 kilograms respectively agree strongly with attainment of menarche at critical weights of between 45.0 and 46.0 kilograms (9-11). Similarly, the study revealed mean, median and mode of 156.25 (±1.52) cm, 156.0cm and 155.0cm respectively in height agreed with the global average of 156cm (9-13, 15, 16, 19, 20).

Attainments of critical weight, and subsequently

menarche, have been severally described to be associated with quality of nutrition (6,21-23). While family income may not absolutely imply good nutrition at all time it is, however, a function of the ability of parents and guardians to provide for their homes and families. This is further corroborated in this study that established statistical differences in the means of menarcheal ages and level of family incomes. The higher the income of the parents the earlier the schoolgirls attained menarche; low-income (n=39) versus middle income (n=18): 14.11 vs. 12.94, $p = 0.001$. Similarly low-income (n=39) versus high-income families (n=6): 14.11 vs. 12.50, $p < 0.0001$. In contrast the difference in middle-income and the high-income whose nutritional quality may not be very different demonstrated no significant statistical difference; middle-income (n=18) versus high-income (n=6): 12.94 vs. 12.50, $p = 0.201$.

In conclusion, this study has demonstrated a leveling off of mean age at menarche in our environment at between the ages of 13 and 14 years, a factor that may be racially related. It has demonstrated that irrespective of this significant difference in our ages and the global average the critical weight hypothesis is also similarly applicable like in findings in other parts of the world, developed or under developed. Sagamu being located in the southwestern part of Nigeria and populated in not too small number by civil and corporate middle-income earners, some of who send their children to middle grade public schools may account for our finding of height that is in agreement with global findings. Serial weight and height assessments in schoolgirls from time of enrolment in schools will therefore be of value in sexual and reproductive health education. This serial health education would bring about early modification in sexuality, eventually targeting prevention of unwanted pregnancies and sexually transmissible diseases.

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