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Age at Menarche and its Predicting Factors in Cities of Ibadan and Ogbomoso of Southwestern Nigeria

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A study of 542 randomly selected female students of the University of Ibadan and Ladoke Akintola University, Ogbomoso, both located in the southwestern Nigeria was carried out to determine the current menarcheal age and predicting factors influencing its onset. Mean age at menarche was found to be 13.66±1.82 years. 49.3% attained menarche between the ages of 13 and 14 years, 75.7% between 12 and 15 years, 8.1% at 16 while 6.1% had their first menstruation at age 11 years. There was a significant linear relationship ($p = 0.004$) between the age at menarche and body weight. The body surface area and height showed an insignificant inverse relationship with age at menarche. Socio-economic status of the parents had no influence on the age at menarche. Simple and multiple regression models for predicting age at menarche were derived from body weight, height and body surface area.

Key words: Menarche, Nigeria, body weight, predictors, girls

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INTRODUCTION

Menarche is the first menstruation in girls. It is generally used as a major sign of sexual maturity, although it indicates neither the commencement nor the climax of pubertal development in girls. The main justification for the use of this criterion is the fact that ovulation is closely connected with menstruation (Kralj-Cercek, 1956).

Several intrinsic and environmental factors such as heredity, race, geographical location, exercise, hormones and nutrition have been reported to influence the age at menarche (Wilson and Sutherland, 1953; Kralj-Cercek, 1956; Richardson *et al*., 1983). Ellis (1950) reported that the mean age of menarche in girls in southern Nigeria city of Lagos was between 14.22±1.00 and 14.40 while that of girls from northern Nigeria ranged between 14.14± 0.6 and 14.50±1.24 years. The results of Wilson and Sutherland (1953) showed that menarche occurred relatively late in the hot dry climate of the northern Nigeria than in the southern Nigerian girls.

Apart from heredity, race, climate and geographical location (which remain more or less constant), other factors that influence menarche such as socio-economic level, psychological responses and nutrition, are subject to changes. There is evidence in the literature to show that the trend towards earlier puberty among adolescents is fast becoming a global phenomenon. A survey of 2,200 adolescents in selected Nigerian schools and institutions (Akingba and Gbajuma, 1969), showed the average age at menarche to be 13.95 years. A study conducted in Benin City, also revealed that urban girls showed evidence of early maturation as against rural girls (Imobekhai, 1986).

Leary (1969), while reviewing numerous previous reports concluded that dietary improvements could lead to a decrease in mean menarcheal age. To the best of our knowledge there is no recent information on the age at menarche in the two largest cities (Ibadan and Ogbomoso) in Oyo state of southwestern Nigeria. It is therefore important to update information on age at menarche. Furthermore, since there is a strong relationship between the nutritional status and body weight (Kralj-Cercek, 1956), it is possible to predict the age at menarche from body weight and related parameters. This will constitute important mathematical models for estimating the age at menarche in girls. In view of the foregoing the present study was undertaken to establish the current menarcheal age, it's predictors and factors influencing its onset in Nigerian girls of Ibadan and Ogbomoso in the southwestern Nigeria.

MATERIALS AND METHODS

The study was carried out among the female undergraduate students of the University of Ibadan and Ladoke Akintola University of Technology, Ogbomoso. These universities are located in the southwestern part of Nigeria and lie between latitude 7.77°N, longitude 3.67°E and latitude 8.13°N, longitude 4.27°E, respectively. In order to achieve a high level of accuracy and precision, we used the method of simple random sampling technique to select the respondents. The respondents were randomly selected from among the list of female undergraduates in the study area according to the size of the population, where the sample size was determined by:

$$n = z^2 pq \mid \varepsilon^2$$

where n is the sample size
p is the proportion of female students who have reached menarcheal age in previous studies
$q = 1\text{-}p$ and ε is the level of precision desired

Using $p = 0.9$, $q = 0.1$ and $\varepsilon = 0.025$

A semi-structured questionnaire was designed using questions from related past surveys (Wilson and Sutherland, 1953; Richardson *et al*., 1983). This was pre-tested and pilot survey carried out among some University of Ibadan female medical undergraduate students. The deficiencies noted in these exercises were corrected before the main survey. The data was collected using the direct personal interview method. The questionnaires were completed anonymously and sought information on the present age, age of first menstruation (menarche), ages of first menstruation of mothers and immediate senior sisters, ethnic group, body weight and height at first menstruation among others.

THEORY AND STATISTICAL ANALYSIS

In most biological studies, variables tend to exhibit linear relationship, which can be expressed in the form:

$$Y_i = \alpha + \beta X_i + e_i \; i = 1, 2, \ldots, k, \qquad (1)$$

where Y_i is the observed response variable, X_i is the explanatory variable and e_i is the random error which is assumed to be identically and independently distributed with mean zero and constant variance σ^2, while α_i and β_i are constants to be estimated by method of least squares (Marshall, 1978). The above simple regression model (1) was used to measure the trend and pattern of movement in the response variables with respect to the movement in the explanatory variables in this study. Meaningful forecast can then made on the basis of such established relationship by using

$$E(Y_i) = \hat{\alpha} + \hat{\beta} X_i \qquad (2)$$

Thereafter an allowance was made for more than one explanatory variable explaining the variation in the response variable (Y_i), using a multiple regression model:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \varepsilon_i \qquad (3)$$

where β is a vector of constants to be estimated and ε is the error term normally distributed with mean zero and constant variance σ^2.

The significance of the regression models (1) and (3) was then tested by partitioning the total variation into two components; variation due to the regression line and variation due to errors. The measure of variation in each case was obtained by taking the sum of squares of each of the deviation from the mean and sum of squares due to deviation from fitted values as follows:

$$\sum (Y_i - \bar{Y})^2 = \sum (\hat{Y} - \bar{Y})^2 + \sum (Y_i - \hat{Y}_i)^2$$

$$SS_{Total} = SS_{Regression} + SS_{Error}$$

The sum of squares (SS), degrees of freedom mean squares and variance ratio for multiple regressions using the analysis of variance (ANOVA).
The true hypothesis:

H_0: $\beta_1 = \beta_2 = ... = \beta_k = O$ versus the alternative hypothesis

H_1: at least one β_i is not equal to zero.

The decision rule is that the null hypothesis is rejected whenever $F^*(F^* = MS_R/MS_E)$ is greater than F distribution with k and (n-k-1) degrees of freedom i.e., $F^* > F_{(1-\alpha, K, n-K-1)}$ or when the p-value > α where α is the level of significance. Otherwise the null hypothesis is accepted (Wetherill, 1981).

A total of 553 were randomly selected and 542 responded giving a response rate of about 98%. The students were at different levels in the universities. The respondents were mainly Yoruba ethnic group although other tribes like Igbos and Hausas that fell into the sample were interviewed (Fig. 1). However, because of the volume of the data and the large number of respondents and the need for quick and accurate results with high precision, a statistical software package (SPSS) with this theory was used in the final analyses of the data in this study. It was basically used in deriving regression equations showing the possible relationship between the age at menarche, present body weight, height and the body surface area. The body surface area was determined from body weight and height using the body surface area normogram.

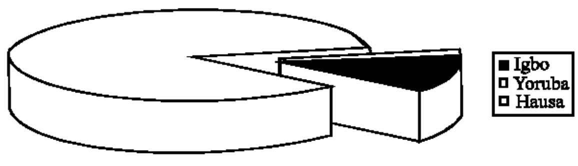

Fig. 1: Pie chart showing ethnic group of respondents

RESULTS

Preliminary analysis: Out of 542 students interviewed, 515 (95.0%) responded to questions on present age; 520 (95.9%) responded to age of first menstruation, 233 (43.0%) responded to age of first menstruation of their immediate senior sisters while only 71(13.1%) of them could have information on the age of first menstruation of their mothers and 478 (88.2%) responded to question on present body weight. Average duration of menstruation was 4.35±2.06 days while the average duration of menstrual cycle was 26.8±5.32 days (Table 1).

It could be observed from Table 1 that the average age at menarche of respondents is 13.66 and that of their mothers is about 14.39 years while that of their sisters is about 13.67 years with their respective standard deviation. The frequency distribution of age at menarche of respondents is shown in Table 2. Majority (about 49.3%)

Table 1: Descriptive statistics of menarcheal age (year) of respondents

	n	Minimum	Maximum	Mean	SD
PAGE	515	16.00	28.00	21.81	2.31
AM	520	9.00	28.00	13.66	1.82
AMM	71	8.00	20.00	14.39	2.28
AMS	233	8.00	19.00	13.67	1.72

PAGE =Present age; AM =Age at menarche of respondents; AMM =Age at menarche of mothers; AMS =Age at menarche of immediate senior sisters; n = number of respondents

Table 2: Frequency distribution of age (year) at menarche of respondents

Age (Year)	Frequency	Percent
9.00	3	0.6
10.00	9	1.7
11.00	33	6.1
12.00	70	12.9
13.00	149	27.5
14.00	118	21.8
15.00	73	13.5
16.00	42	7.7
17.00	8	1.5
18.00	7	1.3
19.00	4	0.7
20.00	3	0.6
28.00	1	0.2
Total	520	95.9
Missing system	22	4.1
Total	542	100.0

Missing system, 4.1%, constitute non-respondents to certain questions in the questionnaire

Table 3: Summary of estimates of parameters of regression models. (Probability of significance of the models and coefficient of determination)

Predictors	Estimates b (p-value)	a (p-value)	Prob. of Sign. of the model. (p-value)	Coefficient of Determination (R^2)
AMS	0.534	6.341	0.000	0.46
	(0.000)	(0.000)		
AMM	0.407	7.549	0.000	0.50
	(0.000)	(0.000)		
AMS	0.367	3.567		
	(0.052)	(0.015)		
AMM			0.000	0.662
AMS	0.345	3.558		
	(0.024)	(0.171)	0.000	0.638
AMM	0.349			
	(0.002)			
BW	0.00417			
	(0.896)			
AMS	0.168	2.318		
	(0.298)	(0.0460)		
AMM	0.368		0.002	0.609
	(0.001)			
BW	0.00255			
	(0.446)			
HT	0.358			
	(0.303)			
BW	-0.0275	15.198	(0.002)	(0.0141)
	0.002	(0.000)		
HT	-0.00611	15.228		
	(0.780)	(0.000)	0.020	0.0142
BW	-0.0274			
	(0.026)			
SESOP	-0.00972	13.676	(0.962)	(0.02)
	0.962	(0.000)		
SA	-1.24	13.864	(0.409)	(0.000)
	0.409	(0.000)		
HT	-0.0082	13.639	(0.700)	0.019
	0.700	(0.000)		

(i) Dependent variable: Age at menarche (AM). (ii) Figures in parenthesis in columns 2 and 3 are probability of significance. HT= Height; SA = Body surface area; SESOP= Socioeconomic status of parents; BW= Body weight; AM=Age at menarche; AMM= Age at menarche of mothers; AMS = Age at menarche of immediate senior sister

Table 4: Socio-economic status of parents of respondents

Age at menarche (Year)	High class	Middle class	Lower class	Total
9.00	1.0	2.0		3
10.00	4.0	5.0		9
11.00	4.0	25.0	1.0	30
12.00	8.0	53.0		61
13.00	24.0	109.0	4.0	137
14.00	22.0	80.0	3.0	105
15.00	17.0	47.0		64
16.00	5.0	34.0		39
17.00	1.0	7.0		8
18.00	1.0	5.0		6
19.00	1.0	2.0		3
20.00		3.0		3
28.00		1.0		1
Total	88.0	373.0	8.0	469
	(18.8%)	79.5%	(1.7%)	(100%)

of the respondents had their first menstruation between the ages of 13 and 14 years while 75.7% had their first menstruation between the ages of 12 and 15 years. About 7.7% of them had their first menstruation at age 16 years while only 6.1% had their first menstruation at age 11. As shown in Table 2, the missing system constituted the non-respondents to some questions and this accounted for 4.1%.

Relationship between the age at menarche (AM) and body weight at menarche (BW): It was found that there is a linear relationship between the age at menarche and body weight (BW) of respondents. The relationship can be expressed mathematically as: AM = 15.198-0.0275 BW. This shows that there is a negative relationship between AM and BW of individuals and implies that individuals with higher body weight are likely to start menstruation earlier than those with lower body weight. The relationship was found to be significant at 5% with P-value = 0.004.

Relationship between the age at menarche (AM) and body surface area (SA): Because of the importance of body surface area in physiological parameters such as basal metabolic rate, the possible relationship between the AM and body surface area (SA) was determined. The relationship was found to be: AM=13.684-1.240 SA. This relationship is negative and implies that a higher body surface area could lead to a reduction in the age at menarche. However, the relationship is not significant at 5% level (p-value = 0.409).

Table 5: Correlation matrix of response variable and the predictors

		AM	AMM	AMS	SESOP	BW	HT	SA
AM	Pearson Correlation	1.00	0.504**	0.406**	-0.002	-0.141**	-0.019	-0.043
	Sig. (2-tailed)		0.000	0.000	0.962	0.002	0.700	0.409
AMM	Pearson Correlation	0.054	1.000	0.412	0.149	0.068	-0.054	-0.018
	Sig. (2-tailed)	0.000		0.004	0.221	0.591	0.680	0.894
AMS	Pearson Correlation	0.406	0.412**	1.000	-0.050	0.010	0.097	0.105
	Sig. (2-tailed)	0.000	0.004		0.460	0.885	0.180	0.156
SESOP	Pearson Correlation	-0.002	0.149	-0.050	1.000	-0.054	0.005	-0.017
	sig. (2-tailed)	0.962	0.221	0.460		0.265	0.923	0.756
BW	Pearson Correlation	-0.141**	0.068	0.010	-0.054	1.000	0.038	0.219**
	Sig. (2-tailed)	0.002	0.591	0.885	0.265		0.460	0.000
HT	Pearson Correlation	-0.019	-0.054	0.097	0.005	-0.017	1.000	0.981**
	Sig. (2-tailed)	0.700	0.680	0.180	0.923	0.756		0.000
SA	Pearson Correlation	-0.043	-0.018	0.105	-0.017	0.219**	0.981**	1.000
	Sig. (2-tailed)	0.409	0.894	0.156	0.756	0.000	0.000	

** Correlation Significant at 1% level. AM = Age at menarche of respondents; AMM =Age at menarche of mothers; AMS =Age at menarche of immediate senior sister; BW =Body weight at menarche of respondent; SESOP = Socio-economic status of parents; SA = Body surface area; HT= Height

Relationship between the age at menarche (AM), body weight at menarche (BW) and height at menarche (HT): The regression equation that can be used to predict age at menarche from present body weight and height of individual was estimated as: AM = 15.220- 0.061 BW- 0.0274 HT. Variables were found to have negative influence on menarche but that of height was not significant at 5% level (p = 0.848). However the multiple regression equation of the combination of the body weight, height and body surface area on menarche was derived as: AM = -0.07315 BW-0.01577 HT+ 3.389 SA. The three factors were found to jointly influence menarche in Nigerian girls at 5% level of significance.

Table 3 gives the estimates of parameters of the model a, the intercept and the regression coefficients b, the probability of significance (p-value) and the coefficient of determination R for each model considered. It could be observed that the age at menarche of the mother (AM) and that of the immediate senior sister (AMS) of the respondents significantly influenced the age at menarche. This is confirmed by the coefficient of determination $R^2 = 0.504$ and $R^2 = 0.460$, respectively. This implies that the respondent's mother's and sister's age at menarche could explained 50.4 and 46% of the variation in age at menarche respectively. The combination of the AM and AMS jointly explain about 66.2% of variation in AM while 33.8% were explained by other factors not considered in the model. Even though the influence of body weight at menarche (BW) is small and singly explains only about 1.41% of variation in AM, its contribution is significant at 1% level (Table 3 and 5). Thus AMS and BW jointly explain 63.8% of variation in AM. It could also be seen that the influence of SESOP, SA and HT exist but are not significant (Table 3). The socioeconomic status of parents therefore has nothing to do with the age at menarche of girls in the present study (SESOP in Table 3 and 4).

DISCUSSION

The results of the present study show that the age at menarche in girls in southwestern Nigeria is about 13.66 years while that of their mothers is about 14.39 years. About 75.7% of the respondents had their first menstruation between the ages of 12 and 15 years, which agree with earlier studies although with slight deviations. In a study of 352 randomly selected secondary school girls in an urban population in southwestern Nigeria, Abioye-Kuteyi *et al.* (1997) reported a mean menarcheal age of about 13.94 years with 76.8% of the girls attaining menarche between ages 13 and 15 years. Uche and Okorafor (1979) also reported that the age at menarche in the eastern Nigerian city of Enugu was about 13.54 years. The mean menarcheal age of girls and that of their mothers in southwestern Nigeria in the present study indicate that there is a rate of decline in the average menarcheal age. This decline is about three months per decade, which is close to the earlier one of four months per decade reported by Uche and Okorafor (1979). The difference in menarcheal age of the respondents and that of their mothers is also about 0.73 years (about 9 months) while the mean difference in age between these mothers and their daughters (respondents) is about 30 years, corroborating a decline in age at menarche of about 3 months per decade in the present study.

There is evidence in the literature to show that the trend towards earlier puberty among adolescents is fast becoming a global phenomenon. In a survey of 2,200 adolescents in selected Nigerian schools and institutions, Akingba and Gbajumo (1969), showed the average age at menarche to be 13.95 years. Results of a study conducted in Benin City, Nigeria, revealed that urban girls showed evidence of early maturation as against rural girls (Imobekhai, 1986). These results indicate that the average age at puberty among adolescents in Africa falls within the general pattern of various populations of the world. This is contrary to other findings that menarcheal manifestations in central African adolescents could come as late as 15 or 17 years due to nutritional deficiencies (Uche and Okorafor, 1979). This variation in age at menarche explains the strong involvement of other factors such as heredity, climate, race and geographical location. Heredity is a prominent factor in the age of menarche in the present study.

Roberts *et al*. (1986) reported that differences in menarcheal status remain associated with pronounced differences in height and weight when all other variables are held constant and there is a slight suggestion that the effect diminishes the later the age at which menarche occurs. Among the factors studied, the age at menarche seems to be strongly influenced by body weight. We report here a simple regression equation for predicting the menarcheal age from body weight alone and multiple regression equation for predicting the age at menarche from body weight, height and body surface area. These regression equations were obtained from data on age at menarche, present body weight and height, body weight and height at menarche and the calculated body surface area, in this study. These derivations show that there is an inverse relationship between age at menarche and body weight at menarche and it is also related to the combination of the present body weight, height and body surface area of individuals. Thus an individual with high body weight is likely to start menstruation earlier than those with lower body weight.

Although several factors have been reported to influence the age at menarche, the impact of nutrition in this phenomenon is becoming increasingly stronger as the factor responsible for continuous decline in this age (Wilson and Sutherland, 1953; Kralj-Cercek, 1956; Richardson *et al*., 1983). Nutrition markedly influences the rate of maturation and body weight; proteinous food accelerates, while carbohydrate nutrition inhibits the process (Kralj-Cercek, 1956). Previous investigations of hormones show a close connection in the activity of the anterior pituitary secretions with sexual organs. The anterior pituitary gland secretes gonadotrophins, which affect the sexual glands by stimulating them to an increased activity. Body weight is known to play an important role in the regulation of gonadotrophin secretion (Boyar *et al*., 1974) and its crucial role for regular cyclic function is well recognized (Knuth *et al*., 1977). Frisch and McArthur (1974) have postulated that, in addition to there being a critical weight at which menarche occurs, there is a critically low weight in relation to height at which amenorrhoea develops. Undernutrition delays menarche and the adolescent growth spurt, which normally precedes menarche (Frisch, 1972).

We found that the relationship between the socioeconomic status of parents and the age at menarche of girls in the present study is negative and insignificant at 5% level. In a similar study in northeast England, age at menarche shows no independent effect of social class, but is strongly influenced by family size and also partly by position in family (Roberts *et al*., 1975). Roberts *et al.* (1986) had earlier reported that age at menarche shows no independent effect of social class or of position in sibship, but is strongly influenced by the size of family in which a girl grows up. In conclusion, the findings in the present study support earlier ones and they indicate a rate of decline in age at menarche. Furthermore a significant finding of this study is the derivation of simple and multiple regression equations for predicting the menarcheal age from body weight alone and from body weight, height and body surface area.

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