

PHYSICAL GROWTH, AGE AT MENARCHE AND AGE AT FIRST UNION IN RURAL GUATEMALA

HERNAN L. DELGADO, ELENA HURTADO and VICTOR VALVERDE

*Institute of Nutrition of Central America and Panama (INCAP), P.O. Box 1188,
Guatemala, Guatemala, C.A.*

(Received: February 7, 1984; in final form: September 20, 1984)

The relationship between anthropometric measurements, age at menarche and age at first union was studied in a group of Guatemalan Indian adolescents. From the data, it was concluded that median age at menarche is considerably high and that anthropometric measurements of girls (weight, height and arm circumference) and their age were positively associated with menarcheal status. In addition, it was found that early maturers get married earlier in all age groups. This result supports the hypothesis that the timing of menarche is related to the timing of pregnancy in traditional societies.

KEY WORDS: menarche; physical growth; adolescence; first union; Guatemala; anthropometry.

INTRODUCTION

Several lines of evidence suggest that nutrition may be an important determinant of age at menarche and age at marriage. These include the delay of menarche reported during war famines (Butler *et al.*, 1945), the downward trend observed in the age at menarche in developed countries in the last century (Tanner, 1973, 1981; Manniche, 1983; Wyshak, 1983) and the earlier age at menarche found in high socioeconomic groups and in developing countries, respectively (Zacharias and Wurtman, 1969; Bhalla, 1975; Flint, 1976; Gray, 1979). In addition to the implications of previous studies, the possibility that nutrition is related to age at menarche is given support by studies showing an association between physical growth and age at menarche (Zacharias, Rand and Wurtman, 1976; Roberts and Dann, 1975). However, the hypothesis of a critical body weight triggering a change that leads to menarche (Frisch and Revelle, 1970, 1971; Frisch, 1972; Frisch, Revelle and Cook, 1973) has been questioned by other authors (Crawford and Osler, 1975; Johnston, Malina and Galbraith, 1971; Billewicz, Fellowes and Hytten, 1976; Cameron, 1976; Trussell, 1980; Garn, LaVelle and Pilkington, 1983).

The study on the association between nutritional status and age at menarche is not purely academic. If nutrition affects menarche and menarche affects the age at first union, as is the case in some traditional societies, the nutritional status of a girl could influence her age at first union through variations in age at menarche. The existence of an association between nutritional status, age at menarche and age at first union could have important public health implications because of the increased risks of pregnancies occurring during adolescence. The potential effect of nutrition on marriage has received, with few exceptions, virtually no attention (Chowdhury, Huffman and Curlin, 1977; Udry, 1979).

This paper presents data on the interrelationships between physical growth, age at menarche and age at marriage in a rural Indian population in Guatemala.

MATERIAL AND METHODS

Girls included in the sample participated in a field study carried out by the Institute of Nutrition of Central America and Panama (INCAP). Available information indicates that the nutritional and health status of the study sample is precarious and that the general condition is one of endemic mild-to-moderate malnutrition. The girls live in 12 coffee plantations located in three different departments of Guatemala (Suchitepéquez, Quezaltenango and Alta Verapaz), and their ethnic extraction is Indian.

The study samples include 444 girls aged 10 to 21 years, present at the coffee plantations in 1981, when a census of these populations took place. During this census, the girls were interviewed about their present menarcheal and marital status and, retrospectively on the date of menarche. The information was collected by non-professional personnel, appropriately standardized and following precise procedures. In addition, a physical anthropometric assessment including height, weight and arm circumference was performed. Finally, the estimation of the girls' ages was based on the registered information of birth dates, when available, or from their own report.

TABLE I

Weight, height, arm circumference and menstrual history of a sample of Indian Guatemalan females

Age (years)	Weight (kg)	Height (cm)	Arm Circumference	Percent Menstruating
10.0-10.9	24.8 ± 3.9 ^a (61)	120.9 ± 7.8 (61)	18.0 ± 1.7 (61)	2.0 (61)
11.0-11.9	27.3 ± 5.7 (55)	124.5 ± 7.7 (55)	18.5 ± 1.9 (55)	5.0 (55)
12.0-12.9	31.8 ± 6.3 (57)	130.1 ± 9.1 (57)	19.6 ± 2.0 (57)	9.0 (57)
13.0-13.9	34.3 ± 6.3 (54)	135.6 ± 7.7 (54)	20.0 ± 2.2 (53)	20.0 (54)
14.0-14.9	37.9 ± 7.4 (42)	139.5 ± 8.6 (42)	21.5 ± 2.2 (43)	49.0 (43)
15.0-15.9	41.6 ± 7.1 (50)	140.1 ± 8.1 (50)	22.1 ± 2.2 (49)	60.0 (50)
16.0-16.9	42.6 ± 6.0 (34)	140.8 ± 6.6 (32)	22.4 ± 2.3 (34)	88.0 (34)
17.0-17.9	47.4 ± 6.3 (35)	145.3 ± 6.8 (37)	23.2 ± 1.9 (35)	84.0 (37)
18.0-18.9	45.9 ± 5.5 (23)	142.7 ± 5.9 (22)	22.0 ± 1.8 (24)	92.0 (24)
19.0-19.9	47.4 ± 9.6 (21)	143.2 ± 6.8 (24)	22.1 ± 1.8 (22)	100.0 (24)
20.0-20.9	50.4 ± 7.6 (5)	147.0 ± 5.0 (4)	24.3 ± 2.4 (4)	100.0 (5)

^a Mean ± standard deviation. In parenthesis, the number of cases.

TABLE II
Distribution of menarche in Indian Guatemalan adolescents by categories of age and weight

Age (years)	Weight (kg)	Number of Cases	Percent Menstruating
10.0-10.9	15.0-24.9	34	0.0
	25.0-39.9	27	3.7
11.0-11.9	15.0-24.9	21	0.0
	25.0-34.9	30	30.7
	35.0-44.9	3	33.3
	45.0-49.9	1	100.0
12.0-12.9	15.0-24.9	6	0.0
	25.0-34.9	34	41.2
	35.0-44.9	15	86.7
	45.0-49.9	2	50.0
13.0-13.9	15.0-24.9	2	0.0
	25.0-34.9	27	0.0
	35.0-44.9	22	36.4
	45.0-49.9	3	100.0
14.0-14.9	15.0-24.9	2	0.0
	25.0-34.9	10	10.0
	35.0-44.9	25	60.0
	45.0-54.9	5	80.0
15.0-15.9	25.0-34.9	10	40.0
	35.0-44.9	21	57.1
	45.0-54.9	19	73.7
16.0-16.9	30.0-39.9	13	76.9
	40.0-49.9	17	94.1
	50.0-59.9	4	100.0
17.0-17.9	35.0-44.9	13	84.6
	45.0-54.9	16	93.8
	55.0-59.9	6	83.3
18.0-18.9	35.0-44.9	11	81.8
	45.0-54.9	11	100.0
	55.0-59.9	1	100.0
19.0-19.9	25.0-34.9	2	100.0
	35.0-44.9	7	100.0
	50.0-59.9	12	100.0
20.0-20.9	40.0-49.9	3	100.0
	50.0-64.9	2	100.0

RESULTS AND DISCUSSION

Descriptive statistics for some characteristics of the study population are presented in Table I. The values of weight, height and arm circumference, given age, are indicative of the nutritional problems in the area. The percentages of girls attaining menarche by years of age are also presented in Table I. The percentage of girls attaining menarche increases steadily with age.

The information on the number of girls having attained menarche at each age

was used to estimate the median age at menarche; this was done by fitting a logistic curve to the data and finding the age which corresponds to the 50% point (Rothman and Boice, 1979). The median age of menarche was 14.81 years and the logistic slope was 0.93. The estimation of the standard errors for a and b were 0.16 and 0.09, respectively. The chisquare for goodness of fit gave $X^2 = 3.61$, $df = 5$, $p > 0.05$, an excellent fit to the trend line for the percentage in individual years of age.

The relationship between girls' weight and percentage having attained menarche is shown in Table II. At all ages, heavier girls have, on the average, a higher probability of having experienced menarche than lighter girls. It should be noted, however, that there are no such differences at 19 and 20 years, all girls having attained menarche at those ages.

Table III presents the distribution of menarche in girls by age and height. Again, at each age, taller girls have, on the average, a higher probability of having attained menarche than shorter girls. A similar pattern is apparent when the relationship between categories of arm circumference (Table IV) and the percentage of girls having attained menarche in each age group is examined.

Table V summarizes the information regarding the Body Mass Index of the girls, their age and their menarcheal status, and presents the results of the stepwise logistic multiple regression performed on these data. The Body Mass Index is a numerical index frequently used to estimate thinness or fatness of individuals and popula-

TABLE III
Distribution of menarche in Indian Guatemalan adolescents by categories of age and height

Age (years)	Height (cm)	Number of Cases	Percent Menstruating
10.0-10.9	100-119	27	0.0
	120-139	34	2.9
11.0-11.9	100-119	11	0.0
	120-139	43	4.7
	140-149	1	100.0
12.0-12.9	100-119	6	0.0
	120-139	43	4.7
	140-149	8	37.5
13.0-13.9	120-139	37	8.1
	140-159	17	47.1
14.0-14.9	120-139	21	33.3
	140-159	21	61.9
15.0-15.9	120-139	22	50.0
	140-159	28	67.9
16.0-16.9	120-139	13	84.6
	140-159	19	94.7
17.0-17.9	130-149	27	85.2
	150-159	10	80.0
18.0-18.9	130-149	20	90.0
	150-159	2	100.0
19.0-19.9	120-139	5	100.0
	140-159	19	100.0
20.0-20.9	140-159	4	100.0

TABLE IV

Distribution of menarche in Indian Guatemalan adolescents by categories of age and arm circumference

Age (Years)	Arm Circumference (cm)	Number of Cases	Percent Menstruating
10.0-10.9	12.5-17.4	21	0.0
	17.5-22.4	40	2.5
11.0-11.9	15.0-19.9	45	0.0
	20.0-24.9	10	30.0
12.0-12.9	15.0-19.9	37	2.7
	20.0-24.9	20	20.0
13.0-13.9	12.5-17.4	5	0.0
	17.5-22.4	42	16.7
	22.5-27.4	6	66.7
14.0-14.9	15.0-19.9	8	12.5
	20.0-24.9	33	57.6
	25.0-27.4	2	50.0
15.0-15.9	17.5-22.4	27	48.1
	22.5-27.4	22	77.3
16.0-16.9	17.5-22.4	18	88.9
	22.5-27.4	16	93.8
17.0-17.9	20.0-24.9	28	85.7
	25.0-27.4	7	100.0
18.0-18.9	17.5-22.4	15	93.3
	22.5-27.4	9	88.9
19.0-19.9	17.5-22.4	13	100.0
	22.5-27.4	9	100.0
20.0-20.9	20.0-24.9	2	100.0
	25.0-27.4	2	100.0

tion. When Body Mass Index is controlled for, the effect of age is evident. On the other hand, when age is controlled for, the effect of the Body Mass Index remains. Similar results were obtained when the other indicators of physical growth were analysed.

The association between the indicators of physical growth, age of menarche and age of first marital union were also explored. As shown in Table VI, age resulted in an increased probability of being married in both groups, those who have attained menarche and those who have not. In addition, in a stepwise logistic multiple regression a significant relationship of menarcheal status and age of first marital union were found, indicating that the probability of being married or in union was higher for those girls who have attained menarche than for the girls who have not attained menarche. A small, non-significant association between the anthropometric measurements (weight, height and arm circumference) and marital status was also found.

The median age of menarche in the sample is higher than that of other populations in Latin American countries obtained over the last decade. For example, the age at menarche in Venezuela and Cuba range from 12 to 13 years (Gray, 1979; López *et. al.*, 1981). In addition, the data support the existence of an association between age, anthropometric indicators and menarcheal status on Guatemalan

TABLE V
Relationship between Body Mass Index (Quetelet index)^a and menarche in Guatemalan Indian adolescents

Menarche	Age Group: 10-13 years Body Mass Index		Age Group: 14-19 years Body Mass Index	
	≤ Median	> Median	≤ Median	> Median
YES	7 (4.6%) ^b	13 (17.3%)	81 (66.9%)	72 (88.9%)
NO	147	60	40	9

^a Body Mass Index = (weight (kg)/height² (cm²)) × 10,000

^b Number of Cases = In parenthesis, proportion of cases who have attained menarche, within each category of body mass index.

Results from a stepwise logistic multiple regression

Variables	X ²	p-value
Age	221.13	0.0000
Quetelet Index	23.70	0.0000
Interaction Age-Quetelet	0.05	0.8245

Indian population. Several other recent studies from developed and developing countries have shown similar results. While some have attempted to demonstrate that the nutritional status of the girls is a causal factor in the onset of menstruation, most have concluded that both physical growth and sexual maturation are interacting processes of the same phenomena known as developmental age (Malina, 1978; Ellison, 1981). Developmental age simply summarizes the intercorrelations among various measurable aspects of the same developmental process. Therefore, the data presented neither support nor contradict the hypothesis of a critical body weight. They simply show that menstruating adolescents have more weight and adipose mass than non-menstruating ones. This has also been recently shown by Garn, Lavelle and Pilkington (1983).

On the other hand, these data indicate that early maturers get married earlier, in all age groups. This information gives support to the view that the timing of menarche is related to the timing of first intercourse and first pregnancy in traditional societies.

TABLE VI
Relation between menarche and marital union formation in two categories of age

		AGE GROUP: 10-13 years		AGE GROUP: 14-19 years	
		Menarche		Menarche	
		NO	YES	NO	YES
IN MARITAL UNION	YES	18	1	91	33
	NO	206	1	43	7

ACKNOWLEDGEMENTS

Data collection was supported by a grant from the Agency for International Development (Contract AID/ta-c/1342), and analyses by AID Grant No. 596-0104 Regional Nutrition Technical Outreach (Amendment 3). The authors are grateful to Rafael Flores, M. Stat., for his valuable comments and suggestions.

REFERENCES

- Bhalla, M. (1975) Age of menarche. A review. *Indian J. Pediat.* **42**, 166-175.
- Billewicz, W.Z., H.M. Fellowes and C.A. Hytten (1976). Comments on the critical metabolic mass and the age of menarche. *Ann. Human. Biol.* **3**, 51-59.
- Butler, A.M., J.M. Ruffin, M.N. Sniffen and M.E. Wickson (1945). The nutritional status of civilians rescued from Japanese prison camps. *N. Engl. J. Med.* **233**, 639-652.
- Cameron, N. (1976) Weight and skinfold variation at menarche and the critical body weight hypothesis. *Ann. Human Biol.* **3**, 279-282.
- Chowdhury, A.K.M.A., S.L. Huffman and G.T. Curlin (1977). Malnutrition, menarche, and marriage in rural Bangladesh. *Soc. Biol.* **24**, 316-325.
- Crawford, J.D. and D.C. Osler (1975). Body composition at menarche: the Frisch-Revelle hypothesis revisited. *Pediatrics*. **56**, 449-458.
- Ellison, P.T. (1981) Threshold hypothesis, developmental age, and menstrual function. *Am. J. Physiol. Anthropol.* **54**, 337-340.
- Flint, M. (1976) Menarche studies in India. *J. Indian M.A.* **66**, 20-23.
- Frisch, R.E. (1972) Weight at menarche: similarity for well-nourished and under nourished girls at differing ages, and evidence for historical constancy. *Pediatrics*. **50**, 445-450.
- Frisch, R.E. and R. Revelle (1970) Height and weight at menarche and a hypothesis of critical body weights and adolescent events. *Science* **169**, 397-399.
- Frisch, R.E. and R. Revelle (1971) Height and weight at menarche and a hypothesis of menarche. *Am. J. Dis. Childh.* **46**, 695-701.
- Frisch, R.E., R. Revelle and J. Cook (1973). Components of weight at menarche and the initiation of the adolescent growth spurt in girls: estimated total water, lean body weight and fat. *Human Biol.* **45**, 469-483.
- Garn, S.M., M. LaVelle and J. Pilkington (1983). Comparison of fatness and pre-menarcheal and post-menarcheal girls of the same age. *J. Pediat.* **103**, 328-331.
- Gray, R.H. (1979) Biological factors other than nutrition and lactation which may influence natural fertility: a review. In H. Leridon and J. Menken (Eds.), *Natural Fertility*. Ordina Editions, Liege, Belgium. pp. 217-251.
- Johnston, F.E., R.M. Malina and M.A. Galbraith (1971). Height, weight and age of menarche and the 'critical weight' hypothesis. *Science* **174**, 1148.
- López, C.M., G. Tobar, N. Farid, M. Landaeta and H. Méndez (1981) Estudios comparados de la estatura y edad de menarquia según estrato socioeconómico en Venezuela. *Arch. Latinoam Nutr.* **31**, 740-757.
- Malina, R.M. (1978) Adolescent growth and maturation: selected aspects of current research. *Yearbook Phys. Anthropol.* **21**, 63-94.
- Manniche, E. (1983). Age at menarche: Nicolai Edvard Ravn's data on 3385 women in mid-19th. century Denmark. *Ann. Human Biol.* **10**, 79-82.
- Roberts, D.F. and T.C. Dann (1979). A 12-year study of menarcheal age. *Brit. J. Prev. Soc. Med.* **29**, 31-39.
- Rothman, K.J. and J.D. Boice (1979). *Epidemiologic Analysis with a Programmable Calculator*. U.S. Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, Washington, D.C. (NIH Publications No. 79-1649).
- Tanner, J.M. (1981). Menarcheal age. *Science* **214**, 604.
- Tanner, J.M. (1973) Trend towards earlier menarche in London, Oslo, Copenhagen, the Netherlands and Hungary. *Nature* **243**, 95-96.
- Trussell, J. (1980). Statistical flaws in evidence for the Frisch hypothesis that fatness triggers menarche. *Human Biol.* **52**, 711-720.
- Udry, J.R. (1979). Age at menarche, at first intercourse, and at first pregnancy. *Biosoc. Sci.* **11**, 433-441.
- Wyshak, G. (1983). Secular changes in age at menarche in a sample of US women. *Ann. Human. Biol.* **10**, 75-77.
- Zacharias, L., W.M. Rand and R.J. Wurtman (1976). A prospective study of sexual development and growth in American girls: the statistics of menarche. *Obstet. Gynecol. Survey.* **31**, 325-337.
- Zacharias, L., and R.J. Wurtman (1969). Age at menarche. Genetic and environmental influences. *N. Engl. J. Med.* **280**, 868-875.