

SOME FACTORS INFLUENCING THE AGE AT MENARCHE OF SRI LANKANS

by

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SUMMARY. The mean age at menarche (MAM) of girls attending two schools in the City of Colombo catering to families of a high socio-economic-educational status has been compared with that of girls of lower socio-economic status in the city and in rural Kadawata. The MAM for the former group is 11.8 years, lower than values reported earlier for more mixed Sri Lankan populations. In all schools studied those who have reached menarche are significantly taller, heavier, have a higher BMI, mid-arm-circumference and skinfold thickness than those who have not attained age. The mean weight of girls who have reached menarche is above 40 kg in all age groups and BMI is above 17.0. The importance of the socio-economic, educational and nutritional status, from the time of birth to the adolescent spurt, to the early onset of menarche, is stressed.

INTRODUCTION

Since 1950 several studies have demonstrated the influence of habitat, ethnicity and socio-economic status on the mean age at menarche (MAM) of Sri Lankans. Wilson and Sutherland (1) showed a significant difference in MAM between rural girls (14 years 5 months) and those living in the city of Colombo (12 years 10 months). Whereas 1% of the girls in the city had reached menarche as early as 9 years 11 months, the corresponding age for rural girls was 10 years 4 months. In the city 99% had attained age by 15 years 4 months, and in rural areas, by 18 years 5 months. A similar influence of habitat has been reported by Kodagoda and Rajapaksa (2).

Influence of ethnicity on MAM was found by Arumugam and Jayewardene (3). The Burghers in Colombo (MAM 12.73 years) and Moors (MAM 12.61 years) differed significantly from the Sinhalese (MAM 13.20 years) and Tamils (MAM 13.02 years).

Chinnatamby (4) reported that MAM falls with increase in socio-economic status. However, 25 years later, Jayasekera and Goonewardena (5) could find no significant influence on MAM of the occupation of the father, the size of the family or the birth order of the girls.

A study of girls outside Colombo and its environs is reported by Balasuriya and Fernando (6) who questioned girls attending schools in Jaffna, Kandy and Nuwara Eliya. The Tamils in Jaffna city had a similar MAM (14.0 years) to that of Tamils in Kandy (13.8 years). The MAM of Sinhalese and Tamils in Nuwara Eliya was significantly later than that of girls in Kandy and Jaffna. They attributed this difference to differences in socio-economic status, although the altitude of Nuwara Eliya (about 1800 m) could also have had some influence on the rate of development (7).

In the study reported here, the influence on MAM of socio-economic-educational level, ethnicity and body composition has been examined. Girls attending two schools in the city of Colombo which are non-state-aided and levy high fees, catering mainly to families of a high socio-economic and educational status have been compared with those in a non-fee-levying, state-aided school in the city and two state-aided schools in the Gampaha District.

MATERIALS AND METHODS

1. **Sample.** The two schools in the Gampaha District were the Kadawata Prashada Vidyalaya and the Kadawata Vidyaloka Vidyalaya, and the schools selected in the City of Colombo were St. Bridget's Convent (SBC), the Holy Family Convent (HFC) and Hindu Ladies' College (HLC). All the girls from Grades 3 to Grades 12 present on the day of the survey were included in the study.
2. **Age.** The age of the student on the day of the interview was determined according to the WHO recommendations (8).
3. **Height.** Height was measured to the nearest 0.1 cm, using a Holtain stadiometer, the subject being in school uniform but barefooted.
4. **Weight.** Weight was measured with a Bauman platform beam balance, with the subject standing erect, barefooted, in school uniform.
5. **Body Mass Index (BMI)** was calculated, using the formula
$$\text{BMI} = \text{Weight in kg}/(\text{height in m})^2,$$
6. **Skinfold thickness** was measured at 4 sites — triceps, biceps, subscapular and supra-iliac — with a Holtain skinfold caliper.
7. **Nutritional status** of the girls was assessed using both the Gomez and Waterlow classifications and the NCHS reference values for comparison (8).
8. **Midarm circumference (MAC)** was measured with a flexible steel tape on the left side, with the arm hanging relaxed (9).
9. **The mean age of menarche** was estimated by the "status quo" method and probit analysis. At the interview each girl was asked whether she was menstruating or not. The percentage of girls who had attained menarche in each age group was calculated, and the probit value for each percentage plotted against log age. The mean age of menarche for the group was calculated from the regression equation.
10. **Statistical analysis.** Data processing and statistical analysis were carried out at the computer Unit, using a Lotus 123 package and some Pascal Programmes.

In each age group, the girls were separated into 2 sub-groups on the basis of their having reached menarche or not. The difference between the sub-groups in their mean height, weight, BMI, MAC and skinfold thicknesses were tested for significance by the 't' test and in their nutritional status by the chi-square test.

RESULTS

Mean age at menarche.

Table 1 shows the mean age at menarche (MAM) for the girls in the 4 schools. The MAM of Sinhalese girls at SBC is almost identical with that of the Sinhalese girls at HFC. Although the MAM for Tamil girls at SBC is slightly higher than that for Tamil girls at HFC, the difference is not significant. The difference in MAM of Tamil girls at SBC and HFC and the value for Sinhalese girls in the same two schools is also not significant.

TABLE 1. The mean age of menarche of girls attending St. Bridget's Convent (SBC), Holy Family Convent (HFC), Hindu Ladies' College (HLC) and the Kadawata schools

School	N	Mean age at menarche years	S.E.	Regression equation
SBC — Sinhalese	570	11.76	0.17	$y = -28.20 + 31.0x$
Tamilis	106	12.24	0.15	$y = -36.99 + 38.59x$
HFC — Sinhalese	898	11.78	0.17	$y = -29.19 + 31.91x$
Tamilis	260	11.81	0.14	$y = -29.18 + 31.58x$
HLC — Tamilis	177	12.4	0.14	$y = -40.20 + 41.34x$
Kadawata — Sinhalese	278	13.01	0.16	$y = -31.63 + 32.87x$
SBC + HFC — Sinhalese	1468	11.78	0.17	$y = -28.73 + 34.48x$
— Tamilis	366	11.89	0.04	$y = -29.53 + 32.14x$
— All	1834	11.8		$y = -28.81 + 31.54x$

On the other hand, the MAM of girls attending HLC is higher than the values for SBC and HFC, and lower than the MAM of girls at the Kadawata schools.

Table 2 illustrates the increase with age of the percentage of girls who have attained age. At SBC and HFC the earliest age at which menstruation starts is the 10th year, and, by the age of 15 years, all the girls have attained age. On the other hand, the earliest age of menarche among HLC and Kadawata girls is the 10th year. At HLC 100% of the girls have attained age by 15 years and, at Kadawata, by 16 years.

Therefore, there is a disappearance of girls with late onset of menarche and a consequent closing up of the distribution in the lower end of the range, as one moves from the Kadawata Schools to HLC and to HFC and SBC.

TABLE 2. The percentage of girls in each age group who have reached menarche

Age yr.	SBC + HFC		HLC		Kadawata		All 4 Schools	
	N	%	N	%	N	%	N	%
9—	288	0					315	0
10—	264	3.78	28	0	49	0	341	2.93
11—	270	24.07	28	7.14	51	3.90	349	19.77
12—	283	52.65	26	15.39	29	20.69	338	47.04
13—	283	82.33	26	79.92	22	31.82	331	78.55
14—	260	95.76	19	74.74	39	64.10	318	91.82
15—	186	100	33	100	69	91.13	288	97.92
16—					9	100	290	100

SBC + HFC St. Bridget's Convent and Holy Family Convent

HLC Hindu Ladies' College

Kadawata Two Schools at Kadawata.

Weight

Table 3 shows the mean weight of girls in each age group who have reached menarche and of those who have not, in the 4 schools. The difference in the mean weights of the two groups in several age groups is significant.

In Table 4 the weights of girls in each age group in all 4 schools have been pooled. The mean weight of those who have attained age is significantly higher than the weight of those who have not. Although most girls who have reached menarche weigh 40 kg or more, there are several who have attained age who are below this weight.

Height

The marked differences in the height of those who have reached menarche and those who have not, is shown in Table 5. The pooled data from the 4 schools is shown in Table 6. In each age group, those who have reached menarche are significantly taller than the others.

TABLE 3. Comparison of weight (in kg) of girls who have attained menarche and those who have not, in each age group, at St. Bridget's Convent (SBC), Holy Family Convent (HFC), Hindu Ladies College (HLC) and the Kadawata schools.

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean weight	SD	N	Mean weight	SD		
Kadawata (S)								
11—	2	36.3	3.4	49	28.4	4.3	2.56	0.02
12—	6	33.1	4.3	23	29.9	3.9	1.73	ns
13—	7	38.4	8.5	15	31.4	4.2	2.62	0.02
14—	25	40.6	5.8	14	33.7	7.0	3.31	0.01
15—	63	41.1	5.4	6	33.4	3.5	3.39	0.01
SBC (S)								
10—	5	43.9	6.5	85	31.2	8.5	3.26	0.01
11—	23	44.3	8.5	64	33.6	9.8	4.61	0.01
12—	54	40.9	9.4	50	36.5	7.9	2.60	0.01
13—	70	45.0	10.2	16	37.9	9.8	2.54	0.02
14—	79	45.5	9.1	4	34.4	2.2	2.39	0.02
HLC (T)								
11—	2	34.5	1.8	26	26.4	3.1	3.55	0.01
12—	4	41.4	6.9	22	31.7	4.8	3.48	0.01
13—	20	43.3	5.2	6	31.2	3.3	4.78	0.01
HFC (S)								
10—	4	35.6	6.8	76	34.8	7.4	0.198	ns
11—	33	42.2	8.9	103	32.3	6.5	6.91	0.01
12—	66	42.8	7.5	49	34.2	5.9	6.63	0.01
13—	105	45.0	8.8	25	38.8	8.6	3.15	0.01
14—	122	46.2	9.7	4	42.3	10.9	0.75	ns

S = Sinhalese

T = Tamil

ns = not significant

TABLE 4. Comparison of weights (in kg) of girls who have reached menarche and those who have not, from all the schools studied.

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance P <
	N	Mean weight	SD	N	Mean weight	SD		
10—	9	40.2	7.5	161	32.9	8.2	2.60	0.01
11—	60	42.5	8.6	242	31.2	7.3	10.28	0.01
12—	131	41.4	8.4	144	33.9	6.7	8.22	0.01
13—	202	44.6	9.1	62	36.1	8.3	6.59	0.01
14—	244	44.9	9.1	23	35.5	7.6	4.74	0.01

BMI

Table 7 shows the differences in the mean BMI in the two groups. Those who have reached menarche have a higher BMI. When the two groups in all 4 schools are considered together, the BMI is seen to be much greater in those who have attained age, in all age groups (Table 8).

Table 9 shows the 25th, 50th and 75th centiles of weight, height and BMI of the girls in each age group who have reached menarche. Girls who attain age early (in their 10th year) have a relatively high weight (mean about 45 kg) and BMI (mean above 20.0) when compared with those who reach menarche a year later.

MAC and Skinfold thickness.

These measurements were made on girls attending the Kadawata schools and SBC. Although both the MAC and the sum of the skinfold thickness at the 4 sites tend to be greater in those who have reached menarche (Tables 10 and 11), the differences are not as significant as those in height, weight and BMI.

Nutritional Status

Comparison of the nutritional status of the girls in the 4 schools (assessed according to the Gomez classification) by the khi square test showed the inter-school variation to be highly significant (khi square 196.31 d.f. 9, $p < 0.001$). The status of girls at HFC and SBC were not significantly different (khi square 0.323, d.f. 3), whereas that of girls in HLC differed significantly from the nutritional status of girls at Kadawata (khi square 19.78, d.f. 3, $p < 0.001$). The percentage of girls considered normal fell from 39% at HFC and SBC to 18% at HLC and 6% at Kadawata. Those classified

TABLE 5. Comparison of heights (in cm) of girls who have reached menarche and those who have not, in each age group, at St. Bridget's Convent (SBC), Holy Family Convent (HFC), Hindu Ladies College (HLC) and the Kadawata schools.

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean height	SD	N	Mean height	SD		
Kadawata (S)								
11—	2	143.4	3.3	49	137.5	5.7	1.43	ns
12—	6	145.7	8.9	23	138.6	6.5	2.17	0.05
13—	7	149.9	8.8	15	143.5	5.8	2.07	ns
14—	25	151.9	4.6	14	145.8	7.6	3.10	0.01
15—	63	162.7	11.1	6	152.2	12.7	2.18	0.01
SBC (S)								
10—	5	145.8	4.6	85	139.1	6.8	2.17	0.05
11—	23	150.9	7.4	64	143.7	6.5	4.33	0.01
12—	55	151.2	6.8	50	147.9	6.6	2.46	0.02
13—	70	150.5	9.6	16	147.5	9.1	1.14	ns
14—	79	154.5	6.6	4	144.9	11.2	2.75	0.01
HLC (T)								
11—	2	154.4	4.0	26	136.3	4.4	5.60	0.01
12—	4	156.0	4.0	22	144.9	6.7	3.18	0.01
13—	20	153.2	5.6	6	146.6	6.2	2.47	0.02
HFC (S)								
10—	4	144.5	2.0	76	140.8	5.4	1.37	ns
11—	33	149.8	5.1	103	142.5	6.5	5.86	0.01
12—	66	151.8	4.9	49	147.7	6.1	3.96	0.01
13—	105	156.2	5.3	25	150.5	7.2	4.46	0.01
14—	122	154.7	6.8	4	147.2	11.2	2.11	0.02

S = Sinhalese

T = Tamil

ns = not significant

as suffering from Grades 2 and 3 malnutrition increased from 24% at HFC and SBC to 45% at HLC and 55% at Kadawata. There was a significant difference in nutritional status between those who had reached menarche and those who had not (khi square 22.3, $p < 0.01$ for HFC girls and khi square 14.20, $p < 0.05$ for the Kadawata girls).

TABLE 6. Comparison of heights (in cm) of girls who have reached menarche and those who have not, from all the schools studied.

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean height	SD	N	Mean height	SD		
10—	9	145.2	3.5	161	139.9	6.2	2.55	0.01
11—	60	150.2	6.1	242	141.1	6.7	9.41	0.01
12—	131	151.4	6.1	144	145.9	7.2	6.73	0.01
13—	202	153.7	7.7	62	147.6	7.7	5.43	0.01
14—	244	154.1	6.5	23	146.4	8.6	5.31	0.01

According to the Waterlow classification, there were more "normal" children in all the schools than was obtained by the Gomez classification, the percentage of such children at SBC and HFC being again greater than at HLC or at Kadawata. There were more "normal" children among those who had reached menarche than among those who had not.

DISCUSSION

The mean age at menarche (MAM) shown in Table 1 has been derived by probit analysis of data collected by the "status quo" method. Although Arumugam and Jayewardene (3) placed reliance on the recall method "due to special ceremonies associated with menarche among Sinhalese, Tamils and Moors leaving a permanent imprint on the memory of the child", this method was found to be unreliable even among rural girls at Kadawata. A similar conclusion was reached by David and Jayewardene (10) in 1974. Probit analysis requires only the age at the time of interrogation and the "status quo" as regards the commencement of menstruation, and is the simplest method of collecting data of high validity. The age corresponding to the probit value of 5.0 in the sigmoid curve obtained by plotting probit values against age, has been taken as the MAM by Balasuriya and Fernando (6) and Jayasekera and Goonewardena (5). However, such a value will depend upon the goodness of fit of the curve. By plotting the probit value for each age frequency against log age, a straight line is obtained and the goodness of fit can be checked by statistical methods. Probit analysis avoids the distortion introduced by selection of age groups and estimates the population mean. The empirical means were found to cluster about a reasonably straight line, which indicates that there is no tendency for the girls to leave school on reaching maturity (11).

Mean age at menarche

The MAM for girls attending SBC and HFC is 11.8 years, a value that is lower than 12.4 years reported for high socio-economic status families in Singapore (12) and Turkey (13), 12.46 years in Finland (14), 12.49 years in Naples (15), 12.5 years from Cairo (16) and Florence (17), and 12.51 years in Hong Kong (18).

TABLE 7. Comparison of body mass index (BMI) of girls who have reached menarche and those who have not, in each age group, at St. Bridget's Convent (SBC), Holy Family Convent (HFC), Hindu Ladies College (HLC) and the Kadawata schools:

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean BMI	SD	N	Mean BMI	SD		
Kadawata (S)								
11—	2	17.65	0.84	49	14.96	1.59	2.35	0.02
12—	6	15.59	1.44	23	15.59	2.05	0.004	ns
13—	7	16.88	2.44	15	15.23	1.85	1.76	ns
14—	25	17.58	2.31	14	15.71	2.34	2.42	0.02
15—	63	15.62	2.33	6	14.73	3.02	0.868	ns
SBC (S)								
10—	5	20.66	3.18	85	15.96	3.33	3.08	0.01
11—	23	19.59	4.30	64	16.08	3.46	3.89	0.01
12—	55	17.69	3.27	50	16.57	2.97	1.82	ns
13—	70	19.81	3.49	16	17.37	4.27	2.40	0.02
14—	79	19.02	3.49	4	16.67	3.13	1.32	ns
HLC (T)								
11—	2	14.50	1.52	26	14.16	1.14	0.394	ns
12—	4	16.93	2.26	22	15.03	1.46	2.196	0.05
13—	20	18.46	2.53	6	14.49	0.89	3.725	0.01
HFC (S)								
10—	4	17.02	3.01	76	17.53	3.23	0.314	ns
11—	33	18.72	3.39	103	15.82	2.49	5.31	0.01
12—	66	18.54	2.86	49	15.58	1.94	6.23	0.01
13—	105	18.41	3.12	25	17.06	3.08	1.95	ns
14—	122	19.73	3.68	4	19.44	3.37	0.081	ns

S = Sinhalese

T = Tamil

ns = not significant

TABLE 8. Comparison of body mass index (kg/m^2) of girls who have reached menarche and those who have not, from all the schools studied

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance $p <$
	N	Mean BMI	SD	N	Mean BMI	SD		
10—	9	19.0	3.5	161	16.7	3.4	2.02	0.02
11—	60	18.8	3.7	242	15.5	2.6	8.07	0.01
12—	131	17.9	3.0	144	15.8	2.4	6.58	0.01
13—	202	18.8	3.2	62	16.4	3.2	5.09	0.01
14—	244	18.8	3.5	2	16.5	2.8	3.15	0.01

TABLE 9. The 25th, 50th and 75th centiles of weights, heights and body mass indices (BMI) of girls, in each age group, who have reached menarche.

Parameter	Age yr	N	25th centile	50th centile	75th centile
Weight (kg)	10—	10	32.0	45.0	46.5
	11—	60	35.6	40.9	46.6
	12—	151	35.1	40.2	45.3
	13—	243	39.1	42.7	49.5
	14—	280	38.9	44.0	49.0
Height (cm)	10—	10	142.7	145.5	146.3
	11—	60	147.0	150.2	154.2
	12—	151	149.6	154.4	158.8
	13—	243	150.5	154.9	158.9
BMI (kg/m^2)	10—	10	15.59	20.57	21.60
	11—	60	16.30	17.67	20.35
	12—	151	15.62	17.44	19.08
	13—	243	16.67	18.21	20.40
	14—	280	16.50	18.38	20.35

TABLE 10. Mid-arm circumference (in cm) of girls who have reached menarche and those who have not, in each age group, in St. Bridget's Convent (SBC) and the Kadawata schools.

Age years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean MAC	SD	N	Mean MAC	SD		
Kadawata								
11—	2	20.0	0.7	43	17.8	1.4	2.08	0.05
12—	6	18.1	1.5	23	18.0	1.3	0.195	ns
13—	7	20.3	3.0	15	18.5	1.9	1.71	ns
14—	25	21.5	1.7	14	19.4	1.8	3.53	0.01
15—	63	20.9	1.8	6	18.9	1.5	2.48	0.02
SBC								
11—	9	23.3	2.3	21	20.0	4.3	2.17	0.05
12—	9	20.1	3.4	31	19.9	2.9	1.47	ns
13—	23	22.6	2.9	5	17.8	1.0	3.59	0.01

TABLE 11. The sum of skinfold thicknesses ST (in cm) at 4 sites, of girls who have reached menarche and those who have not, in each age group, at St. Bridget's Convent (SBC) and the Kadawata schools

Age Years	Girls who have reached menarche			Girls who have not reached menarche			t value	Level of significance p <
	N	Mean ST	SD	N	Mean ST	SD		
Kadawata								
11—	2	4.01	0.50	49	2.53	0.72	2.86	0.01
12—	6	3.40	1.06	23	3.16	0.79	0.61	ns
13—	7	4.35	1.58	15	3.27	0.92	2.03	ns
14—	23	3.91	1.18	14	3.18	1.07	1.88	ns
15—	63	4.93	1.54	6	3.67	1.11	1.95	0.05
SBC								
11—	9	5.64	1.77	20	3.89	1.47	2.78	0.01
12—	8	4.33	1.67	31	4.52	2.07	0.23	ns
13—	23	5.81	2.41	5	2.82	0.58	2.71	0.01

It is also lower than the values reported earlier for Sri Lankans. In one study (3), reliance was placed on the "recall method", a method we have found to be unreliable. In the others (1, 5, 6) the MAM was obtained from the sigmoid curve obtained by plotting probits against age. In their longitudinal study Kodagoda and Rajapaksa (2) limited their questioning to the age groups 11 to 15 years. Had the younger age groups (9 and 10 years) been included the MAM might have been lower than the values of 13.7 years for city and 14.4 years for rural girls reported by them. The populations studied by Wilson and Sutherland (1) and Balasuriya and Fernando (6) contain girls of varying socio-economic levels. Both SBC and HFC cater to the managerial and higher professional classes in Colombo. No attempt was made to separate those from poorer homes who were on scholarships and bursaries. Both schools are fee-levying and receive no financial assistance from the State, and the students form a highly selective group.

Ethnicity

In 1957 Arumugam and Jayewardene (3) reported different MAMs for different ethnic groups. The Burghers and Moors reached menarche at a significantly earlier age than the Sinhalese and Tamils. Chinnatamby (4) and Balasuriya and Fernando (6) have confirmed that differences between the two major ethnic groups in Sri Lanka, the Sinhalese and the Tamils, are minimal. The present study also shows that the difference between the MAMs for Sinhalese and Tamils attending the same schools (SBC and HFC) is not significant. The number of Burghers and Moors in these schools was too small for comparison with the Sinhalese and the Tamils.

Habitat

As in the study of Wilson and Sutherland (1), this study also indicates the influence of habitat on MAM. Girls living in rural Kadawata mature 1.21 years later than those attending SBC and HFC in the city, and 0.6 years later than the HLC girls (also in the city). Whether the differences are due entirely to habitat or to varying socio-economic status is uncertain. No attempt was made to ascertain the socio-economic status of the individual girls included in the study.

Various reasons have been suggested for the effect of habitat on MAM. Girls in agricultural areas begin menstruation later (19), material conditions and burdening of farm girls with manual work being listed as causes for the differences. Another explanation could be that the psycho-sexual environment in rural areas is different from that in the city. Psychological and cultural pressures may retard or accelerate a triggering-off process and determine when a girl, who is otherwise sexually mature, produces her first show of blood (20). The psycho-sexual environment in rural Kadawata could well be different from that in the city of Colombo. On the other hand, the Kadawata schools, being co-educational, could be expected to provide a more sexually stimulating environment than the girls' schools (SBC, HFC and HLC). It would, however, be surprising if the psycho-sexual environment of the girls attending any of these schools is contained within the classroom and the playground.

Socio-economic-educational status

The MAM of girls attending SBC and HFC is lower than that of girls in HLC and the Kadawata schools. HLC is in the city, catering to the lower-income families. It does not levy tuition fees and receives financial assistance from the state. Many of the girls attending HLC have fled from the war-torn Jaffna peninsula during recent years. The schools at Kadawata cater to families of lower-income level, are non-fee-levying and fully state-aided. MAM decreases with the socio-economic status of the families.

Opinion seems to be divided on the effect of socio-economic status on MAM. Reports from South Africa (21) Turkey (11), India (22), Naples (13), Cairo (14), Roumania (23) and Singapore (12) support the view that MAM is strongly influenced by socio-economic factors. Millicer (24) holds the view that the strongest influence on MAM is the socio-occupational factor. On the other hand, Roberts et al (25) conclude that, in Britain, differences in MAM operate through family size and no longer by socio-economic categories, and that environment and in particular standards of nutrition and general care, are still important factors. But family size could be a factor influencing the socio-economic status of the family. In 1962, Chinnatamby (4) found that in Colombo MAM falls with increase in socio-economic status. Jayasekera and Goonewardena (5) however find that, in the same city 25 years later, family size, birth order and the father's occupation exerted no influence on MAM.

All these studies assessed the socio-economic status of the family at the time of the investigation. The status of the parents could well have been different at the time of birth of the daughter and during her early childhood, periods during which the rate of growth is high. The importance of the socio-economic status of the family at the time of birth of the child and during early childhood on her age at menarche has been stressed by Liestol (26). During adolescence the maturation process may be influenced somewhat, but probably not as much, as long as the conditions are not adverse.

In most studies, as in the one by Jayasekera and Goonewardena (5), the socio-economic level is defined according to the father's occupation. In many countries, however, this does not distinguish people's living standards or life-styles. An index reflecting housing conditions and the amount of the family budget spent on the children should be considered along with the total family income. In the present study it has been assumed that in SBC and HFC households these are of a higher order than at Kadawata.

The educational level of the parents as well as of the girls themselves is said to influence MAM (27). In the present study there could be little difference in the level of school education of girls in the same grade in different schools, but the level of education of the parents of girls in SBC and HFC and the educational experiences to which their daughters are exposed, would be significantly different from that of the Kadawata girls. The importance of the level of education has been highlighted in studies in Poland (27) and Denmark (28). But Carfagna et al (15) stress that, in Naples, the educational level of the parents, by itself, has little or no influence on MAM, provided the girls are of the same "good" economic status.

Body size and nutritional status

The importance of body size for the attainment of puberty has been demonstrated in experimental animals. In the rat, puberty is reached at a set body size rather than at a specific age (29). In sheep, failure to grow to the appropriate body size may lead to the maintenance of the pre-pubertal anovulatory condition due to the hypothalamic pulse-generator continuing to operate at a low frequency (30). In agreement with such experimental findings, the results of the present study show that in all 5 schools, those who have reached menarche are taller, heavier and have a higher BMI than those who have not. A similar result has been reported by Kodagoda and Rajapaksa (2) but no figures are available in their published abstract, for comparison. Roberts et al (25) have also found that, in age groups 12 to 16 years, the effect of menarcheal age on stature and weight is significant, in each age group. In a longitudinal study in Colorado, Frisch and Revelle (31) found that the mean weight at menarche was 48 kg and that the mean weight remains the same as menarcheal age increases, while the mean height increases significantly. In the present cross-sectional study, the mean weight was more than 40 kg for those who had reached menarche, in all age groups. Sri Lankan girls at SBC and HFC are shorter and weigh less at menarche than the Colorado girls, although their MAM (11.9 years) is less than that of the latter (12.9 years).

BMI, MAC and skinfold thicknesses are measures of fatness. In the present study these measurements, like height and weight, are greater in those who have reached menarche (Tables 7, 8, 10, 11). Frisch and Mc Arthur (32) stress the importance of weight for height and body fat content for initiation of puberty in girls. The secular trend in MAM demonstrated in developed countries has accompanied the improvement of the nutritional status of the population as shown by an increase in height and weight (33, 34). This is evident in the present study. The better nourished and taller and heavier girls at SBC and HFC attain age earlier than the smaller and less-well-nourished girls at Kadawata. A longitudinal study of pre-school children in Hyderabad (35) showed that those who had been undernourished at age 5 had a significantly later menarche than those who had been well-nourished. Shortness and late menarche were both attributed by the authors to undernutrition in the early years of life. It is possible that the nutritional status of girls attending SBC and HFC was higher in early childhood as well as during the period of the adolescent spurt, than that of girls in the Kadawata schools. Another factor to be considered is that iodine deficiency is more prevalent in the Gampaha District than in Colombo city. Iodine deficiency can retard growth and development at all ages.

The difference between the values for SBC and HFC and for HLC (Table 2) could be due to stress as well as to economic status. Although no girls at HLC have reached menarche at age 10 years (as in the case of Kadawata girls), by age 13 years the percentage who have attained age has risen rapidly to about the same value as the HFC and SBC girls, and 100% have reached menarche by age 15 years. Girls who underwent a period of stress during childhood and early adolescence (while living in Jaffna) would reach puberty late. The older girls who migrated from Jaffna would have

begun their adolescent spurt before the stressful period, and have reached menarche at about the same age as the girls at SBC and HFC. Balasuriya and Fernando (36) have reported the effect of stress of attending school. Most girls in their study attain age in the months of December/January, with smaller peaks in April/May and August/September. These peaks coincide with school holidays.

The results in Table 2 may be compared with curves for girls in England during 1845, 1890, 1949 and 1962 (20) which indicate the secular change in the mean age at menarche. In studies quoted by Brown (20) girls begin to menstruate after the age of 9 years but the age at which 100% of the girls have attained age has moved from 23 years in 1845 to 16 years in 1962. This has been attributed to an improvement in the standard of living and in nutritional status. The Kadawata girls, with a MAM of 13.01 years and 100% attaining age by 16 years, could be expected to catch up with girls at SBC and HFC once they reach a similar standard of living to that of the latter.

We conclude that

- (i) ethnicity has no influence on the age of menarche
- (ii) habitat appears to have some influence.
- (iii) the most important determinant of MAM is body size; girls born to families of a high socio-economic status and exposed from birth onwards to adequate care and nutrition would reach the required body size at an earlier age than the less fortunate.

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