

Secular changes in body size and menarche age of Javanese adolescent in Yogyakarta

Neni Trilusiana Rahmawati and Janatin Hastuti
Dept. of Anatomy, Embryology, and Anthropology
Faculty of Medicine, Gadjah Mada University
Yogyakarta

ABSTRACT

Neni Trilusiana Rahmawati and Janatin Hastuti - *Secular changes in body size and menarche age of Javanese adolescent in Yogyakarta*

Background: Secular changes observed in human development are very sensitive bioindicators of social stresses, social and economic changes, as well as pollution and transformation of the natural environment. Environmental factors, such as nutritional habits, lifestyle and infectious diseases appear to be the main causes of differences in growth and maturation between ethnic and social groups.

Objectives: This study was undertaken to know the secular changes in body size and menarche age of Javanese adolescent in Yogyakarta.

Methods: The sample consisted of 562 Yogyakarta adolescent (300 girls and 262 boys), ranging from 11 to 18 years of age, measured in August – September 2005. For comparison, data on body size and menarche age of Yogyakarta adolescent examined in 1982 by Aswin *et al* were used. Measurements of stature and height, and menarche age were obtained for two samples of the Yogyakarta adolescent. Means and standard deviation were calculated for each measurement and for menarche age.

Results: The results for stature, weight and menarche age of adolescent measured in 2005 were greater compared with other Javanese Yogyakarta samples adolescent 23 years ago. Significant positive trends in stature, weight and menarche age were apparent between the two samples: 7.37 cm (5.1 %), 9.21 kg (26.1 %) and 16.6 months (10.6 %), respectively.

Conclusions: In summary, the results show a positive secular trend in body dimensions (height and weight) and menarche age, and this can be related to improvement in living conditions in Yogyakarta, especially during the last 23 years.

Key words: secular change – anthropometric – menarche age - adolescent

ABSTRAK

Neni Trilusiana Rahmawati and Janatin Hastuti - *Perubahan sekular terhadap ukuran badan dan usia menarche para remaja Jawa di Yogyakarta*

Latar Belakang Penelitian: Perubahan lingkungan, sosial dan ekonomi, serta adanya kemajuan transformasi dapat menjadi bioindikator yang sangat sensitif terhadap perubahan sekular dalam pertumbuhan dan perkembangan individu. Faktor-faktor tersebut, di antaranya pola makan, gaya hidup maupun penyakit-penyakit infeksi, terlihat sebagai penyebab utama pada perbedaan pertumbuhan dan maturasi antarpopulasi

Tujuan: Penelitian ini bertujuan untuk mengetahui perubahan sekular terhadap status pertumbuhan dan usia menarche terhadap remaja Jawa di Yogyakarta.

Bahan dan Cara: Subyek penelitian terdiri dari 562 remaja Jawa di Yogyakarta (300 perempuan dan 262 laki-laki), usia berkisar antara 11 – 18 tahun, diukur pada bulan Agustus – September 2005. Untuk data perbandingan, adalah remaja Jawa di Yogyakarta yang diukur tahun 1982 oleh Aswin dkk.

Hasil: Hasil penelitian menunjukkan bahwa rerata tinggi dan berat badan serta usia menarche remaja Yogyakarta yang diukur tahun 2005 lebih besar dengan usia menarche lebih muda dibanding remaja Yogyakarta 23 tahun yang lalu. Adanya sekular positif pada dua sampel, berturut-turut untuk tinggi dan berat badan serta usia menarche: 7,37 cm (5,1 %), 9,21 kg (26,1 %) dan 16,6 bulan (10,6 %).

Simpulan: Terdapat kecenderungan positif terhadap dimensi badan maupun usia menarche, hal ini dapat dihubungkan dengan adanya perbaikan gaya hidup, selama 23 tahun di Yogyakarta.

INTRODUCTION

Stature and age maturation (menarche), the well known positive indices of health, are also a mirror of changes in the socio-economic conditions of a population, ethnic group, social strata and country.¹ In studies on secular changes, it is still debated whether the increase of stature is due to a proportional increase of both sitting height and lower limb length or instead is due to a greater increase of lower limb length than sitting height.² Intergenerational changes in modern humans do not always occur in the same direction and do exhibit fluctuations. These changes are caused by ecological and social conditions; therefore, they are of an adaptational nature.³ The causes of secular trends include both environmental and genetic factors; thus, the intergenerational changes ought to be interpreted in terms of phenotypic and microevolutionary changes.³

Secular changes observed in human development are very sensitive bioindicators of social stresses, social and economic changes, as well as pollution and transformation of the natural environment. Environmental factors, such as nutritional habits, lifestyle and infectious diseases appear to be the main causes of differences in growth and maturation between ethnic and social groups.³

Environmental changes are responsible for changes between parents and their children. It has been suggested that a higher sensitivity to environmental factors, as the result of cross-breeding and heterosis, may occur, and causes some changes in living conditions.⁴ The secular change in stature has been widely reported for many populations.^{1,5,6,7} However, very few definitive studies have been made on the secular trends in Indonesia. So, the purpose of this study was to describe the secular changes in body size and menarche age of Yogyakarta population during the last 23 years; a period of considerable transformation in economic structure, politics, demography and lifestyle. This research tried to compare the body size and menarche age of Javanese adolescents in 1982 and 2005 in Yogyakarta. This article presented data for body size (stature and weight) and menarche age of adolescents in Yogyakarta, Indonesia.

METHOD

The cross-sectional data of adolescents in Yogyakarta province were obtained in August - September 2005. The study was undertaken at 2 schools (Senior and Junior High School) in Yogyakarta. The participants for the study were 562 adolescents (300 boys, 262 girls) randomly selected from a total of 600 children, aged 11 - 18 years, only children whose verified age was within the category for a particular school were assessed. The samples were born and lived in Yogyakarta city. The data were compared with those of adolescents of the same age and from the same city measured by Aswin *et al.*⁸ in 1982.

The majority of their fathers were civil servants, and the majority of their mothers were house keepers. Birth records were obtained from the principals of each school, samples sizes per age group fluctuated within and between sexes because within each school there were different numbers of children of the designated age.

Data were obtained from each subject by first completing questionnaire and interviewing the subjects. The subjects filled inclusion criterion (completing questionnaire, ready to be measured and prepared to fill and sign informed consent).

All the children within selected age group underwent a series of anthropometric measurements of stature and body weight using standard techniques described in Olivier (1960)⁹. Stature was measured to the nearest 1 mm with an anthropometer, body weight with minimal clothing was measured to the nearest 0.05 kg with weighing scale. All the measurements were obtained in the morning as far as possible, and grouped by sex and decimal age.

Ponderal Index or PI = height / weight^{1/3}

Nutritional status or BMI = weight (kg) / height² (m).

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS), version 10. The ANOVA and t-test were applied to reveal the differences of anthropometric measurements, nutritional status between the data of 2005 and 1982 in a variety of sex and age groups.

RESULTS AND DISCUSSION

TABLES 1. reports the descriptive statistics of anthropometric variables weight, stature and BMI of adolescents in Yogyakarta (divided by age and sex) measured in 2005, respectively. TABLE 2 reports the comparison body size (height and weight), Ponderal Index (IP) and menarche age between 1982 and 2005 (girls).

The mean values of the following variables were significant in the boys than in the girls for each age groups: weight and stature each age-class. The differences between the means were not significant for body mass index (BMI).

The mean values of body size (stature and weight) were significantly higher in the adolescent measured in 2005 than in those measured in 1982. TABLE 3.

reports mean and SD of height, weight, and body mass index (BMI) of boys and girls of this present study and data from literature¹⁰.

As expected, adolescent boys showed greater mean values for height and weight than adolescent girls did, but only for the 11 year old, the mean of height of girls was higher than boys. These results were as expected, because at puberty girls show greater values of height and weight than boys (TABLES 1 and FIGURE 2).

The mean values of height of adolescent boys and girls, were increasing with age, but after 18 years old the mean values decreased (TABLE 1). Body weight in boys increasing with age up to 17 years, after which it tended to decrease (TABLE 1). However in girls, body weight was increasing up to about 15 years.

TABLE 1. Descriptive statistics (mean and standard deviation) of the anthropometric variables in the sample of adolescent (11- 18 years) from Yogyakarta measured in 2005

Age	Sex	N	Weight (Kg)		Stature (cm)		BMI	
			x	sd	x	sd	x	sd
11	M	32	32.1	9.62	136.3	6.88	17.57	4.34
	F	21	31.1	6.51	138.7	6.99	16.03	2.60
12	M	22	41.0	9.07	148.6	9.32	19.15	3.99
	F	27	40.5	6.4	148.4	5.94	18.31	2.22
13	M	40	44.4	9.79	154.4	7.60	19.17	4.16
	F	42	44.3	9.23	152.5	5.40	19.34	4.18
14	M	38	50.6	9.78**	161.4	6.73**	20.34	5.29
	F	46	45.9	8.55	154.1	5.24	19.32	3.17
15	M	32	48.4	8.04	161.6	6.86**	18.47	2.38
	F	48	46.3	6.84	154.4	5.84	19.45	2.80
16	M	21	55.7	10.5**	166.3	5.25**	21.19	6.63
	F	22	45.8	4.93	154.4	4.27	19.26	2.42
17	M	36	54.6	9.13**	166.7	5.63**	21.18	5.15
	F	63	48.7	7.72	154.6	5.49	20.42	3.16
18	M	38	52.8	10.2**	166.5	6.76**	19.95	4.43
	F	29	43.6	6.33	153.6	5.05	18.50	2.51

**p<0.01

BMI = Body Mass Index

In Yogyakarta adolescents, height tended to follow a pattern 11 – 17 years, after 17 years of age, there was a consistent tendency for the mean height to fall for boys, however for girls, after 16 years the mean height to fall.

Mean weight followed a more consistent pattern from 11- 16 years for boys, and from 11-17 years for girls. The mean height of boys and girls showed a significant difference from 14 – 18 years, and the mean weight of boys and girls showed a significant difference at 14, 16-18 years (FIGURE 1-2). In almost age-groups studied the mean values of BMI of boys were higher than those of girls except for 13 and 15 year groups.

TABLE 2 indicates that the mean values of stature and weight of girls in 2005 were significantly higher than girls in 1982, this may be due to the better diet and socio-economic status of girls in 2005 than girls in 1982. The Yogyakarta girls (measured in 2005) were taller (7.37 cm) and heavier (9.21 kg) than the girls in 1982. Wieringen (1986) wrote that environmental factors such as an improvement of nutritional conditions are considered to be the main cause of secular change in height and weight, mainly in early childhood.¹¹ In this study, the girls showed a greater percentage increase of weight than stature from 2005 to 1982, weight increase 26.1 %, and stature increase 5.1 %. With time of

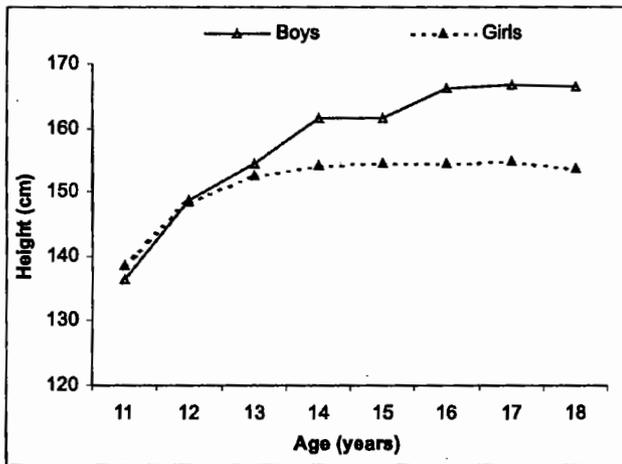


FIGURE 1. Cross-sectional growth curve of height of adolescent (measured in 2005)

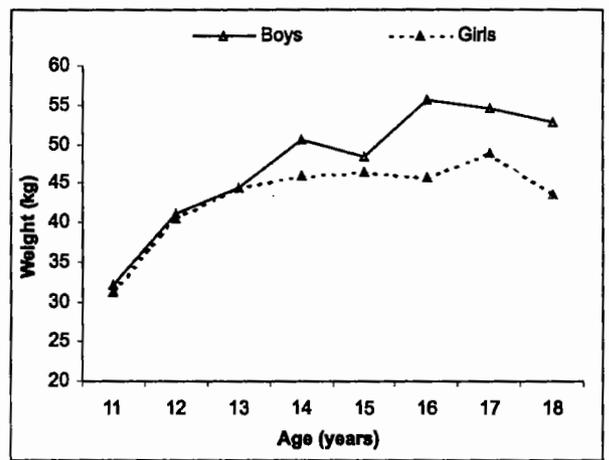


FIGURE 2. Cross-sectional growth curve of weight of adolescent (measured in 2005)

TABLE 2. Comparison in body size (height and weight), Ponderal Index (IP) and menarche age between 1982 and 2005 (girls).

Variable	1982 (Aswin <i>et al.</i>) ⁸			2005			p
	n	x	SD	n	x	SD	
Stature	169	144.61	16.74	130	151.37	11.26	**
Weight	167	35.27	5.40	130	44.48	9.30	**
Ponderal Index	170	24.69	2.41	130	22.95	2.26	**
Menarche age	389	13.07	0.95	109	11.69	0.84	**

** p<0.01

menarche age was younger (16.6 months) in the girls (2005) than the girls in 1982. This results as also showed by Sanna and Palmas (2003) suggest that the improvement of socio-economic and cultural conditions had a fundamental influence on the secular trend.¹²

Some authors found that the secular trend in growth was affected by socio-economic factors such as social class, income and education, family size, urban and rural location, and region (Cole, 2000).¹³ Similar factors affect the menarcheal trend. Table 2 shows that mean of the menarcheal age of the girls in 2005 tended to be younger than the girls in 1982. According to Wolanski (1999)⁴, this acceleration of sexual maturation, or general the acceleration of sexual maturation by generation parallel with the increase of stature. It is also known that growth is affected by poor housing and overcrowding. These factors are more or less affecting the health of the growing child through their environmental wealth and/ or hygiene (Cole, 2000).¹³

Supposing that the differences between condition and situation (1982 and 2005) like socio-economic classes, technology, information, etc, one cause of this may be found in the difference of lifestyle between both groups (2005 and 1982).

The results of the present study should be compared to the finding of other studies of secular trends in stature, weight and BMI. Comparing to the results of Singh (1995)¹⁰, study on well-nourished adolescent (11 – 17 years) in New Delhi, it revealed that the present study showed higher values of height as well as weight than in Delhi (TABLE 3).

It is interesting to note that the mean values of BMI of the present study were greater than those of Delhi coevals reported by Singh (1995).¹⁰ According to Tanner, *et al.* (1982)¹⁴ and Ali *et al.* (2000)¹⁵ on positive secular trends in height, there was evidence that the statural increase was due more to the increase of lower limb length than the increase of sitting height. Various factors can be contribute to the different trend. Socioeconomic conditions have different meanings in the various countries and may affect growth differently.

There is evidence of a positive trend in the height of Javanese adolescent. Factors that may have contribute to this trend were: nutrition, health care, education, housing, hygiene and the like. Further study is required to determine whether this secular trend in the standing height of Javanese adolescent is still continuing after 2005.

TABLE 3. Mean and sd of height, weight, and body mass index (BMI) of boys and girls of present study and data from literature (Singh, 1995).

Age	Sex	N	Author						Delhi School (1982-85)						
			Weight (kg)		Stature (cm)		BMI		Weight (kg)		Stature (cm)		BMI		
			x	sd	x	sd	x	sd	N	x	sd	x	sd	x	sd
11	M	32	32.1	9.62	136.3	6.88	17.57	4.34	164	30.7	6.1	139.3	7.1	15.7	2.3
	F	21	31.1	6.51	138.7	6.99	16.03	2.60	166	31.6	6.1	141.1	6.9	15.8	2.1
12	M	22	41.0	9.07	148.6	9.32	19.15	3.99	175	32.5	5.3	142.2	6.9	15.8	1.9
	F	27	40.5	6.40	148.4	5.94	18.31	2.22	189	34.9	7.2	145.9	7.1	16.3	2.4
13	M	40	44.4	9.79	154.4	7.60	19.17	4.16	186	38.0	8.3	150.8	9.4	16.5	2.4
	F	42	44.3	9.23	152.5	5.40	19.34	4.18	199	39.2	7.8	149.4	6.1	17.5	2.6
14	M	38	50.6	9.78	161.4	6.73	20.34	5.29	159	42.0	8.4	156.9	9.1	16.9	2.1
	F	46	45.9	8.55	154.1	5.24	19.32	3.17	213	41.4	6.8	151.9	5.3	17.9	2.5
15	M	32	48.4	8.04	161.6	6.86	18.47	2.38	150	47.2	8.2	162.5	6.8	17.8	2.3
	F	48	46.3	6.84	154.4	5.84	19.45	2.82	213	43.9	6.5	153.2	5.1	18.7	2.4
16	M	21	55.7	10.5	166.3	5.25	21.19	6.63	165	52.2	8.0	167.3	6.5	18.6	2.5
	F	22	45.8	4.93	154.4	4.27	19.26	2.42	170	44.9	6.7	153.6	4.7	19.0	2.8
17	M	36	54.6	9.13	166.7	5.63	21.18	5.15	90	51.4	7.0	166.8	5.3	18.5	2.3
	F	63	48.7	7.72	154.6	5.49	20.42	3.16	84	45.5	6.3	153.6	4.1	19.3	2.2

BMI = Body Mass Index

CONCLUSION

It was concluded that:

1. The boys were significantly taller and heavier than the girls
2. There are significant positive trends in stature, weight and menarche age between the girls (measured in 2005) than the girls (measured in 1982).
3. It has been postulated that improved health, nutritional and social conditions were the most important factors affecting secular changes.

ACKNOWLEDGMENTS

The authors would like to thank to the Dean Faculty of Medicine Gadjah Mada University. We would also like to express heartfelt thanks to the directors, teachers and especially to the children of the junior, and senior high school (SMPN II and SMAN 4) in Yogyakarta Province. This study was supported by a Grant of Gadjah Mada University Society 2005.

REFERENCES

1. Siniarska A. and Wolański N. Secular changes and economic transformations in Yucatán, México. In Henneberg, M. & Singh, R. (eds.): *Persp Hum Biol. Center for Human Biology, The Univ. of Western Australia, Nedlands.*, 1999; 4(2):190-99.
2. Bodzsar EB and Papai J. Secular trend in body proportions and composition. *Humanbiologia Budapestinensis*, 1994; 25: 245-54.
3. Wolanski N. Secular trends, secular changes, or long-term adaptational fluctuations? *Acta Med Auxol* 1985; 17: 7-19.
4. Wolanski N. Factors and trends in secular changes in human populations: present knowledge and prospects for research. In Henneberg M. and Singh R. (eds.): *Persp Hum Biol. Nedlands: The Univ. of Western Australia.* 1999; 4(2): 145-56.
5. Kokare I, Vetra J, Krumina D and Teibe U. Secular changes in the body height of Latvian conscripts during the last 122 years. *Persp Hum Biol.* 1999; 4(2): 176-79.
6. Fellman J and Eriksson AW Secular changes in the seasonal patterns of births in Nordic countries. *Persp Hum Biol.* 1999; 4(2): 203-12.
7. Wolański N. Secular changes in stature and age at menarche in some populations from Yucatán, México. *Am J Hum Biol.* 1994; 6(1): 135.
8. Aswin S, Wilopo SA, Rochmah W. Hubungan antara ukuran-ukuran antropometrik dengan umur menarche pelajar-pelajar putri sekolah lanjutan tingkat pertama di Kotamadya Daerah Istimewa Yogyakarta. Gadjah Mada Univ. Yogyakarta 1982.
9. Olivier G. *Practical Anthropology.* Springfield: Charles C Thomas Publisher, 1960.
10. Singh R. Secular increase in body size and nutritional anthropometric measurements of Indian children. In Hauspie R., Lindgren G and Falkner: *Essays on Auxology*, London: Castlemead Publications Welwyn Garden, 1995.
11. Wieringen JC. Secular growth changes. In: Falkner F and Tanner JM (eds.), *Human Growth, Volume 3*, Plenum, New York, 1986: 307-31.
12. Sanna, E. and Palmas, L. Changes in body and head dimensions in urban Sardinian children (3-5 years) from 1986 to 2001. *Ann of Hum Biol*, 2003; 30 (3):295-303.
13. Cole TJ. Secular trends in growth. *Proceedings of the Nutrition Society.* 2000; (59): 13-25.
14. Tanner JM, Hayashi T, Preece MA, and Cameron N Increase in length of leg relative to trunk in Japanese children and adults from 1957 to 1977: comparison with British and Japanese-Americans. *Ann Hum Biol* 1982; 9: 411-23.
15. Ali A, Uetake T and Ohtsuk, F. 2000 Secular changes in relative leg length in post-war Japan. *Am J Hu Biol*, 2000; 12: 405-16.