

## Original article

# The age of onset of pubertal development in healthy Thai girls in Khon Kaen, Thailand

Nongnapat Jirawutthinan<sup>a</sup>, Ouyporn Panamonta<sup>a</sup>, Sumittra Jirawutthinan<sup>b</sup>, Chatchai Suesirisawat<sup>a</sup>, Manat Panamonta<sup>a</sup>

<sup>a</sup>Department of Pediatrics, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, <sup>b</sup>Faculty of Accountancy and Management, Mahasarakham University, Mahasarakham 44150, Thailand

---

**Background:** Onset of puberty has shifted toward a younger age in the 21<sup>st</sup> century. The useful pubertal assessment in the individual child must be based on recent and reliable reference data from the same population. However, currently representative pubertal data for Thai girls are lacking.

**Objective:** We determined the current prevalence and mean ages at onset of pubertal characteristics in healthy urban Thai girls in Khon Kaen Province, northeast Thailand.

**Methods:** A cross-sectional study was carried out between January and July 2011. Five hundred and three schoolgirls aged 7 to 16 years were enrolled. All were in good physical health. Stages of breast and pubic hair development were rated on girls by Tanner's criteria. Assessment was performed by a trained pediatrician. Data on menstruation were collected by the status quo method.

**Results:** Median (range) ages of the onset of thelarche and pubarche were 9.3 (7.8 to 13.4) and 10.8 (8.9 to 14.5) years, with the mean $\pm$ SD of 10.1 $\pm$ 1.2 and 11.6 $\pm$ 1.2 years, respectively. One hundred and eighteen girls had experienced menstruation. The median (range) age of menarche was 11.2 (10.0 to 14.0) years. Mean age was 11.6 $\pm$ 0.8 years. The mean ages of pubarche and menarche decreased from the previous study significantly ( $p < 0.001$ ).

**Conclusions:** The secular trend in decline of the ages of pubarche and menarche were observed in urban Khon Kaen Thai girls. These data can be used as the reference of normal pubertal development in Thai girls in Khon Kaen to determine precocious or delayed puberty.

**Keywords:** Menarche, pubarche, pubertal maturation, thelarche

---

Puberty is the developmental stage during which a child becomes a young adult, characterized by the maturation of gametogenesis, and development of secondary sexual characteristics [1, 2]. Onset of puberty and secular trends in timing of puberty are different in relation to ethnic, geographical, and socioeconomic background [3]. The onset of puberty in girls starts from 8 to 13 years of age [1, 2]. Girls with breast development before 8 years of age have been defined as having sexual precocity [4]. During recent decades, secular trend analyses have been conducted in several countries. However, conclusions vary from country to country, with some studies

finding a tendency toward earlier pubertal development in girls [5-10] and others finding no such trend [11-13].

There are no data on pubertal development in children in Thailand during the last decade. This study aims to determine the current normative reference data for the timing of onset of sexual maturity including thelarche, pubarche, and menarche in healthy urban Thai girls in Khon Kaen Province, northeast Thailand.

## Material and methods

Between January and July 2011, a cross-sectional study was carried out in a municipal school in Khon Kaen, which comprised of both primary and secondary classes. Girls, aged between 7 to 16 years were invited to participate in this study. Informed consents were obtained from the patients and their legal guardians and assents from the schoolchildren. Height and weight measurements were performed by a specially trained

---

**Correspondence to:** Professor Ouyporn Panamonta, MD, Pediatric Endocrinology Unit, Department of Pediatrics, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand. E-mail: ouypan@kku.ac.th

nurse using the beam balance scale. Height was recorded in centimeters and weight in kilograms. Careful physical examination was performed by a well-trained female pediatrician. Girls with chronic illness (i.e. thalassemia, asthma), weight, or height less or more than 2SD of normal Thai girls and girls with history of regular use of corticosteroids were excluded. The sexual maturity staging criteria and definition were staged according to the method of Tanner (**Table 1**) [14]. Breast development was examined by palpation and inspection whereas pubic hair development was examined by inspection. Data on menstruation were collected by the status quo method. Age, height, weight, BMI, medication history, and onset of menarche were recorded. Exact age at the time of examination was calculated in years and months using birth certificates and school records. The study was approved by Khon Kaen University Ethics Committee for Human Research.

### Statistical analysis

Statistics were performed using SPSS version 16 to calculate the medians, mean±standard deviation. Mean±SD and frequency were used to describe the patient's characteristics for continuous and categorical data, respectively. Probit analysis was used and fitted to the proportion of post thelarcheal, post pubarcheal and post menarcheal girls at each age. Cumulative proportion curve versus age was constructed and median proportion was estimated.

### Results

Nine hundred schoolgirls were invited to participate the study, 560 girls participated the study. Fifty-seven girls were excluded, 54 girls had weight or height less or more than 2SD of normal Thai girls, and three girls had regular use of corticosteroids. There were 503 girls enrolled in the study. All had good physical and mental health. Mean weight, height and body mass index (BMI) were categorized by age groups as shown in **Table 2**. The mean age of onset of breast, pubic hair and menarche were 10.1±1.2, 11.6±1.2, and 11.6±0.6 (mean±SD) years, respectively. The mean ages of each pubertal stage of breast, pubic hair, and menarche were demonstrated in **Table 3**, **Figures 1 and 2**. Probit analysis was used and fitted to proportion of post thelarcheal, post pubarcheal and post menarcheal girls in each age. The median age of onset of breast development was 9.3 (95% confidence interval [CI]: 9.06-9.54) years with the range of 7.6 years and 13.4 years (**Tables 3, 4, and Figure 3**). However, it was noted that 6.7 % of the girls aged between 7 and 8 years had stage 2 breast development. The median age of onset of pubic hair development was 10.8 (95% CI: 10.41-11.29) years with the range of 8.9 to 14.5 years (**Tables 3, 4, and Figure 4**). One hundred and eighteen girls had experienced menstruation. The median age of menarche was 11.2 (95% CI: 11.14-12.16) years and the corresponding ages of this range were 10.0 to 14.0 years (**Tables 3, 4, and Figure 5**).

**Table 1.** Classifications of Tanner stages in girls [14]

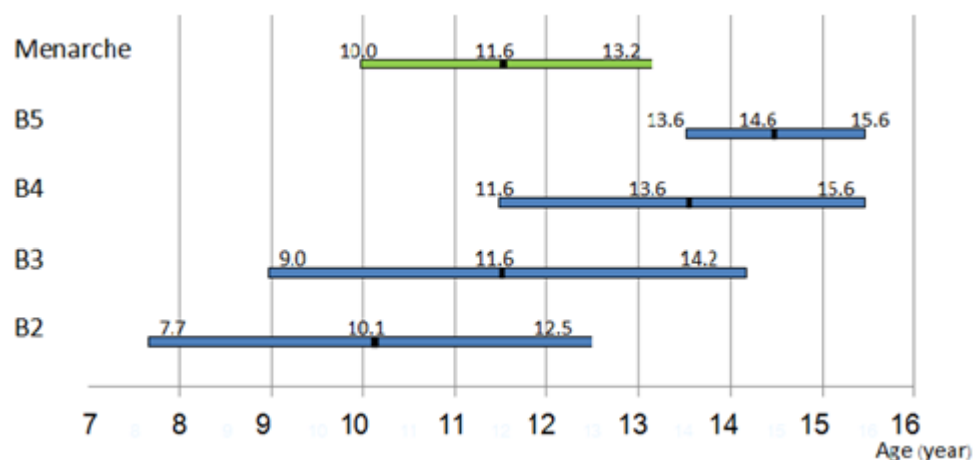
Tanner stages	Breast (B)	Pubic hair (PH)
1	Preadolescent	Preadolescent
2	Breast and papilla elevated as small mound, diameter of areola increased	Sparse, lightly pigmented, straight, , medial border of labia
3	Breast and areola enlarged, no contour separation	Darker, beginning to curl, increased amount
4	Areola and papilla from secondary mound	Coarse, curly, abundant, but less than in adults
5	Mature, nipple projects, areola part of general breast contour	Adult feminine triangle, spread to medial surface of thigh

**Table 2.** Weight, height, and body mass index (BMI) of 503 girls by age group

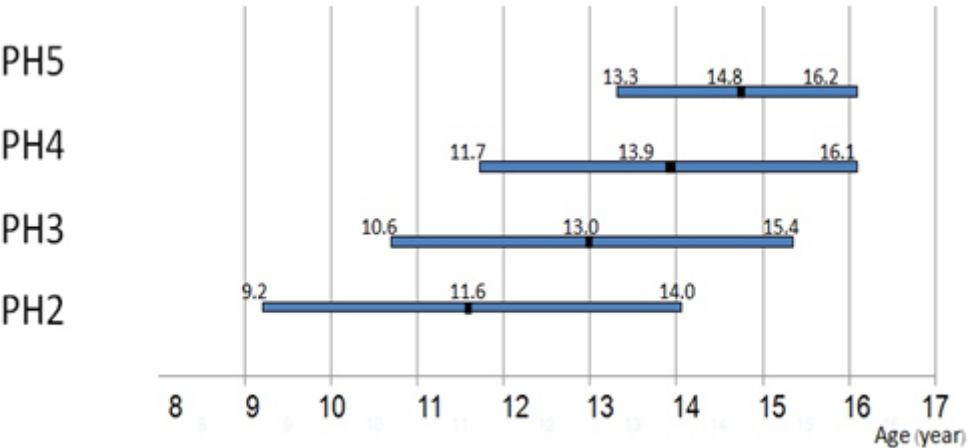
Age (years)	Number	Mean±SD		
		Weight (kg)	Height (cm)	BMI (kg/m <sup>2</sup> )
7.0-7.9	30	23.3±3.4	124.0±4.5	16.4±2.2
8.0-8.9	62	27.4±5.7	128.4±5.3	16.5±2.8
9.0-9.9	76	31.1±6.7	132.4±4.8	17.7±3.4
10.0-10.9	77	33.7±7.3	137.7±7.1	17.6±3.5
11.0-11.9	70	37.5±8.3	145.3±7.0	17.6±3.0
12.0-12.9	41	40.7±6.7	149.0±6.3	18.3±3.1
13.0-13.9	66	46.1±7.5	154.4±5.7	19.3±2.7
14.0-14.9	62	48.6±6.1	156.7±4.7	18.7±2.1
15.0-15.9	19	46.5±7.1	157.0±4.6	18.8±2.1
Total	503			

**Table 3.** Mean ages according to Tanner's stages of breast development (B), pubic hair (PH), and menarche

Stage	Number	Age (mean±SD) (yr)	Range (yr)
B1	81	9.3±1.1	7.0-12.1
B2	191	10.1±1.2	7.6-13.4
B3	116	11.6±1.3	9.4-15.0
B4	75	13.6±1.0	11.5-15.4
B5	40	14.6±0.5	12.4-16.0
PH1	233	9.8±0.9	7.0-12.5
PH2	94	11.6±1.2	8.9-14.5
PH3	73	13.0±1.2	9.4-15.1
PH4	91	13.9±1.1	10.1-15.4
PH5	12	14.8±0.7	12.4-16.0
Menarche	118	11.6±0.8	10.0-14.0



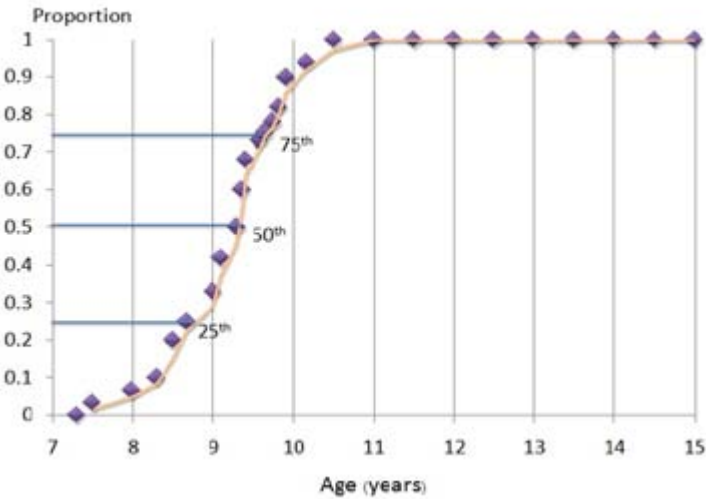
**Figure 1.** Ages (mean±2SD) on reaching each Tanner's stages of breast (B) and menarche



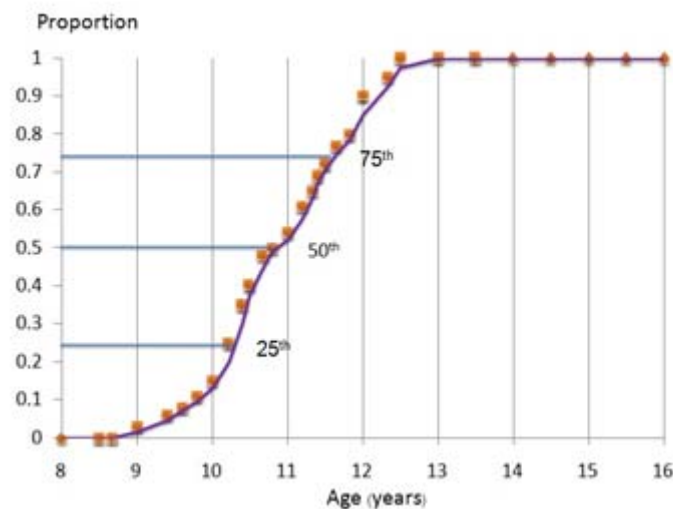
**Figure 2.** Ages (mean±2SD) on reaching each Tanner’s stages of pubic hair (PH)

**Table 4.** Ages of attainment of different pubertal stages and menarche according to Probit analysis for selected percentiles of urban Khon Kaen Thai girls

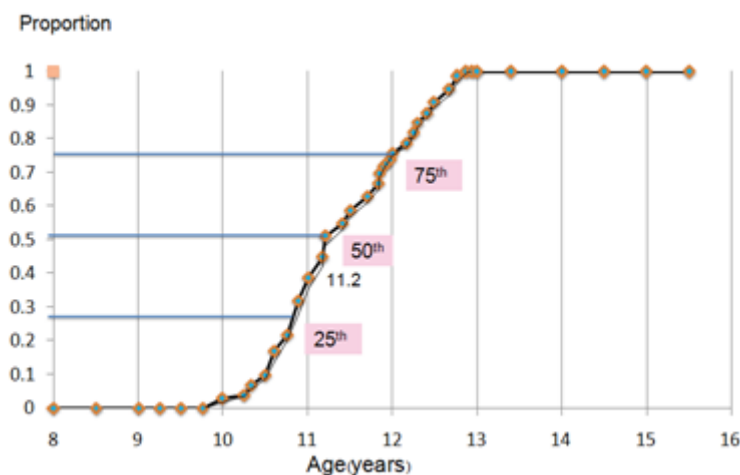
	P <sub>3</sub>	P <sub>10</sub>	P <sub>25</sub>	P <sub>50</sub> (95%CI)	P <sub>75</sub>	P <sub>90</sub>	P <sub>97</sub>
B2	7.6	7.8	8.8	9.3 (9.1-9.5)	9.7	10.0	10.2
P2	9.3	9.8	10.3	10.8 (10.4-11.3)	11.6	12.1	12.6
Menarche	10.3	10.5	10.8	11.2 (11.1-12.2)	12.0	12.5	12.9



**Figure 3.** Proportion of girls with Tanner II of breast development. Median age at thelarche is 9.3 years



**Figure 4.** Proportion of girls with Tanner II of pubic hair development. Median age at pubarche is 10.8 years



**Figure 5.** Proportion of girls reached menarche. Median age at menarche is 11.2 years

## Discussion

There have been periodic studies of pubertal development in Thailand [15-19]. Most studies reported pubertal stages from children self-assessments using pictures of Tanner staging. The median thelarcheal age of Thai schoolgirls in previous studies were 10.6 in 1984 [15], 9.9 in 1993 [17] and 9.4 years [19] in 1997 to 1999, respectively. The median age of thelarche by direct examinations in our study was 9.3 years. This appears to show slight decline of median age of thelarche in Thai girls. For pubarche and menarche, a recent study in the last decade from Bangkok (capital of Thailand) schoolgirls revealed the median age at pubarche and menarche

were 11.1 and 11.2 years, respectively [19]. In our study, however, the age of pubarche was 10.8 years, which is a reduction of 5 months in 10 years. However, the median age of menarche was 11.2 years, which was similar to the previous study in 1999 [19]. This demonstrated that the onset of secondary sexual development had shifted toward a younger age. The secular trend of earlier sexual maturation in Thai girls is also similar with other developed countries [5-9]. The declining age of thelarche and pubarche of urban Thai schoolgirls can be explained by improvement of nutrition, health, and socioeconomic status. The median age of thelarche in white girls in the USA was 10.4 years [5] whereas in this study it was 9.3 years. The

mean age of menarche in white girls in the USA was 12.9 years and has remained stable over the last 45 years [20]. In Thailand, the mean age was 12.1 years and has remained stable over the last 12 years. A study of pubertal progression in US girls showed that the onset of menarche was about 3 years behind the thelarche [20], but it was about 2 years in our study and did not change from the previous study in Thai girls. The rate of pubertal progression through menarche in the present study was 1 year sooner than US girls. The recent study of pubertal maturation in USA revealed the onset of puberty had shifted toward a younger age [20]. The Lawson Wilkins Pediatric Endocrine Society issued new recommendations for the age at which puberty should be considered precocious, lowering the prevailing standards from 8 years to 7 years for white girls and to 6 years for black girls [21]. Only two Thai girls (6.7%) had thelarche before 8 years. The Thai Society of Pediatric Endocrinology used cut-off of precocious puberty at 8 years in girls therefore recommendations for the age at which puberty should be considered precocious remained unchanged. All girls had thelarche and menarche before 13.4 and 14.0 years, therefore pubertal delay should be considered in Thai girls who had no breast development at 13 years and no menstruation at 14 years.

## Conclusion

The secular trend in decline of the ages of pubarche and menarche were observed in urban Khon Kaen Thai girls. These data can be used as the reference of normal pubertal development in Thai girls in Khon Kaen for determining precocious or delayed puberty.

## Acknowledgements

This study was granted by Faculty of Medicine, Khon Kaen University, Thailand (Grant Number I54219). We wish to acknowledge the support of the Khon Kaen University Publication Clinic, Research and Technology Transfer Affairs, Khon Kaen University, for their assistance. The authors have no conflict of interest to declare.

## References

- Needlman RD. Growth and development. In: Kliegman RM, Stanton BF, St. Geme JW, Schor NF, Behrman RE, editors. *Nelson textbook of pediatrics*. 19th ed. Philadelphia: Elsevier Saunders; 2011. p. 649-54.
- Reiter EO, Rosenfeld RG. Normal and aberrant growth. In: Larsen PR, Kronenberg HM, Melmed S, Polonsky KS, editors. *Williams textbook of endocrinology*, 10<sup>th</sup> ed. Philadelphia: Saunders; 2003. p. 1003-114.
- Eveleth PB, Tanner JM. Sexual development. In: Eveleth PB, editor. *Worldwide variation in human growth*. Cambridge: Cambridge University Press; 1990. p. 161-75.
- Rogol A, Blizzard RM. Variations and disorders of pubertal development. In: Kappy MS, Blizzard RM, Migeon CJ, editors. *Wilkins' the diagnosis and treatment of endocrine disorders in childhood and adolescence*. Springfield: Charles C Thomas; 1994. p. 857-917.
- Sun SS, Schubert CM, Chumlea WC, Roche AF, Kulin HE, Lee PA, et al. [National estimates of the timing of sexual maturation and racial differences among US children](#). *Pediatrics*. 2002; 110:911-9.
- Lindgren G. Pubertal stages 1980 of Stockholm schoolchildren. *Acta Paediatrica*. 1996; 85:1365-7.
- Fredriks AM, van Buuren S, Burgmeijer RJ, Meulmeester JF, Beuker RJ, Brugman E, et al. Continuing positive secular growth change in the Netherlands 1955–1997. *Pediatr Res*. 2000; 47: 316-23.
- de Muinich Keizer SM, Mul D. Trends in pubertal development in Europe. *Hum Reprod Update*. 2001; 7: 287-91.
- Castellino N, Bellone S, Rapa A, Vercellotti A, Binotti M, Petri A, et al. Puberty onset in Northern Italy: a random sample of 3597 Italian children. *J Endocrinol Invest*. 2005; 28:589-94.
- Cromer B, Gordon GM. [Early pubertal development in Chinese girls](#). *Pediatrics*. 2009; 124:799-801.
- Engelhardt L, Willers B, Pelz L. [Sexual maturation in East German girls](#). *Acta Paediatr*. 1995; 84:1362–5.
- De Simone M, Danubio ME, Amicone E, Verrotti A, Gruppioni G, Vecchi F. Age of onset of pubertal characteristics in boys aged 6–14 years of the Province of L'Aquila (Abruzzo, Italy). *Ann Hum Biol*. 2004; 31: 488-93.
- Juul A, Teilmann G, Scheike T, Hertel NT, Holm K, Laursen EM, et al. [Pubertal development in Danish children: comparison of recent European and US data](#). *Int J Androl*. 2006; 29:247-55.
- Marshall WA, Tanner JM. [Variations in pattern of pubertal changes in girls](#). *Arch Dis Child*. 1969; 44: 291-303.
- Khanjanastiti P, Wattanakasert S, Junnanond C,

- Kotchabhakdi N, Sriwatnankul K. Adolescent growth. J Med Assoc Thai. 1987; 70:187-97.
16. Department of Preventive and Social Medicine. Menarche in Chiang Mai women. Chiang Mai Med Bull. 1971; 10:292.
  17. Jaruratanasirikul S, Lebel L. Ages at thelarche and menarche: study in Southern Thai schoolgirls. J Med Assoc Thai. 1995; 78:517-20.
  18. Piya-anant M, Suvannichchati S, Bharschari M, Jirochkul V, Worapitaksanond S. Sexual maturation in Thai girls. J Med Assoc Thai. 1997; 80:557-64.
  19. Mahachoklertwattana P, Suthatvoravut V, Charoenkiatkul S, Chongviriyaphan N, Rojroongwasinkul N, Thakkestian A, et al. Earlier onset of pubertal maturation in Thai girls. J Med Assoc Thai. 2002; 85 (Suppl. 4):S1127-34.
  20. Herman-Giddens ME, Slora EJ, Wasserman RC, Bourdony CJ, Bhapkar MV, Koch GG, et al. [Secondary sexual characteristics and menses in young girls seen in office practice: a study from the pediatric research in office settings network](#). Pediatrics. 1997; 99:505-12.
  21. Kaplowitz PB, Oberfield SE. Reexamination of the age limit for defining when puberty is precocious in girls in the United States: implications for evaluation and treatment. Drug and Therapeutics and Executive Committees of the Lawson Wilkins Pediatric Endocrine society. Pediatrics. 1999; 104:936-41.