UDC: 618.172-053.6(497.75)
Original scientific paper

RELATIONSHIP BETWEEN AGE AT MENARCHE AND ANTHROPOMETRIC PARAMETERS IN GIRLS AGED 12–17 YEARS IN THE POLOG REGION, NORTH MACEDONIA

Veton ADEMI[1], Muhamed TAIRI[1], Alajdin HASANI[2], Beshra ELEZI ADEMI[2], Ema BEXHETI[2], Sadi BEXHETI[2]

[1*]*Department of Nursing, Faculty of Medical Sciences, University of Tetova, North Macedonia*
[2]*Department of Anatomy, Faculty of Medical Sciences, University of Tetova, North Macedonia*
[*]*Corresponding Author: e-mail: veton.ademi@unite.edu.mk*

Abstract

Background: Menarche is an important developmental milestone in a girl's reproductive life. The early onset of pubertal development is a significant medical and social issue. It can result in increased morbidity and mortality in later life. This study aimed to investigate the age of menarche in girls (aged 12–17 years) in the Polog region and to compare the time at which they attain menarche to their peers in other regions and Europe.
Methods: Using a cluster sampling technique, data were collected from schools in the Polog region, North Macedonia. A total of 309 schoolgirls aged 12–17 years were considered a sample for this study. Analysis of results was conducted using statistical programs STATISTICA 10.0 and SPSS 20.0.
Results: This study revealed that more than 75% of girls had already attained menarche. Among them, 50% of girls experienced menarche within 12.4 ± 1.1 years. Furthermore, there was no difference in the age of menarche in terms of living area, and those who lived in rural and urban areas reached their menarche at the same age. It was observed that the menarcheal girls had increased values of body weight ($p < 0.05$), body height ($p < 0.01$), waist circumference ($p < 0.05$), and biacromial distance ($p < 0.01$) compared with their nonmenarcheal peers.
Conclusions: The participants in our study attained menarche at the same age as their peers in Europe. It was observed that some of the age groups of menarcheal girls had increased values in some anthropometric characteristics compared with their nonmenarcheal peers.

Keywords: Age at menarche, Schoolgirls, Polog region.

1. Introduction

Menarche, or the first menstrual bleeding, is crucial in a woman's reproductive life. Several hormonal changes during puberty precede its onset, where clinically, the onset of puberty is indicated by the appearance of secondary sex characteristics, in particular the appearance of the breast in females, enlargement of the testicles in males, and pubic/axillary hair in both sexes.
Early onset pubertal development is one of the most severe medical and social issues, leading to increased morbidity and mortality later in life [Walvoord, 2010]. Menarcheal age (MA) is a crucial developmental milestone commonly used in epidemiological studies of female sexual maturity. It usually occurs 2 years after the first signs of puberty, between ages 11 and 15, and most commonly between ages 12 and 13. The first likely fertilization is only possible after 2 to 4 (even 6) years from the first menstruation, where the earliest possible age is 14 years old [Scholl *et al*, 2013; Talma *et al*, 2013; Gohlke *et al*, 2009; Flaws *et al*, 2000].
Being overweight has a significant impact on health in early adolescence, leading to the early onset of puberty, previously manifested by the development of breasts [Herman-Giddens *et al*, 1997] and menarche [Kaplowitz, 2006]. Environmental pollutants, socioeconomic status changes, and other factors are all believed to play a role in early puberty. However, diet plays a vital role in the timing and progression of puberty.
According to Bralic [Bralić *et al*, 2012], women who have experienced early menarche are significantly more likely to be overweight and have obesity. Similarly, Gavela Pérez's [Gavela-

Pérez *et al*, 2015] study emphasizes that obesity in women is associated with early menarche. Thus, having obesity and being overweight can predict the onset of menarche at a young age. Likewise, Frisch–Revelle [Johnston *et al*, 1975] posited that the onset of menstruation is positively associated with increased body fat in females during puberty (approximately 22 of body weight). However, despite some skepticism and criticism, the Frisch–Revelle hypothesis has provided reasonable explanations for how body fat affects the onset of menarche from the 1970s [Johnston *et al*, 1975; Crawford *et al*, 1975; Baker *et al*, 1985; Scott *et al*, 1982; Stark *et al*, 1989] to the present. Anthropometric measurements are noninvasive and quantitative measurements of the body used to assess growth, development, morphological characteristics, and health parameters [Fryar *et al*, 2016]. These measurements are now a requirement for the primary and secondary school cycles for students. It is closely linked to physical education and its impact on student health.

This study sought to determine the age of menarche in girls in the Polog region and to compare the time at which they attain menarche to their peers in this region and Europe. We also aimed to assess the role of MA in the structure of these girls' morphological characteristics to obtain growth and development norms. We can assess the impact of menarche on the growth and development of girls at various educational levels in the Polog region.

Material and methods

This study focused on the Polog region, which is located in the northwestern part of North Macedonia and covers an area of 2,416 km^2. This region is one of eight in North Macedonia, each with nine municipalities. There are 184 settlements on this territory, with a total population of 322,605 people [State Statistical Office, 2021; Centre for DPPR]. It is worth noting that this cross-sectional is the first of its kind in this part of North Macedonia. According to the proposal of the International Biologic Program IBP, No. 9, 1969, the research was conducted in primary and secondary schools in the Polog region [State Statistical Office, 2021; Centre for DPPR]. In this study, we surveyed girls aged 12–17 years in the Polog region who were physically capable of performing anthropometric measurements and volunteered to answer the questionnaire.

Sample size determination

Initially, the sample reliability level was set at 95% and P = 0.05. Then, through the statistical formula, the minimum number required for inclusion in the study is derived:

$$n = \frac{N}{1 + N\ (e)^2}$$

where n is the sample size, N is the population size, and e is the accuracy level.

The above formula provided that 292 was the sample size required for the present study. However, 309 samples were considered in our research, and their information was included in this study.

Sample selection procedures

The definition of the sampling frame was done in three stages:

- The first phase: the appropriate sampling frame is defined;
- The second phase: the sampling method is chosen on the basis of the composition of the population to be surveyed;

- The third phase: the average sample size was determined as sufficient to represent the surveyed population, where 309 girls from the surveyed school classes (groups) were randomly selected. Cluster sampling was used for sample selection because of the difficulty in researching all individuals (budgetary and time constraints).

The lead author described the objective of this study to selected participants. Written consent from each selected girl and permission from the school authorities were obtained. Anthropometric data of 309 girls and menarcheal status were recorded in the anthropometric card.

Outcome variable

The study's outcome variable was the menarcheal status (age of first menstruation) of schoolgirls aged 12–17 years. The girls were initially asked, "Did you attain menarche?" Yes (code, a) and No (code, b) were assigned to the sample (code, b). If they said yes, they were asked how old they were when they reached menarche in years, and the final question asked is which month they attained menarche.

Data collection procedure

The intervention protocols were developed according to the Helsinki Declaration [World Medical Association, 2001] and approved by the Regional Bureau for Development of Education in the municipalities where students' anthropometric measurements were taken. Additionally, written consent from each selected participant and permission from the school authorities were obtained. Anthropometric measurements were taken by trained individuals in two-person teams: one conducted the measurements, and the other recorded the measurements in a questionnaire. Given the population's culture and customs and the sensitivity of the issue of menarcheal status, this method was directed and led by female collaborators.

Anthropometric measurements were taken early in the morning during physical education class, while the subjects were dressed in light clothing (T-shirts, shorts, and socks), using the techniques of Martin and Saller [Martin *et al*, 1957]. An anthropometric card was formed for each student, and the biological age of each girl was determined by the date of birth and the date of measurement. GPM Swiss Made anthropological instruments were used for anthropometric measurements. The measurements for height and weight were 1 cm and 0.1 kg, respectively.

Statistical analysis

Results were processed using the statistical programs STATISTICA 10.0 and SPSS 20.0. The collected data were analyzed using statistical techniques such as attributive statistical series by calculating the coefficients of relationships, proportions, norms, and the statistical significance of detected differences in the difference test. Central tendency and data distribution measures were used to analyze numerical series (mean and standard deviation).

Results

In total, 309 girls aged 12–17 years were considered as the sample for this study, among them 52 (16.8%) aged 12 years; 54 (17.5%), 13 years old; 50 (16.2%), 14 years old; 51 (16.5%), 15 years old; 50 (16.2%), 16 years old; and 52 (16.8%), 17 years old. The number of girls in each age group was approximately the same.

Prevalence of age at menarche in schoolgirls aged 12–17 years

Table 1. The proportions of menarcheal and nonmenarcheal girls.

Age (years)	Response to the question, "Did you attain menarche?"			
	Yes		No	
	N	%	N	%
12	8	15.38	44	84.62
13	31	57.41	23	42.59
14	43	86.0	7	14.0
15	49	96.08	2	3.92
16	49	98.0	1	2.0
17	52	100.0	0	0
Total	232	75.1	77	24.9

Of the selected girls, 232 (75.1%) had already attained menarche, and 77 (24.9%) of girls had not yet attained menarche. The percentage of girls who had attained menarche was 15.38% of 12-year-olds, 57.41% of 13-year-olds, 86.0% of 14-year-olds, 96.08% of 15-year-olds, 98.0% of 16-year-olds, and 100.0% of 17-year-olds (Table 1).

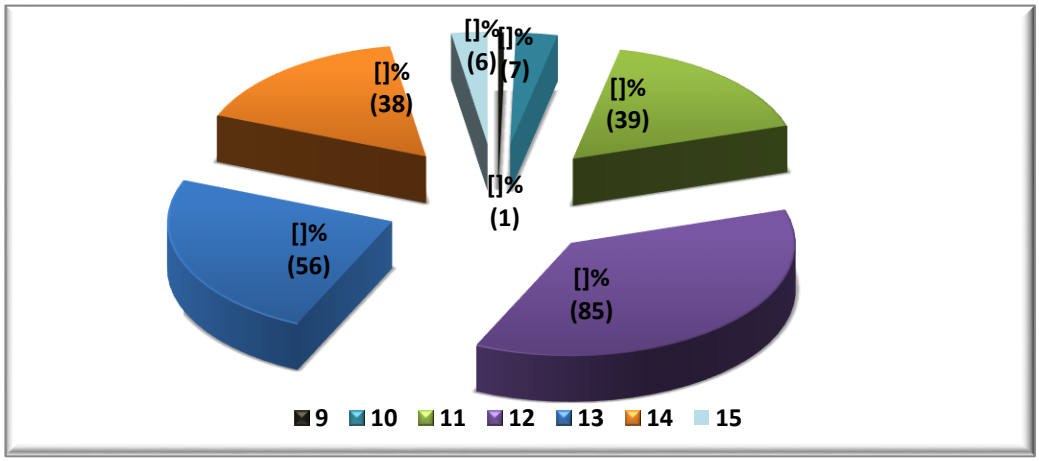

Figure 1. Prevalence of age at menarche among girls in the Polog region.

Of the 232 girls who attained menarche, 1 or 0.4% stated that they attained menarche at the age of 9, 7% or 3.0% at the age of 10, 39% or 16.8% at the age of 11, more than half or 60.8% (36.7% = age 12 and 24.1% = age 13) of girls at the age of 12 and 13, 38% or 16.4% at the age of 14, and 6% or 2.6% at the age of 15 (Figure 1).

Table 2. The mean age of menarche by age groups.

Age (years)	Mean	N	Std.Dev.	Minimum	Maximum	Q25	Median	Q75
12	10.6	8	0.744024	9.0	11.0	10.5	11.0	11.0
13	11.8	31	0.599283	10.0	13.0	11.0	12.0	12.0
14	11.8	43	0.843186	10.0	13.0	11.0	12.0	12.0
15	12.4	49	0.816497	11.0	14.0	12.0	12.0	13.0
16	12.9	49	1.151751	10.0	15.0	12.0	13.0	14.0
17	13.1	52	1.152085	10.0	15.0	12.0	13.0	14.0

Total	12.4	232	1.139442	9.0	15.0	12.0	12.0	13.0

In the survey, the participants were found to have attained their menarche, at the mean age of 12.4 ± 1.1 years, the minimum age of 9 years and the maximum age of 15 years; over 50% of the surveyed students attained the menarche at the age of ≥12 years, for IQR Median = 12 (12–13) (Table 2).

Table 3. The average age at menarche by their demographic variable.

Mean - rural	Mean - urban	N - rural	N - urban	Std.Dev. - rural	Std.Dev. - urban
12.41	12.40	155	77	1.143569	1.138556

Furthermore, those living in rural areas attained their menarche at the age of 12.41 years, whereas 77 of their peers living in urban settlements attained their menarche at the age of 12.40 years (Table 3).

Mean difference in anthropometric parameters between menarcheal and nonmenarcheal girls

Table 4. Mean difference in anthropometric variables between menarcheal and nonmenarcheal girls by age groups.

Variable / age years	Did you attain menarche? (N)	Mean	SD	*t* value	*p* value
Weight (kg)					
12	Yes (8) No (44)	51.2 41.3	4.32 4.43	3.84	**0.005**
13	Yes (31) No (23)	50.3 48.8	3.17 4.15	0.84	0.402
14	Yes (43) No (7)	58.3 49.1	3.33 4.12	3.45	**0.014**
15	Yes (49) No (2)	58.9 57.3	3.41 0.42	0.66	0.511
16	Yes (49) No (1)	56.4 55.5	3.76 0.00	0.98	0.328
Height (cm)					
12	Yes (8) No (44)	158.7 149.8	7.41 6.50	3.47	**0.001**
13	Yes (31) No (23)	159.3 157.8	6.19 6.23	0.84	0.402
14	Yes (43) No (7)	161.2 158.3	5.72 6.21	1.23	0.223
15	Yes (49) No (2)	162.9 160.3	5.59 0.35	0.66	0.511
16	Yes (49) No (1)	162.8 157.5	5.34 0.00	0.98	0.328
Waist circumference (cm)					
12	Yes (8) No (44)	72.4 65.6	9.97 6.16	−2.58	**0.012**

13	Yes (31)	68.6	7.55	−1.39	0.169
	No (23)	65.9	6.36		
14	Yes (43)	68.2	6.25	−1.88	0.066
	No (7)	63.1	8.68		
15	Yes (49)	71.8	7.54	−1.54	0.129
	No (2)	63.5	3.53		
16	Yes (49)	70.4	7.93	−0.79	0.429
	No (1)	64.0	0.00		
Biacromial distance (cm)					
12	Yes (8)	33.1	1.35	−3.68	**0.000**
	No (44)	30.2	2.18		
13	Yes (31)	32.5	2.05	−3.26	**0.001**
	No (23)	30.6	2.25		
14	Yes (43)	32.9	1.17	−4.53	**0.000**
	No (7)	30.2	2.73		
15	Yes (49)	33.2	1.97	−1.03	0.306
	No (2)	31.7	0.35		
16	Yes (49)	33.6	1.74	−0.36	0.716
	No (1)	33.0	0.00		

The average body weight of menarcheal girls aged 12 years (51.2 ± 4.32 kg) and 14 years (58.3 ± 3.33 kg) was significantly higher than that of nonmenarcheal girls aged 12 years (41.3 ± 4.43 kg) and 14 years (49.1 ± 4.12 kg) ($p < 0.05$). The mean body height of menarcheal girls aged 12 years (158.7 ± 7.41 cm) was significantly higher ($p < 0.01$) than their nonmenarcheal peers (149.8 ± 6.50 cm).

Likewise, the average waist circumference of menarcheal girls aged 12 years (72.4 ± 9.97 cm) was significantly larger ($p < 0.05$) than their nonmenarcheal peers (65.6 ± 6.16 cm). Additionally, the mean biacromial distance of menarcheal girls aged 12 years (33.1 ± 1.35 cm), 13 years (32.5 ± 2.05 cm), and 14 years (32.9 ± 1.17 cm) was significantly higher ($p < 0.01$) than their nonmenarcheal peers aged 12 years (30.2 ± 2.18 cm), 13 years (30.6 ± 2.25 cm), and 14 years (30,2 ± 2.73 cm), respectively ($p < 0.01$) (Table 4).

No statistically significant result was recorded for body weight in the age groups of 13, 15, and 16 years ($p > 0.05$). In the age groups of 13, 14, 15, and 16 years, no statistically significant results were recorded for the average height and waist circumference ($p > 0.05$). In the age groups of 15 and 16 years, no statistically significant results were recorded for the biacromial distance.

Discussion

This study aimed to investigate the role of MA in the structure of morphological characteristics of these adolescent girls (aged 12–17 years). Additionally, we determined several growth and development benchmarks from which we can assess the impact of menarche on the growth and development of girls at different educational levels in the Polog region. It was discovered that approximately 75.1% of girls provided positive responses, indicating that they had reached menarche, whereas 24.1% gave negative responses indicating that they had not reached menarche.

Overall, the examined girls reached menarche at the mean age of 12.4 ± 1.1 years, the minimum age of 9 years and the maximum age of 15 years; over 50% of the surveyed girls attained the

menarche at the age of 12 years, for IQR Median = 12 (12–13). As no other research has previously documented the data, this is the first time these crucial statistics of Polog and the Republic of North Macedonia have been disclosed. Our findings show that the girls in our study reached menarche at the same age as their peers in Europe [Tomova *et al*, 2009; Rubin *et al*, 2009, Rigon *et al*, 2010], the United States [McDowell *et al*, 2007, Morris *et al*, 2011], and Asia [Tang *et al*, 2003, Chang *et al*, 2008]. However, although some studies have discovered a significant decrease in the average age of menarche worldwide [Meng *et al*, 2017], others have identified variations in the average MA, which was found to be 11.73 years in Pakistani girls [Chan, 2004], 12.4 years in Indian girls [Khadgawat *et al*, 2016], and 12 years in Nigerian girls [Irewole-Ojo *et al*, 2018].

Menarcheal age and anthropometric parameters

A large proportion of the data indicates that girls who experienced menarche sooner are more likely to be overweight as adults [Freedman *et al*, 2003; Pierce *et al*, 2005; val Lenthe *et al*, 1996]. Similar to previous studies, our study found that adolescent girls who attained early menarche had a larger waist circumference than groups of girls who attained menarche later, implying that early sexual maturity leads to the accumulation of body fat mass [Freedman *et al*, 2003]. In a study conducted over a decade in European countries since 1950, Hauspie et al. [Hauspie *et al*, 1997] found that adults with early menarche had increased body height ranging from 0.3 to 1.3 cm. Unlike the data obtained in our findings, Chang [Chang *et al*, 2000] discovered that although body height increases faster in subjects with later menarche, there is no increase in statistical significance. Similarly, Kang [Kang *et al*, 2019] determined that 10.5% of their subjects with early menarche had shorter body lengths than their peers. By contrast, in another study, researchers described the case of a Korean girl who grew approximately 0.445 cm more in her final height for each year of age delay in menarche. According to Kim [Kim *et al*, 2010], girls who had reached menarche were taller and had a higher body weight than those who had not. The research found that menarchal girls had larger waist circumferences than their nonmenarchal counterparts. At certain ages, the different age groups in menarche showed significant differences ($P < 0.001$) in waist circumference, percentage of body fat mass, body length, and weight. Bratke [Bratke *et al*, 2017] reported that all anthropometric variables obtained in his research were directly related to menarcheal time. A low BMI, waist circumference, tricep skinfold thickness, and subscapular skinfold thickness were associated with later menarche, whereas a high value of these anthropometric parameters was associated with early menarche. Consequently, MA is seen as an indicator of faster sexual maturity in some studies, leading to a faster accumulation of fat in the peripubertal period, which can then continue into adulthood [Pierce *et al*, 2005]. Previous research suggests that many endo-neurocrine stimulants can affect the rate of sexual maturity and the likelihood of becoming overweight [val Lenthe *et al*, 1996].

Conclusion

In this study, we investigated the age of menarche in girls aged 12–17 years in North Macedonia's Polog region and analyzed the role of age at menarche in the morphological structure of girls. The findings indicate a prevalence of menarcheal status among girls of 75.1%. Generally, the examined girls attained their menarche at the age of 12.4 ± 1.1, reaching menarche at the same age as their peers in Europe, the United States, and some Asian countries. Compared with their nonmenarcheal peers, some age groups of menarcheal girls had higher values of body weight, body length, waist circumference, and biacromial distance. It is important to conduct similar studies on children and adolescents in various regions of North

Macedonia. Research of this kind will allow health professionals and policymakers to track their growth and development, observe anthropometric changes, and monitor changes in health-related data such as physical activity, eating habits, and lifestyle. These data will be immensely useful for observing healthcare trends and developing interventions policies tailored to the needs of this region.

Abbreviations

MA: *Menarcheal age*; Wt: *Weight*; Ht: *Height*; BD: *Biacromial distance*; Wc: *Waist circumference*; P: *P-value.*

Acknowledgments

The authors would like to acknowledge the schoolgirls who were willing to participate voluntarily in this study. The authors also wish to express their thanks to the school authorities for the permission to contact their female students.

Ethics approval and consent to participate

The authors complied with all laws and rules of the ethical committee. The intervention protocols were used following the guidelines of the Helsinki Declaration and were approved by the Regional Bureau for Development of Education in the respective municipalities of the Polog region. Written consent was obtained from each participant in this study.

Competing interests

The authors declare that they have no competing interests.

References

[1] Baker ER. (1985). Body weight and the initiation of puberty. Clinical Obstetrics and Gynecology. 28(3):573–579.

[2] Bralić I, Tahirović H, Matanić D, Vrdoljak O, Stojanović-Spehar SS, Kovacić V, Blazeković-Milaković S. (2012). Association of early menarche age and overweight/obesity. Journal of Pediatric Endocrinology and Metabolism. 2012;25(1–2):57–62.

[3] Bratke H, Bruserud IS, Brannsether B, Aßmus J, Bjerknes R, Roelants M, Júlíusson PB. (2017). Timing of menarche in Norwegian girls: associations with body mass index, waist circumference and skinfold thickness. BMC Pediatrics.17(1):138.

[4] Centre for development of Polog planning region. Polog Planning Region. (2018). [cited 2021 Jun 15]. Available from: https://rdcpolog.mk/abouttheregion/.

[5] Chan YH. (2004). Biostatistics 202: logistic regression analysis. Singapore Medical Journal. 45(4):149–153.

[6] Chang SH, Tzeng SJ, Cheng JY, Chie WC. (2000). Height and weight change across menarche of schoolgirls with early menarche. Archives of Pediatrics and Adolescent Medicine. 154(9):880–884.

[7] Chang SR, Chen KH. (2008). Age at menarche of three-generation families in Taiwan. Annals of Human Biology.35(4):394–405.

[8] Crawford JD, Osler DC. (1975). Body composition at menarche: the Frisch Revelle hypothesis revisited. Pediatrics.56(3):449–458.

[9] Flaws AJ, Sharara IF, Silbergeld KE, Hirshfield NA. (2000) Environmental exposures and women's reproductive health. In Women and Health, 2nd ed. Cambridge, Cambridgeshire: Academic Press; p. 625–633.

[10] Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. (2003). The relation of menarcheal age to obesity in childhood and adulthood: the Bogalusa heart study. BMC Pediatrics. 3(3):3.

[11] Fryar CD, Gu Q, Ogden CL, Flegal KM. (2016). Anthropometric reference data for children and adults: United States, 2011–2014. Vital and Health Statistics. Series 3, Analytical Studies. 39(39):1–46.
[12] Gavela-Pérez T, Garcés C, Navarro-Sánchez P, López Villanueva L, Soriano-Guillén L. (2015). Earlier menarcheal age in Spanish girls is related with an increase in body mass index between pre-pubertal school age and adolescence. Pediatric Obesity. 10(6):410–415.
[13] Gohlke B, Woelfle J. (2009). Growth and puberty in German children: is there still a positive secular trend? Deutsches Ärzteblatt International. 106(23):377–382.
[14] Hauspie RC, Vercauteren M, Susanne C. (1997). Secular changes in growth and maturation: an update. Acta Paediatrica. 423:20–27.
[15] Herman-Giddens ME, Slora EJ, Wasserman RC, Bourdony CJ, Bhapkar MV, Koch GG, Hasemeier CM. (1997). Secondary sexual characteristics and menses in young girls seen in office practice: a study from the pediatric research in office settings network. Pediatrics. 99(4):505–512.
[16] Irewole-Ojo FO, Senbanjo IO, Oduwole AO, Njokanma OF. (2018). Age of pubertal events among schoolgirls in Lagos, Nigeria. Journal of Pediatric Endocrinology and Metabolism.31(3):313–321.
[17] Johnston FE, Roche AF, Schell LM, Norman H, Wettenhall B. (1975). Critical weight at menarche. Critique of a hypothesis. American Journal of Diseases of Children.129(1):19–23.
[18] Kang S, Kim YM, Lee JA, Kim DH, Lim JS. (2019). Early Menarche is a risk factor for short stature in young Korean females: an epidemiologic study. Journal of Clinical Research in Pediatric Endocrinology.11(3):234–239.
[19] Kaplowitz P. (2006). Pubertal development in girls: secular trends. Current Opinion in Obstetrics and Gynecology.18(5):487–491.
[20] Khadgawat R, Marwaha RK, Mehan N, Surana V, Dabas A, Sreenivas V. (2016). Age of onset of puberty in apparently healthy school girls from Northern India. Indian Pediatrics.53(5):383–387.
[21] Kim JY, Oh IH, Lee EY, Oh CM, Choi KS, Choe BK. (2010). The relation of menarcheal age to anthropometric profiles in Korean girls. Journal of Korean Medical Science.25(10):1405–1410.
[22] Martin R, Lehrbuch SK. (1957). DER Anthropologie. Stuttgart: Gustav Fischer Verlag.
[23] McDowell MA, Brody DJ, Hughes JP. (2007). Has age at menarche changed? Results from the National Health and Nutrition Examination Survey (NHANES) 1999–2004. Journal of Adolescent Health. 40(3):227–231.
[24] Meng X, Li S, Duan W, Sun Y, Jia C. (2017). Secular trend of age at menarche in Chinese adolescents born from 1973 to 2004. Pediatrics.140(2):1–9.
[25] Morris DH, Jones ME, Schoemaker MJ, Ashworth A, Swerdlow AJ. (2011). Secular trends in age at menarche in women in the UK born 1908–93: results from the Breakthrough Generations Study. Paediatric and Perinatal Epidemiology. 25(4):394–400.
[26] Pierce MB, Leon DA. (2005). Age at menarche and adult BMI in the Aberdeen children of the 1950s cohort study. The American Journal of Clinical Nutrition. 82(4):733–739.
[27] Rigon F, Bianchin L, Bernasconi S, Bona G, Bozzola M, Buzi F. (2010). Update on age at menarche in Italy: toward the leveling off of the secular trend. Journal of Adolescent Health.46(3):238–244.
[28] Rubin C, Maisonet M, Kieszak S, Monteilh C, Holmes A, Flanders D. (2009). Timing of maturation and predictors of menarche in girls enrolled in a contemporary British cohort. Paediatric and Perinatal Epidemiology.23(5):492–504.
[29] Scholl OTh, Chen X. (2013). Puberty and adolescent pregnancy. In Women and Health. Lebanon. Grafton County: Academic Press; p. 151–162.
[30] Scott EC, Johnston FE. (1982). Critical fat, menarche, and the maintenance of menstrual cycles: A critical review. Journal of Adolescent Health Care. 2(4):249–260.
[31] Stark O, Peckham CS, Moynihan C. (1989). Weight and age at menarche. Archives of Disease in Childhood. 64(3):383–387.
[32] State Statistical Office. (2021). Regional Yearbook: Regions in Republic of North Macedonia 2020. Skopje. p. 16–17.
[33] Talma H, Schönbeck Y, van Dommelen P, Bakker B, van Buuren S, Hirasing RA. (2013). Trends in menarcheal age between 1955 and 2009 in the Netherlands. PLOS ONE. 8(4):e60056.
[34] Tang CS, Yeung DY, Lee AM. (2003). Psychosocial correlates of emotional responses to menarche among Chinese adolescent girls. Journal of Adolescent Health. 33(3):193–201.
[35] Tomova A, Genov N, Kumanov F, Robeva R. (2009). Menarche in Bulgarian-secular trend in twenty century. Akusherstvo i Ginekologiia. 48(3):10–14.
[36] van Lenthe FJ, Kemper CG, van Mechelen W. (1996). Rapid maturation in adolescence results in greater obesity in adulthood: the Amsterdam Growth and Health Study. The American Journal of Clinical Nutrition. 64(1):18–24.

[37] Walvoord EC. (2010). The timing of puberty: is it changing? Does it matter? Journal of Adolescent Health. 47(5):433–439.
[38] World Medical Association. (2001). World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. Bulletin of the World Health Organization. 79(4):373–374.