

## Generational Trends in Menarcheal Age: A Comparative Analysis of Adolescent Girls and Their Mothers in Southern Kerala, India.

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### Abstract

**Background:** The onset of menarche serves as a profound developmental milestone, reflecting both the reproductive maturation and systemic health of female populations. Over the past century, global epidemiological data have highlighted a secular trend demonstrating a gradual reduction in the age of first menstruation.

**Methods:** Employing a descriptive, cross-sectional framework, this investigation assessed the AOM (Age of Menarche) among pair of 180 adolescent girls (aged 11–19 yrs.) and their biological mothers in Rural areas of Kollam, South Kerala. Data regarding demographic variables, socio-economic status, and dietary habits were systematically gathered via validated structured questionnaires.

**Results:** A stark generational decline in age was documented. Mothers reported a Mean AOM of 13.13 yrs, whereas their adolescent daughters experienced menarche at an average age of 11.69 yrs, a significant decline of -1.44 yrs. across a single/filial generation. Statistical analysis revealed a moderate positive correlation ( $r=0.541^{***}$ ,  $p<0.001$ ), suggesting that while genetic factors remain a primary determinant, the modern transition in dietary habits, BMI ( $r = -0.68^{**}$ , BMI V/S AOM,  $p<0.01$ ), and sedentary lifestyles are accelerating the onset of puberty.

**Conclusion:** A localized downward secular trend in pubertal timing is clearly evident. These findings underscore the profound influence of evolving dietary patterns such as junk food consumption, increasing body mass index and socio-economic landscapes on human biological maturation, necessitating updated frameworks for early adolescent reproductive health education.

**Keywords:** Age of Menarche (AOM); Puberty; Adolescent health; Generational trends; BMI; Dietary habits; Reproductive health; Southern Kerala

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### 1. Introduction

Adolescence is a transformative phase characterized by rapid somatic growth and the attainment of reproductive capacity. Menarche is the most definitive biological marker of this maturation. Over the last century, a "secular trend", a progressive decline in the age of pubertal onset has been documented globally. While European data suggests a stabilization of this trend, developing nations like India continue to see a significant downward shift.<sup>1</sup> For female adolescents, the most definitive marker of sexual maturation is menarche. The chronological timing of pubertal changes and menarche serves as a vital sensor for both individual developmental trajectories and broader population health. While genetic inheritance establishes a biological baseline, the actual onset of puberty is deeply sensitive to environmental modulators.<sup>2</sup> Investing in adolescent health is essential for national prosperity, as the nutritional and physiological status of young girls directly influences the health of future generations. Recent studies emphasize that the age of menarche is not a fixed biological constant but a plastic trait influenced by parental age at childbirth and intrauterine

environments.<sup>3</sup> Furthermore, research in the Indian context has highlighted that affluent Indian children reach maturity faster than their rural counterparts, pointing toward socioeconomic and nutritional determinants.<sup>4</sup> Across various global cohorts, from the Middle East to the Caribbean, improved living standards and changes in body fatness have been consistently linked to earlier maturation.<sup>5,6</sup> This biological acceleration carries significant clinical implications. The early initiation of puberty is intricately linked to several long-term health vulnerabilities. Women who experience early menarche (typically classified as before age 12) exhibit a heightened predisposition to adult obesity, metabolic syndromes, and cardiovascular events.<sup>7</sup> Furthermore, the premature activation of the hypothalamic-pituitary-gonadal axis prolongs lifetime exposure to endogenous oestrogens, establishing a known risk factor for hormone-dependent malignancies such as breast cancer.<sup>8,9</sup> Recent meta-analyses have confirmed a robust J-shaped correlation between early Menarcheal age and systemic cardiovascular morbidity.<sup>10</sup> This study aims to quantify this shift within a specific rural cohort in Kerala, examining how the

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transition from traditional cereal-based diets to modern sedentary lifestyles and increasing body mass index influence the Age of Menarche among adolescent girls in correlation to their mothers

### Study Objectives

- ❖ Assess the age of menarche (AOM) among adolescent daughters and their mothers
- ❖ Compare the Mean AOM among adolescent daughters and mothers
- ❖ Find out the Correlation between the AOM in adolescent daughters and their mothers
- ❖ Assess the BMI levels in adolescent girls
- ❖ Examine the correlation between BMI and AOM among adolescent daughters

## 2. Methodology

### Study Design and Setting

A quantitative, descriptive research design was employed. The study was localized in Vadekkevila village, Kollam district, South Kerala, representing a rural population undergoing lifestyle transitions.

### Participants and Sampling

A sample of 180 adolescent girls (aged 11–19 yrs.) and their biological mothers was selected using purposive sampling. This pairing allowed for a direct genetic and shared-environment comparison. Inclusion criteria required both participants to have attained menarche and reside in the same socio-geographic area.

### Data Collection and Analysis

Data were gathered via a structured questionnaire covering demographic variables, dietary habits, and Menarcheal history. Height and weight were recorded to calculate Body Mass Index (BMI). Analysis was done using SPSS v 27; utilized descriptive statistics (Mean, Median, Mode, SD) and inferential statistics such as Shapiro- Wilks test for checking Normal distribution of data, Paired t test and Wilcoxon Signed Rank tests for comparison of AOM means among Adolescent daughters and mothers; Pearson’s Correlation Coefficient,  $r$  to determine the strength of the intergenerational relationship and correlation between BMI and AOM were performed.

## 3. Results

### Section I: Sample Characteristics

**Table 1: Demographic Characteristics Including Dietary Pattern of Adolescent Girls (N=180)**

SL NO.	Socio-Demographic Variables Adolescent Girls (Daughters)		
<b>01</b>	<b>Age (In years)</b>	<b>f</b>	<b>%</b>
	11-13yrs.	89	49.4%
	14-16yrs.	64	35.6%
	17-19 yrs.	27	15%
<b>02</b>	<b>Religion</b>	<b>f</b>	<b>%</b>
	Hindu	84	46.7%
	Muslim	75	41.7%
	Christians	21	11.6%
<b>03</b>	<b>Type of family</b>	<b>f</b>	<b>%</b>
	Nuclear	165	91.7%
	Joint/Extended	15	8.3%
<b>04</b>	<b>Family Income/Month</b>	<b>(f)</b>	<b>(%)</b>
	Up to 10000 ₹	41	22.7%
	10001-20000 ₹	68	37.7%
	20001-30000 ₹	37	20.7%
	More than 30000 ₹	34	18.9%
<b>05</b>	<b>Dietary Pattern</b>	<b>(f)</b>	<b>(%)</b>
	Vegetarian	11	7.3%
	Non-Vegetarian	169	93.7%
<b>06</b>	<b>No. of Siblings</b>	<b>(f)</b>	<b>(%)</b>
	None	14	7.8%
	01	121	67.2%
	02 or more	45	25%
<b>07</b>	<b>Junk Food Consumption</b>	<b>(f)</b>	<b>(%)</b>
	Yes	171	95%
	No	9	5%
<b>08</b>	<b>Any Medical Ailments</b>	<b>(f)</b>	<b>(%)</b>

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	Yes	12	6.7%
	No	168	93.3%

**Inference:** The table shows that majority (49.4%) belonged to the age group 11-13yrs, (46.7%) were Hindu; 91.7% were from nuclear family; (93.7%) samples were non vegetarian; 95% presented with junk food consumption and 6.7% had medical ailments. Furthermore, Majority belonged to the low (22.7%) and middle-income group (37.7%).

**Table 2: Mean, Median, Mode, SD and Range of Adolescent Girls and their Mothers AOM (N=360)**

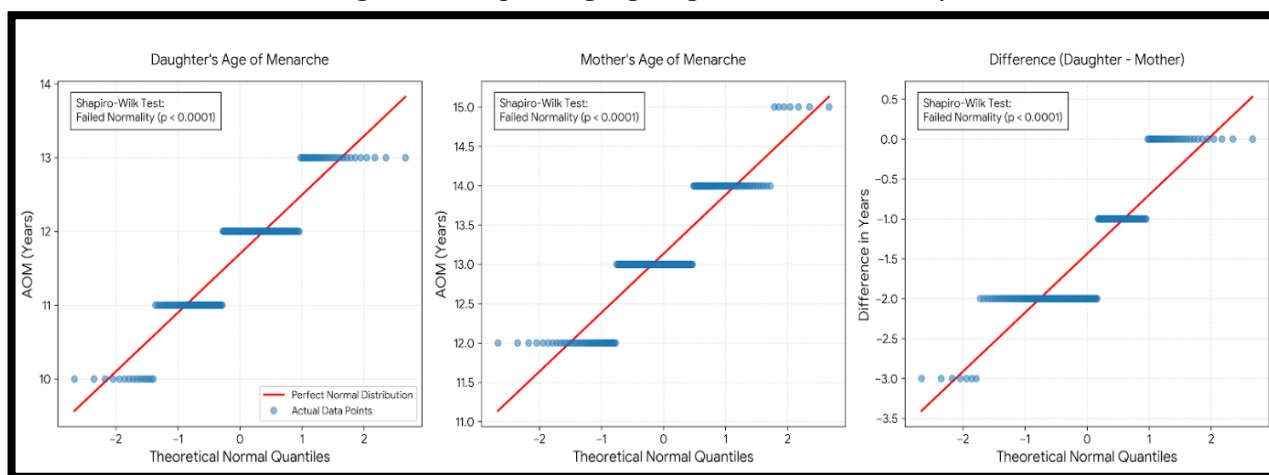
Parameter	Daughters (n=180)	Mothers (n=180)	Mean Difference
Mean (AOM)	11.69 yrs.	13.13 yrs.	-1.44 yrs.
Median (AOM)	12.00 yrs.	13.00 yrs.	-1.00 yrs.
Mode (AOM)	12.00 yrs.	13.00 yrs.	-1.00 yrs.
Standard Deviation (AOM)	0.85 yrs.	0.80 yrs.	--
Range (Min – Max) (AOM)	10 – 13 yrs.	12 – 15 yrs.	--

**Inference:** The above table findings demonstrate a distinct reduction in the age of onset across the filial generation.

**Table 3: Assumption Checks (Normality Test)**

Group / Variable	Shapiro-Wilk (W)	p-value	Inference
Daughters	0.8683	<0.0001	Not normally distributed
Mothers	0.8540	<0.0001	Not normally distributed
Paired Differences	0.8049	<0.0001	Not normally distributed

**Figure 1: Q-Q plots highlighting the test for Normality**



**Inference:** The data was found to be non-normally distributed due to AOM, Age of Menarche being recorded as discrete whole-numbers, resulting in a stair-step distribution pattern on the Q-Q plots.

**Section II: Comparison of AOM**

**Table 4: Paired t test, Wilcoxon Signed Rank Statistics' Comparison of AOM among Adolescents Girls and their mothers (N=180)**

Test / Metric	Statistic Value	p-value	Interpretation
Paired t-test	t= -23.74***	<0.0001	Highly significant difference
Wilcoxon Signed-Rank	Z= -11.023***	<0.001	Highly significant difference (robust)

\*\*\* Highly Significant at p<0.001 levels.

**Inference:** Since the data was not normally distributed, consequently, the Wilcoxon signed-rank test was utilized alongside the paired t-test; both tests yielded highly significant results. The analysis revealed a statistically significant decrease in AOM among daughters compared to their mothers (Z = -11.023\*\*, p < .001). The negative Z-score and rank distribution indicate that the daughters systematically reached menarche at an earlier age than their maternal counterparts, firmly establishing that daughters experienced menarche significantly earlier than their mothers, indicating a generational difference in their AOM. The t-test (t = -23.74\*\*\*, p<0.0001) showed a -1.44-yrs; decline in AOM). However, the "genetic baseline" is still preserved (the Pearson's r). indicating of the massive generational trend.

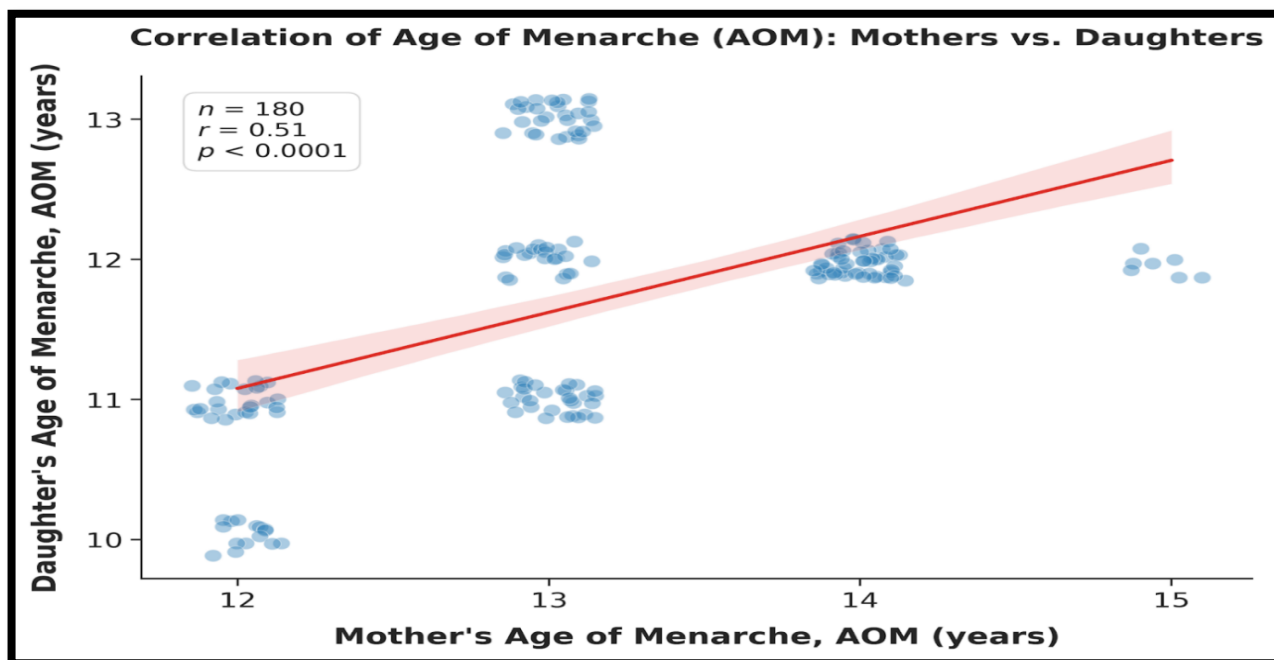
**Section III: Inferential Statistics; Correlation between Mean AOM of Adolescent Daughters and their mothers.**

**Table 5: Pearson Correlation Analysis (r) between AOM of Adolescent Girls (Daughters) and their Mothers. (N=180)**

Metric	Value	Interpretation / Note
Pearson's r	0.514***	Moderate positive correlation
R-squared (R <sup>2</sup> )	0.264	26.4% of variance explained
p-value	< 0.0001	Highly statistically significant
Sample Size (N)	180 pairs	Robust sample size

\*\*\*Highly Significant at p<0.001 levels

**Figure 2: Correlation between AOM in Adolescent Girls (Daughters) and their Mothers.**



**Inference:** The correlation coefficient ( $r = 0.514^{***}$ ) falls into the category of a Moderate Positive relationship. This means that if a mother reached menarche late than the average, her daughter is also highly likely to reach a late menarche in comparison to the general population. Conversely, early-maturing mothers tend to have early-maturing daughters. Approximately 26.4% of the variation in the daughters' age of menarche is directly predictable by, or associated with, their mothers' age of menarche and about 73.6% of the Variance is likely driven by environmental factors, such as modern nutrition, childhood obesity, endocrine disruptors, socioeconomic shifts, and standard biological variation.

**Section IV: Body mass Index of Adolescent Daughters**

**Table 6: BMI levels among adolescent girls (N=180)**

Parameter	Under Weight	Normal Weight	Overweight	Obesity
BMI	07	100	61	12

**Inference:** The table reveals that 61 adolescent girls presented with overweight and 12 samples had obesity.

**Section V: Correlation between BMI and AOM**

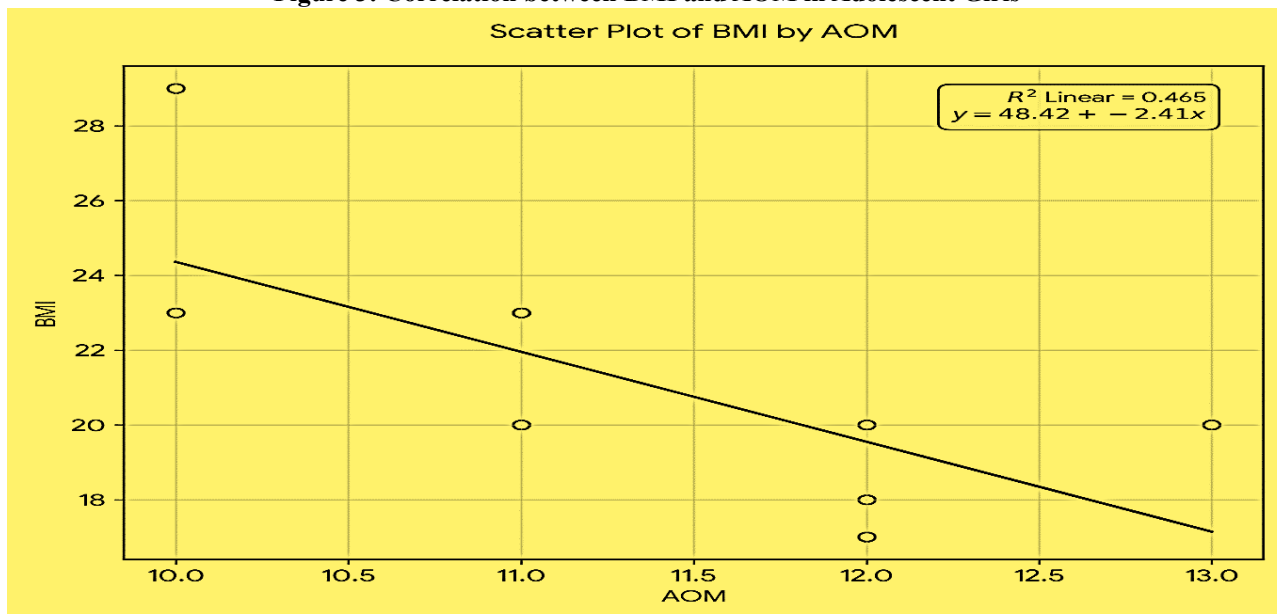
**Table 7: Pearson's r statistics showing Correlation between BMI and AOM among Adolescent girls (N=180)**

Metric	Mean ± SD	Pearsons r	P value	Interpretation / Note
BMI	20.2833 ± 2.98652	-0.682**	<0.01	Moderate Negative correlation
AOM	11.6944 ± .84627			

\*Note: R-squared (R<sup>2</sup>) Value: 0.465; 46.5% of variance explained.

\*\* Highly Significant at p<0.01 levels.

Figure 3: Correlation between BMI and AOM in Adolescent Girls



**Inference:** The negative correlation interprets that as the BMI increases the AOM among adolescent girls decreases; otherwise, increased obesity can induce decline in Menarcheal age and early puberty.

#### 4. Discussion

Our results confirm a secular trend toward earlier menarche in rural Kollam, consistent with findings by Ersoy et al.<sup>5</sup> who noted that while maternal age is a strong predictor, environmental triggers often accelerate the biological process. This investigation provides concrete localized evidence of a rapid secular decline in the age of menarche, documenting a 1.44-year drop between mothers (mean 13.13 yrs.) and their adolescent daughters (mean 11.69 yrs.). These results align seamlessly with broader epidemiological surveillance across India, which has tracked mean AOM declining from above 14 years in older cohorts to below 13.5 years in modern adolescents.<sup>11</sup> While the robust correlation between AOM of adolescent daughters and mothers ( $r = 0.514^{***}$ ,  $p < 0.0001$ ), reinforces the notion that Menarcheal timing is deeply rooted in genetic/hereditary factors, genetics alone cannot explain a shift of over a year within the filial generation. Instead, this phenomenon illustrates the profound plasticity of the human endocrine system in response to shifting environments. The most prominent environmental variable identified in this study was the generational deterioration of dietary quality. Over 26% of the modern adolescents reported high consumption of processed junk food, a stark departure from the traditional diets of their mothers. Extensive pediatric literature corroborates that childhood nutritional status and subsequent body mass index (BMI) act as primary gatekeepers of pubertal onset.<sup>12</sup> Diets excessively rich in simple carbohydrates and fats lead to increased adiposity; adipose tissue subsequently functions as an active endocrine organ, secreting leptin which prematurely stimulates the hypothalamic-pituitary-gonadal axis. The results of the study that a moderate positive correlation was observed between AOM and BMI are in accordance with a similar research conducted among 144 middle school students

in Seoul, south Korea which revealed that increase in BMI was associated with early menarche (8-12 yrs), ( $P < 0.05$ ).<sup>13</sup> Contemporary studies globally have repeatedly demonstrated that higher BMI and waist-to-height ratios are significantly correlated with earlier AOM.<sup>14,15</sup> Furthermore, early-life nutritional transitions and accelerated caloric intake frequently override normal pubertal timelines, bypassing the slower biological maturation rates.<sup>16,17</sup> Similar generational comparative studies in other regions have recorded almost identical drops, confirming that environmental trends acts a universal catalyst for early maturation.<sup>5,18</sup> The rise in adolescent early menarche introduces severe long-term risks. Early menarche hampers the childhood developmental and has been systematically linked to adverse reproductive health outcomes in developing countries. Biologically, it extends a woman's lifetime exposure to endogenous oestrogens, elevating the risk profile for breast malignancies and lifelong metabolic complications.<sup>19</sup>

#### Limitations

The study adopted a non-random sampling technique, generalizability of findings remains difficult. Also, the study was limited to a small geographical location of rural Kollam, Kerala. Keeping aside all the odds, the sheer magnitude of the 1.44 yrs. generational gap remains statistically compelling and conceptually aligned with the literature reviews.

#### 5. Conclusion

The study concludes that adolescent girls in rural Kollam are reaching biological maturity over a year earlier than the previous generation. While maternal history remains a strong genetic predictor of a daughter's relative pubertal onset ( $r = 0.541^{***}$ ), modern environmental variables such as shifting dietary paradigms and

increased caloric density are aggressively accelerating BMI, growth and development in adolescents. ( $r = -0.68^{**}$ , Moderate negative Correlation observed between BMI and AOM). Public health policymakers and paediatricians must adapt to these shifting physiological timelines, prioritizing early nutritional intervention and redefining the chronological frameworks for adolescent reproductive education.

### Ethical implications

All Ethical principles were followed throughout the conduct of this research. IEC certificate Vide, Order No. PMU/PMCH/IEC/21; Dated 01/04/2023 was obtained along with all formal permissions prior to the study. Also, an informed consent was taken from the study participants. Furthermore, full confidentiality was maintained during the period of the study.

### Conflicts of Interest

None

### Funding

None, Self-Budgeted

### References (Vancouver Style)

1. Meher T, Sahoo H. Secular trend in age at menarche among Indian women. *Scientific Reports* [Internet]. 2024 Mar 5 [cited 2024 Apr 29];14(1):5398. Available from: <https://www.nature.com/articles/s41598-024-55657-7>
2. Perry JRB, Stolk L, Franceschini N, Lunetta KL, Zhai G, McArdle PF, et al. Meta-analysis of genome-wide association data identifies two loci influencing age at menarche. *Nature Genetics* [Internet]. 2021 [cited 2026 Apr 28];41(6):648–50. Available from: <https://cdr.lib.unc.edu/concern/articles/hq37vx63d>
3. Warp ML, Grindstad T, Skåra KH, Magnus MC, Håberg SE, Morken N, et al. Maternal time interval between menarche and childbirth is associated with daughter's age at menarche. *Acta Obstetrica et Gynecologica Scandinavica* [Internet]. 2025 Apr 8 [cited 2026 Apr 28];104(6):1101. Available from: <https://pubmed.ncbi.nlm.nih.gov/articles/PMC12087503/>
4. Agarwal D, Agarwal K. Original Articles Physical Growth in Indian Affluent Children (Birth -6 Years) [Internet]. [Cited 2025 May 7]. Available From: <https://www.Indianpediatrics.Net/Apr1994/377.Pdf>
5. Ersoy B, Balkan C, Gunay T, Egemen A. The factors affecting the relation between the menarcheal age of mother and daughter. *Child: Care, Health and Development*. 2005 Apr 11;31(3):303–8. Available From: <https://pubmed.ncbi.nlm.nih.gov/15840150/>
6. Ramraj B, Subramanian VM, Vijayakrishnan. Study on age of menarche between generations and the factors associated with it. *Clin Epidemiol Glob Health* [Internet]. 2021;11(100758):100758. Available from: <http://dx.doi.org/10.1016/j.cegh.2021.100758>
7. Lee HS. Why should we be concerned about early menarche? *Clinical and Experimental Pediatrics*. 2020 Jul 13;64(1). Available from: <https://www.e-cep.org/journal/view.php?doi=10.3345/cep.2020.00521>
8. Bodicoat DH, Schoemaker MJ, Jones ME, McFadden E, Griffin J, Ashworth A, et al. Timing of pubertal stages and breast cancer risk: the Breakthrough Generations Study. *Breast Cancer Research*. 2014 Feb;16(1). Available from: <https://pubmed.ncbi.nlm.nih.gov/articles/PMC3978643/>
9. Dall GV, Britt KL. Estrogen Effects on the Mammary Gland in Early and Late Life and Breast Cancer Risk. *Frontiers in Oncology*. 2017 May 26;7. Available from: <https://pubmed.ncbi.nlm.nih.gov/28603694/>
10. Behboudi-Gandevan S, Moe CF, Ingunn Skjesol, Arntzen EC, Raziieh Bidhendi-Yarandi. The J shaped association of age at menarche and cardiovascular events: systematic review and meta-analysis. *Scientific Reports* [Internet]. 2024 Feb 1;14(1). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10834967/>
11. Pathak PK, Tripathi N, Subramanian SV. Secular Trends in Menarcheal Age in India-Evidence from the Indian Human Development Survey. Baradaran HR, editor. *PLoS ONE*. 2014 Nov 4;9(11):e111027. Available from: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0111027>
12. Soliman A, Sanctis V, Elalaily R. Nutrition and pubertal development. *Indian Journal of Endocrinology and Metabolism* [Internet]. 2014;18(7):39. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4266867/>
13. Oh CM, Oh IH, Choi KS, Choe BK, Yoon TY, Choi JM. Relationship Between Body Mass Index and Early Menarche of Adolescent Girls in Seoul. *Journal of Preventive Medicine and Public Health* [Internet]. 2012 Jul 1 [cited 2021 Apr 9];45(4):227–34. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3412985/>
14. Marconi D, Lipari D, Pammolli A, Dalmaso P, Nardone P, Vieno A, et al. How does BMI correlate with menarche onset? Evidence from the Italian HBSC cross-sectional study. *BMC Women's Health*. 2025 Jan 29;25(1). Available from: <https://link.springer.com/article/10.1186/s12905-025-03572-y>
15. Rakic R, Pavlica T, Havrljenko J, Bjelanovic J. Association of Age at Menarche with General and Abdominal Obesity in Young Women. *Medicina*. 2024 Oct 18;60(10):1711. Available from: <https://www.mdpi.com/1648-9144/60/10/1711>

16. Lyu Y, Mirea L, Yang J, Warre R, Zhang J, Lee SK, et al. Secular trends in age at menarche among women born between 1955 and 1985 in Southeastern China. *BMC Women's Health*. 2014 Dec;14(1). Available from: <https://link.springer.com/article/10.1186/s12905-014-0155-0>
17. Song Y, Ma J, Agardh A, Lau PWC, Hu P, Zhang B. Secular trends in age at menarche among Chinese girls from 24 ethnic minorities, 1985 to 2010. *Global Health Action*. 2015 Jul 27;8(1):26929. Available from: <https://www.tandfonline.com/doi/full/10.3402/gha.v8.26929>
18. Anitha A, Jayakumari J. A Comparative Study of Daughter and Mother's Menarche Age with their BMI and Socioeconomic Status. *International Journal of Enterprise Network Management*. *Int. J. Pharm. Sci. Rev. Res.*, 41(1), November - December 2016; 122-125. Available from: <https://globalresearchonline.net/journalcontents/v41-1/24.pdf>
19. Forman M, Mangini L, Thelus-Jean R, Hayward. Life-course origins of the ages at menarche and menopause. *Adolescent Health, Medicine and Therapeutics*. 2013 Jan;4:1. Available from: <https://www.dovepress.com/article/download/12010>