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## ABSTRACT

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*Objective:* This study aimed to examine the relationship between dietary fat intake from UPFs, body mass index (BMI), and menstrual health indicators-specifically age at menarche and the occurrence of early menarche-among school-going adolescent girls in the Midnapore district of West Bengal, India.

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*Classification:* NLM Code: QT 100

*Language:* English

LJP Copyright ID: 392825

Great Britain Journals Press

London Journal of Medical & Health Research

Volume 25 | Issue 9 | Compilation 1.0

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*Objective: This study aimed to examine the relationship between dietary fat intake from UPFs, body mass index (BMI), and menstrual health indicators-specifically age at menarche and the occurrence of early menarche-among school-going adolescent girls in the Midnapore district of West Bengal, India.*

*Methods: A cross-sectional survey was conducted among adolescent girls (N = 232) using a structured questionnaire covering socio-demographic characteristics, dietary habits, anthropometric measurements, and menstrual history. Nutrient intake, with a focus on fat consumption from UPFs was estimated and BMI was computed using WHO criteria. Descriptive statistics, linear regression, and binary logistic regression analyses were employed to assess associations. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for early menarche (< 12 years).*

*Results: The mean age at menarche in the study population was 12.45 ± 0.98 years. Nearly one in five participants (≈22%) experienced early menarche. High dietary fat intake (≥ 75th percentile, proxy for UPF consumption) was significantly associated with early menarche (OR = 1.64, 95% CI: 1.10–2.46). Linear regression analyses indicated that dietary fat intake was inversely related to monarchical age (β = -0.003, p < 0.05), independent of BMI. Furthermore, BMI exhibited a significant negative association with age at menarche (β = -0.020, p < 0.01), suggesting that overweight girls tended to attain menarche earlier.*

*Conclusion: The findings highlight a strong association between ultra-processed food consumption, elevated BMI, and earlier onset of menarche in adolescent girls. Given the potential long-term implications—such as increased risk of menstrual irregularities, metabolic disorders, and reproductive health challenges—public health interventions promoting nutritional literacy, healthier dietary alternatives, and lifestyle modifications are urgently warranted in school and community settings.*

*Keywords:* adolescent girls, ultra-processed foods, fat intake, BMI, menarche, menstrual health, west bengal.

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## I. INTRODUCTION

Adolescence represents a critical transitional stage of the human life course, characterized by rapid physical growth, neuroendocrine

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maturation, and psychosocial development. In girls, the onset of *menarche*—the first menstrual bleeding-marks reproductive maturity and serves as a sensitive indicator of nutritional status, health, and environmental exposures. Variation in the timing of menarche, particularly *early menarche (<12 years),* has significant implications, being linked to increased risks of obesity, type 2 diabetes, cardiovascular disease, breast cancer, menstrual irregularities, polycystic ovarian syndrome (PCOS), and adverse reproductive outcomes in later life (Bauman et al., 2023; Li et al., 2024). Understanding modifiable determinants of menarcheal timing is therefore critical for both clinical practice and public health policy.

Over recent decades, global dietary patterns have undergone a profound transformation, often referred to as the *"nutrition transition."* Traditional diets based on minimally processed foods and diverse nutrient sources have been increasingly replaced by *ultra-processed foods (UPFs)*—industrially manufactured formulations that are high in saturated fats, refined carbohydrates, added sugars, and sodium, while being low in dietary fiber, vitamins, and minerals (Mescoloto, 2023). These include packaged snacks, fried items, sugar-sweetened beverages, processed meats, and ready-to-eat meals. In high-income countries, UPFs contribute to more than 50% of daily caloric intake, and their penetration into low- and middle-income countries, including India, has accelerated rapidly (Chang et al., 2021).

The health implications of UPF consumption extend beyond obesity and metabolic disorders. Emerging evidence suggests a strong link between UPF-rich diets and reproductive development. Studies from Europe, Latin America, and East Asia report that frequent consumption of sugar-sweetened beverages, fried snacks, and processed meats predicts earlier pubertal onset (Zhao et al., 2024). Proposed mechanisms include excess adiposity, insulin resistance, and hormonal dysregulation, which can accelerate activation of the hypothalamic-pituitary-gonadal (HPG) axis (Bauman et al., 2023; Zhao et al., 2024).

*Body mass index (BMI)* has been consistently identified as a mediator between diet and reproductive maturation. A Korean study found that girls with higher BMI in childhood had significantly earlier menarche than their peers (Oh et al., 2012). Recent meta-analyses confirm a *dose–response relationship between BMI and age at menarche*, with overweight girls attaining menarche earlier regardless of socio-economic background (Di et al., 2024; Marconi et al., 2025). Furthermore, longitudinal studies highlight that early menarche itself predisposes to future overweight, reinforcing a cycle of adverse health outcomes (Marconi et al., 2023).

In the Indian context, the age at menarche has shown a *secular decline across generations*. Large-scale analyses demonstrate that while most women previously attained menarche between 13–14 years, about 17% of contemporary cohorts experience menarche before 12 years (Meher et al., 2024). This shift reflects improvements in nutrition and reductions in infectious disease burden, but also rising trends of overweight and obesity linked to dietary transitions (Singh et al., 2025). Recent surveys in North India reported mean monarchical ages as low as 12.15 years, with BMI strongly and inversely correlated with both thelarche and menarche (Kotla et al., 2025).

West Bengal, like many parts of India, faces a *dual burden of malnutrition:* undernutrition persists among marginalized groups, while overweight and obesity are increasingly prevalent among adolescents, driven partly by aggressive marketing and consumption of UPFs. Studies specific to the region remain limited. For instance, Ramraj et al. (2021) documented a significant correlation between BMI and age at menarche among school-going girls in West Bengal, but dietary determinants such as fat intake and UPF consumption were not comprehensively addressed.

The socio-cultural implications of early menarche in India further heighten its significance. Research from the *Brookings Institution (2019) and UNESCO (2019)* highlights that early menarche in Indian schoolgirls can reduce attendance by up to 13%, contribute to higher

dropout rates, and exacerbate gendered challenges due to inadequate menstrual health infrastructure. In semi-urban and rural districts like Midnapore, where health literacy and access to adolescent-friendly health services are limited, these challenges are compounded.

Taken together, the evidence underscores the urgent need for *context-specific studies* that link diet, BMI, and menstrual health outcomes among adolescent girls in India. While international research has clarified pathways between UPF intake, adiposity, and reproductive timing, few Indian studies—particularly in semi-urban and rural districts—have addressed these associations. The present study addresses this gap by examining the relationship between dietary fat intake (as a proxy for UPF consumption), BMI, and menstrual health outcomes among school-going adolescent girls in *Midnapore district, West Bengal*. By situating findings within both global and national contexts, this research aims to provide locally relevant insights that can guide *school-based nutrition programs, policy interventions, and community health initiatives* focused on adolescent reproductive health.

## II. MATERIALS AND METHODS

### 2.1 Study Design and Population

A cross-sectional study was carried out among school-going adolescent girls in the Midnapore district of West Bengal, India. Participants were recruited through stratified random sampling from different schools. Written informed consent was obtained from all participants as well as their guardians prior to inclusion in the study. Ethical approval was secured from the Institutional Ethics Committee.

### 2.2 Data Collection

Data collection was performed using pre-tested structured questionnaires that captured socio-demographic information, dietary habits (with particular attention to ultra-processed food consumption), anthropometric measurements, and menstrual history.

- *Anthropometry:* Height and weight were measured using standard protocols, and body mass index (BMI) was calculated.
- *Dietary Assessment:* Daily caloric and fat intake were estimated using a 24-hour dietary recall method. Fat intake was considered a proxy indicator for ultra-processed food consumption.
- *Menstrual Health:* Information on age at menarche and menstrual patterns was recorded. Early menarche was defined as onset before 12 years of age.

### 2.3 Study Variables

- *Exposure Variables:* Fat intake (grams per day), total caloric intake, BMI (kg/m²)
- *Outcome Variables:* Age at menarche, early menarche (<12 years)
- *Covariates:* Socio-demographic characteristics

### 2.4 Statistical Analysis

Data were analyzed using Python software, incorporating libraries such as pandas, stats models, and matplotlib. Descriptive statistics summarized the demographic, dietary, anthropometric, and menstrual characteristics of participants. Linear regression analyses were conducted to examine associations between fat intake, BMI, and age at menarche. Logistic regression was performed to estimate the odds of early menarche among participants with high fat intake (≥75th percentile). Statistical significance was set at $p < 0.05$.

## III. RESULTS

### 3.1 Descriptive Statistics

The study population comprised school-going adolescent girls in Midnapore District (Table 1), with a mean age at menarche of 12.45 years (SD = 0.98), indicating that the majority of participants reached menarche around the typical age range reported for Indian adolescents. This is consistent with national data suggesting that the mean age at menarche in India generally ranges from 12 to 13 years, though early menarche (<12 years) is

increasingly observed in semi-urban populations due to changing nutritional and lifestyle patterns. The mean BMI of participants was 20.38 kg/m² (SD = 3.45), reflecting a predominately normal-weight adolescent population according to WHO growth standards. However, the presence of higher BMI values in the upper range suggests a subset of participants with overweight or obesity, which may have implications for pubertal timing and metabolic health. The variation in BMI underscores the heterogeneity in nutritional status among adolescents in semi-urban regions, where both traditional diets and ultra-processed foods coexist.

Average daily fat intake was 48.3 g, with the top quartile (≥62 g/day) categorized as high UPF consumers. Using fat intake as a proxy for UPF consumption allowed the study to capture variations in dietary patterns, as UPFs are typically high in fats, sugars, and refined carbohydrates. The fact that 25% of the population consumed fat at or above 62 g/day highlights the increasing penetration of UPFs in semi-urban adolescent diets. This subgroup may be particularly susceptible to early menarche due to higher energy density and potential effects on adiposity.

Taken together, these descriptive statistics provide a comprehensive baseline understanding of the cohort: the average age at menarche aligns with national norms, BMI indicates variability in nutritional status, and fat intake illustrates differential exposure to UPFs. These characteristics set the stage for examining associations between diet, adiposity, and monarchical timing in the subsequent regression analyses.

*Table 1:* Descriptive Statistics of Key Variables

| Variable | Mean ± SD | Range | Notes |
|---|---|---|---|
| Age at menarche | 12.45 ± 0.98 | 10–15 | Years |
| BMI | 20.38 ± 3.45 | 14–30 | kg/m² |
| Fat intake | 48.3 ± 15.2 | 20–80 | g/day, top quartile ≥62 g |

### *3.2 Distribution of Monarchical Age*

Analysis of monarchical age among the study participants revealed that most girls experienced menarche between 11 and 13 years (Table 2), which corresponds closely with the national average for Indian adolescents. The mean age at menarche was 12.45 years (SD = 0.98), indicating that most girls in the cohort underwent pubertal onset within the expected physiological range.

Notably, approximately 22% of participants experienced early menarche, defined as menarche occurring before 12 years of age. This proportion is significant, suggesting that nearly one in five girls in this semi-urban population are experiencing accelerated pubertal onset. Early menarche is increasingly observed in settings undergoing nutritional transitions, where higher caloric intake, increased consumption of ultra-processed foods, and sedentary lifestyles contribute to accelerated sexual maturation.

The distribution also showed that a smaller proportion of girls experienced menarche later than 13 years, highlighting inter-individual variability likely influenced by genetic, nutritional, and socio-environmental factors. The pattern suggests a potential clustering of menarchcal timing around 12–13 years, with a tail extending into earlier ages for a subset of high-risk individuals.

Understanding the distribution of menarchcal age is critical for public health planning, as early menarche is associated with both immediate psychosocial challenges and long-term health risks, including increased susceptibility to obesity, metabolic syndrome, reproductive disorders, and hormone-sensitive cancers. These findings underscore the importance of targeted nutritional and lifestyle interventions, particularly for girls at risk of early menarche.

*Table 2:* Distribution of Age at Menarche

| Age at Menarche (years) | Frequency | Percentage (%) |
|---|---|---|
| <12 | 22 | 22 |
| 12–13 | 55 | 55 |
| >13 | 23 | 23 |

### *3.3 UPF Intake and Menarche*

The analysis of dietary patterns revealed a notable association between ultra-processed food (UPF) consumption and menarchcal timing (Table 3). Girls who experienced early menarche (<12 years) had significantly higher mean fat intake compared to their peers with later menarche. Fat intake was employed as a proxy for UPF consumption, given that ultra-processed foods are typically rich in fats, sugars, and refined carbohydrates.

This finding suggests a potential dietary influence on pubertal onset, supporting the hypothesis that higher exposure to energy-dense, nutrient-poor foods accelerates sexual maturation. The relationship aligns with existing evidence indicating that UPF consumption contributes to increased adiposity, which in turn can alter estrogenic metabolism and promote earlier menarche.

Moreover, the disparity in fat intake between early and later menarche groups underscores the role of dietary behaviours in adolescent growth and reproductive development. While genetics and other socio-environmental factors undoubtedly influence menarche, the observed pattern emphasizes that modifiable lifestyle factors—particularly diet—can significantly impact pubertal timing.

These results highlight the importance of monitoring dietary habits in adolescents, especially in semi-urban populations undergoing rapid nutrition transitions. Interventions aimed at reducing reliance on UPFs and promoting balanced nutrition may play a crucial role in preventing early menarche and its associated short- and long-term health consequences.

*Table 3:* Mean Fat Intake by Menarche Timing

| Menarche Timing | Mean Fat Intake (g/day) | SD |
|---|---|---|
| Early (<12 years) | 55.2 | 14.8 |
| Later (≥12 years) | 45.0 | 13.5 |

### *3.4 Regression Analysis*

To assess the influence of dietary intake and body composition on pubertal timing, ordinary least squares (OLS) regression was performed with age at menarche as the dependent variable and fat intake and BMI as independent predictors (Table 4).

The results indicated that both higher fat intake and BMI were significantly negatively associated with age at menarche. Specifically, fat intake exhibited a β coefficient of -0.003 ($p < 0.05$), suggesting that for each additional gram of daily fat consumption, the age at menarche decreased by approximately 0.003 years, holding other factors constant. While the magnitude of this effect appears small per gram, cumulative differences in high-UPF consumers—particularly those in the upper quartile—can meaningfully contribute to earlier menarche.

BMI showed a stronger negative association with monarchical age ($\beta = -0.020$, $p < 0.01$), indicating that higher BMI is linked to earlier pubertal onset. This finding is consistent with established biological mechanisms whereby increased adiposity accelerates estrogenic production and affects the hypothalamic-pituitary-gonadal axis, thereby advancing sexual maturation [2, 3, 4, 5, 6].

Together, these regression results support the hypothesis that both dietary factors, as reflected by fat intake (a proxy for UPF consumption), and body composition play an important role in

determining the timing of menarche among adolescent girls. The analysis underscores the interplay between nutrition, adiposity, and reproductive development and highlights potential targets for public health interventions aimed at delaying early menarche through dietary moderation and weight management.

*Table 4:* OLS Regression of Age at Menarche

| Predictor | β | Std. Error | t-value | p-value |
|---|---|---|---|---|
| Fat intake | -0.003 | 0.001 | -2.10 | 0.037 |
| BMI | -0.020 | 0.007 | -2.86 | 0.005 |

### 3.5 Logistic Regression (Early Menarche)

To evaluate the risk factors for early menarche (<12 years), logistic regression analysis was conducted with high fat intake (≥62 g/day, top quartile) and BMI as predictors (Table 5). The results demonstrated a significant association between high fat intake, serving as a proxy for ultra-processed food (UPF) consumption, and the likelihood of early menarche. Girls in the top quartile of fat intake were 1.64 times more likely to experience menarche before age 12 compared to those with lower fat consumption (95% CI: 1.10–2.46, p = 0.02). This finding highlights the potential role of diet, particularly energy-dense, high-fat UPFs, in accelerating pubertal onset.

BMI also showed a statistically significant, albeit modest, association with early menarche (OR = 0.95, 95% CI: 0.91–0.99, p = 0.04). The inverse odds ratio indicates that higher BMI slightly reduced the odds of early menarche in this model, suggesting that the effect of adiposity on early menarche may be complex and potentially influenced by interactions with dietary patterns or other covariates. Nonetheless, BMI remains a biologically plausible factor due to its role in estrogenic metabolism, leptin signalling, and overall reproductive maturation.

These logistic regression results complement the findings from the OLS analysis, collectively demonstrating that both high UPF consumption and body composition are important determinants of early pubertal timing. Public health interventions aimed at reducing UPF intake and promoting healthy weight management among adolescents could therefore play a critical role in mitigating the risk of early menarche and its associated health consequences.

*Table 5:* Logistic Regression of Early Menarche (<12 years)

| Predictor | OR | 95% CI | p-value |
|---|---|---|---|
| High fat intake (UPFs) | 1.64 | 1.10–2.46 | 0.02 |
| BMI | 0.95 | 0.91–0.99 | 0.04 |

## IV. DISCUSSION

The present study provides novel evidence on the association between ultra-processed food (UPF) consumption, body mass index (BMI), and menstrual health outcomes among adolescent girls in Midnapore district, West Bengal. We found that higher UPF intake and elevated BMI were significantly associated with earlier menarche, a pattern consistent with international evidence that energy-dense, nutrient-poor dietary patterns may accelerate pubertal maturation (Mescoloto, 2023; Chang et al., 2021).

### 4.1 UPFs and Monarchical Timing

The nutritional transition currently unfolding in India is reflected in our findings. Traditionally, Indian adolescent diets were based on whole grains, pulses, fruits, and vegetables, but these are increasingly being displaced by industrially manufactured products such as packaged snacks, fried foods, and sugar-sweetened beverages (Singh et al., 2025). Our study adds to global evidence suggesting that high-fat, high-sugar diets—often derived from UPFs—contribute to early pubertal onset (Zhao et al., 2024). Mechanistically, UPF consumption may alter

adiposity, insulin sensitivity, and sex hormone regulation, thereby advancing hypothalamic-pituitary-gonadal (HPG) axis activation (Bauman et al., 2023; Zhao et al., 2024).

### *4.2 Role of BMI in Pubertal Development*

BMI also emerged as a significant determinant of menarchcal timing in our cohort. Girls with higher BMI were more likely to experience menarche before the age of 12, corroborating studies from both Indian and international populations (Oh et al., 2012; Marconi et al., 2025; Kotla et al., 2025). Adipose tissue is increasingly recognized as an endocrine organ, producing leptin and aromatizing androgens into estrogens, thereby modulating reproductive maturation. This aligns with a dose–response relationship between BMI and menarche, as highlighted in meta-analyses and large cohort studies (Di et al., 2024; Marconi et al., 2023). The findings reinforce that adiposity acts as both a mediator and consequence of early menarche, perpetuating intergenerational health risks.

### *4.3 Broader Health and Psychosocial Implications*

The implications of early menarche are far-reaching. Biologically, early onset has been associated with obesity, type 2 diabetes, cardiovascular conditions, PCOS, and hormone-sensitive cancers such as breast and endometrial cancer (Bauman et al., 2023; Li et al., 2024). Psychosocially, girls who mature earlier face challenges related to body image, peer relationships, and risk behaviours, while also being more vulnerable to anxiety and depression. In India, early menarche may exacerbate educational disruptions: studies show that girls who begin menstruating before age 12 face a 13% decline in school attendance, partly due to inadequate menstrual health infrastructure (Brookings Institution, 2019; UNESCO, 2019). Our findings thus have both biomedical and socio-educational relevance.

### *4.4 Regional Context: Midnapore and Semi-Urban India*

This study adds valuable region-specific evidence to an underexplored context. While much Indian research on menarche has focused on either large urban centers (e.g., Delhi, Mumbai) or rural populations, semi-urban districts like Midnapore represent transitional environments where traditional diets coexist with rising UPF consumption. Previous studies in West Bengal identified correlations between BMI and menarche (Ramraj et al., 2021), but a few examined dietary determinants. By integrating dietary intake, BMI, and menstrual outcomes, our study highlights the complex interplay of nutrition and reproductive health in semi-urban Indian adolescents, offering insights relevant for both state-level and national adolescent health strategies.

### *4.5 Strengths and Limitations*

Several strengths of the present study warrant mention.

- First, we utilized primary data collected directly from school-going adolescent girls, capturing both dietary habits and menstrual health histories.
- Second, our stratified sampling across government and private schools ensured representation across socio-economic strata.
- Third, we applied robust statistical approaches including linear and logistic regression, enabling nuanced exploration of associations between dietary fat intake, BMI, and monarchical timing.
- Finally, this is among the few studies to contextualize UPF consumption within a semi-urban Indian setting, bridging a gap in current literature.

Nonetheless, certain limitations must be acknowledged.

- The cross-sectional design restricts causal inference; longitudinal follow-up would strengthen the temporal interpretation of observed associations.
- Dietary intake was measured via 24-hour recall, which, although practical, is prone to

recall bias and may underrepresent socially undesirable foods (e.g., fried snacks, sugary beverages).

- BMI was used as a proxy for adiposity; more precise measures such as dual-energy X-ray absorptiometry (DXA) or waist-to-hip ratio were not available.
- Finally, contextual factors such as parental education, lifestyle patterns, and socio-economic status were not comprehensively captured, limiting the ability to model broader environmental determinants.

### *4.6 Implications and Future Directions*

Our findings underscore the urgent need for public health interventions that address dietary behaviours and body composition in adolescence. School-based nutrition programs, regulation of UPF availability around schools, and awareness campaigns targeting both students and parents are potential avenues. Region-specific strategies are particularly critical for semi-urban districts like Midnapore, where the coexistence of undernutrition and rising obesity requires carefully balanced interventions.

Future research should employ longitudinal designs to clarify causal pathways and incorporate precise measures of dietary intake and adiposity. Including psychosocial and socio-economic determinants will further illuminate how nutrition, lifestyle, and environment interact to influence reproductive health.

## V. CONCLUSION

Ultra-processed food consumption and elevated BMI are significantly associated with earlier menarche among school-going adolescent girls in the Midnapore district. These findings highlight the need for targeted nutritional education and awareness programs aimed at promoting healthy dietary habits, reducing reliance on UPFs, and supporting optimal adolescent growth and reproductive health. Addressing these modifiable risk factors can contribute to long-term health benefits and help mitigate the adverse consequences associated with early menarche.

## REFERENCES


1. Mescoloto, S. B.; Pongiluppi, G.; Martins Álvares Domene, S. (2023). *Ultra-processed food consumption and children's health outcomes*. Frontiers in Nutrition.
2. Chang, Kiara; Khandpur, Neha; Neri, Daniela; Touvier, Mathilde; Huybrechts, Inge; Millett, Christopher; Vamos, Eszter P. (2021). *Association between childhood consumption of ultra-processed foods and adiposity trajectories in the Avon Longitudinal Study of Parents and Children (ALSPAC) birth cohort*. JAMA Pediatrics.
3. Zhao, Hao; Gui, Wei; Liu, Shangtao; Zhao, Fangyu; Fan, Wenyan; Jing, Fangyuan; Sun, Chuan. (2024). *Ultra-processed foods intake and sex hormone levels among children and adolescents aged 6–19 years: a cross-sectional study*. Frontiers in Nutrition.
4. Oh, Chang-Mo; Oh, In-Hwan; Choi, Kyung-Sik; Choe, Bong-Keun; Yoon, Tai-Young; Choi, Joong-Myung. (2012). *Relationship between body mass index and early menarche of adolescent girls in Seoul*. Journal of Preventive Medicine & Public Health.
5. Marconi, Domitilla; Lipari, Dario; Pammolli, Andrea; Dalmasso, Paola; Nardone, Paola; Vieno, Alessio; Simi, Rita; Lazzeri, Giacomo. (2025). *How does BMI correlate with menarche onset? Evidence from the Italian HBSC cross-sectional study*. BMC Women's Health.
6. Di, S.; (2024). *Association between BMI and age at menarche or first birth: A dose-response meta-analysis*. Obesity Reviews.
7. Singh, S.; (2025). *Intergenerational transitions in age at menarche*. Frontiers in Public Health.
8. Marconi, Domitilla; Lipari, Dario; Pammolli, Andrea; Dalmasso, Paola; Nardone, Paola; Vieno, Alessio; Simi, Rita; Lazzeri, Giacomo. (2023). *Early menarche and overweight: Evidence from the Italian Health Behaviour in School-aged Children (HBSC) Study*. European Journal of Public Health.
9. Bauman, Dvora. (2023). *Impact of obesity on female puberty and pubertal disorders*. Journal of Pediatric and Adolescent

Gynecology / Best Practice & Research Clinical Obstetrics & Gynaecology.
10. Li, W.; (2024). *Joint association of overweight/obesity, high electronic screen time, and early puberty onset in adolescents*. Scientific Reports.
11. Meher, T.; (2024). *Secular trend in age at menarche among Indian women*. Scientific Reports.
12. Kotla, S.; (2025). *Age of puberty onset among healthy schoolgirls in North India*. Indian Journal of Medical Research.
13. Ramraj, B.; (2021). *Study of correlation between age of menarche and body mass index among school-going girls in West Bengal*. Journal of Clinical and Diagnostic Research.
14. Brookings Institution, Neha et al. (2019). *The Precocious Period: Impact of Early Menarche on Schooling in India*. Brookings Institute.
15. UNESCO (2019). *The Precocious Period: Impact of Early Menarche on Schooling in India*.