

Trends of Age at Menarche & Mysteries of its Impact on Girls' Holistic Health!

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Abstract:

Menarche is the first menstrual bleeding, marks the beginning of female puberty and the potential for future reproduction. Menarche happens between the ages of nine and sixteen, with 13 being the average age. The age at which menarche begins is influenced by genetics, diet, and body mass index. An early menarche is defined as menarche before the age of twelve and late menarche is defined as menarche after the age of fourteen years.

Many developed and developing nations have seen a secular declining trend in the age of menarche, since the beginning of 20th century across the globe. Recent studies revealed that average age of menarche is 11.8 in rural area and 10.75 in urban area globally.

Analysis of NFHS V data (2019-21) India demonstrated that most women (66.2%) attained menarche between the ages of 13–14 years. About 17.2% of women experienced an early age at menarche, whereas 16.7% of women had a late age at menarche. Recent studies in India indicate that most urban girls attained menarche at the age of 10, whereas rural girls attained menarche at 12 years of age. This is attributed to higher income, high parental occupation and unhealthy food choices. Basic variables of menstrual history, age of menarche, regularity, menstrual flow, and habitual and lifestyle factors like dietary habits especially junk food consumption, sedentary or active lifestyle, sleep, polycystic ovary syndrome show significant difference between current adolescent girls their mothers, grandmothers and great grandmothers. Though food consumption, sedentary lifestyle or hours of activity have changed significantly in last century, only sedentary lifestyle is found to be significant for early menarche.

Ayurveda, Indian ancient medicine believes that early menarche occurs due to an imbalance in the body's natural rhythms, and factors like Vata Dosha, excessive consumption of processed foods, sugary snacks, and dairy products, and Ama an external toxin as result of poor digestion, unhealthy eating habits accumulating in the body over time, contribute to this disruption.

Materials & Methods: This article is born out of an observational study among four generations of authors family tree to clarify the determinants of menarche timing, and its link to later reproductive and health outcomes.

Keywords: puberty; thelarche; menarche; pubarche dietary habits; physical activity; rural area; urban area

Introduction

The onset of menstruation represents a significant biological and psychological transition, marking a girl's progression from childhood into adolescence. With the onset of menarche, females start their reproductive journey, first menstrual cycle that enables women to develop fertility through ovulation. The first menstrual bleeding in general, occur between the ages of 12 and 13 globally, In India, the mean menarche is 12.77 years. Early menarche is generally defined as onset before age 12, while late menarche is considered occurring after age 15. Early menarche has been associated with heightened risks of early sexual debut, adolescent pregnancy, polycystic ovarian syndrome, reproductive cancers, obesity, and mental health issues

including depression and anxiety. Late menarche signals undernutrition, delayed growth, or chronic illness, and has been linked to lower bone mineral density, dysmenorrhea, & cardiometabolic complications in later life [1].

Puberty is defined as the developmental stage during which a child becomes a young adult, characterized by the maturation of gametogenesis (eggs and sperm), secretion of gonadal hormones (estrogen, progesterone, and testosterone), and development of secondary sexual characteristics and reproductive functions. Some key terms include i) Thelarche is the onset of breast development, an estrogen effect, about 20-40% of adolescent males

may have temporary breast development known as gynecomastia ii) Menarche is the onset of menses iii) Pubarche is the onset of sexual hair growth, caused by androgen hormone production by the adrenal gland [9]. Puberty has been identified as a critical “window of susceptibility” to breast cancer due to the exponential proliferation of mammary epithelial cells during puberty which makes these cells uniquely sensitive to environmental carcinogens during developmental stage. Recent secular changes in the timing and tempo of puberty in girls, including earlier thelarche and a longer time between thelarche and menarche, are also believed to increase future risk of breast cancer in part due to a prolonged period of unopposed estrogen action on the breast. According to a 2020 article published in Journal of Preventive Medicine and Holistic Health, 34% of the girls have breast development, pubic hair appearance and onset of first menstruation, before the age of 8 years in India due to high levels of estrogen without an accompanying increase in progesterone [2]. A delay in the development of ovulatory cycles, with increased progesterone exposure, would be predicted to further exacerbate the risk by delaying breast maturation [3].

This article is an effort to track secular trends in the age at menarche, clarify the determinants of menarche timing, that have critical link to later reproductive and health outcomes. Both early and delayed menarches are turning out to be public health concerns that necessitate urgent attention by Public Health Systems of all countries.

Case Reports:

Case 1. Menarche among four generations a family:

Sona the paternal great-grandmother of this case report was from middle class rural woman got married at the age of 18 years to graduate schoolteacher. She had menarche at the age of 14 years in 1950. She had 5 daughters before bearing a son. All these girls had menarches around 13 years as they were exposed to more of urban living due to father ascending from a teacher's post to that of Joint director of education department. While first and second daughters had first child as girl and 2 sons, third daughter had three girls, and the fourth girl too had two girls followed by a son. The fifth daughter had just one daughter and one son. Interesting issue is this third generations had menarches around 10-11 years, the youngest of them at 10 years. This last daughter's daughter had her menarche around 9.5 years and her daughter only around 8 years. This fourth-generation girl was well-built and was in class 2 at first periods. At the age of 14 years now she looks like well grown-up adult.

This case report is pointing to a menarcheal age declined in a secular manner than their mothers and grandmothers and there was a significant difference in the diet, physical activity and lifestyle pattern of the subjects, and upbringing starting from rural and ending in urban areas for last 3 generations.

Case 2: Secular decreasing Trend in Menarche: The second case is of maternal great grandmother Sita (Sona's husband's younger sister), who had menarche around 13.5 years, was married to a priest (second marriage for him) around the same time as Sona. She gave birth to 5 girls and 4 boys. The eldest daughter was author's cohort and had her first periods around 12.5 years, when in 6th year of schooling. The other 3 younger sisters too had menarche around the same age of 12.5 yrs. The youngest of them had menarches at 11.5 years. While second daughter was unmarried, other four sisters had 2,1,0, and 1 daughter respectively and most of them had menarche around 11 years only. While all the five sisters apparently had progressed to menopause by now, their girls do have polycystic ovarian syndrome (PCOS), or endometritis or Uterine fibroids and are being treated.

Case 3 Late Menarche: 27yrs old female, a distant relative newly married, presented with complaints of coital difficulty. On detailed history patient revealed the fact that she has not attained menarche. No family history of

primary amenorrhea or late menarche in the family. She got married without revealing this fact to the partner and consulted me because of my seniority having retired after 50 years of active public health practice.

On general Examination, she had normal breast development with Tanner stage 4, her body hair including axillary hair, & pubic hair, distribution was normal-Tanner stage 4, Her height was 160cm and weight of 55kg, and normal arm span. There is no skeletal abnormality. Local Examination: Inguinal region was normal. External genitalia were normal and well estrogenized. Speculum examination was not possible. PV Examination: Blind vaginal pouch of 2cm length. Per Rectal Examination: uterus could not be palpated. An ultrasound of the abdomen and pelvis showed a hypoplastic uterus to be imaged. Both ovaries were normal in size and appearance. Both kidneys were normal.

HORMONAL PROFILE: 1. Follicular stimulating hormone (FSH) 2. Luteinizing hormone (LH), Estradiol, and 17-hydroxyprogesterone, were all normal, indicating normal hypothalamic-pituitary-ovarian axis. KARYOTYPING: showed normal (46, XX) female karyotype.

Management: The couple were explained about her condition and counselled psychologically informing them that childbearing was not possible. A McIndoe vaginoplasty was done and thereby finding a solution to the coital difficulty. They requested not to disclose her condition to other family members.

Discussions:

Puberty is a critical period that begins between eight and 13 years old in girls. It is accompanied by physiological changes in various organs. Menarche is the last event of puberty and a turning point as the initiation of fertility. Menstrual cycles are commonly irregular in the first years after menarche. The menstrual cycle developmental trajectory (time interval between age at menarche and the onset of the regular menstrual cycle) varies from several months to several years. Several influential factors on this trajectory are known but there are still many unknowns. Close interaction between hypothalamic-pituitary ovarian (HPO) axis hormones is fundamental for a regular and predictable ovulatory cycle. Several genetic and environmental factors from prenatal to later in life can affect the HPO axis. It has been shown that menstrual irregularity during adolescence may result from exposure to environmental stress during pregnancy and childhood. Later in life, several endocrine disorders, including polycystic ovary syndrome (PCOS), premature ovarian failure (POF), pituitary hypothalamic dysfunction, anorexia nervosa, thyroid dysfunction, and hyperprolactinemia, are often accompanied by menstrual irregularities. The menstrual cycle pattern has a significant impact on the reproductive life of adolescents, and an irregular menstrual cycle threatens their physical and mental health, though this irregularity is modifiable. Besides, long & irregular menstrual cycles are associated with premature mortality. Precocious puberty involves the premature activation of the hypothalamic-pituitary-gonadal axis, leading to early development of secondary sexual characteristics and fertility. Causes can include genetic factors, brain tumors, or exposure to external hormones [1,2].

The youngest confirmed case of childbirth belongs to Lina Medina, a Peruvian girl who gave birth at the astonishing age of 5 years and 7 months in 1939. Her medical examinations revealed that she had fully developed reproductive organs capable of supporting pregnancy despite her extremely young age. Her uterus was mature enough to carry a fetus to term, which is highly unusual but possible under such rare hormonal conditions [3].

Tiny mother from India, was 6 years old, though it lacks full medical verification but was cited in media reports, amounting to attaining menarche at around 5 yrs age [4].

Most Gynecology and Obstetrics consultants, in India concur that the early menarche and late menarche, pose several health risks for adolescent girls [2]:

Factors that can contribute to national menarche age include:

i) **Physical Activity:** The lower body fat percentages associated with active lifestyles and lots of exercise sometimes delay menarche. For this reason, it occurs later rather than sooner in countries where active lifestyles are the norm like rural India where girls work in agricultural fields and household chores.

ii) **Health Factors-** The quality and accessibility of healthcare services and nutritious food can contribute to the average age of menarche in a country. Better nutrition and easier access to adequate healthcare solutions can lead to earlier average menarche ages. The mean age of malnourished rural girls in India as compared to well fed urban girls, this factor comes through clearly. A study in Kerala indicated that most urban girls attained menarche at the age of 10, whereas rural girls attained menarche at 12 years of age [9]. This difference was attributed to lifestyle factors, including family income, occupation, consuming junk food often, meal skipping, and a higher incidence of overweight and obesity in urban places.

iii) **Psychological Factors:** Psychological factors like Stress and trauma often correlate to a later average menarche age.

Influence of age at Menarche on overall health of girls:

Early Menarche:

i) An increased Risk of Hormonal Cancers: Women who have menstruated earlier in their life carry higher risk of developing cancer in breasts, ovaries and endometrium, because of the body is exposed to estrogen for a long period of time

ii) Mental Health Concerns: Early maturation leads to psychological issues such as sadness, feeling down, lack of self-confidence and depression. The social stress of aging faster than her mates can take a toll on young girls

iii) Metabolic Disorders: Premature menarches are 2-4 times more likely to result in metabolic disorders such as obesity, type 2 diabetes, & cardiovascular disease.

iv) Bone Health: Due to hormonal alterations and quick bone loss, perimenopausal women risk having osteoporosis and breaking their bones in middle age [6,7,8].

Delayed Menarche:

By the age of 15, about 98% of girls India would have already started their menstrual cycle. If a girl has not had her first period by the age of 15-16 years, it is delayed menarche. In many cases, this runs in families, meaning that if the mother or close relatives were "late bloomers," the daughter might also experience her first period later than average. Once menstruation begins, however, it usually progresses normally. Variations within the normal range of menarches are common and typically do not indicate significant health concerns. When periods are delayed beyond 15 or 16 years, consultation with gynecologists to investigate any health concerns is warranted [10].

Late menarches occur after age 15 or 16, also have implications.

i. Osteoporosis: It is associated with low bone density, which can increase the risk of osteoporosis later in life.

ii. Infertility: While delayed puberty itself is not a direct cause of infertility, underlying causes for late menarche, like hormonal imbalances, could affect fertility.

While genetics can be involved in determining the age of the onset of menarche; some of the other factors that contribute to the trend of earlier menstruation among girls in India, include not eating well and being too fat, exposure to chemicals like pesticides, plasticizers, industrial pollutants; sitting around or doing mostly low intensity physical movements.

Causes of Delayed Menarche:

Genetic Factors: Family history plays a role, with delayed menarches as it runs in families.

Nutritional Factors: Inadequate nutrition, particularly a low body weight or insufficient intake of essential nutrients, can contribute -a) Lack of Body Fat: Girls who are very thin, undernourished, or struggling with eating disorders like anorexia or bulimia may not have enough fat reserves to support puberty. b) Obesity: Just as very low body fat can delay menarche, excessive fat may also disrupt hormonal balance, causing late periods.

Hypogonadism: When the ovaries produce very little or no hormones, due to ovaries getting damaged or if there are problems in the brain regions that regulate puberty, puberty is delayed. Conditions leading to hypogonadism include Genetic disorders (e.g., Turner Syndrome, Kallmann Syndrome), Chronic illnesses such as diabetes, hypothyroidism, celiac disease, cystic fibrosis, and inflammatory bowel disease (IBD), Autoimmune disorders-Hashimoto's thyroiditis or Addison's disease, Tumors in the pituitary gland & exposure to radiation or chemotherapy.

Chronic Illness: Certain medical conditions like TB, malabsorption syndromes, allergies, Cancer's depression, and management of such conditions like medications, surgeries, hormonal therapy also delay menarche.

Stress and Medications: High scholastic or any stress levels can interfere with hormonal signals that trigger menstruation as prolonged exposure to high-stress levels impact hormonal balance

Anatomical Causes: Sometimes the reproductive organs may develop abnormally, like Imperforate hymen, Müllerian agenesis

Athletic Training: Intense physical activity, rigorous training, may delay menarches.

Delayed Menarche Diagnosis: When a girl shows no signs of puberty by 14 years or has not had her first period by 16 years, a thorough evaluation must follow which include: Physical examination and assessment of growth and nutrition, Tanner staging to evaluate pubertal development, Blood tests to check hormone levels and rule out chronic illnesses, Genetic testing if a hereditary disorder is suspected, Bone-age X-ray to assess skeletal maturity, MRI scans to detect brain or pituitary gland abnormalities, if necessary.

Delayed menarche can stem from various factors, including genetic predispositions, nutritional influences, chronic illness, stress, or intense physical activity. Beyond the biological aspect, delayed menarche may impact psychological well-being, as girls might face emotional challenges related to differences from their peers. It is essential to foster understanding and create environments that celebrate diverse timelines, promoting positive body image and individual empowerment in the journey of womanhood.

Responding to aberrant Menarche- Monitoring Menstruation among girls:

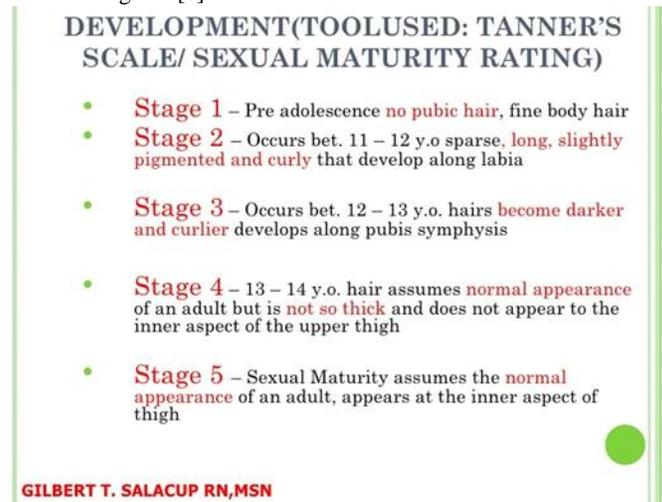
States Responsibility: Information education and Empowerment: To counter this trend, enlightening girls on menstruation and helping them overcome their fears regarding physical changes is an important public health states and national health and education system can do!

For girls not attending schools, the Anganwadi centers Adolescents initiative can be a platform.

Emotional Support: Give them emotional support in a bid to assist them to withstand the psychological pressure of early puberty. Seeking help through counselling or therapy will help those with problems as well.

Healthy Lifestyle: Support an even eating pattern and suitable physical activity. Help them adopt ideal weight management to reduce the risks of some illnesses that come along with early menarches.

Regular Health Checkups to Monitor menarche: Monitoring the changes in characteristics of tissue and body chemistry including hormone levels. Annual check-ups for girls in Primary (starting from class II) and middle and high schools' classes (till 10th standards) hold promising future. Any girl not having menarche by 10th standard needs to be investigated [8].



A general practitioner/pediatrician or a Gynecologist must take detailed history before assessing the issue. The history must include:

i) Does the menstrual flow recur at too short an interval or is delayed beyond the proper time? ii) How many days it lasts iii) Whether its flow is continuous or interrupted iv) What is its general quantity? v) How heavy is it? vi) How dark is its colour?

ii) Whether there is leucorrhoea before its appearance or after its termination, and what bodily or mental ailments? If there is leucorrhoea, what is its nature, what sensations attend its flow, in what quantity it is, and what are the conditions and occasions under which it occurs? Aggravation and amelioration before, during, after. Both physically and mentally

iii) What sensations and pains preceded, accompanied or followed?

iv) Date of establishment? v) Regularity (early or late)

After this interrogation, a physician can ascertain:

A) Stages of Breast Development: 1. Prepubertal 2. Breast Bud 3. Breast Elevation 4. Areolar Mound 5. Adult Contour

B) Stages of Pubic Hair Development: 1. Prepubertal 2. Sparse, Fine, Straight Pubic Hair 3. Long, Dark, Curly Pubic Hair 4. Not Yet Spread to Thighs 5. Adult-like, Spread to Thighs [8].

Conclusion:

The situation in 2025 in India is that most of urban girls attain menarche at the age of 10, whereas rural girls reach menarche at an average age of 12. This difference is attributed to lifestyle factors, including family income and occupation, unhealthy eating behaviors particularly consuming junk food often, meal skipping, and a higher incidence of overweight and obesity in urban places. The higher education status of urban populations may also contribute to these differences. While urban areas exhibit higher literacy

Assessing Individual Girls of sexual maturity:

Adolescence is a crucial developmental stage marked by notable physical and psychological transformations. Early menarche, the commencement of menstruation before age 11, is a significant health concern that often goes unobserved. Early menarches are associated with an increased risk of metabolic disorders, cardiovascular disease, mental health issues, and reproductive health challenges, having long-lasting effects on adolescent girls' emotional & physical well-being. As a result, it is a public health concern that necessitates attention [10].

levels, which aid in adopting unhealthy eating habits such as junk food consumption, meal skipping, and above-normal BMI for age. Menstrual symptoms are more prevalent among girls who experience early menarche. Although various factors influence the age of menarche, genetic factors appear to have minimal impact. The trends in last 6 decades as the author observed highlights a generational decline in the age of menarche, as great grandmothers, grandmothers, and mothers of current adolescent girls attained menarche at a later age than their daughters. This shift can be linked to improved lifestyle factors, higher income levels, better nutrition, increased caloric intake, and higher body fat percentages in the current generation.

Early menarche has been associated with heightened risks of early sexual debut, adolescent pregnancy, polycystic ovarian syndrome, reproductive cancers, obesity, and mental health issues including depression and anxiety. Delayed menarche can stem from various factors, including genetic predispositions, nutritional influences, chronic illness, stress, or intense physical activity. Beyond the biological aspect, delayed menarche may impact psychological well-being, as girls might face emotional challenges related to differences from their peers.

Monitoring Menstruation among girls is the States Responsibility. This can be done through i) Information education and Empowerment in schools and Anganwadi centers ii) Give an emotional support to aberrant menarched girls in a bid to assist them to withstand the psychological pressure of early or late puberty iii) Support an even eating pattern and suitable physical activity and promoting adoption of ideal weight for age iv) Regular Health Checkups to Monitor the changes in characteristics of tissue and body chemistry including hormone levels. Annual check-ups for girls in 8–16-year age groups in schools and Anganwadi Centers v) Investigating all girls with early or late menarche to assessing Individual girls of sexual maturity.

Both early and delayed menarches turn out to be public health concerns that necessitates urgent attention by Public Health Systems of all countries.

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