Section: Community Medicine

Original Research Article

DOES BODY MASS INDEX (BMI) INFLUENCE MENSTRUAL PATTERNS? A RURAL-URBAN CONTRAST OF ADOLESCENT SCHOOL GIRLS IN SRIKAKULAM

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ABSTRACT

Background: Menstruation reflects normal hypothalamic-pituitary-ovarian axis function in adolescents, and Body Mass Index (BMI) is a key indicator of nutritional status influencing reproductive health. Rural-urban differences in diet, socioeconomic status, and lifestyle can affect both BMI and menstrual health. **Objectives:** 1) To categorise BMI and compare impact of BMI on menstrual patterns and menstrual dysfunctions among rural and urban adolescent schoolgirls. 2) To estimate the prevalence of menstrual irregularities among them. 3) To predict the probability of menstrual irregularities based on multiple lifestyle factors in them.

Materials and Methods: An observational cross-sectional analytical study was conducted among 277 adolescent schoolgirls (148 rural, 129 urban) aged 11-16 years in Srikakulam for about 3 months, using convenient sampling technique. Data on sociodemographic factors, anthropometry, lifestyle, and menstrual history were collected via questionnaire and analysed in Epi Info 7 using Chi-square test, t-test, and logistic regression.

Results: Menstrual irregularity was significantly higher in rural girls (63.5%) than urban girls (22.4%), with residence as the strongest predictor (OR=0.036, p<0.001). Overweight BMI significantly increased odds of irregularity (OR=4.41, p=0.027). Mean BMI did not differ between groups (p=0.487) or between girls with/without irregularity (p=0.199). BMI was associated with school absenteeism due to pain (p=0.0075) and PCOS diagnosis (p=0.0027) in rural girls; maternal illiteracy was linked to irregularity (p=0.007). Lifestyle factors showed no independent association.

Conclusion: Residence and overweight BMI are significant predictors of menstrual irregularity. School-based menstrual health education, nutritional support, and maternal awareness programmes are needed, especially in rural areas.

Keywords: Adolescents, BMI, Menstrual irregularities, Rural-urban, PCOS.

INTRODUCTION

Menstruation is an important physiological process in adolescent girls and reflects the normal functioning status of the hypothalamic–pituitary–ovarian (HPO) axis.[1] Menstrual irregularities are commonly associated with changes in cycle regularity, duration, flow volume, and bleeding patterns. During adolescence, menstrual cycles may become irregular because of hormonal immaturity, stress, undernutrition, overweight, or obesity. Although some irregularity is considered normal during the early years after menarche, persistent menstrual disturbances can negatively affect physical health, psychological well-being, academic performance, and overall quality of life.[2]

Nutritional status plays a major role in regulating menstrual function. Body Mass Index (BMI) is an

important indicator of nutritional status and has a significant influence on the reproductive health of adolescents and women.[3] World Health Organization (WHO) says *adolescence* is the stage of life between 10 and 19 years old. It's the time when a child slowly changes into an adult, going through big body changes (like puberty) and important mind changes (like learning independence and shaping identity). It is the bridge between childhood and adulthood — a period full of growth, discovery, and challenges.[4] The occurrence of menstrual irregularities varies depending on factors such as nutritional status, physical activity, psychological stress, and geographical differences, Variations in dietary practices, socioeconomic conditions, educational status, healthcare accessibility, and lifestyle patterns between urban and rural populations can significantly influence both BMI and menstrual health.[5] Urbanization and sedentary lifestyles have increased the prevalence of overweight and obesity in urban areas, whereas undernutrition remains more common in rural populations.

In recent years, Indian adolescent girls have increasingly been exposed to unhealthy dietary habits, physical inactivity, stress, and lifestyle changes, leading to both undernutrition and overweight or obesity. These conditions may alter hormonal balance and contribute to menstrual irregularities.[6] Overweight and obesity are associated with changes in estrogen metabolism and ovulatory dysfunction, which can result in irregular menstrual cycles. Similarly, low BMI and undernutrition may also disturb normal reproductive function due to inadequate hormonal production.

As noted in study by Gayatri Koyya, Thotlapalepu Sahiti Royal, Menstrual irregularities among adolescents are considered an important public health issue worldwide, with prevalence ranging from 23% to 45%. In India, studies report prevalence rates between 23% and 45%, highlighting a considerable public health concern.[1]

The study focused on adolescent girls who had already started menstruating. To truly support them, menstrual health needs to be looked at in a complete way, not just the physical side, but also the emotional, social, and educational aspects. Doing this helps improve their overall well-being and gives them more confidence and independence.[1]

Menstrual irregularities can lead to school absenteeism, decreased participation in daily activities, and reduced quality of life among adolescent girls. Therefore, studying the relationship between BMI and menstrual irregularities is important for the early identification of adolescents at risk for PCOS (PMOS) and for developing preventive strategies. Such studies can also help increase awareness regarding adolescent reproductive health and support the implementation of effective school-based health interventions.[4]

MATERIALS AND METHODS

An observational,cross-sectional analytical study done among high school adolescent girls, related to urban and rural field practice areas of Medical College (Gujaratipeta and srikurmam) in Srikakulam from March to May 2026 by convenient sampling technique.

Inclusion Criteria

Adolescent girls who have attained menarche.

Students who agreed and from whom the informed assent and parental consent is taken.

Exclusion Criteria

Adolescent girls who are seriously ill.

Students who are absent or not available even after 3 visits and incomplete questionnaires.

The data was collected from the eligible participants who fulfilled inclusion and exclusion criteria. Interviewer-administered questionnaire was used and those participants who have not attained menarche and incomplete questionnaire were excluded from the study.

Sample size: calculated using $n=Z^2pq/d^2$

P = prevalence from previous study 35.7% (In a study done by Kumar A, Seshadri JG, Murthy NS, 35.7% reported to have menstrual irregularities.[7])

q = 100 – p, Confidence level =95% (Z=1.96), Absolute precision d = 6%, Non response rate 10%

Calculated Sample size =269.5 ~270; Total sample size= 277

The students and school authorities were informed about the purpose of the study .Data was collected using a structured questionnaire with predefined questions. The questionnaire, prepared in English, and translated to Telugu included details regarding , socio-demographic characteristics, anthropometric measurements (age, weight, height, BMI, waist circumference and hip circumference), life- style practices, menstrual history such as age at menarche, menstrual cycle length, duration of menstrual bleeding, passage of clots, dysmenorrhoea, absenteeism from school due to menstrual pain, use of medications, and premenstrual symptoms and physical activity patterns was obtained.

Age was documented in completed years. Weight was measured using a standardized weighing scale that was placed on a firm horizontal surface to the nearest 500g. The weight of the girls was measured barefoot, with minimal clothing; shoes and socks were removed. While height was measured using a stadiometer in centimetre to the nearest 1cm. The height of the girls was measured barefoot and was asked to stand with their heels together, medial malleoli touching, and feet slightly spread apart. The students were instructed to look straight ahead and height was recorded. Waist and hip circumferences were also measured using a measuring tape. Waist circumference was measured according to the World Health Organization protocol at the midpoint between the lower rib and the top of the hip bone using a non-stretchable measuring tape. Hip

circumference was measured at the widest part of the buttocks. During both measurements, participants were asked to stand upright with feet close together, arms at the sides. Body Mass Index (BMI) and waist-to-hip ratio were calculated using the recorded measurements.

Menstrual history over the previous six months was recorded. Girls with menstrual cycles lasting between 21 and 35 days were considered to have regular cycles, whereas cycles shorter than 21 days or longer than 35 days, missed periods greater than or equal to 2 months, bleeding more than 7 days, severe dysmenorrhea affecting school were categorized as irregular menstrual cycles. Information about Physical activity, Junk food consumption, Consumption of Sugary drinks, and Screen time was assessed. Anthropometric measurements and menstrual characteristics were analysed to study their association with menstrual irregularities among adolescent girls.

Data was entered in a Microsoft Excel and was analysed through EPI Info software version 7. Descriptive statistics were done in the form of frequency and percentages for categorical data and mean and (SD) standard deviation for continuous data. Chi-square test was applied to find out association between the categorical values (ex: BMI categories and menstrual irregularities). Independent t-test was used to compare mean BMI among urban and rural girls. Logistic regression analysis was used to predict the probability of having irregular cycles based on the lifestyle factors.

Permission was sought from principals of urban and rural school and data was collected in a period which is allotted to us by school administration where school academics were not disturbed. Informed ascent was obtained from students and parental consent was also obtained. Study was started after obtaining approval from (IEC) Institutional Ethics Committee.

RESULTS

Table 1: Sociodemographic characteristics of study participants (n=277)

	Rural (n=148)	**Urban(n=129)**
Sociodemographic variable	Frequency (%)	Frequency (%)
Age		
11-13yrs	40(27)	47(36.4)
14-16yrs	108(72.9)	82(63.5)
Class		
6	9(6%)	5(3.8)
7	16(10.8)	20(15.5)
8	43(29)	46(35.6)
9	80(54)	58(44.9)
Father's education		
Literate	109(73.6)	126(97.6)
Illiterate	39(26.3)	3(2.3)
Mother's education		
Literate	114(77)	128(99.2)
Illiterate	34(22.9)	1(0.7)
Father's occupation		
Employed	147(99.3)	129(100)
Unemployed	1(0.6)	0(0)
Mother's occupation		
Employed	101(68.2)	75(58.1)
Unemployed	47(31.7)	54(41.8)

The sociodemographic characteristics of the study participants are shown in [Table 1]. In the rural school girls, majority (72.9%) belong to 14-16 years of age, 80% belong to 9th class, 73.6% of them have fathers who are literate, 77% of their mothers are literate. In the urban school girls, majority (63.5%) belong to 14-16 years of age, 44.9% belong to 9th class, 97.6% of fathers were literate, 99.2% of mothers were literate.

Table 2: Responses to menstrual patterns by the study participants (n=277)

Menstrual history questions	**Rural (n=148)**	**Urban (n=129)**
	Frequency (%)	**Frequency (%)**
Age at menarche		
10-12yrs	50(33.7)	67(51.9)
13-15yrs	98(66.2)	49(37.9)
Cycle length		
<21 days	24(16.2)	19(14.7)
21-35days	51(34.4)	55(42.6)
>35days	11(7.43)	11(8.5)
Irregular/not sure	62(43.2)	30(23.2)
Regular periods		
Yes	89(60.1)	89(68.9)
No	59(39.8)	27(20.9)
Missed periods		

Yes	29(19.5)	31(24)
No	119(80.4)	87(67.4)
Number of irregular cycles		
None	107(72.2)	63(48.8)
1-2cycles	36(24.3)	37(28.6)
3 or more cycles	5(3.3)	15(11.6)
Duration of bleeding		
<3days	29(19.5)	17(13.1)
3-7days	88(59.4)	76(58.9)
>7days	31(20.9)	23(17.8)
Menstrual flow		
Scanty	5(3.3)	6(4.6)
Normal	113(76.3)	87(67.4)
Heavy	30(20.2)	24(18.6)
Passing Large clots		
Yes	57(38.5)	29(22.4)
No	89(60.1)	88(68.2)
Sanitary pads/day		
1-2pads	23(15.5)	20(15.5)
3-4pads	74(0.5)	75(58.1)
>=5pads	51(34.4)	22(17)

[Table 2] shows the responses to menstrual history among the participants where in rural areas the age of menarche was predominantly 13-15 years, in urban areas it is predominantly 10-12 years of age.

Table 3: Distribution of pain and other symptoms in study participants (n=277)

Pain &Other symptoms	**Rural (n=148)**	**Urban (n=129)**
	Frequency (%)	**Frequency (%)**
Lower abdominal pain		
Yes	107(72.2)	88(68.2)
No	41(27.7)	29((22.4)
Interference of Pain with school attendance		
Yes	39(26.3)	39(30.2)
No	109(73.6)	78(60.4)
Symptoms before/during periods		
Headache	9(6)	9(6.9)
Mood changes	43(29)	47(36.4)
Bloating	10(6.7)	1(0.7)
Breast tenderness	7(4.7)	6(4.6)
None	79(53.3)	58(44.9)
Hormonal imbalance symptoms		
Excessive facial /body hair growth		
Yes	25(16.8)	12(9.3)
No	123(83.1)	105(81.3)
Persistent acne		
Yes	16(10.8)	31(24)
No	132(89.1)	86(66.6)
Unexplained weight gain		
Yes	24(16.2)	12(9.3)
No	124(83.7)	105(81.3)
PMOS(PCOS) diagnosis		
Yes	1(0.6)	2(1.5)
No	147(99.3)	114(88.3)

In [Table 3], lower abdominal pain was reported in 72.2% of the rural girls and 68.2% of the urban girls Mood changes were reported in 29% of rural girls and 36% of urban girls. PCOS was diagnosed in 1 rural and 2 urban school girls.

Table 4: Distribution of Lifestyle factors among the study participants (n=277)

	Rural (N=148)	**Urban (N=129)**
Lifestyle Factors	**Frequency (%)**	**Frequency (%)**
Physical Activity Per Day		
<30 Mins	28(18.9)	45(34.8)
30-60 Mins	31(20.9)	66(51.1)
1-2hrs	31(20.9)	12(9.3)
>2hrs	58(39.1)	6(4.6)
Screen Time Per Day		
<30 Mins	44(29.7)	41(31.7)
30-60 Mins	40(27)	46(35.6)
1-2hrs	42(28.3)	26(20.1)
>2hrs	22(14.8)	16(12.4)

Frequency of Junk Food Consumption		
Daily	14(9.4)	7(5.4)
3-4 Times/Week	13(8.7)	36(27.9)
Once/Week	49(33.1)	54(41.8)
Rarely	72(48.6)	32(24.8)
Frequency of Sugary Drinks Consumption		
Daily	10(6.7)	13(10)
3-4 Times/Week	18(12.1)	33(25.5)
Once/Week	47(31.7)	41(31.7)
Rarely	73(49.3)	42(32.5)

[Table 4] shows distribution of life style factors. In rural girls, 39.1% of them reported physical activity levels more than 2 hours per day, 29.7% of them reported less than 30 mins per day, 48.6% of them reported consumption of junk food rarely, 49.3% reported rare consumption of sugary drinks.

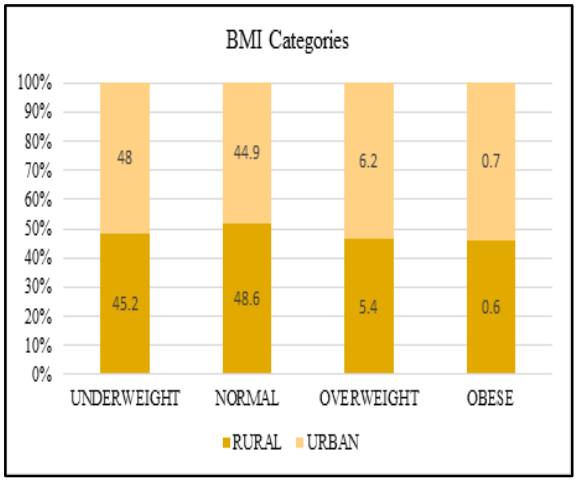

Figure 1: Classification of BMI categories in Rural and Urban School girls (n=277)

In [Figure 1] among Rural girls 67(45.2%) were underweight, 72(48.6%) were normal, 8 (5.4%) were overweight, 1 (0.6%) was obese. Among urban girls, 62 (48%) were underweight, 58(44.9%) were normal, 8 (6.2%) of them were overweight, 1(0.7)% of them was obese.

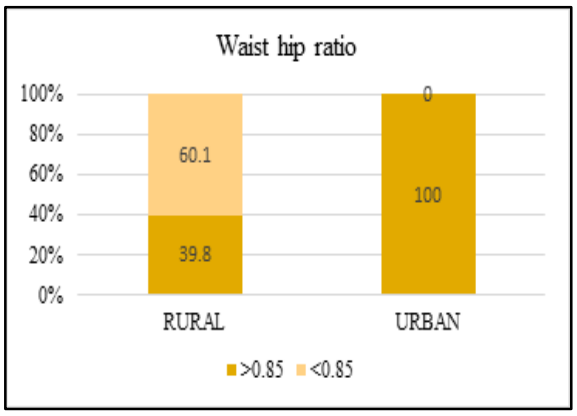

Figure 2: Classification of Waist hip ratio in Rural and urban girls (n=277)

In [Figure 2], in the rural girls, 59 (39.8%) of them had WHR greater than 0.85 and 89 (60.1%) of participants had less than 0.85. In urban girls, 129 (100%) of them had WHR greater than 0.85.

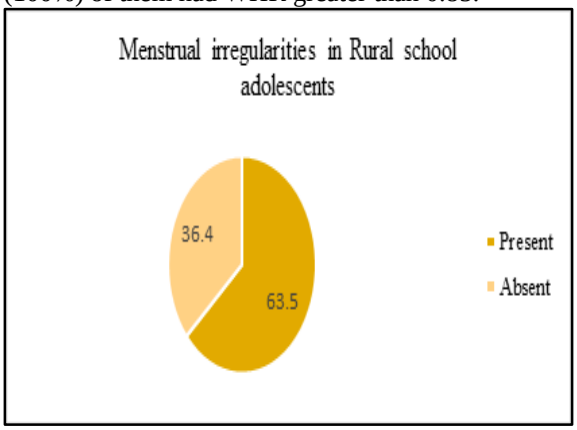

Figure 3: Prevalence of menstrual irregularities in Rural school adolescents (n=148)

[Figure 3] shows that there is 63.5% prevalence of menstrual irregularities in rural schoolgirls.

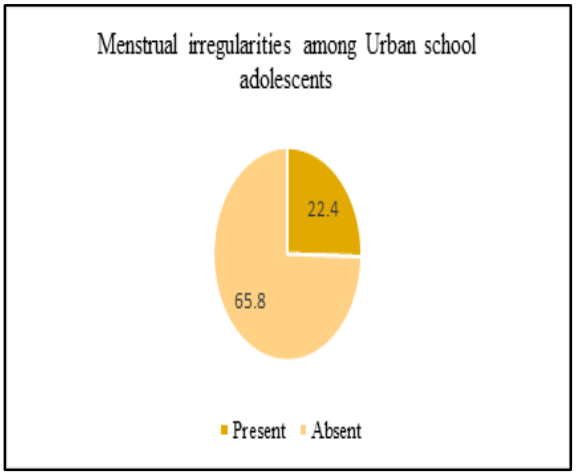

Figure 4: Prevalence of menstrual irregularities in Urban school adolescents (n=129)

[Figure 4] shows that prevalence of menstrual irregularities in urban school adolescents is 22.4%.

It was found that there is no statistically significant difference in mean BMI between Rural (M=19, SD=3.21) and urban adolescent school girls (M=19.4, SD=5.69) using Independent sample t test (t(275)=-0.696, p= 0.487,cohen's d=0.0839).

It was found that there is no statistically significant difference in mean BMI between participants with (M=19.4, SD=3.32) and without (M=18.9, SD=3.23) menstrual irregularities using Independent sample t test (t (260)=-1.29, p= 0.199,cohen's d=-0.159).

Table 5: Binomial Logistic Regression of Lifestyle factors with Menstrual irregularity among study participants (n=277)

Model Fit Measures			
Model	**Deviance**	**AIC**	**R^2_{McF}**
1	289	333	0.202

Model Coefficients - Menstrual Irregularity							
						95% Confidence Interval	
Predictor	**Estimate**	**SE**	**Z**	**p**	**Odds ratio**	**Lower**	**Upper**
Intercept	1.5173	4.363	0.3478	0.728	4.5601	8.81e-4	23603.703
Age	-0.2411	0.161	-1.4958	0.135	0.7858	0.57292	1.078
Residence:							
Urban – Rural	-3.3315	0.776	-4.2938	< .001	0.0357	0.00781	0.164
Ses [Bg Prasad]:							
2 – 1	-0.8720	0.770	-1.1320	0.258	0.4181	0.09239	1.892
3 – 1	-1.6635	0.818	-2.0348	0.042	0.1895	0.03816	0.941
4 – 1	-1.8820	0.897	-2.0980	0.036	0.1523	0.02625	0.884
Bmicategories:							
Obese – Normal	-15.5109	882.744	-0.0176	0.986	1.84e-7	0.00000	Inf
Overweight – Normal	1.4842	0.670	2.2152	0.027	4.4116	1.18650	16.403
Underweight – Normal	-0.3175	0.321	-0.9895	0.322	0.7280	0.38817	1.365
Whr	5.3665	4.190	1.2807	0.200	214.1082	0.05805	789692.454
Screen Time:							
2 – 1	0.0429	0.379	0.1132	0.910	1.0438	0.49700	2.192
3 – 1	-0.6494	0.411	-1.5789	0.114	0.5224	0.23327	1.170
4 – 1	-0.4048	0.503	-0.8042	0.421	0.6671	0.24874	1.789
Junk/Fast Food:							
1 – 4	1.0977	0.655	1.6768	0.094	2.9974	0.83077	10.814
2 – 4	0.5019	0.483	1.0402	0.298	1.6519	0.64159	4.253
3 – 4	-0.1165	0.361	-0.3230	0.747	0.8901	0.43907	1.804
Sugary Drinks:							
1 – 4	0.7085	0.672	1.0545	0.292	2.0310	0.54422	7.580
2 – 4	-0.2988	0.457	-0.6544	0.513	0.7417	0.30310	1.815
3 – 4	-0.3348	0.364	-0.9186	0.358	0.7155	0.35028	1.462
Physical Activity:							
1 – 4	-0.2514	0.470	-0.5352	0.592	0.7777	0.30978	1.953
2 – 4	-0.2872	0.450	-0.6386	0.523	0.7504	0.31081	1.812
3 – 4	-0.5440	0.484	-1.1240	0.261	0.5805	0.22482	1.499
Note. Estimates represent the log odds of "Menstrual Irregularity = 1" Vs. " Menstrual Irregularity = 0"							

SES: 1-upper, 2-upper middle, 3-middle, 4-lower middle, 5-lower
Physical activity, Screen time- 1: <30 min, 2:30-60 mins, 3:1-2 hours, 4: >2hours
Sugary drinks, Junk foods- 1: daily, 2:3-4 times/week, 3: once /week, 4: rarely.
Menstrual Irregularity=1, No Menstrual Irregularity =0

[Table 5] shows that Urban girls had significantly lower odds of experiencing menstrual irregularities compared to rural girls (OR=0.036, p<0.001).

There is a statistically significant association of residence with period regularity with higher number of girls reporting absence of regular periods in rural areas.(χ^2=8.15,p=0.004), normal BMI levels and regular periods (χ^2=6.26p value-0.01), overweight BMI and and period regularity(χ^2=5.33, p value-0.02)

There was no statistically significant association between underweight BMI and regular periods, obese BMI and regular cycles, BMI and other menstrual patterns, symptoms, hormonal imbalance symptoms. In addition in urban areas, there was no statistically significant association between BMI and menstrual pain interfering with school attendance, BMI and diagnosis of PCOS.

There is no statistically significant association between Lifestyle factors and menstrual irregularity in rural and urban school girls, socioeconomic status and menstrual irregularity in rural (p=0.46) and urban (p=0.77) school girls.

In Rural Girls

There is statistically significant association of BMI with menstrual pain interfering with school attendance (χ^2=11.95,p value =0.0075), BMI and PCOS diagnosis indicating higher the BMI , more likely is the diagnosis of PCOS (χ^2=9,p value =0.0027), mother's education with menstrual irregularity (χ^2=7.16, p value=0.007)

In Urban Girls

There is statistically significant association between overweight and obese BMI and hormonal imbalance symptoms like excessive facial hair / body hair. (χ^2=3.93, p value=0.04).

DISCUSSION

The study was conducted among 277 adolescent school girls (148 rural and 129 urban) aged 11–16 years to assess the prevalence of menstrual irregularities and their association with Body Mass Index (BMI), lifestyle factors, and sociodemographic variables. The majority of participants in both rural

(72.9%) and urban (63.5%) groups belonged to the 14–16 years age group, reflecting the target population of mid to late adolescence, a critical phase of reproductive development. A higher level of parental literacy was observed in urban girls compared to their rural part, which may influence health-seeking behaviour and awareness regarding menstrual health.[8]

The prevalence of menstrual irregularities was notably higher among rural school girls (63.5%) compared to urban school girls (22.4%). The higher prevalence in rural areas may be attributed to nutritional deficiencies, a higher proportion of underweight girls (45.2% rural vs. 48% urban), lower maternal literacy, and limited access to healthcare and menstrual health education. A statistically significant association was found between residence and period regularity (χ^2=8.15, p=0.004), with rural girls reporting a significantly higher proportion of absent or irregular periods. KoyyaG and Royal TS,[9] reported comparable findings regarding the prevalence of menstrual irregularities among adolescent girls in similar settings, underscoring the influence of rural-urban disparities on reproductive health outcomes.

The age at menarche was found to be earlier in urban girls (predominantly 10–12 years, 51.9%) compared to rural girls (predominantly 13–15 years, 66.2%). This difference may be attributable to better nutritional status, higher BMI, and urban lifestyle factors including dietary habits. These findings are consistent with evidence suggesting that urbanization and improved socioeconomic conditions are associated with earlier onset of menarche. Earlier menarche in urban areas has been observed in multiple Indian studies and is linked to increasing trends of overweight and sedentary behaviour among urban adolescents.[10]

In the meta-analysis study on BMI and primary dysmenorrhoea found that underweight was significantly associated with dysmenorrhoea. In our study, 72.2% of rural and 68.2% of urban girls reported lower abdominal pain, with BMI in rural girls showing significant association with menstrual pain interfering with school attendance (p=0.0075). This aligns well with Wu L et al,[11] meta-analytic findings.

The distribution of BMI categories revealed that underweight was the predominant nutritional status in both rural (45.2%) and urban (48%) girls, followed by normal BMI. Overweight and obesity were uncommon in both groups. The mean BMI did not differ significantly between rural (19.0 kg/m²) and urban (19.4 kg/m²) girls (p=0.487).Singh et al. [4] found that adolescent girls with BMI <18.5 experienced more symptoms and problems associated with menstrual cycles, and this difference was statistically significant.

In the study by Dhar S et al,[12] from West Bengal found that lifestyle factors such as dietary patterns and physical activity significantly influenced menstrual outcomes among adolescents and young women. This corroborates our finding that 39.1% of rural girls reported >2 hours of physical activity daily—predominantly through domestic and agricultural chores—which may paradoxically contribute to menstrual irregularities through energy deficiency rather than offering protection.

Majeed J et al,[13] in their meta-analysis on menstrual hygiene practices among Indian adolescent girls highlighted the crucial role of health literacy and socioeconomic factors and menstrual distress, including pain, is a major determinant of school absenteeism, a finding that corresponds well with the results of the present study. Our finding that mother's literacy was significantly associated with menstrual irregularity in rural girls (p=0.007)—where illiterate mothers' daughters had higher irregularity—directly supports this meta-analytic evidence that maternal education is a key determinant of adolescent menstrual health. Lower abdominal pain during menstruation was highly prevalent in both rural (72.2%) and urban (68.2%) girls, with approximately 26–30% reporting that this pain interfered with school attendance.

The binomial logistic regression analysis between lifestyle factors and menstrual irregularity among adolescent girlsrevealed that residence, socioeconomic status, and BMI category were significantly associated with menstrual irregularity. Urban girls had significantly lower odds of experiencing menstrual irregularities compared to rural girls (OR=0.036, p<0.001).Thisfinding is consistent with the work of Apeksha Kumar et al.[14] Girls belonging to middle and lower-middle socioeconomic classes also showed significantly lower odds of menstrual irregularity compared to those from the upper socioeconomic class. Among BMI categories, overweight girls were 4.4 times more likely to have menstrual irregularities than girls with normal BMI (OR=4.41, p=0.027). This finding is consistent with the study by Singh et al,[4] which reported a significant association between increased BMI and menstrual abnormalities among adolescent girls. Overweight status is an important predictor of menstrual irregularities among adolescent girls, while the lifestyle factors assessed in this study did not show a significant independent effect. Similarly, Sen et al,[15] observed a higher prevalence of menstrual disorders among overweight and obese adolescents. In contrast, lifestyle factors such as physical activity, screen time, junk food intake, and sugary drink consumption were not independently associated with menstrual irregularity in the current study, suggesting that BMI may have a stronger influence on menstrual health than these behavioural factors in this population. Therefore, maintaining a healthy body weight during adolescence may play an important role in promoting normal menstrual function and preventing future reproductive health problems.

This study demonstrates that menstrual irregularity is substantially more prevalent among rural adolescent girls, with residence emerging as the strongest

independent predictor. Overweight BMI significantly increases the odds of menstrual irregularity, and specific BMI categories (normal and overweight) show significant associations with period regularity. While overall mean BMI did not differ significantly between groups or between girls with and without menstrual irregularity, categorical BMI analysis and logistic regression revealed clinically meaningful associations. Lifestyle factors did not independently predict menstrual irregularity in this sample, though their role in the broader context of reproductive health cannot be discounted. These findings highlight the need for targeted school-based reproductive health programmes, nutritional interventions, and improved healthcare access in rural areas to address the burden of menstrual irregularities among adolescent girls.

Limitations

1) The cross-sectional design limits the ability to establish causal relationships between BMI, lifestyle factors, and menstrual irregularities.

2) Frequency of junk food and sugary drink consumption was used as a proxy for diet quality; a validated dietary assessment tool such as a food frequency questionnaire would have provided more robust dietary data.

Recommendations

Based on the findings of this study, menstrual health education programs should be strengthened in schools, particularly in rural areas where menstrual irregularities were highly prevalent. Nutritional counselling and regular growth monitoring are essential due to the high proportion of underweight adolescents and the increased risk of menstrual irregularities. Awareness programs for mothers should also be promoted, as maternal literacy was significantly associated with menstrual health outcomes. Adolescents with menstrual irregularities and symptoms suggestive of hormonal imbalance should be screened early for conditions such as PCOS. Additionally, school-based support for managing menstrual pain and promoting healthy lifestyle practices is recommended, while further longitudinal studies are needed to better understand the factors influencing menstrual health in adolescents. Continuous access to water, soap, and menstrual hygiene management facilities should be provided to promote healthy hygiene practices among schoolgirls. Provision of covered disposal bins and regular maintenance of sanitation facilities can improve menstrual hygiene management in schools.

CONCLUSION

The present study highlights a significantly higher prevalence of menstrual irregularities among rural adolescent school girls (63.5%) compared to their urban counterparts (22.4%), with residence emerging as the strongest independent predictor of menstrual irregularity (OR=0.036, p<0.001). Overweight BMI was found to be a statistically significant risk factor for menstrual irregularity (OR=4.41, p=0.027).

Lifestyle factors including physical activity, screen time, junk food, and sugary drink consumption did not independently predict menstrual irregularity after adjusting for demographic and anthropometric variables, underscoring the multifactorial and socioecological nature of adolescent menstrual health. Maternal literacy was identified as a sociodemographic correlate of menstrual irregularity in rural girls. These findings call for integrated school-based menstrual health programs, nutritional support, BMI monitoring, and community-level maternal education, particularly in rural and low-income settings.

In line with existing literature from India and globally, this study reinforces the imperative for adolescent-sensitive healthcare policies that address menstrual health not merely as a reproductive issue, but as an indicator of broader nutritional, metabolic, and social wellbeing. Early identification and management of menstrual disorders in this foundational period of life can have lasting positive impacts on the reproductive and overall health of young women.

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