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**Original Article**

# Association between menstrual cycle regularity and obesity-related anthropometric indices in dormitory students of Kashan University of Medical Sciences, Iran

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ABSTRACT

**Background & Aim:** A significant proportion of the women in reproductive ages suffer from problems such as menstrual irregularities. The aim of this study was to determine the association between menstrual cycle regularity and obesity-related anthropometric indices in students of Kashan University of Medical Sciences in 2012.

**Methods & Materials:** This cross-sectional descriptive study was conducted using a questionnaire through systematic random sampling at dormitory of Kashan University of Medical Sciences from September to October 2012. The questionnaire contained demographic questions, menstrual cycle characteristics, anthropometric measurements and Visual Analog Scale questionnaire for pain. A midwifery student measured obesity-related anthropometric measurements included waist, pelvis, thigh and mid-arm circumference, height and weight.

**Results:** A total of 250 students entered in the study. Mean ± Standard deviation (SD) age of students was 21.295 ± 1.585 years. Irregular menstruation was seen in 17 students (6.8%). Results showed a significant statistical between menstrual cycles regularity with height (MD = −3.37, confidence interval [CI] = −6.039 to 0.703, P = 0.013), body mass index (BMI) (MD = 1.654, CI = 0.199–3.109, P = 0.026), and pelvic-to-height ratio (MD = 0.027, CI = 0.003–0.051, P = 0.023). Mean ± SD duration and interval of menstrual cycles were 6.564 ± 1.3014 and 29.301 ± 4.821 days, respectively. Based on the Pearson correlation index, menstrual intervals showed significant statistical between waist-to-thigh (P = 0.010) and arm-to-thigh (P = 0.019) ratio, but showed no correlation with other anthropometric indices. In the univariate analysis to assess the unadjusted relationships, there were significant statistical between waist-to-thigh and arm-to-thigh ratio with menstrual interval.

**Conclusion:** Due to association between menstrual cycle regularity and obesity-related anthropometric indices, control of weight and BMI may lead to a reduction of menstrual irregularity.

## Introduction

A significant proportion of women in reproductive age have some problems such as menstrual irregularities (1). Percentage of menstrual irregularity is 12.9%, 17.1%, and 23.1% (2-4). The prevalence of menstrual dysfunction was reported 30.1% in Iran (5). It is likely that obesity may play a role in the etiology of menstrual problems (6). Various kinds of lipids are

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stored by fat tissue, which they are able to metabolize steroids such as androgens (7). Increased body weight and fat tissue gain, especially in the central areas of the body destroys the balance of steroid hormones such as androgens, estrogens, and sex hormone binding globulin (SHBG). Changes in SHBG level has also led to changes in the release of androgen and estrogen in target tissues (8). Obesity can increase production of estrogen and estrogen has an effect on weight and body fat. The role of fat tissue in the sex hormone balance is very important (7). On the other hand, body mass index (BMI) has limitations for determination of obesity (8). BMI is independent of body size, and cannot determine the type of obesity and body fat distribution (7). Furthermore, BMI is influenced by factors such as a variation in race, gender, and age and it is not a good indicator to characterize obesity (5). It is showed that the percentage and distribution of body fat, is a more credible criterion for determining obesity (8). It is found that BMI is an important factor affecting irregular menstrual cycles (3). However in another study, no significant statistical observed between length and height dimensions and the menstrual cycle patterns (7). The risk of amenorrhea and oligomenorrhea was increased by an increase in obesity (9). Trunk fat mass was also significantly higher in women with menstrual disorders than in the control group (10).

Given the recent rise in obesity, especially abdominal obesity and the general lack of research about the correlation between anthropometric indices and menstrual characteristics, the aim of this study was to determine the association between menstrual cycle regularity and obesity-related anthropometric indices in students of Kashan University of Medical Sciences, Iran, in 2012.

## Methods

### *Protocol*

This is a descriptive, cross-sectional study performed between March and June 2012. Study has been approved at Kashan University of Medical Sciences and proposal approval code was 9078. Female medical students who lived at Kashan University of Medical Sciences dormitories were studied. Inclusion criteria included: absence of self-reported genital diseases, pain during the whole menstrual cycles or all time of bleeding, usage of oral contraceptives, history of abdominal or pelvic surgery. Based on the prevalence of 17.1% for menstrual irregularity, error rate of 5%, and 95% confidence, sample size were 218 students using Systematic random sampling. Students were selected based on the list of student dormitories. Loss of 20% of the samples was considered. Sampling was conducted using random numbers table to select the first student and a random number of 2 for continue. Then for the completion of sample size, sampling was repeated using a random number table for the first student and a random number of 25 for continue. Regarding the inclusion criteria, 250 students were enrolled in the study. Students were taught something related to the menstrual cycle and received a questionnaire. The questionnaire was developed by the authors and consisted of 14 questions in two sections. The first section had eight questions including demographic characteristics (including age, discipline, and marital status) and menstrual history (including menarche, menstrual regularity and intervals, and duration of bleeding). The second section of the questionnaire had six anthropometric measurements. In this section, obesity-related anthropometric indices were measured including height without shoes from top of the head to the floor, waist circumference at the umbilicus, pelvic circumference at its highest settings, arm circumference in the middle of the distance from elbow to shoulder and thigh circumference in the middle of the thigh using non-elastic tape, weight was measured in light clothing with 0.1 kg accuracy using German Weight Bridge Model GS46.

We defined the menstrual cycle as interval between the first days of menses. Irregular menstrual period was defined as <21 or >35 days (13). A midwifery student was trained to collect the information using a questionnaire via face to face interviews. Informed consent was obtained from all students. The students were described that they can be excluded from the study at any time and this information will keep confidential and are generally used.

Data were calculated as frequency (percentage) for qualitative variables and mean (±standard deviation [SD]) for quantitative variables. Normal distribution of the quantitative variables were assessed and confirmed by one-sample Kolmogorov–Smirnov test. Pearson correlation coefficient was used to measure the correlation between menstrual intervals and obesity-related anthropometric indices. In the univariate analysis to calculate the unadjusted relationships, between anthropometric indices and menstrual interval, simple linear regression were used. In the multivariate analysis, multiple regression analysis with backward removal strategy was used to calculate the adjusted relationships between anthropometric indices and menstrual interval. In this strategy all anthropometric indices were first put in the model and in the next steps variables with a lower amount of relationships removed from the model until the criterion of P-value were satisfied. The assumption of residual variance homogeneity and residual independency were also assessed and confirmed by scatter plot of residual versus predicted values and Durbin–Watson statistics respectively. There was no co-linearity among independent variables which were assessed by variance inflation factor (values <10). In each analysis, B, standard error, beta, and their related P-values were reported. SPSS 13 software (SPSS Inc., Chicago, IL, USA) was used to data analysis. $P < 0.05$ was considered as significant level.

## Results

Up to 250 students fulfilled the inclusion criteria and all accepted the invitation (response rate was 100%).

No one used alcohol or drugs and students were studying at different disciplines. Table 1 shows the distribution of discipline in students.

Irregular menstruation was seen in 17 students (6.8%). Mean ± SD menarche was 13.392 ± 1.328 years, mean ± SD bleeding duration was 6.564 ± 1.3014 day, and mean ± SD for menstrual intervals was 29.301 ± 4.821 days. T-test showed a significant statistical relation between menstrual cycles regularity and height (MD = −3.371, P = 0.013), BMI (MD = 1.654, P = 0.026), pelvic-to-height ratio (MD = 0.027, P = 0.023), and arm-to-height ratio (MD = 0.007, P = 0.048). There were no association between menstrual cycle regularity and other anthropometric indices.

**Table 1.** Distribution of absolute frequency of personal characteristics in students

| Personal information | Mean (±SD) or N (%) |
|---|---|
| Age (years) | 21.295 (±1.585) |
| Marital status | |
| Single | 217 (86.8) |
| Married | 33 (13.2) |
| Discipline | |
| Health | 89 (35.6) |
| Anesthesiology | 24 (9.6) |
| Laboratory sciences | 33 (13.2) |
| Radiology | 16 (6.4) |
| Midwifery | 23 (9.2) |
| Nursing | 38 (14.8) |
| Operating room | 19 (7.6) |
| Others | 9 (3.6) |
| Total | 250 (100) |

Values are given as mean (±SD) or number (%) unless otherwise indicated. SD: Standard deviation

T-test showed no significant statistical relation between menstrual regularity and menarche (MD = −0.317, P = 0.306) or duration of menstrual cycles (MD = −0.069, P = 0.819).

In the univariate analysis to assess the unadjusted relationships, there were significant statistical between waist-to-thigh and arm-to-thigh ratio with menstrual interval. The relationship between the waist-to-weight ratio and menstrual interval was not significant (Table 2).

In the multivariate regression analysis with backward removal strategy to assess the adjusted statistical relationships, the BMI, waist circumference, pelvic circumference, waist-to-height ratio, and arm-to-thigh remained in the final model; therefore, there were significant statistical of these variables with menstrual interval (Table 3). Discipline variable was adjusted in analysis.

**Table 2.** Relationship between menstrual intervals and obesity-related anthropometric indices in students

| Menstrual interval anthropometric indices | Mean ± SD | Min–max | r* | P-value |
|---|---|---|---|---|
| BMI (kg/m$^2$) | 21.470 ± 3.193 | 15.106–29.935 | 0.002 | 0.972 NS |
| Waist circumference (CM) | 74.768 ± 8.708 | 52.000–104.000 | 0.042 | 0.507 NS |
| Pelvic circumference (CM) | 93.660 ± 8.516 | 74.000–116.000 | 0.054 | 0.399 NS |
| Waist-to-height ratio | 0.462 ± 0.053 | 0.341–0. 654 | 0.07 | 0.272 NS |
| Waist-to-weight ratio | 1.344 ± 0.132 | 0.993–1.725 | 0.11 | 0.084 NS |
| Waist-to-thigh ratio | 1.594 ± 0.146 | 1.276–2.125 | 0.17 | 0.010 S |
| Arm-to-thigh ratio | 0.522 ± 0.035 | 0.437–0.627 | 0.155 | 0.019 S |

*Pearson correlation coefficient n = 250. The values of P < 0.05 were considered significant. S: Significant; NS: Non-significant. The r values show weak effect size and the significance may be due to large sample size. Therefore, some additional tests like multiple linear regressions were done. SD: Standard deviation; BMI: Body mass index

**Table 3.** Multiple logistic regression model analyzing the relationship between anthropometric indices and menstrual interval

| Anthropometric indices | Unadjusted | | | | Adjusted | | | |
|---|---|---|---|---|---|---|---|---|
| | B | SE | Beta | P-value | B | SE | Beta | P-value |
| BMI | 0.00 | 0.10 | 0.00 | 0.972 NS | −0.49 | 0.19 | 0.32 | 0.009 S |
| Waist circumference (CM) | 0.02 | 0.04 | 0.04 | 0.507 NS | −0.29 | 0.14 | 0.51 | 0.038 S |
| Pelvic circumference (CM) | 0.03 | 0.04 | 0.05 | 0.399 NS | 0.12 | 0.06 | 0.20 | 0.036 S |
| Waist-to-height ratio | 6.30 | 5.72 | 0.07 | 0.272 NS | 62.75 | 22.89 | 0.69 | 0.007 S |
| Waist-to-weight ratio | 3.99 | 2.30 | 0.11 | 0.084 NS | - | - | - | - |
| Waist-to-thigh ratio | 5.72 | 2.21 | 0.17 | 0.010 S | - | - | - | - |
| Pelvic-to-height ratio | 8.37 | 5.91 | 0.09 | 0.158 NS | | | | |
| Arm-to-thigh ratio | 21.44 | 9.11 | 0.16 | 0.019 S | 24.58 | 9.35 | 0.18 | 0.009 S |

Dependent variable: menstrual interval. Confounding variables were adjusted. Multiple R = 0.263 for backward model with arm-to-thigh, pelvic circumference, waist-to-height ratio, waist circumference, BMI variables as predictors. S: Significant; NS: Non-significant. SE: Standard error; BMI: Body mass index

## Discussion

Considering high prevalence of women suffering problems such as menstrual irregularities (5) the aim of this study was to determine the association between menstrual cycle regularity and obesity-related anthropometric indices in students.

The average age of our students was closed to Yamamoto et al. (2009) and Hossain et al. (2011) studies (1, 3) because they conducted their research in students as well.

Menstrual cycle's regularity in this study showed significant statistical with height, BMI, pelvic-to-height ratio, and arm-to-height ratio. These ratios were considered because Mirbolok et al. (2009) study showed that BMI cannot determine the type of obesity and body fat distribution (14) and other indices are necessary for this purpose. Also in the study of Wei et al. (2009) general obesity and central obesity was associated with menstrual irregularities (15). In Douchi et al. study (2002) on obese women, trunk-leg fat ratio in women with menstrual disorders had statistically significant increased compared to the control group. Also trunk fat mass was significantly higher in women with menstrual disorders than in the control group. However, percentage of body fat, body fat mass, leg fat mass, height, and weight did not differ between the two groups (menstrual disorders group and control group). They concluded that upper body, but not lower body, obesity is associated with menstrual disorders (10). It was reported that body weight gain and increased fat tissue, especially in central areas of the body can increase estrogen production (14). These reports explain the causative role of central fat on menstrual characteristics. In Hossain et al. study (2011) irregular menstrual cycle was associated with higher BMI but this relationship was not observed in height and weight (3). In Castillo-Martinez et al. study (2003) weight, BMI, waist and pelvic circumference and waist-to-pelvic ratio were higher in case of irregular menstruation compared with regular menses (9). In a study by Lambert-Messerlian et al. (2011) menstrual irregularities were associated with higher BMI and waist circumference (16). In the studies by Chang et al. (2009) and Yamamoto (2009) BMI were found to be

significant predictors for having experienced irregular menstrual cycles (1, 17). In Ziomkiewicz's study (2008) both very low and high body fat was associated with decreased estradiol levels. In their study, anthropometric measurements were taken randomly with respect to phase of the menstrual cycle and energy balance was specified based on changes in body fat percentage from the beginning to the end of the menstrual cycle and levels of 17-beta-estradiol were analyzed by radioimmunoassay. They concluded that there is a relationship between estradiol level, body fat and women's energy balance (18). These findings could explain the relationship between the obesity-related anthropometric indices and irregular menstruation.

In this study, most of the students have menstrual intervals between 21 and 35 days. This is almost similar to Yamamoto et al. (2009) and Adefuye et al. (2010) studies (1, 19). Our study showed significant statistical between menstrual intervals and BMI, waist circumference, pelvic circumference, waist-to-height ratio, waist-to-thigh, and arm-to-thigh ratio. Similarly, Castillo-Martinez et al. (2003) and Chang et al. (2009) studies reported that there are significant statistical between obesity and oligomenorhea (9, 17). Douchi et al. study (2002) reported that trunk-leg fat ratio in women with menstrual disorders was significantly higher than the control group. They concluded that upper body, but not lower body, obesity is associated with menstrual disorders (10). These results confirm our findings because we found a relationship between the waist-to-thigh ratio that is upper body, and menstrual intervals. Age at menarche in the present study was close to Adefuye et al. (2010) and Hossain et al. (2010) studies (19, 20).

In the present study, BMI was inversely associated with age at menarche. Similarly, in a study by Hossain et al. (2010) menarche was inversely correlated with BMI and directly with height (20) and because of this the body fat is defined by BMI but height is not an indicator of body fat. On the other hand, in Douchi et al. study (2002) BMI did not differ between the two groups (menstrual disorders group and control group) (10). The reason of these different results probably is study population, because Douchi et al. (2002) studied 83 women. This sample size is low. Moreover, BMI of their population all was over 25 that may effects on results. In Anai et al. study (2001) the age of menarche was higher in those who had irregular menstrual cycle (21). Also Hossain et al. (2010) reported that irregular menstrual cycle was associated with higher menarche (20). However, in the present study there were not statistically significant differences between menarche and menstrual irregularity. Our finding confirms the results of Douchi et al. study (2002) who reported that menarche did not differ between women with menstrual disorders and control group (10).

In the present study, duration of bleeding was mostly between 3 and 7 days. Similar results were obtained in Hossain et al. study (2011). In their study 97% of students had the same range (3–7 days). Also they reported that irregular menstrual cycle was associated with higher bleeding duration (3), but in our study there was not significant correlation between duration of bleeding and irregular menstrual cycles.

## Conclusion

Given the recent rise in obesity, especially abdominal obesity and due to the association between menstrual cycle regularity and obesity-related anthropometric indices, control of weight and body size may lead to a reduction of menstrual symptoms.

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