Original Article

The relationship between the duration of menstrual bleeding and obesity-related anthropometric indices in students

Mahboobeh Kafaei-Atrian[1], Zahra Mohebbi-Dehnavi[2], Leila Sayadi[3], Mohammad Asghari-Jafarabadi[4,5], Zahra Karimian-Taheri[1], Mohammad Afshar[6]

Abstract:

BACKGROUND: Many women of childbearing age suffer from problems such as dysmenorrhea and irregular menstruation.

OBJECTIVES: The objective of the study is to determine the relationship between the duration of menstrual bleeding and obesity-related anthropometric indices in students.

METHODS: This cross-sectional study was carried out on 250 students in 2016. Data were collected by a questionnaire composed of: 1) demographic information, 2) information concerning menstrual cycle and 3) obesity-related anthropometric parameters. Anthropometric parameters include height, weight, waist circumference, hip circumference, and arm circumference. Independent t-test, Pearson correlation coefficient, and multiple linear regressions with backward strategy were used.

RESULTS: The average age of students was 21/295 (±1/585) years. For most participants, the duration of menstrual bleeding was 3–7 days (87/2%, 218 people). None of the participants had menstrual bleeding <3 days, and the duration of bleeding was >7 days for 32 participants (12/800%). A significant relationship was observed between the intervals of menstruation and the waist-to-hip ratio ($r = 0/136$, $P < 0/041$). Based on multiple linear regression, hip circumference and waist-to-weight, hip-to-waist, arm-to-weight, hip-to-thigh, and arm-to-height ratios are predictors for menstrual duration.

CONCLUSIONS: In this study, a significant association was found between the anthropometric indices and menstrual characteristics. These findings suggest the need for modifying anthropometric indicators to control menstrual cycle problems.

Keywords:

Anthropometric indices, menstrual disorders, menstruation

[1]Department of Midwifery, Kashan University of Medical Sciences, Kashan, Iran, [2]Department of Midwifery, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran, [3]Nursing and Midwifery Care Research Center, School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran, [4]Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran, [5]Department of Statistics and Epidemiology, Faculty of Health, Tabriz University of Medical Sciences, Tabriz, Iran, [6]Department of Operating Room, Faculty of Nursing and Midwifery, Kashan University of Medical Sciences, Kashan, Iran

Address for correspondence:
Ms. Zahra Mohebbi-Dehnavi, Department of Midwifery, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: zahra.midwife@yahoo.com

Received: 19-04-2018
Accepted: 15-01-2019

Introduction

A large number of women of reproductive age suffer from problems such as dysmenorrhea and irregular menstrual bleeding.[1] Menstrual disorders have a wide range of disorders. However, some of them can lead to significant problems and can even be considered as important causes of infertility.[2]

There is a strong possibility that overweight and obesity play a role in the etiology of some menstrual problems. Body weight gain and an increase in adipose tissue, especially in the central region of the body, can disturb the balance of steroid hormones such as androgens, estrogen, and sex hormone-binding globulin (SHBG). Changes in SHBG also lead to a change in the release of androgens and estrogens in the target tissues. The type of obesity also plays an important role. An android body

How to cite this article: Kafaei-Atrian M, Mohebbi-Dehnavi Z, Sayadi L, Asghari-Jafarabadi M, Karimian-Taheri Z, Afshar M. The relationship between the duration of menstrual bleeding and obesity-related anthropometric indices in students. J Edu Health Promot 2019;8:81.

fat distribution is associated with the least amount of menstrual bleeding. In addition, obesity can increase the production of estrogen, which in turn is related to body weight and its fat content. Adipose tissue stores various lipids which are able to metabolize steroids such as androgens.[3]

In addition, it has recently been found that the use of body mass index (BMI) has been restricted to determine obesity and weight problems. BMI is independent of body size and cannot determine the type of obesity and body fat distribution. Furthermore, BMI is influenced by factors such as differences in race, sex, and age, and it is not an appropriate index to determine obesity. Recent research has introduced body fat distribution as a more valid criterion for determining obesity than BMI.[4,5]

The disorder of menstrual cycle indicates major disruptions such as functional impairment in the endocrine system, reproductive system, organic disorders, polycystic ovarian syndrome, and obesity.[2]

According to some studies, both extremes of BMI are associated with menstrual disorders.[4,5] Menstrual bleeding has been reported to be higher in obese women,[6] Moreover, it has been reported that excessive weight is an important factor for uterine cramps during menstruation and increases the likelihood of prolonged pain.[5]

The average age of menarche is higher in people with irregular menstrual cycles.[7] In contrast, other studies have reported that there is no association between height, weight, and menstrual characteristics.[8]

However, published studies on the relationship between body fat mass and duration of menstrual bleeding have focused on BMI, and some results are contradictory as well as anthropometric indices have received little study. Severe and prolonged menstrual irregularities require discovery and treatment; there may be a primary endocrinopathy which also reduces fertility in the future; however, it may improve with preventive measures and adolescent treatment. Identifying abnormal menstrual patterns from adolescence may help identify early potential health problems for women.

On the other hand, given the growing prevalence of obesity, especially abdominal obesity, if this issue affects the etiology of some gynecological disorders, the consequences of these disorders in women can be reduced by controlling the influencing anthropometric parameters. Therefore, this study aimed to determine the relationship between the duration of menstrual bleeding and obesity-related anthropometric indices in students.

Methods

This is a cross-sectional study. The research project (no. 29/5/1/3507) was approved by the ethics committee of the research deputy of Kashan University of Medical Sciences. Using this formula $N = z^2pq/d^2$ and the prevalence of %17.1.[9] For menstrual irregularity, the sample size was calculated to be 217. Considering the sample attrition, a systematic random sample of 500 students at a dormitory of Alzahra Kashan was invited to participate in the study. Kashan University of Medical Sciences has two dormitories (Al-Zahra and Imam Ali). Al-Zahra dormitory was selected by sampling method.

Sampling was conducted in 2016. All invited individuals participated in the research (the response rate of 100%). Inclusion criteria for the study included female students living at a dormitory, without any known genital tract diseases, having no pain throughout the cycle or during menstrual bleeding days, and previous abdominal or pelvic surgery. Exclusion criteria were composed of the use of oral contraceptives and intrauterin device IUD.

By considering inclusion and exclusion criteria, a total of 250 students were studied. After obtaining informed consent, students were explained about confidentiality and their right to withdraw the study at any time. A questionnaire containing demographic questions and menstrual characteristics was completed by the participants, and a visual analog scale (VAS) was used to assess the peak of pain intensity.[10] VAS is a questionnaire with a ruler numbered from 0 to 10, and respondents mark on the line the point representing the amount of their pain.

Reliability and validity of this questionnaire has already been approved and it has been used in several studies.[11,12]

Dysmenorrhea intensity was considered as no pain (0), mild pain (1–3), moderate pain (4–6), and severe pain (7–10). Confounder variables were as follows: age, marital status, menstrual regularity, using painkillers, using heat, menarche, severe stress in the last 6 months, taking anti-inflammation, and hypothyroidism. Obesity-related anthropometric parameters were measured by a same-sex student including height (from the top of the head to the ground), waist circumference at the umbilicus, hip at greatest circumference, arm circumference in the middle of the distance from elbow to shoulder, and thigh circumference in the middle of the thigh using nonelastic tape, and weight was measured in light clothing by a digital weight scale (made in German digital glass scale [GS46]). BMI was defined as weight in kilograms divided by the square of height in meters. Menstrual periods were counted from the 1st day of one bleeding to the 1st day of the next bleeding according to students'

recalls, and menstrual periods <21 days or >35 days were regarded irregular.

Normal distribution of the quantitative variables was assessed and confirmed by one-sample Kolmogorov–Smirnov test. Independent *t*-test was used to compare mean anthropometric indices based on menstrual regularity. To investigate the association between anthropometric indices and age at menarche and the duration of bleeding, Pearson correlation coefficient was applied. Furthermore, ANOVA test and Pearson correlation coefficient were used to assess the relationship between anthropometric indices and pain intensity.

In the univariate analysis to calculate the unadjusted relationships between anthropometric indices and menstrual interval, simple linear regression was 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 firstly put in the model, and in the next steps, variables with lower amount of relationships were removed from the model until the criterion of *P* value was satisfied. The assumption of residual variance homogeneity and residual independency was also assessed and confirmed by scatter plot of residuals versus predicted values and Durbin–Watson statistics, respectively. There was no colinearity among independent variables which were assessed by variance inflation factor (values <10). In each analysis, B, standard error, β, and their related *P* values were reported. SPSS software version 16(IBM Company, Armonk, NY, USA) was employed for data analysis, and values <0.05 were considered significant.

Results

Results revealed that the minimum age of participants was 18 and the maximum age was 25 with an average of 21.2 ± 1.5. One participant smokes and none of them use alcohol or drug. Among the participants, 217 (86.8%) were single.

Menstrual periods <21 days were observed in 2 participants (0.8%) and menstrual periods longer than 35 days in 15 patients (6%). The menstrual bleeding of <3 days was observed in none of the participants, and 32 participants (12.8%) had menstrual bleeding beyond 7 days.

Regular menstrual cycles were seen in 230 participants (92%). Two hundred and forty-nine (99.6%) experienced dysmenorrhea.

Sixty-six cases (26.4%) had mild dysmenorrhea, 103 cases (41.2%) had moderate dysmenorrhea, and

80 cases (32%) had severe dysmenorrhea. There was no relationship between the severity of dysmenorrhea and anthropometric indices. Table 1 shows the mean and standard deviation of menstrual characteristics.

Table 2 presents the association between the duration of menstrual bleeding and the anthropometric indicators of obesity. According to this table, menstrual duration had a significant relationship with weight, and the circumference of waist, hip and arm. Also there were significant relationship between menstrual duration and waist-to-height, waist-to-hip, hip-to-height and arm-to-height ratios.

The relationship between duration of menstrual bleeding with underlying predictors is showed in Table 3. For this purpose, multiple linear regression model was used For this test, the duration of menstrual bleeding was considered as a dependent variable. Excluded variables from the model were: arm, waist, thigh circumference, hip-to-arm ratio, menstrual regularity, using painkillers or using heat for relief of pain, menarche, waist-to-thigh, waist-to-height, arm-to-thigh and waist-to-hip ratios, Other excluded variables from the model were weight, BMI, voluntary

Table 1: Mean and standard deviation of some menstrual characteristics in students

Variable	Mean±SD	Minimum–maximum
Menarche age (year)	13.39±1.32	10-18
Menstrual cycle length (day)	6.56±1.30	3-10
Menstrual cycle interval	30.13±13.59	17-230

SD=Standard deviation

Table 2: The relationship between duration of menstrual bleeding and obesity-related anthropometric index students

Anthropometric indicators	Mean±SD	Minimum–maximum	r*	P
Weight	56.09±8.78	32.20-81.60	−0.18	0.003
BMI	21.43±3.16	15.11-29.94	−0.15	0.015
Waist circumference	74.85±8.62	52.00-104.00	−0.16	0.010
Hip circumference	93.96±6.55	74.00-115.00	−0.18	0.003
Arm circumference	24.51±2.71	18.00-34.00	−0.22	<0.001
Thigh circumference	46.98±4.78	35.00-62.00	−0.20	0.002
Waist to height ratio	0.46±0.05	0.34-0.65	−0.13	0.031
Hip to thigh	1.99±0.16	0.20-2.37	−0.20	0.002
Hip to height	0.57±0.05	0.06-0.72	−0.15	0.014
Arm to height	0.52±0.03	0.44-0.63	−0.19	0.002
Waist-to-weight ratio	1.34±0.13	0.99-1.72	0.08	0.189
Waist-to-hip ratio	0.82±0.43	0.66-7.78	0.05	0.349
Waist-to-thigh	1.59±0.14	1.28-2.12	−0.01	0.963
Hip to waist	1.25±0.11	0.13-1.52	0.01	0.864
Hip to arm	3.84±0.32	0.39-4.79	0.08	0.174
Arm to weight	0.44±0.03	0.36-0.57	0.03	0.577
Arm to thigh	0.52±0.03	0.44-0.63	−0.06	0.303

*The correlation coefficient using Pearson's correlation test (*n*=250).
BMI=Body mass index, SD=Standard deviation

Table 3: Results of multiple linear regression with backward strategy assessing the relationship between duration of menstrual bleeding with underlying predictors

Variables	B	SE	β	P
Hip circumference	−0.09	0.03	−0.61	0.005
Hip circumference to height	9.49	4.83	0.37	0.051
Waist-to-weight ratio	−23.51	8.34	−2.33	0.005
Hip to waist	−23.75	8.73	−2.13	0.007
Arm to weight	65.97	24.88	1.88	0.009
Hip to thigh	16.17	5.57	2.02	0.004
Arm to height	−60.29	21.33	−1.60	0.005
Anemia	−0.39	0.23	−0.10	0.100
Taking anti-inflammation	0.57	0.16	0.21	0.001
Hypothyroidism	0.79	0.40	0.11	0.051

Excluded variables from the model: Arm to thigh, arm, waist, menstrual regularity, thigh, using painkillers, hip to arm, using heat, waist to thigh, menarche, waist to height, weight, BMI, waist to hip, voluntary weight loss, and severe stress in the last 6 months (all *P* values >0/05). Hip circumference, waist-to-weight ratio, hip to waist, arm to weight, hip to thigh, and arm to height are predictors. Dependent variable: Duration of menstrual bleeding. SE = Standard error, BMI = Body mass index

weight loss and having severe stress in the last 6 months (all $P > 0.05$).

According to this test, hip circumference, waist-to-weight ratio, hip to waist, arm to weight, hip to thigh, and arm to height ratios are predictors.

Discussion

Menstruation is a unique phenomenon and represents the beginning and end of reproductive age. In addition, menstruation is considered as an indicator of women's health. Therefore, adolescent girls should understand the patterns of menstruation and factors affecting it such as age, weather, activity, and BMI. As a result, this understanding improves their understanding of menstrual characteristics, proper management, and menstrual issues.[2]

Accordingly, the present study was conducted to determine the relationship between the duration of menstrual bleeding and obesity-related anthropometric indices in students.

The results showed that the average age of participants in this study was 21.295 years which is close to the study of Ameade and Garti with an average age of 23.04 ± 5.07 years and the study of Hossain *et al.* with an average age of 19.29 and the study of Yamamoto *et al.*[1,13,14] Furthermore, for most students, menstrual interval was 21–35 days. In a study by Yamamoto *et al.*, most students had the menstrual interval of 25–38 days.[1] In the study of Adefuye *et al.*, The mean length of the cycle was 26.9 and the range was from 14 days to 32 days.[15]

In this study, age of menarche is close to the study of Adefuye *et al.*,[15] the study of Hussain *et al.*,[16] and the

study of Ameade and Garti.[14] In the present study, BMI was inversely associated with age at menarche, which is confirmed by the study of the De Sanctis *et al.*. In general, studies have supported this hypothesis that some fat is necessary for the occurrence of menarche.[17]

In the study of Hussain *et al.* and Lee *et al.*, BMI had an inverse correlation with age at menarche a direct correlation with height.[16,18] This is justified because BMI is correlated with body fat mass but not with height. Besides, the increase in sex hormones after menarche prevents the longitudinal growth of the long bones that stop the increase in height.[18]

There are several explanations for the association between age at menarche and obesity, but the specific mechanisms remain unclear. One of the possible explanations is that higher levels of prepubertal BMI lead to an increase in the production and availability of estrogen through various mechanisms, which predisposes to early menarche. Another explanation suggests that early menarche was associated with higher levels of estrogen which increase fat deposition in peripheral adipose tissues.[19]

The menstrual bleeding of <3 days was observed in none of the participants, and 32 participants had menstrual bleeding beyond 7 days. Similar results were obtained in the study of Hussein *et al.* that the duration of menstrual flow for 97% of students was 3–7 days, and none of them had bleeding of <3 days.[13] In this study, duration of bleeding had a significant relationship with weight, and the circumference of waist, hip and arm. Also there were significant relationship between menstrual duration and waist-to-height, waist-to-hip, hip-to-height and arm-to-height ratios. Similarly, in the study of Chang *et al.*, in the students who have BMI above 27, the duration of bleeding was over 7 days.[20] In the study of Santos *et al.*, menstrual bleeding was more likely to occur obese in women.[6]

Doutchi *et al.* studied 83 obese women with a BMI over 25 in which 39 of them had a menstrual disorder. Results showed that the accumulation of fat in the upper body not in other parts of the body results in menstrual disorders. Therefore, in their study, general indicators of obesity such as body fat mass, body fat percentage, and BMI had no effect on menstrual disorders, but fat mass in the upper body trunk-to-leg fat ratio in obese women with menstrual disorders was higher than in obese women without menstrual disorders.

These results are explained by the interaction between adipose tissue and sex hormones. Moreover, in this regard, the study of Rowe *et al.* showed that Projin is interrelated with anthropometric factors that affect endometrial function.[21] Lambert-Messerlian *et al.*

showed that free androgen increases with increasing BMI[22] and it is expected that the level of this hormone as a sex hormone is associated with the amount of bleeding endometrial growth. In addition, the study of Carranza-Lira showed that BMI above 35 is associated with the greatest amount of bleeding and android fat accumulation with the least amount of bleeding.[3] Adipose tissue distribution pattern seems to regulate the production and release of androgens.

The frequency of dysmenorrhea was very high in our study, and most participants experienced moderate dysmenorrhea. Similarly, in the study of Adefuye *et al*., 53.4% of people had different degrees of dysmenorrhea.[15] In a study by Hossain *et al*., the prevalence of dysmenorrhea was 72.3%.[13] In the present study, any significant correlation was not found between the severity of dysmenorrhea and anthropometric characteristics. In the study of Heydari also, most people experienced moderate-to-severe dysmenorrhea. In their study, a significant relationship was observed between dysmenorrhea and waist circumference, hip circumference, body fat percentage, and waist-to-height ratio, but there was no relationship between dysmenorrhea, BMI, and waist-to-hip ratio.[9] However, the number of participants in the study of Heidari *et al*. was 388 that is higher in comparison to our study, and the high number of samples influence the level of significance. The study of Rad *et al*. showed that there was a significant relationship between the presence of primary dysmenorrhea and anthropometric indices such as height, waist circumference, waist-to-height ratio, height-to- thigh ratio, waist-to-hip circumference ratio, and hip-to-thigh ratio.[11]

There are several known mechanisms on the effect of adipose tissue on ovulation and menstrual cycle: (1) adipose tissue transforms androgens into estrogens; (2) body weight in lower lean women with less power and obese women is more likely to affect estrogen metabolism; and (3) obese women have less ability to attach estrogen to sexually transmitted globulin, which causes estrogen to be inactivated and thus increases the serum-free estradiol level.[11]

In this study, age at menarche was not associated with menstrual regularity. However, in the study of Soltani *et al*. which was conducted with the aim of determining the association between menarche age and menstrual disorders in high-school girls in Hamadan, the results showed that age at menarche has a significant relationship with cycle time, the occurrence of menstrual irregularity, the discharge of blood clots and the incidence of dysmenorrhea,[7] while a study by Bassi *et al*., which was conducted with the aim of determining the relationship between menstrual cycle pattern and

BMI on 196 students aged 17–20 years, showed that only 6.6% and 5.6% of participants in the study had short and long cycles, and there is no correlation between cyclic duration and BMI.[23] In the study of Rad *et al*., the results showed that some anthropometric indices were associated with menstrual disorders in female high-school students.[2]

Lifestyle modifications such as regular physical activity, decreasing the intake of junk food, promoting healthy eating habits, and maintaining optimal BMI should improve menstrual health. Improvement of menstrual health prevents future problems such as heavy bleeding, dysmenorrhea, premenstrual symptoms, polycystic ovarian disease, hyperlipidemia, obesity, and infertility.

Limitations
The limitation of this study is its cross-sectional design that does not provide a good judgment about causality.

Conclusions

The results of the study showed that menstrual bleeding duration had a significant relationship with weight, and the circumference of waist, hip and arm. Also there were significant relationship between menstrual duration and waist-to-height, waist-to-hip, hip-to-height and arm-to-height ratios. Given the increasing prevalence of obesity and the effect of body fat mass on gynecologic disorders, training families seems to be necessary to adopt measures for proper nutrition and weight control. These educational materials can be the part of the school curriculum for students at the age of puberty in high schools.

Conflicts of interest
There are no conflicts of interest.

References

1. Yamamoto K, Okazaki A, Sakamoto Y, Funatsu M. The relationship between premenstrual symptoms, menstrual pain, irregular menstrual cycles, and psychosocial stress among Japanese college students. J Physiol Anthropol 2009;28:129-36.

2. Rad M, Torkmannejad Sabzevary M, Mohebbi Dehnavi Z. Association between menstrual disorders and obesity-related anthropometric indices in female high school students: A cross-sectional study. Int J Sch Health 2018;5:e65716.

3. Carranza-Lira S, Flores-Hernández MI, Sandoval-Barragán MP, Martínez-Chéquer JC, Martínez-Rodríguez OA. Variability of the menstrual cycle in Mexican women according to the weight and the distribution of the adipose fabric. Ginecol Obstet Mex 2013;81:321-8.

4. Mirbolok F, Sharemi Hajar RF. Association of some working factors and menstrual function among nurses. J Med Fac Guilan Univ Med Sci 2009;18:26-34.

5. Nuttall FQ. Body mass index: Obesity, BMI, and health: A critical review. Nutr Today 2015;50:117-28.

6. Santos IS, Minten GC, Valle NC, Tuerlinckx GC, Silva AB, Pereira GA, *et al.* Menstrual bleeding patterns: A community-based cross-sectional study among women aged 18-45 years in Southern Brazil. BMC Womens Health 2011;11:26.

7. Soltani F, Artimani T. Evaluation the relationship between menarch age and menstrual disorders. Sci J Hamadan Nurs Midwifery Fac 2010;17:46-567.

8. Ganesh R, Ilona L, Fadil R. Relationship between body mass index with menstrual cycle in senior high school students. Althea Med J 2015;2:555-60.

9. Nohara M, Momoeda M, Kubota T, Nakabayashi M. Menstrual cycle and menstrual pain problems and related risk factors among Japanese female workers. Ind Health 2011;49:228-34.

10. Heidary F, Akrami A, Sarhad M, Mohammad Shahi M. Prevalence of dysmenorrhea and its association with anthropometric indexes. Hayat 2010;17:70-7.

11. Rad M, Sabzevari MT, Rastaghi S, Dehnavi ZM. The relationship between anthropometric index and primary dysmenorehea in female high school students. J Educ Health Promot 2018;7:34.

12. Charandabi SM, Nashtaei MS, Kamali S, Majlesi R. The effect of acupressure at the sanyinjiao point (SP6) on primary dysmenorrhea in students resident in dormitories of Tabriz. Iran J Nurs Midwifery Res 2011;16:309-17.

13. Hossain MG, Sabiruzzaman M, Islam S, Hisyam RZ, Lestrel PE, Kamarul T. Influence of anthropometric measures and socio-demographic factors on menstrual pain and irregular menstrual cycles among university students in Bangladesh. Anthropol Sci 2011;119:239-46.

14. Ameade EP, Garti HA. Age at menarche and factors that influence it: A study among female university students in Tamale, Northern Ghana. PLoS One 2016;11:e0155310.

15. Adefuye PO, Odusoga OL, Adefuye BO, Akindele RA. Age at menarche and menstrual pattern in secondary schoolgirls in Sagamu. Niger J Clin Pract 2010;13:109-13.

16. Hossain MG, Islam S, Aik S, Zaman TK, Lestrel PE. Age at menarche of university students in Bangladesh: Secular trends and association with adult anthropometric measures and socio-demographic factors. J Biosoc Sci 2010;42:677-87.

17. De Sanctis V, Bernasconi S, Bianchin L, Bona G, Bozzola M, Buzi F, *et al.* Onset of menstrual cycle and menses features among secondary school girls in Italy: A questionnaire study on 3,783 students. Indian J Endocrinol Metab 2014;18:S84-92.

18. Lee SE, Yang JY, Lee JH, Kim HW, Kim HS, Lee HJ, *et al.* Relationship of age at menarche on anthropometric index and menstrual irregularity in late adolescent girls in seoul. Ann Pediatr Endocrinol Metab 2013;18:116-21.

19. Al-Awadhi N, Al-Kandari N, Al-Hasan T, Almurjan D, Ali S, Al-Taiar A, *et al.* Age at menarche and its relationship to body mass index among adolescent girls in Kuwait. BMC Public Health 2013;13:29.

20. Chang PJ, Chen PC, Hsieh CJ, Chiu LT. Risk factors on the menstrual cycle of healthy Taiwanese college nursing students. Aust N Z J Obstet Gynaecol 2009;49:689-94.

21. Rowe EJ, Eisenstein TK, Meissler J, Rockwell LC. Gene x environment interactions impact endometrial function and the menstrual cycle: PROGINS, life history, anthropometry, and physical activity. Am J Hum Biol 2013;25:681-94.

22. Lambert-Messerlian G, Roberts MB, Urlacher SS, Ah-Ching J, Viali S, Urbanek M, *et al.* First assessment of menstrual cycle function and reproductive endocrine status in samoan women. Hum Reprod 2011;26:2518-24.

23. Bassi R, Sharma S, Saini AS, Kaur M. Correlation of menstrual pattern with body mass index in young female students. J Physiol Pharmacol Adv 2015;5:556-64.