



Socioeconomic factors and lifestyle affecting the variability of menstrual cycle characteristics in women from Central Poland

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ABSTRACT: Regularity, length of the cycle and duration of menstrual flow are a reflection of women health. The purpose of the research was to assess the relationships between socioeconomic status, cycle length, duration of menses, regularity and dysmenorrhea. A survey was conducted among 896 healthy women from Łódź and Warsaw (Poland), aged 15.71–26.98. Women who were menarche at least 3 years ago were asked to complete the survey. Women were asked about cycle length (number of days), duration of menstrual flow, regularity of the cycle, dysmenorrhea, birth place, parental education level, attendance at physical education classes, participation in additional sports activities, self-assessment of stress levels at home and at school/university, and smoking. For data analysis, t-test, analysis of variance, and chi-square were used, and $p < 0.05$ was considered to be statistically significant. There were no significant relationships between the mean cycle length, regularity and the environmental factors, except for differences in the average length of the menstrual cycle in women from Łódź who attend additional sports activities. Women who are more physically active are characterized by a shorter menstrual cycle. In terms of the length of the menstrual flow, daughters of better educated fathers were characterized by longer menses. In contrast, dysmenorrhea was associated with longer menstrual periods and longer menstrual bleeding, as well as with higher levels of stress, both at home and at school. Environmental factors affected the features of menstruation cycles in women from Central Poland.

KEY WORDS: menses, regularity, bleeding, SES

Introduction

Menstruation is a cyclical phenomenon in the life of a woman, which occurs from the moment of first bleeding (menarche) to menopause, which is the end of the reproductive period. The first menstrual periods can be irregular, and regularity appears in the first two/three years after menarche (Popat et al. 2008; Hillard 2012). A similar phenomenon of lack of regularity of cycles is also observed in women over 40 years, during the few years before menopause (De Sanctis et al. 2014).

The length of the cycle is calculated from the first day of one menstrual period to the first day of the following menstrual period, and the average duration is 28 days with a variation between 21 and 35 days (Fehring et al. 2006; De Sanctis et al. 2014). The length of the menses is about 5–6 days and may differ between populations, while a regular cycle is observed in about 60% of women (Aziz et al. 2018). Disturbances to the menstrual cycle and its irregularity may be caused by environmental factors related to illness, stress, diet, and socioeconomic status as well as lifestyle, including cigarette smoking and alcohol consumption (Geetha et al. 2016; Lyngsø et al. 2014; Drosdzol-Cop et al. 2017). Data on practising sports and the regularity of monthly cycles are divergent, but it is assumed that regular cycles are related to the fat content in the woman's body (minimum 22%), and often those individuals who practise sport are much slimmer (Fischetto and Sax 2013).

An important feature of the menstrual cycle in most women is dysmenorrhea. According to researchers, most women experience pain during menstruation (Emmanuel et al. 2013). The factors that cause menstrual pains have not been suf-

ficiently explained. Among the factors affecting the perception of pain, it has been found that the age of the woman, menarche age, regularity of the cycle, length of the cycle, eating habits, smoking, and physical activity may have a differential effect on the dysmenorrhea (Pawłowski 2004). It is believed that an impact may also derive from endocrine factors such as hyper-production of uterine prostaglandins, longer duration of menstrual bleeding and longer cycle length (Bernardi et al. 2017). Among environmental factors, high stress levels affect the frequency and intensity of pain, while socioeconomic factors and lifestyle (e.g., sports, diet) provide ambiguous results (Ju et al. 2014).

As the regularity of a woman's menstrual cycle is treated as a marker of a woman's health, it is important to determine which of the environmental factors can affect the non-rhythmic nature of the cycles and other characteristics of the menstrual period (Popat et al. 2008).

The aim of the study is to determine whether selected environmental factors affect the characteristics of the menstrual cycles of women from Central Poland.

Material and methods

The survey was conducted in 2017 in Łódź and Warsaw among 896 healthy women, aged 15.71–26.98, and the average age of the respondents was 20.10. The research material consisted of high school and university students from Warsaw (n=422) and Łódź (n=474).

The cities mentioned above vary in terms of area, population density, life expectancy and material status. Warsaw, as the capital of Poland, is inhabited by 1.74 million people, where the population of Łódź (the third biggest city) is estimat-

ed at 0.70 million. Statistics show that in the Mazowieckie Voivodship (Warsaw), average income per capita reaches 1350 EUR compared to 1050 EUR in Łódzkie Voivodship (Łódź). Although cost of living in the capital is higher, on average, its inhabitants are richer than the residents of Łódź. Other sociodemographic data also indicate differences in both cities, for example the Statistics Poland noted that life expectancy is two years longer in the capital than in Łódź (Statistics Poland 2015, 2017, 2018).

The research project received a positive assessment from the Bioethics Committee at the University of Łódź. Women were informed about the purpose of the research and agreed to participate in the survey and could also resign from completing the form without bearing any legal consequences. Healthy women who were not using hormonal contraceptives and who had a natural menstrual cycle were included in the study. Women with menarche more than 3 years ago were invited to participate in the study. The second criteria was cycle length: too long or too short menstrual cycle may indicate gynecological or hormonal complications, therefore it was considered that further statistical analysis will be carried out in women whose cycle is between 21 and 35 days ($n=825$).

Women were asked about various menstrual cycle characteristics, such as the regularity of the cycle (yes/no), the cycle length (number of days), menstrual bleeding (number of days), contraception (yes/no), and painful menstruation (yes, always/yes, often/yes, but rare/no). Questions about socioeconomic status (SES) and lifestyle were as follows: birth place (city, village), mother's and father's educational level (elementary, trade school, college, University), attendance

at physical education classes (yes/no), participation in additional sports activities (yes/no), self-assessment of stress levels at home and at school/university (low, medium, high), and smoking (yes/no). The menstrual cycle regularity pattern was determined based on Wang's et al. (2011) research.

Three characteristics of the menstrual cycle of women from Łódź and Warsaw were analysed: cycle regularity, average cycle length and number of bleeding days. Differences in the characteristics of the menstrual cycle between data from both cities were tested with the chi-squared test and t-test ($p<0.05$). In order to determine whether the above mentioned factors significantly affected the menstruation cycle characteristics in the case of the studied women the Pearson's chi-squared test, analysis of variance and t-test were used ($p<0.05$). Statistical analysis was performed using Statistical13.1 software (Dell Inc. 2016).

Results

The average, maximum, minimum, and standard deviation (SD) of the characteristics of menstrual cycle for Warsaw and Łódź women were calculated. The mean length of the cycle in the case of Warsaw women was 28.66 (minimum 15 days, maximum 65 days, SD 4.37), while in the case of women from Łódź this was 29.43 (16 days, 75 days, SD 5.01). It was reported that 2.22% of women from Warsaw and 0.96% of women from Łódź had a menstrual cycle shorter than 21 days, while 3.94% and 4.32% had a cycle longer than 35 days, respectively. Further statistics were made for women whose menstrual cycle was between 21 and 35 days.

In the case of the regularity of the cycle and the length of the bleeding, there

Table 1. Differences in the average cycle length and average length of bleeding in women from Warsaw and Łódź

	Mean	SD	Student's <i>t</i> -test	<i>p</i> -value
Average cycle length				
Warsaw	28.29	2.51	-2.954	0.003
Lodz	28.81	2.39		
Average length of bleeding				
Warsaw	5.52	1.25	1.705	0.089
Lodz	5.37	1.18		

were no significant differences between the data from Łódź and Warsaw. However, statistically significant differences were observed in the case of the average cycle length. Therefore, analyses of the regularity of the cycle and the length of the bleeding were carried out for the entire cohort, while those for the average cycle length were separate for both cities (Table 1).

The average length of bleeding days was 5.48 (minimum 2 days, maximum 14 days, SD 1.26) for women in Central Poland. Regular menstrual cycles were

characteristic for 80.90% of respondents, while irregular menstrual periods were observed in 19.10% of the studied women.

Relationships between the average length of the menstrual cycle, the average length of the bleeding and the regularity of the menstrual cycle, environmental factors and lifestyle

There were significant differences between the length of the cycle in women

Table 2. Relationships between the average length of the menstrual cycle and environmental factors in women from Warsaw and Łódź

	Factor	Mean	SD	Student's <i>t</i> -test	<i>p</i> -value
Warsaw					
Birth place	City	28.33	2.50	1.209	0.227
	Village	27.41	2.26		
Attendance at physical education classes	Yes	28.32	2.50	0.876	0.381
	No	27.92	2.63		
Participation in additional sports activities	Yes	28.33	2.63	0.193	0.846
	No	28.27	2.45		
Smoking	Yes	28.29	2.47	0.417	0.677
	No	28.11	3.01		
Lodz					
Birth place	City	28.78	2.42	-1.062	0.289
	Village	29.34	1.70		
Attendance at physical education classes	Yes	28.81	2.45	-0.043	0.964
	No	28.83	1.59		
Participation in additional sports activities	Yes	28.56	2.51	-2.000	0.046
	No	29.04	2.25		
Smoking	Yes	28.86	2.34	1.091	0.276
	No	28.46	2.72		

from Łódź who attend or do not participate in additional sports activities. Women who practice extra sports were characterized by a shorter menstrual cycle in relation to women who were not physically active (Table 2).

In the case of other examined environmental factors, there were no significant relationships between the cycle length and socioeconomic status and lifestyle in women from both Warsaw and Łódź. The factor that significantly influenced the length of menstrual

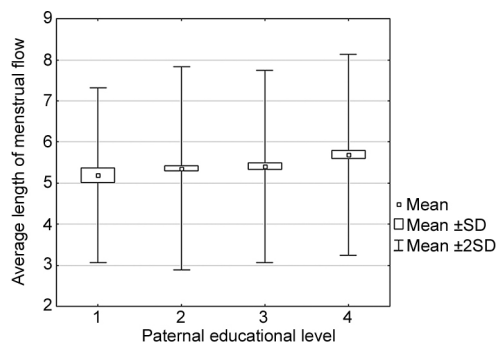


Fig. 1. Relationships between average length of menstrual bleeding and paternal educational level in women from Central Poland

Table 3. Association between characteristics of the menstrual cycle and socioeconomic and lifestyle factors in women from Warsaw and Łódź or both

ANOVA	SS	df	MS	F	p-value
Average length of the menstrual cycle					
Warsaw					
Maternal educational level	29.8	3	9.9	1.56	0.198
Paternal educational level	23.7	3	7.9	1.25	0.291
Stress level at school / university	12.7	2	6.4	1.01	0.367
Stress level at home	3.3	2	1.6	0.26	0.774
Lodz					
Maternal educational level	5.1	3	1.7	0.30	0.827
Paternal educational level	15.8	3	5.3	0.91	0.437
Stress level at school / university	3.0	2	1.5	0.26	0.768
Stress level at home	0.8	2	0.4	0.07	0.931
Average length of menstrual flow (Warsaw and Lodz data combined)					
Maternal educational level	8.32	3	2.77	1.905	0.127
Paternal educational level	14.66	3	4.89	3.358	0.018*
Stress level at school / university	7.77	2	3.89	2.620	0.073
Stress level at home	0.64	2	0.32	0.215	0.806

ANOVA – one way analysis of variance; SS – sum of square, MS – mean of square; df – degree of freedom.

Table 4. Relationships between the average length of menstrual flow and selected environmental factors in women from Central Poland (Warsaw and Łódź data combined)

Factor	Mean	SD	Student's t-test	p-value
Birth place	City	5.46	0.370	0.711
	Village	5.37		
Attendance at physical education classes	Yes	5.42	-1.607	0.108
	No	5.68		
Participation in additional sports activities	Yes	5.42	-0.507	0.612
	No	5.47		
Smoking	Yes	5.46	0.784	0.433
	No	5.35		

Table 5. Differences in regularity of the cycle in women from Central Poland (Warsaw and Łódź data combined)

Socioeconomic and lifestyle characteristics	Chi ² Pearson	df	p-value
Birth place	0.363	1	0.547
Maternal educational level	3.005	3	0.390
Paternal educational level	1.219	3	0.748
Stress level at school/university	0.077	2	0.962
Stress level at home	0.491	2	0.782
Attendance at physical education classes	0.098	1	0.754
Participation in additional sports activities	0.036	1	0.849
Smoking	2.997	1	0.083

bleeding was the education of the father of the subjects. Daughters of better educated fathers were characterised by longer menstrual bleeding. Regularity of menstruation did not depend significantly on any of the factors studied, that is: parental' education, place of residence and practising sports (Table 3, 4, 5 and Fig. 1).

Relationships between dysmenorrhea, cycle characteristics and environmental factors

In the case of women from Warsaw, it was observed that more frequent pains accompanied longer menstrual cycles and longer duration of flow, while in subjects from Łódź this relationship only concerned the length of the cycle. Among

Table 6. Associations between characteristics of menstrual cycle and dysmenorrhea, analysis of variance results for Warsaw and Łódź (or both) women

Variable	ANOVA				
	SS	df	MS	F	p-value
Average length of the menstrual cycle					
Warsaw	77.1	3	25.70	4.14	0.007
Łódź	11.3	3	3.80	0.66	0.579
Average length of menstrual flow					
Central Poland	56.87	3	18.96	13.30	0.000

SS – sum of square, MS – mean of square, df – degree of freedom.

Table 7. Relationships between dysmenorrhea and socioeconomic status in women from Central Poland, chi-square test results

Socioeconomic and lifestyle characteristics	Chi ² Pearson	df	p-value
Birth place	2.498	3	0.476
Maternal educational level	12.790	9	0.172
Paternal educational level	13.215	9	0.153
Stress level at school/university	14.493	6	0.024
Stress level at home	15.104	6	0.019
Attendance at physical education classes	4.276	3	0.233
Participation in additional sports activities	1.585	3	0.663
Smoking	0.625	3	0.891

the environmental factors, both the level of stress at school/university and the level of stress at home significantly affected the menstrual pain. A higher level of stress was associated with more frequent and more severe dysmenorrhea symptoms (Table 6, 7).

Discussion

The variability of menstrual cycle parameters can be caused by both genetic and environmental factors, where the latter can be determined using cross-sectional surveys of a random sample of women. The most common characteristics are, among others, the average length of the cycle, the duration of menses or its regularity, as well as environment factors, for example socioeconomic factors (education, profession, income, social origin) or lifestyle (for example: eating habits, stress levels, physical activity) (Jeyaseelan and Rao 1995; Jahanfar et al. 2012).

In the current study of women from Warsaw, it was found that the average length of the cycle was 28.29 days, while the menstrual cycle of women from Łódź was significantly longer (28.81 days). Among the socioeconomic factors, participation in additional sports activities had a significant impact on the length of the menstrual cycle. In the case of the regularity of the menstrual cycle, no effect of any of the studied factors was noted. The level of paternal education significantly influenced the length of the bleeding. Dysmenorrhea was dependent on the length of the cycle, the length of menstrual bleeding, and the level of stress at home and at school/university.

These results are similar to those presented by other authors, both domestic and foreign (Shortridge 1988; Fehring et al. 2008; Gudmundsdottir et al. 2011;

Merklinger-Gruchala et al. 2017). According to different authors, longer cycles are usually associated with a higher level of stress, while smoking may cause a significant shortening of menstrual cycles (Windham et al. 1999; Rowland et al. 2002), although not all studies indicate such dependence (Hornsby et al. 1998; Fenster et al. 1999; Makowiec-Dąbrowska et al. 2004). In addition, smoking may lead to a decreased duration of flow (Hornsby et al. 1998). Researchers point to the direct toxic effect of smoking on the reproductive system of women, including the secretion of oestrogen and progesterone (Jandíková et al. 2017).

A direct influence of increased physical activity on the nature of menstrual cycles was also noticed – a higher frequency of physical exercise is related to the prolongation of the menstrual cycle (Harlow and Matanoski 1991; Gudmundsdottir et al. 2011; Omidvar et al. 2019). The result of current research surprised, therefore, that women characterized by moderate levels of physical activity had a shorter menstrual cycle than their counterparts with sedentary lifestyle. It has been noticed that only in the case of athletes, high physical effort can lead to a shortening of the luteal phase (Ellison and Lager 1986). Because it was not asked about the type or intensity of physical activity in the survey, it is difficult to interpret the result without additional research.

The other characteristics of the cycle did not differ significantly between women from Warsaw and Łódź, with the average length of bleeding for all subjects being 5.53 days. A study published by the WHO in 1983 showed that the average bleeding length was 5 days and this ranged from 4.3 in Manila to 5.9 in Dublin women (Fehring et al. 2008). Harlow and Ephross (1995) noted that duration

of flow in Mexican and Latin-American women was 4.5 days and this was shorter than the length of the menses in women from Europe (5.9 days).

The results suggest that the length of menstrual bleeding may be affected by a variety of environmental factors, although these results are not conclusive (Elshiekh and Ali Mohammed 2011). In the present study, the only factor that influenced the length of flow was paternal educational level. Daughters of fathers with a better education were characterised by longer menses. Better paternal education may bring greater family well-being, better hygiene and better access to additional sports activities or a more varied diet (Yermachenko and Dvornyk 2014). However, it is not clear how socioeconomic factors can affect the length of bleeding, and it is difficult to discuss trends given the small research sample. The impact of these factors should be checked against results for a large number of women of different social classes and ages (Harlow and Ephross 1995). Among women from India, there was no relationship between the profession of the father and the length of menstrual bleeding (Sanyal and Ray 2008).

The third issue under consideration was the regularity of the menstrual cycle. Among respondents, regular menstrual cycles were characteristic for 80.90%. In the literature, reports on the regularity of the cycle are very diverse. In one of the studies, it was pointed out that cycle irregularity is noted 18.6% of women from Greenland, 8.0% of women from Poland and 5.1% of women from Ukraine (Lyngsø et al. 2014). Toft et al. (2008) observed that cycle irregularity was characteristic of 14% of women from Greenland, 9% of women from Warsaw (Poland) and 4% of women from Kharkiv (Ukraine). The high

proportion of women in our study with irregular menstruation can be explained by changing environmental factors, including environmental pollution. One of the factors that causes air pollution may be increased car traffic. In Poland, from 2011 to 2015, the number of registered cars increased by 14%, and cars in Poland, Latvia and Lithuania are the oldest in the European Union (ACEA Report: Vehicles in use – Europe 2017). In addition, it has been noted that one of the more important factors regarding the lack of regular menstruation is obesity, with forecasts suggesting that by 2030 this will affect 18% of women (WHO 2013; Stepaniak et al. 2016; Bae et al. 2018).

Among the environmental factors analysed at work, none showed a significant effect on the regularity of menstruation, which is not consistent with the reports of other authors. Factors that affect the regularity of the menstrual period include, among others, body height and weight, smoking, high levels of stress or exposure to diethylstilbestrol (Elshiekh and Ali Mohammed 2011; Palm-Fischbacher and Ehlert 2014; Nagma et al. 2015; Bae et al. 2018).

An important aspect regarding the menstrual cycle is the perception of menstrual pain. Among the respondents, dysmenorrhea appeared more often when the menstrual cycle was longer (among women from both Łódź and Warsaw) and with longer menses (only women from Warsaw). Among environmental factors, the feeling of frequent pain was related to the stress levels of the examined women. Among the reports on the prevalence of dysmenorrhea, those associated with both the menstrual cycle and environmental factors are listed. Many authors have also found that factors such as earlier menarche age, young age (less

than 30 years), stress, smoking, irregular cycle, longer menstrual cycle or heavy menstrual flow may cause stronger and more frequent dysmenorrhea (Sundell et al. 1990; Omidvarand Begum 2012; Coelho et al. 2014; Jeon et al. 2014; De Sanctis et al. 2015; Najafi et al. 2018). However, not all results confirm these relationships – research conducted at Isfahan University of Medical Sciences in Iran indicated that there is no association between the length of a period and dysmenorrhea (Habibi et al. 2015). The influence of stress on the perception of menstrual pain is not fully understood, it is thought to be related to neuroendocrine responses (Wang et al. 2004).

In summary, among the factors significantly affecting the length of menstruation for women from central Poland, participation in additional sports activities can be mentioned. However, the length of bleeding significantly depended on the level of education of the father. Menstrual pain was more frequently reported in women who noted higher levels of stress in the survey.

Studies on the menstrual cycle, and factors affecting its characteristics are extremely important due to the monitoring of the reproductive life of women. In addition, the results of such research can provide the basis for the development of women's education and pro-health habits. It is extremely important to determine the diversity of cycle characteristics in a given population, as this is significant for both gynecologists and women. Clinicians should be able to respond quickly to existing exceptions, which would result in better detection of certain diseases related to menstrual cycle disorders, for example polycystic ovary syndrome or endometriosis (Panidis et al. 2015; Bae et al. 2018).

Our research has some limitations that made it difficult to interpret the results. First, this was a cross-sectional data study based on a survey, which could cause inaccuracies in women's responses, related to, for example, memory. We suggest research using more extensive and more diverse material covering the whole country, including women of similar ages and different life status.

Authors' contributions

JN-D originator of research, principal researcher, preparation of the text; BB researcher, text editing, JA researcher, KS statistical analysis of data, text editing. All authors read and improved final version of the paper.

Conflict of interest

Authors declare that there is no conflict of interest regarding publication of this paper.

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References

- ACEA Report: Vehicles in use – Europe, 2017. Available at: https://www.acea.be/uploads/statistic_documents/ACEA_Report_Vehicles_in_use-Europe_2017.pdf [accessed 2019 May 21].
- Aziz AA, Kurnia N, Hartati H, Purnamasari AB. 2018. Menstrual cycle length in wom-

- en ages 20–30 years in Makassar. *J Phys Conf Ser* 1028:012019.
- Bae J, Park S, Kwon JW. 2018. Factors associated with menstrual cycle irregularity and menopause. *BMC Womens Health* 18:36.
- Bernardi M, Lazzeri L, Perelli F, Reis FM, Petraglia F. 2017. Dysmenorrhea and related disorders. *F1000Research* 6:1645.
- Coelho LS, Brito LM, Chein MB, Mascarenhas TS, Costa JP, Nogueira AA, et al. 2014. Prevalence and conditions associated with chronic pelvic pain in women from São Luís, Brazil. *Braz J Med Biol Res* 47:818–25.
- De Sanctis V, Bernasconi S, Bianchin L, Bona G, Bozzola M, Buzi F, et al. 2014. Onset of menstrual cycle and menses features among secondary school girls in Italy: a questionnaire study on 3,783 students. *Indian J Endocrinol Metab* 18(1):84–92.
- De Sanctis V, Soliman A, Bernasconi S, Bianchin L, Bona G, Bozzola M, et al. 2015. Primary dysmenorrhea in adolescents: prevalence, impact and recent knowledge. *PER* 13(2):512–20.
- Drosdzol-Cop A, Bąk-Sosnowska M, Sajdak D, Białka A, Kobiolka A, Franik G, et al. 2017. Assessment of the menstrual cycle, eating disorders and self-esteem of Polish adolescents. *J Psychosom Obstet Gynaecol* 38(1):30–36.
- Ellison PT, Lager C. 1986. Moderate recreational running is associated with lowered salivary progesterone profiles in women. *Am J Obstet Gynecol* 154:1000–03.
- Elshiekh M, Ali Mohammed AM. 2011. Influence of socioeconomic status in the age at the of menarche and duration of menstrual bleeding. *Mater Sociomed* 23(4):195–99.
- Fehring RJ, Schneider M, Raviele K. 2006. Variability in the phases of the menstrual cycle. *J Obstet Gynecol Neonatal Nurs* 35(3):376–84.
- Fenster L, Waller K, Chen J, Hubbard AE, Windham GC, Elkin E, et al. 1999. Psychological stress in the workplace and menstrual function. *Am J Epidemiol* 149(2):127–34.
- Fischetto G, Sax A. 2013. The menstrual cycle and sport performance. *Obes Rev* 28(3/4):57–69.
- Geetha P, Chenchuprasad C, Sathyavathi RB, Bharathi T, Surendranadha RK, Reddy K. 2016. Effect of socioeconomic conditions and lifestyles on menstrual characteristics among rural women. *J Women's Health* 5(1):1–5.
- Gudmundsdottir SL, Flanders WD, Augestad LB. 2011. A longitudinal study of physical activity and menstrual cycle characteristics in healthy Norwegian women – The Nord-Trøndelag Health Study. *Norsk Epidemiologi* 20(2):163–71.
- Habibi N, Huang MS, Gan WY, Zulida R, Safavi SM. 2015. Prevalence of primary dysmenorrhea and factors associated with its intensity among undergraduate students: a cross-sectional study. *Pain Manag Nurs* 16(6):855–61.
- Harlow SD, Ephross SA. 1995. Epidemiology of menstruation and its relevance to women's health. *Epidemiol Rev* 17:265–86.
- Harlow SD, Matanoski GM. 1991. The association between weight, physical activity, and stress and variation in the length of the menstrual cycle. *Am J Epidemiol* 133(1):38–49.
- Hillard PJA. 2012. Benign diseases of the female reproductive tract. In: JS Berek, editor. *Berek and Novak's Gynecology*, 15th edition. Philadelphia: Lippincott Williams and Wilkins. 374–437.
- Hornsby PP, Wilcox AJ, Weinberg CR. 1998. Cigarette smoking and disturbance of menstrual function. *Epidemiology* 9(2):193–98.
- Jahanfar S. 2012. Genetic and environmental determinants of menstrual characteristics. *Indian J Hum Genet* 18(2):187–92.
- Jandíková H, Dušková M, Stárka L. 2017. The influence of smoking and cessation on the human reproductive hormonal balance. *Physiol Res* 66(Suppl.3):323–31.
- Jeon GE, Cha NH, Sok SR. 2014. Factors influencing the dysmenorrhea among Korean adolescents in middle school. *J Phys Ther Sci*. 26:1337–43.

- Jeyaseelan L, Rao PSS. 1995. Effect of occupation on menstrual cycle length: causal model. *Hum Biol* 67(2):283–90.
- Ju H, Jones M, Mishra G. 2014. The prevalence and risk factors of dysmenorrhea. *Epidemiol Rev* 36:104–13.
- Lyngsø J, Ramlau-Hansen CH, Høyer BB, Støvring H, Bonde JP, Jönsson BA, et al. 2014. Menstrual cycle characteristics in fertile women from Greenland, Poland and Ukraine exposed to perfluorinated chemicals: a cross-sectional study. *Hum Reprod* 29(2):359–67.
- Emmanuel A, Achema G, Gimba SM, Mafuyai MJ, Afoi BB, Ifere IO. 2013. Dysmenorrhea, pain relief strategies among a cohort of undergraduates in Nigeria. *J Int Med Res* 2(2):142–46.
- Makowiec-Dąbrowska T, Hanke W, Sprusińska E, Radwan-Włodarczyk Z, Koszarda-Włodarczyk W. 2004. Menstrual disorders. Is this a problem to be handled by occupational medicine physician?. *Medycyna Pracy* 55(2):161–67. In Polish.
- Merklinger-Gruchala A, Jasienska G, Kapiszewska M. 2017. Effect of air pollution on menstrual cycle length – a prognostic factor of women’s reproductive health. *Int J Environ Res Public Health* 14(816). doi:10.3390/ijerph14070816.
- Nagma S, Kapoor G, Bharti R, Batra A, Batra A, Aggarwal A, et al. 2015. To evaluate the effect of perceived stress on menstrual function. *J Clin Diagn Res* 9. doi: 10.7860/JCDR/2015/6906.5611.
- Najafi N, Khalkhali H, Moghaddam A, Tabrizi F, Zarrin R. 2018. Major dietary patterns in relation to menstrual pain: a nested case control study. *BMC Women’s Health* 18(1):69.
- Omidvar S, Amiri FN, Firouzbakht M, Bakhtiari A, Begum K. 2019. Association between physical activity, menstrual cycle characteristics and body weight in young South Indian females. *Int J Women’s Health* 7(3).
- Omidvar S, Begum K. 2012. Characteristics and determinants of primary dysmenorrhea in young adults. *Am J Med* 3(1) 8–13.
- Palm-Fischbacher S, Ehlert U. 2014. Dispositional resilience as a moderator of the relationship between chronic stress and irregular menstrual cycle. *J Psychosom Obstet Gynaecol* 35:42–50.
- Panidis D, Tziomalos K, Papadakis E, Chatzis P, Kandaraki EA, Tsourdi EA et al. 2015. Associations of menstrual cycle irregularities with age, obesity and phenotype in patients with polycystic ovary syndrome. *Hormones* 14(3):431–37.
- Pawłowski B. 2004. Prevalence of menstrual pain in relation to the reproductive life history of women from the Mayan rural community. *Ann Hum Biol* 31(1):1–8.
- Popat VB, Prodanov T, Calis KA, Nelson LM. 2008. The menstrual cycle: a biological marker of general health in adolescents. *Ann N Y Acad Sci* 1135:43–51.
- Rowland AS, Baird DD, Long S, Wegienka G, Harlow SD, Alavanja M, et al. 2002. Influence of medical conditions and lifestyle factors on the menstrual cycle. *Epidemiology* 13(6):668–74.
- Sanyal S, Ray S. 2008. Variation in the menstrual characteristics in adolescents of West Bengal. *Singapore Med J* 49(7):542–50.
- Shortridge LA. 1988. Assessment of menstrual variability in working populations. *Reprod Toxicol* 2:171–76.
- Statistics Poland. 2015. Warsaw (Poland): Statistics Poland [accessed 2019 May 20]. Available at: <https://stat.gov.pl/statystyka-regionalna/rankingi-statystyczne/miasta-najwieksze-pod-wzgleciem-liczby-ludnosci/>.
- Statistics Poland. 2017. Warsaw (Poland): Statistics Poland [accessed 2019 May 20]. <http://stat.gov.pl/statystyka-regionalna/rankingi-statystyczne/>.
- Statistics Poland. 2018. Warsaw (Poland): Statistics Poland [accessed 2019 May 20]. Available at: <https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc-powierzchnia-i-ludnosc-w-przekroju-terytorialnym-w-2017-r-7,14.html>.
- Stepaniak U, Micek A, Waśkiewicz A, Bielecki W, Drygas W, Janion M. et al. 2016. Prevalence of general and abdominal obesity

- and overweight among adults in Poland. Results of the WOBASZ II study (2013–2014) and comparison with the WOBASZ study (2003–2005). *Polish Arch Intern Med* 126(9):662–71.
- Sundell G, Milsom I, Andersch B. 1990. Factors influencing the prevalence and severity of dysmenorrhoea in young women. *BJOG* 97(7):588–94.
- Toft G, Axmon A, Lindh CH, Giwercman A, Bonde JP. 2008. Menstrual cycle characteristics in European and Inuit women exposed to persistent organochlorine pollutants. *Hum Reprod* 23(1):193–200.
- Wang ET, Cirillo PM, Vittinghoff E, Bibbins-Domingo K, Cohn BA, Cedars MI. 2011. Menstrual irregularity and cardiovascular mortality. *J Clin Endocrinol Metab* 96(1):114–18.
- Wang L, Wang X, Wang W, Chen C, Ronnenberg AG, Guang W, et al. 2004. Stress and dysmenorrhoea: a population based prospective study. *Occup Environ Med* 61(12):1021–26.
- WHO. 2013. Nutrition, physical activity and obesity, Poland. 2013. Available at: http://www.euro.who.int/__data/assets/pdf_file/0020/243317/Poland-WHO-Country-Profile.pdf?ua=1 [accessed 2019May 20].
- Windham GC, Elkin EP, Swan SH, Waller KO, Fenster L. 1999. Cigarette smoking and effects on menstrual function. *Obstet Gynecol* 93(1):59–65.
- Yermachenko A, Dvornyk V. 2014. Nongenetic determinants of age at menarche: a systematic review. *BioMed Res Int* 2014:371583. doi:10.1155/2014/371583.