

Menstrual patterns and disorders among Chinese women of reproductive age

A cross-sectional study based on mobile application data

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Abstract

Menstruation is an important indicator of women's health. Identification of abnormal menstrual patterns in adolescence may improve early diagnosis of potential health concerns in adulthood. This study aimed to evaluate menstrual patterns and disorders of Chinese women of reproductive age based on an APP.

From December 2015 to January 2016, a cross-sectional study was conducted. We utilized a mobile application (APP) to collect information about participants' age at menarche, length of menstruation, duration of menstruation, amount of menstrual flow, regularity of menstrual cycle, prevalence of abnormal uterine bleeding and dysmenorrhoea.

A total of 156,055 women (25,716 from the questionnaire survey and 130,000 from the mobile APP users) participated in the study. The average age of the subjects was 26.32 ± 6.97 years (median age, 25 years). Mean age at menarche was 13.08 ± 1.87 years; average length of menstrual cycle, 30.9 ± 4.28 days (median 30 days); and average duration of menstruation, 5.01 ± 1.13 days (median 5 days). Women with irregular menstrual cycles accounted for 36.41%. Women aged < 18 years and > 30 years were more likely to experience irregular menstrual cycles. The prevalence of secondary amenorrhoea was 4.07%. More than 20% of women reported abnormal menstrual flow. About 20.11% of women had abnormal uterine bleeding, and 77.65% had dysmenorrhoea. A hot compress was the most commonly used approach to ameliorate dysmenorrhoea. Women with low education and low income and those with high education and high income tended to have menstrual problems.

A mobile APP as a survey tool has the advantages of large sample size, low cost, and high efficiency. The use of a mobile APP is an emerging approach for collecting big data in the field of health research. The results showed that the prevalence of menstrual disorders among Chinese reproductive women was high. Healthcare providers should educate girls and their caregivers about menstrual physiology, normal menstrual pattern, and reproductive health to prevent long-term diseases.

Abbreviations: AUB = Abnormal uterine bleeding, BMI = Body mass index, HPRL = hyperprolactinemia, PCOS = polycystic ovary syndrome, POI = premature ovarian insufficiency.

Keywords: application, Chinese women, cross-sectional study, menstrual disorders, menstrual patterns

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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1. Introduction

Adolescence is a transitional stage between childhood and adulthood during which major physical and mental changes occur. Menarche is a vital sign of female adolescence, and it is an indicator of reproductive ability. Menstruation is the monthly shedding of the uterine endometrium lining that occurs along with the periodic changes in the ovaries.^[1] Menstruation is described in terms of frequency, regularity, duration, and amount of menstrual flow,^[2] descriptive data falling outside the normal range are considered as indicative of menstrual disorders. Polymenorrhoea, oligomenorrhoea, and even amenorrhoea, are often used to describe abnormal menstrual cycles. Duration of flow > 8 days is abnormal.^[3] Hypomenorrhoea and hypermenorrhoea are used to describe the amount of menstrual flow disorders. Regularity is defined as variation in cycle length. Abnormal uterine bleeding (AUB) should not appear between normal menstrual periods. The coordination of the hypothalamus-pituitary-ovarian axis ensures normal menstruation. Many factors, such as mental, psychological, and diseases, can affect the function of the reproductive axis, leading to abnormal menstruation. Menstruation is an important indicator of women's health. Abnormal menstruation is often associated with a variety of diseases, such as ovulatory dysfunction

(premature ovarian insufficiency POI, polycystic ovary syndrome PCOS, hyperprolactinemia HPRL) and abnormal uterine bleeding (endometrial polyps, endometrial hyperplasia, submucosal myoma of the uterus, or adenomyosis).^[4] Differentiating between normal and abnormal menstruation plays an important role in the screening, diagnosis, and treatment of gynaecological diseases.

The available studies on this topic mainly includes small student population.^[5–7] Student population facilitate in investigating the menarche pattern, but they are in early menstrual stages and more susceptible to menstrual disorders, particularly ovulation dysfunction due to immaturity of the reproductive axis. If these sample populations are used, other characteristics of menstruation and disorders are limited and higher selection bias occurs.

Healthy big data have attracted increasing attention in the medical field. Mobile applications (APPs) are an important tool for collecting big data. Health care APPs, such as those that help control weight during pregnancy,^[8] target alcohol use control,^[9] and focus on sedentary behavioural changes,^[10] are also emerging. The mobile APP in our study is widely used in Chinese women of reproductive age to manage menstruation. There are more than 1 million active online users. Mobile APPs can record the details of menstruation, including interval between periods, duration of period, amount of menstrual flow, and menstrual symptoms, as well as remind the users of the next period. Users can also obtain reproductive health information from the APPs, and information can be collected via questionnaires. In this study, we aimed to investigate the menstrual patterns and prevalence of menstrual disorders in Chinese reproductive women using the APP, at the same time, the difference between traditional data collection method and APP is compared.

2. Materials and methods

Women who downloaded and actively used the menstruation management mobile APP were selected as research subjects. With the help of mobile devices, a cross-sectional study was carried out across China from December 2015 to January 2016. Some subjects were randomly selected from the APP users who had at least five consecutive menstrual records, and the other subjects were from the questionnaire survey that was published on the homepage of the APP. Anonymity was assured and emphasized. The study was approved by the ethics committee of Peking University First Hospital. Informed consent was obtained from all individual participants included in the study. Participants who downloaded and completed the questionnaire in the APP were considered to consent and participate in the study.

A self-designed, semi-structured questionnaire was used. The questionnaire included items on sociodemographic information, menstrual cycle characteristics (age at menarche, duration of menstruation, amount of menstrual flow, regularity of menstrual cycle), type and severity of pain related to menstruation (need for analgesia), and menstrual disorders and other accompanying symptoms. We mainly collected the menstrual information in the recent 6 months.

Data of length, regularity, duration, and amount of menstruation flow falling outside the normal range were considered as menstrual disorders. Normal or regular period was defined as shortest to longest cycle variation $\leq 7-9$ days, irregular period was defined as shortest to longest cycle variation $\geq 8-10$ days.^[3] The

degree of dysmenorrhoea pain was categorized as mild with no need for pain medication, moderate with need for pain medication (quality of life is not affected), and severe with need for pain medication (quality of life is affected). The amount of menstrual blood flow^[11–13] was expressed by the quantity of pads. Less than 5 pads a cycle was considered as hypomenorrhoea and more than 20 pads as hypermenorrhoea. The classification of regions was based on the four major economic regions of China's mainland, which was generally adopted since 2005.

To ensure that the questionnaire was accurately understood, we conducted a pre-survey in Peking University First Hospital outpatient department and revised the questionnaire before releasing it on the APP. Data were exported directly by the APP. All collected data were verified and analyzed by two statisticians. Disagreements were resolved by discussions with at least two senior gynaecologists to arrive a final judgment.

Data verification was based on the following principles. For significant extremes, such as 0, 255, and so on, the values that were apparently inconsistent with the logic within the different variables may be considered as missing due to users sometimes do not fill-in the APP accurately or computer system problems. The age at menarche beyond the range of 5 to 25 years was considered as missing. As for the length and duration of menstruation, the time interval between two cycles < 10 days or > 100 days was removed, and the duration of menstruation > 20 days was also removed. We used the median to describe the length and duration of menstruation, which were randomly selected from the users. SAS 9.4 (SAS Institute, Cary, NC, USA) statistical software was used to analyse data. Data was expressed as frequency and mean \pm standard deviation ($\bar{x} \pm SD$).

3. Results

A total of 156,055 women participated in the study, of which 25,716 participated in the survey questionnaire and 130,000 were randomly selected from the mobile APP. We used all the samples for analysis of length and duration of menstruation. The rest of the analysis was performed using questionnaire data. After examination of data, 111,258 and 118,783 women were included in the final analysis of the length of menstruation and duration, respectively.

The subjects were aged 14–44 years, with an average age of 26.32 ± 6.97 years (median age, 25 years); the 18–25-year old population dominated the samples by 56.53%. The average body mass index (BMI) was 20.18 ± 3.40 , and 25.26% of the people were underweight, and 10.28% were overweight and obese. Most of the subjects came from the eastern region. Occupations mainly included students, service industries, and freelance occupations. The total composition ratio was 54.15%. Almost 90% of the subjects had a monthly income of < 5000 yuan (Table 1).

According to full sample analysis, the average length of the menstrual cycle was 30.9 ± 4.28 days (median 30 days). Fifty percent of the population had a menstrual cycle between 28 and 33 days. Women aged > 30 years had a menstrual cycle of 30.04 days, and 50% of them had a cycle between 27 and 32 days, which is a day shorter than that of women aged < 30 years. Women's menstrual cycle tend to shorten with increasing age. The average length of menstrual cycle in women aged < 18 was 30.52 days and there was a wide variation in the length of menstrual cycle (see Table 1, Supplemental digital content, which

Table 1
Population characteristics.

	Number	%
Age at data collection (years) (n=25712)		
<18	2496	9.71%
18–25	14534	56.53%
26–30	3740	14.55%
>30	4942	19.22%
BMI (kg/m ²) (n=23610)		
Underweight (<18.5)	5965	25.26%
Normal (18.5–24.9)	15219	64.46%
Overweight (25–29.9)	1591	6.74%
Obesity (≥30)	835	3.54%
Living area (n=23711)		
East	11564	48.77%
Central	5674	23.93%
West	4443	18.74%
Northeast	1436	6.06%
Occupation (n=25716)		
Students	5563	21.63%
Computer industry	1034	4.02%
Medical and health industry	1623	6.31%
Education industry	1654	6.43%
Service industry	4256	16.55%
Institution	1034	4.02%
Freelance	4106	15.97%
Financial industry	924	3.59%
Others	5522	21.47%
Education (n=25716)		
Senior high school or below	11145	43.34%
Technical college	8267	32.15%
Undergraduate	5758	22.39%
Graduate or above	546	2.12%
Income per month (yuan) (n=25716)		
<2000	11723	45.59%
2000–5000	11366	44.20%
5000–8000	1854	7.21%
>8000	773	3.01%

illustrates the relationship between menstrual cycle length and age, <http://links.lww.com/MD/F984>). The menstrual cycle length of women with abnormal BMI (underweight, overweight, and obese) was longer than that of women with normal weight (see Table 2, Supplemental digital content, which illustrates the relationship between menstrual cycle length and BMI, <http://links.lww.com/MD/F985>). The average duration of menstruation was 5.01 ± 1.13 days (median 5 days), and >80% of women had an average duration of 4–8 days. The menstrual duration of women aged <18 years varied greatly, showing a high proportion of menstrual duration of only 1 day. The duration of menstruation gradually decreased with age, and the average duration in women >30 years was <5 days (see Table 3, Supplemental digital content, which illustrates the relationship between duration of menstruation and age, <http://links.lww.com/MD/F986>). Underweight women tended to have long menstrual duration, whereas obese women tended to have short menstrual duration (see Table 4, Supplemental digital content, which illustrates the relationship between duration of menstruation and BMI, <http://links.lww.com/MD/F987>). The average age at menarche was 13.08 ± 1.87 years. About 70% of subjects had menarche ages ranging from 12 to 14 years. Women with lower BMI had later age at menarche, whereas women with higher BMI had earlier age at menarche (see Table 5, Supplemental digital

Table 2
Menstrual characteristics of Chinese women of reproductive age.

Menstrual characteristics	Number	%
Age at menarche (years) (n=25716)		
<9	808	3.14%
9–11	2295	8.92%
12–14	18074	70.28%
14–16	3918	15.24%
≥17	621	2.41%
Duration of menstrual flow (days) (n=24670)		
≤1	976	3.96%
2–3	3202	12.98%
4–8	20221	81.97%
≥9	271	1.10%
Amount of flow (pads per cycle) (n=24670)		
≤5	2022	8.20%
6–10	4497	18.23%
11–15	7048	28.57%
16–20	6733	27.29%
21–30	3670	14.88%
≥31	700	2.84%
Regular pattern (n=24670)		
Yes (period variation ≤ 7–9 days)	15688	63.59%
No	8982	36.41%

content, which illustrates the relationship between menarche and BMI, <http://links.lww.com/MD/F988>). The results of menstrual length and duration derived from the questionnaire were consistent with the data obtained from the APP. Hypomenorrhoea was noted in 8.2% women, and hypermenorrhoea in 17.72% women. Women with irregular menstrual cycles accounted for 36.41% (Table 2).

The prevalence of secondary amenorrhoea was 4.07%, and 20.11% of women had abnormal uterine bleeding, approximately 77.65% of the respondents had dysmenorrhoea, and >40% of them had moderate or severe dysmenorrhoea. The proportion of dysmenorrhoea was higher and heavier in women aged <18 years (see Table 6, Supplemental digital content, which illustrates the relationship between dysmenorrhoea and age, <http://links.lww.com/MD/F989>) and those who were underweight (see Table 7, Supplemental digital content, which illustrates the relationship between dysmenorrhoea and BMI, <http://links.lww.com/MD/F990>). Hot compress was the most commonly used approach to ameliorate dysmenorrhoea, accounting for 52.06%; 46.33% of women did not take any management measures, and only 9.44% of women used drugs or went to the hospital. In addition to dysmenorrhoea, the top three menstrual symptoms were stomachache, body ache, and abdominal bulge, and their prevalence was 23.29%, 21.08%, and 21.55%, respectively (Table 3).

Women aged <18 and >30 years tend to suffer from menstrual cycle disorders, and those aged 18–30 years were more likely to have a stable menstrual cycle (see Table 8, Supplemental digital content, which illustrates the relationship between regularity of menstrual cycle and age, <http://links.lww.com/MD/F991>). Abnormal uterine bleeding gradually decreased with increasing age. Overweight women were more likely to have amenorrhoea and irregular menstrual cycles (see Table 9, Supplemental digital content, which illustrates the relationship between regularity of menstrual cycle and BMI, <http://links.lww.com/MD/F992>). Monthly income and academic level were also related to irregular menstruation. Women with high education

Table 3
Prevalence of menstrual disorders of Chinese women of reproductive age.

Menstrual disorders and treatment	Number	%
Secondary amenorrhoea (no periods in the past 6 months) (n=25716)		
Yes	1046	4.07%
No	24670	95.93%
Abnormal uterine bleeding (n=24670) (in the past 6 months)		
Yes	4960	20.11%
No	19710	79.89%
Dysmenorrhoea (n=24670)		
Yes	19156	77.65%
No	5514	22.35%
Classification of pain (n=19156)		
Mild	9098	47.49%
Moderate	6454	33.69%
Severe	3605	18.81%
Treatment of pain (n=20655)		
No treatment	8875	46.33%
Hot compress	9972	52.06%
Analgesic	1479	7.72%
Oral contraceptives	76	0.40%
Go to hospital	253	1.32%
Prevalence of gynaecological diseases (n=25716)		
Yes	9435	36.69%
No	16281	63.31%
Additional symptoms		
Stomachache	36351	23.29%
Body ache	32898	21.08%
Abdominal bulge	33624	21.55%
Breast pain	27276	17.48%
Anorexia	26879	17.22%
Headache	26426	16.93%
Skin acne	23175	14.85%
Constipation	20017	12.83%

and high income or low education and low income were more likely to have menstrual disorders and amenorrhoea (see Table 10, Supplemental digital content, which illustrates the relationship between regularity of menstrual cycle and education, <http://links.lww.com/MD/F993>) (see Table 11, Supplemental digital content, which illustrates the relationship between regularity of menstrual cycle and income, <http://links.lww.com/MD/F994>). Women with higher incomes were more likely to take pain medication or go to the hospital to relieve dysmenorrhoea compared with other income levels (see Table 12, Supplemental digital content, which illustrates the relationship between treatment of dysmenorrhoea and income, <http://links.lww.com/MD/F995>), and the prevalence of gynaecologic diseases was higher.

4. Discussion

A mobile APP was utilized to investigate menstruation characteristics and disorders in this study. It has the advantage of exploring large sample size with low cost, and high efficiency. As most Chinese women of reproductive age use a tool to manage menstruation, real-time recording of menstrual data ensures the authenticity of the research. However, using an APP also has limitations. It cannot guarantee complete random sampling and ensure absolute authenticity of research data, but other methods also have this problem.

The first instance of menstruation is called menarche. Menarche is affected by many factors, such as genetics, ethnic background, nutritional status, and environment.^[14–17] Menstruation is regulated by the hypothalamus-pituitary-ovarian axis. Developing follicles secrete estrogen to stimulate thickening of the endometrium. Owing to the immaturity of the reproductive axis, ovulation cannot be promoted, which leads to progesterone deficiency and occurrence of breakthrough bleeding. Menarche is often an anovulatory menstruation. It takes 2 years for women to establish a regular menstrual cycle after menarche.^[18] At this time, anovulatory diseases occur, such as polycystic ovary syndrome, hyperprolactinemia, hypothyroidism, and premature ovarian insufficiency.^[19] Long-term anovulation can lead to endometrial cancer and infertility, and the long-term health of women is affected. Our study found that the age at menarche was 13.08 ± 1.87 years, which was consistent with that reported in some studies (i.e., 12–13 years),^[20,21] but slightly higher than that reported in Rigon et al's study (i.e., 12.4 (± 1.3) years)^[22] and Abdelmoty et al's study (i.e., 12.49 years).^[5] This difference may be attributed to the inclusion of 14–44-year-old Chinese reproductive women, which is a large age range, in the present study. With the improvement in nutrition and health status, the age at menarche decreases to 0.3 years for every decade.^[23,24] And it is reported that racial and ethnic background could influence the age of menarche, black girls have earlier onset of puberty and menarche than white girls, with Hispanic or Mexican American girls being intermediate between black and white girls.^[17]

Menstruation is affected by many factors, including gynaecological diseases, mental stress, nutritional status, and environmental factors.^[25] Menstrual disorders are more common among younger girls, becoming less frequent as they grow older, 3–5 years after menarche.^[26,27] In 75% of adolescents at the first gynaecological year (one year after menarche), the average menstrual cycle length is 21–45 days. However, by the third gynaecological year, 60–80% of girls have menstrual cycles 21–35 days long as adult women. Studies showed that menstrual disorders occur in 35% of women: hypermenorrhoea in 17% of women; hypomenorrhoea in 8% of women; and abnormal uterine bleeding in 20% of women. Dysmenorrhoea is the most common symptom experienced by women during menstruation. Severe dysmenorrhoea requires drugs and affects work and life. Dysmenorrhoea is closely related to endometriosis, adenomyosis, and pelvic inflammation. Previous studies found that the prevalence of dysmenorrhoea is 51%–80%.^[28–30] Our survey found that 76% of women have dysmenorrhoea, but only 9.44% of women use drugs or go to hospital. Abdominal pain and pelvic bulge are also a common symptom during menstruation among women. Abnormal menstruation often indicates the occurrence of some diseases. Early diagnosis and standardized treatment are beneficial for long-term reproductive health.

Identification of abnormal menstrual patterns in adolescence may improve health in adulthood. Clinicians should educate girls and their caregivers that menstruation is a normal physiological phenomenon. They should also provide information on what to expect during the first menstrual period and the range of normal cycle length of subsequent menstruation. They should also be encouraged to seek medical help when a condition is beyond the normal range. In addition, paying attention to reproductive health and sexual mental health is equally important to avoid occurrence of long-term unplanned pregnancies and miscarriages. In future, users can record each period in real time and give

early warning information menstrual pattern is beyond the normal range, and doctors can provide effective health information according to the recorded menstrual information. Whether to promote pregnancy or contraception, APP can play a significant role, so as to avoid harm to women's long-term health.

This study has the following limitations. First, APP, as a survey tool, cannot guarantee complete random sampling and cannot ensure the authenticity of the data. Nevertheless, other methods also have the same problem. But APP can record menstrual data in real-time ensures the authenticity of the research and avoid recall bias. Second, it failed to cover all women of reproductive age, particularly those who cannot use mobile phones due to poor economic conditions, but the sample size of the study was large enough to make up for this deficiency. Third, the study only investigated the APP users, the results in this study only represents the feelings or thoughts of women who use the APP. Further study is needed on the prevalence of menstrual irregularities of the whole Chinese women. Finally, since the APP was only used to record menstruation and cannot collect other information, questionnaires are still needed to collect other information. The results of the questionnaire data are also satisfactory to verify the authenticity and accuracy of the data collected by the APP.

5. Conclusions

Mobile APP as a survey tool has the advantage of exploring large sample size with low cost, and highly efficient. The use of mobile APP is an emerging approach to collect big data in the field of health research. The results showed that the prevalence of menstrual disorders among Chinese women of reproductive age was high.

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