The Influential Associating Factors for Primary Dysmenorrhea: A Propensity Score-matched Analysis

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Abstract

Background:

Dysmenorrhea is a common painful nuisance for reproductive women. This study was to investigate the influential and modifiable factors, regarding health behaviors, lifestyles and dietary habits, for primary dysmenorrhea in a Taiwanese population.

Methods:

This cross-sectional study retrieved data from 5,000 individuals in the Taiwan Biobank. After excluding men, menopausal and cigarette smoke women and missing values, the 1,325 individuals aged 30 to 56 were analyzed. We used propensity score-matching (PSM) at 1:3 ratio, and the final sample size was 824. The data were analyzed in SPSS 22.0 using Chi-square test, Fisher's test, Student's t-test and conditional logistic regression method.

Results:

After PSM, univariable analysis showed that the higher incidence rates of dysmenorrhea were in exposure to tobacco smoke ($P=0.007$), less likely to cook at home ($P=0.01$) and more tendency of tea consumption ($P=0.036$). On multivariable analysis, compared with non-dysmenorrhea group, the risk of exposure to tobacco smoke was 1.42 times with AOR (CI) = 1.42(1.00, 2.02), $P=0.048$ and of having the habit of home-cooking was 0.74 times with AOR (CI) = 0.74(0.56, 0.98), $P=0.034$.

Conclusion:

The findings implied that exposure to tobacco smoke and no habit of home-cooking habit were the potential risk factors for developing primary dysmenorrhea.

Introduction

Dysmenorrhea, a painful nuisance in a woman's menstrual cycle, is a prevailing illness occurring repeatedly just before or during menstruation among a considerable number of women of reproductive age, with the prevalence ranging from 34–85.4%^{1,2}, thereby posing a great burden on public health and the economy since it leads to absenteeism from work and school³. This means that women with menstrual pain incur higher health costs, have work or academic performance undermined⁴ and quality of life is impaired⁵. Dysmenorrhea is categorized into two types: the primary type referring to crampy pain in the lower abdomen without any other underlying diseases that could lead to this pain frequently accompanied with symptoms such as vomiting, nausea, tiredness, irritability, dizziness, headache, backache and depression^{6,7}; while the secondary type, which elicits a similarly painful course as the primary type, is caused by anatomic and/or obvious pathological pelvic diseases such as endometriosis or adenomyosis^{8,9}. Compared to the secondary type, primary dysmenorrhea accounts for most cases of painful menses and associated symptoms with the incidence of dysmenorrhea decreasing by aging¹⁰. Some studies have suggested that primary dysmenorrhea is associated with stress, dietary patterns, passive smoking, and lifestyles^{11–13}, but most of these did not exclude the causes of secondary dysmenorrhea, which are mainly female-related diseases such as myoma, endometriosis. In addition, more than half of these papers regarding dysmenorrhea focused on college students or adolescents^{7,14,15}, probably due to the fact that they are more likely prone to be victims of dysmenorrhea. Some mature women aged over 30 however, do suffer from the same illness as younger women, and only a few studies^{1,16} have covered this mature population. Hence, in this study, we analyzed mature female individuals from the government-based Taiwan Biobank database^{17,18} and utilized the propensity-score matched method to mitigate the effects of age and the causes of secondary dysmenorrhea. All in all, the purpose of this study was to investigate the influential and modifiable factors, in terms of health behaviors, lifestyles and dietary habits, for primary dysmenorrhea, especially in a Taiwanese population.

Method

Data source:

This study consisted of Taiwanese individuals from the Taiwan Biobank ^{17,18}, which is the largest community-based cohort study in Taiwan with the purpose of providing a tremendous source for biomedical research and identifying disease-related factors and mechanisms of common diseases since 2012. As of August 1, 2020, this Biobank is comprised of over 130,000 community-based individuals, with inclusion criteria being community-based individuals aged 30 to 70 without history of cancer(s). Information gathered includes basic socio-demographics, personal health behaviors, lifestyles, dietary habits, family and personal non-cancerous disease history, and biochemical data from urine and blood samples. The data were retrieved via standardized questionnaire and a face-to-face interview with well-trained interviewers. The Taiwan Biobank obtained ethical approval from the Institutional Review Board on Biomedical Science Research, Academia Sinica, Taiwan. Informed consents from all participants were obtained and all experiments were executed in accordance with relevant guidelines and regulations.

Study subjects and design:

This cross-sectional study retrieved data from 5,000 individuals in the Taiwan Biobank between December 2008 and May 2014(application number: TWBR10709-01) with the information of socio-demographics, health behaviors, living styles, dietary habits and personal non-cancerous disease history. The flow diagram of this study is shown in Fig. 1. The definition of dysmenorrhea in the questionnaire was “Have you experienced dysmenorrhea during your period in the recent three months?” with a yes/no answer. In brief, the 1,325 female individuals aged 30 to 56 without menopause were included in the final analysis. Then, in order to mitigate the influences of age as a non-modifiable factor and the causes of secondary dysmenorrhea that include confounding factors like personal history of uterine myoma, ovarian cysts, endometriosis and cervical or uterine polyps, we conducted a propensity score-matching method ¹⁹ to match the dysmenorrhea group to a non-dysmenorrhea group at a 1:3 ratio. After propensity score-matching, the numbers of individuals of each group were 226 for dysmenorrhea and 598 for non-dysmenorrhea respectively. In the end, a total 824 subjects with information of socio-demographic, health behaviors, lifestyles and dietary habits were analyzed.

Measurements:

The detailed data we retrieved from the Taiwan Biobank were divided into four categories as follows: Category One was basic socio-demographic including age, body mass index, educational status, current marital status, living-alone status, current job status; Category Two was health behaviors and lifestyles including current drinking habit, exposure to tobacco smoke, sporting habit, experience of dependent drug use, current cook-for-self status, and exposure to incense fumes status; Category Three was dietary habits including tea and coffee consumption, vegetarian food intake, night-snack consumption status, the frequency of eating-out and the intake of dietary supplement; and Category Four was female-related diseases including the history of diagnosed uterine myoma, ovarian cysts, endometriosis and cervical or uterine polyps. All the above variables analyzed were categorical except for age.

Statistical analysis:

All data were processed and analyzed via IBM SPSS (Statistical Product and Service Solutions) Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY). The data were presented as percentages for categorical variables and as mean $\pm$ SD for continuous variables. Categorical variables were processed using Chi-square test or Fisher's test, whichever was appropriate, and numerical variables were processed with Student's *t*-test. A 2-tailed *P* value < 0.05 was regarded as significant.

Propensity scores for 1,325 subjects were calculated by a logistic regression model containing five covariates: age, and history of four female-related diseases. One-to-three nearest-neighbor matching was processed with a caliper width of 0.1. After propensity score-matching, matched-pairs were analyzed. The variables with *P* value < 0.05 in the univariate analysis were included in the conditional logistic regression analysis with the use of Cox regression in SPSS in order to pinpoint the independent associating factors for dysmenorrhea.

Results

In this study, a total of 824 individuals were finally analyzed after PSM at a ratio of 1:3 and the sample size of the dysmenorrhea group was 226 and the non-dysmenorrhea group being 598 respectively.

Characteristics of covariates before and after PSM

Before PSM, the original sample size was 234 individuals in the dysmenorrhea group and 1,091 in the non-dysmenorrhea group respectively. Compared with the non-dysmenorrhea group, individuals with dysmenorrhea were significantly younger with a mean age of 38.5 ± 6.1 years ($P < 0.001$) and more frequent history of diagnosed endometriosis with occurrence rate of 9.8% ($P < 0.001$).

However, after PSM, there were no statistically significant differences in the covariates of age and the history of diagnosed endometriosis between those with and without dysmenorrhea. The results are displayed in Table 1.

Table 1
Table 1. The characteristic of covariates before and after propensity score matching.

Covariates	Before PSM (n = 1,325)				After PSM (n = 824)			
	All n = 1,325	Dysmenorrhea n = 234	Non- dysmenorrhea n = 1,091	p-value	All n = 824	Dysmenorrhea n = 226	Non- dysmenorrhea n = 598	p-value
Age (years)	41.5 ± 6.5	38.5 ± 6.1	42.2 ± 6.4	< 0.001	39.2 ± 6.2	38.6 ± 6.2	39.4 ± 6.2	0.072
Uterine myoma, n (%)								
Yes	164(12.5)	36(15.4)	128(11.7)	0.124	110(13.3)	30(13.3)	80(13.4)	0.969
No	1,161(87.6)	198(84.6)	963(88.3)		714(86.7)	196(86.7)	518(86.6)	
Ovarian cysts, n (%)								
Yes	44(3.3)	7(3)	37(3.4)	0.757	26(3.2)	6(2.7)	20(3.3)	0.613
No	1,281(96.7)	227(97)	1054(96.6)		798(96.8)	220(97.3)	578(96.7)	
Endometriosis, n (%)								
Yes	63(4.8)	23(9.8)	40(3.7)	< 0.001	51(6.2)	16(7.1)	35(5.9)	0.514
No	1,262(95.2)	211(90.2)	1051(96.3)		773(93.8)	210(92.9)	563(94.1)	
Cervical or uterine polyps, n (%)								
Yes	25(1.9)	7(3)	18(1.6)	0.184	18(2.2)	5(2.2)	13(2.2)	1.00
No	1,300(98.1)	227(97)	1073(98.4)		806(97.8)	221(97.8)	585(97.8)	
Categorical data were presented as number (%); Continuous data were expressed as mean ± standard deviation.								

Demographic characteristics between groups

According to the results, there were no statistically significant differences in terms of body mass index ($P = 0.661$), education status ($P = 0.669$), current employment status ($P = 0.654$) and current marital status ($P = 0.119$). In addition, compared to the non-dysmenorrhea group, there was a marginally significant status of living alone with a higher occurrence rate of 9.3% ($P = 0.051$) in the dysmenorrhea group. These results are displayed in Table 2.

Table 2
Demographic characteristics between groups after propensity score matching.

Variables	All n = 824	Dysmenorrhea n = 226	Non-dysmenorrhea n = 598	p-value
BMI [†] (kg/m ²)				0.661
Normal	530(64.3)	146(64.6)	384(64.2)	
Underweight	53(6.4)	14(6.2)	39(6.5)	
Overweight	134(16.3)	41(18.1)	93(15.6)	
Obese	107(13)	25(11.1)	82(13.7)	
Education				0.669
Elementary	6(0.7)	1(0.4)	5(0.8)	
High school	293(35.6)	76(33.6)	217(36.3)	
College/graduate	525(63.7)	149(65.9)	376(62.9)	
Living alone status				0.051
Yes	54(6.6)	21(9.3)	33(5.5)	
No	770(93.4)	205(90.7)	565(94.5)	
Employed currently				0.654
Yes	644(78.2)	179(79.2)	465(77.8)	
No	180(21.8)	47(20.8)	133(22.2)	
Marital status				0.119
Yes	615(74.6)	160(70.8)	455(76.1)	
No	209(25.4)	66(29.2)	143(23.9)	
Variables were presented as number (%) or mean ± standard deviation.				
[†] BMI stands for body mass index.				

Lifestyles and dietary characteristics between groups

In this category, the results showed that there were no statistically significant differences with respect to current drinking habit (P = 0.226), sporting habit (P = 0.823), dependent drug use (P = 1), exposure to incense fumes (P = 0.464), coffee consumption habit (P = 0.352), vegetarian food consumption (P = 0.712) and late-night snacking habit (P = 0.425). On the other hand, compared with the non-dysmenorrhea group, there were higher rates of exposure to tobacco smoke (P = 0.007), less likely to cook at home (P = 0.01) and more tendency of tea consumption (p = 0.036). The results are displayed in Table 3.

Table 3
Lifestyles and dietary characteristics between groups after propensity score matching.

Variables	All n = 824	Dysmenorrhea n = 226	Non-dysmenorrhea n = 598	p-value
Drinking habit, currently				0.226
Yes	14(1.7)	6(2.7)	8(1.3)	
No	810(98.3)	220(97.3)	590(98.7)	
Exposure to tobacco smoke				0.007
Yes	107(13)	41(18.1)	66(11)	
No	717(87)	185(81.9)	532(89)	
Sporting habit				0.823
Yes	183(22.2)	49(21.7)	134(22.4)	
No	641(77.8)	177(78.3)	464(77.6)	
Dependent drug use				1
Yes	10(1.2)	3(1.3)	7(1.2)	
No	814(98.8)	223(98.7)	591(98.8)	
Home-cooking habit, currently				0.01
Yes	535(64.9)	131(58)	404(67.6)	
No	289(35.1)	95(42)	194(32.4)	
Exposure to incense fumes				0.464
Yes	204(24.8)	60(26.5)	144(24.1)	
No	620(75.2)	166(73.5)	454(75.9)	
Tea consumption				0.036
Yes	317(38.5)	100(44.2)	217(36.3)	
No	507(61.5)	126(55.8)	381(67.3)	
Coffee consumption				0.352
Yes	298(36.2)	76(33.6)	222(37.1)	
No	526(63.8)	150(66.4)	376(62.9)	
Vegetarian food consumption				0.712
Yes	47(5.7)	15(6.6)	32(5.4)	
No	732(88.8)	200(88.5)	532(89)	
Used to	45(5.5)	11(4.9)	34(5.7)	
Late-night snacking habit				0.425
No	555(67.4)	144(63.7)	411(68.7)	
Less than 3 times/month	113(13.7)	31(13.7)	82(13.7)	
1–6 times /week	123(14.9)	40(17.7)	83(13.9)	

Variables were presented as number (%) or mean $\pm$ standard deviation.

Variables	All n = 824	Dysmenorrhea n = 226	Non-dysmenorrhea n = 598	p-value
Almost every day	33(4)	11(4.9)	22(3.7)	0.916
Eating-out habit				
Less than 3 times/month	174(21.1)	46(20.4)	128(21.4)	
1–6 times/week	244(29.6)	69(30.5)	175(29.3)	0.794
Almost every day	406(49.3)	111(49.1)	295(49.3)	
Dietary supplement intake				
No	363(44.1)	99(43.8)	264(44.1)	0.794
Yes, irregular	244(29.6)	64(28.3)	180(30.1)	
Yes, regular	217(26.3)	63(27.9)	154(25.8)	
Variables were presented as number (%) or mean ± standard deviation.				

Factors associated with dysmenorrhea

On multivariable analysis, the risk of dysmenorrhea in subjects who experienced exposure to tobacco smoke was 1.42 times higher with AOR (CI) = 1.42(1.00, 2.02), $P = 0.048$. However, subjects having the habit of home-cooking brought about 0.74 times less events of dysmenorrhea with AOR (CI) = 0.74(0.56, 0.98), $P = 0.034$. Besides, after multivariable analysis, having the habit of tea consumption was no longer statistically significant. The results are displayed in Table 4.

Table 4
Multivariable analysis of independently associated factors for dysmenorrhea.

Variables	AOR	95% CI of AOR	p-value
Exposure to tobacco smoke	1.42	1.00—2.02	0.048
Home-cooking habit, currently	0.74	0.56—0.98	0.034
Tea consumption	1.17	0.89—1.53	0.272
AOR = adjusted odds ratio; CI = confidence interval.			

Discussion

Dysmenorrhea, in definition, consists of two types being primary and secondary. As to the causes of secondary dysmenorrhea, in our pre-matched sample with 1,325 individuals in Fig. 1, the univariable analysis showed that women with history of diagnosed endometriosis had a higher occurrence rate of dysmenorrhea than women without it ($P < 0.001$) and this was in line with a study showing that women with endometriosis had 2.2-times more incidents of menstrual pelvic pain/cramping than women without it ²⁰. Indeed, endometriosis is the major leading cause for secondary dysmenorrhea.

As to age, it is a non-modifiable and well-established influential factor of primary dysmenorrhea revealed in previous studies ^{2,21}, that correlated with our pre-matched sample showing that women with dysmenorrhea were younger than women without it ($P < 0.001$). Nevertheless, after PSM, the powerful influential factors were no longer statistically significant (all $P > 0.05$) and provided a clearer picture for primary dysmenorrhea.

After PSM, regarding demographic characteristics, BMI (body mass index) showed that there were no differences between the two groups ($P = 0.661$), and it was inconsistent with a prospective population-based cohort study suggesting that a U-shaped association was found between dysmenorrhea and BMI ²². One explanation is the clear difference of age between studies that included women over 30 in this study and under 30 in the quoted study. Moreover, speaking of marital status, Chiu et al. suggested

that unmarried women had 2.59-times more incidents of dysmenorrhea than married women ²³; however, our study showed no statistical significance between dysmenorrhea and marital status of women.

In terms of lifestyles and dietary patterns, according to the univariable analysis, our study revealed that exposure to tobacco smoke ($P = 0.007$), current home-cooking habit ($P = 0.01$) and tea consumption habit ($P = 0.036$) were statistically significantly influential factors for dysmenorrhea. In addition, the result of exposure to tobacco smoke was consistent with a previously prospective cohort study that showed a significant relationship between an increased occurrence of dysmenorrhea and exposure to tobacco smoke ¹¹. However, concerning the tea-drinking habit, there was a discrepancy between our study and the previous study, which revealed that tea-drinking was associated with a lower incidence rate of dysmenorrhea ²⁴, as our study reflected the opposite result. Indeed, the relationship of tea-drinking habit to dysmenorrhea remains unclear and needs to be further analyzed. Notably, our study revealed that women having the habit of home-cooking had lower incidences rate of dysmenorrhea than women without this habit and to the best of our knowledge, few studies have mentioned this relationship. This trend might be due to the different nutritious status between women with and without the home-cooking habit ²⁵; specifically, the home-cooking habit could provide more comprehensive nutrition and healthy food intake than the eating-out habit ²⁶.

Furthermore, in this study, we found no association between vegetarian food consumption and risk of dysmenorrhea. This result is in line with the nested case control study conducted by Najafi et al. ¹².

Regarding multivariable analysis, our study suggested that women with exposure to tobacco smoke had 1.42-times more chances to develop dysmenorrhea than women without exposure. This seemed to be a risk factor of dysmenorrhea and correlated with the previous studies ^{11,27}. Hopefully, this result could raise public awareness of anti-passive smoking and reduce the occurrence of dysmenorrhea; besides, women with the home-cooking habit could reduce the 26% incidence rate of dysmenorrhea in women without this habit. Clearly, it poses a protective factor for dysmenorrhea in women and probably implies that by home-cooking, women tend to get more nutritious and healthier diet intake that could lessen the menstrual pain, as supported by previous studies ^{25,26,28}. As to the tea-drinking habit, in multivariable analysis, there was no longer a statistical significance between the two groups, and the influential effect of tea-drinking needs to be further analyzed.

There are some limitations in this study. Firstly, this study was a questionnaire-based retrospective design and recall bias for data collection should be considered. Secondly, although powerfully statistical adjustments were performed by propensity score matching, numerous possible confounders may have affected the results of this study. Besides, the use of PSM means that there are no missing values in the covariates used in the analysis, so it reduces somewhat the required sample size. Thirdly, since this study was a retrospective design, it was difficult to pinpoint the causal relationships of dysmenorrhea perfectly, and lastly, most studies have focused on adolescents or young women, but in this study, mature women aged over 30 were targeted; hence, this mature population lacked other supportive and comparison studies.

In conclusion, dysmenorrhea is a common illness among reproductive women and the primary type accounts for most cases of this pain. In this study, PSM was used to mitigate the effects of secondary type being female-related diseases, so specifically influential factors for primary dysmenorrhea could be clearly visualized. Hence, after multivariable analysis, exposure to tobacco smoke and no habit of home-cooking were found to be the potential risk factors for developing dysmenorrhea in women.

Declarations

Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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Y.H.C wrote the main manuscript text and C.Y.H prepared the figure and tables. M.T.W and C.Y.L supervised the project. All the co-authors reviewed the manuscript before submission.

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Competing interests

The authors declare no competing interests that might have influenced the presentation of the work described in this manuscript.

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Figures

Figure 1

Flow chart of participants selection and reasons for exclusion; the Taiwan Biobank study. (n = 5,000) * Propensity score matching method is included 5 covariates: age, the history of diagnosed uterine myoma, ovarian cysts, endometriosis and cervical or uterine polyps. † To focus on passive smoking population, we excluded active smoking women.