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Comparison of Vegetable Intake in Nurses with and without Premenstrual Syndrome: A Case-Control Study

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Abstract

Objectives: Premenstrual syndrome (PMS) is a common cyclic disorder in women, which is characterized by multiple emotional or physical symptoms. The protective effect of vegetable intake against PMS was not completely investigated. Thus, in the current study, we compared vegetable intake in nurses with and without PMS.
Methods: In this case-control study, 307 female nurses with PMS (n = 156) and without PMS (n = 151) were participated from eight hospitals affiliated to the Tehran University of Medical Sciences, Iran. This study was performed from March to October 2014. Anthropometric measurements were performed for all nurses using standard methods. International physical activity questionnaire (IPAQ) was used for the physical activity assessment. The premenstrual symptoms screening tool (PSST) was applied to identify women who suffer from PMS. A validated semi-quantitative food frequency questionnaire (FFQ) was used for dietary intake measurement during the past years.
Results: Across increasing total vegetable quartiles, individuals had a significantly higher energy intake ($P < 0.001$). A significant difference was found in job duration, working shift, and physical activity, according to quartiles of total vegetable intakes ($P < 0.05$). A significant difference was observed in the mean intake of cruciferous vegetables between cases and controls ($P = 0.001$). Healthy women had significantly more cruciferous vegetable intakes compared to PMS women (6.8 ± 3.9 vs 4.0 ± 3.3). After adjusting for the confounders such as total vegetables, cruciferous vegetables, green leafy vegetables, dark yellow vegetables, and other vegetables, subjects in the highest quartile of cruciferous vegetables had lower odds (ratio OR) of PMS compared with those in the lowest-quartile ($P = 0.002$; OR = 0.33; CI = 0.16 - 0.67).
Conclusions: Our findings showed that higher consumption of cruciferous vegetables might be associated with a lower OR of PMS.

Keywords: Premenstrual Syndrome, Vegetables, Nurses, Case-Control Study

1. Background

Premenstrual syndrome (PMS) is a common type of periodic disorder in women during their reproductive years, which is characterized by multiple emotional or physical changes in the luteal phase of the menstrual cycle (1). It has been reported that about 70% - 95% of women during the reproductive age suffer from PMS (2, 3). The prevalence of PMS in Iran has been reported at around 52.9%, in which 34.5% suffer from PMS with severe symptoms (4). Irritability and depression, anxiety, fatigue, mood swings, change in libido, headache, abdominal bloating, appetite changes and food cravings, as well as tender breasts are the major signs and symptoms of PMS (5). Although the exact mechanism of PMS is unknown, multiple factors such as genetics or a family history of PMS, history of depression, cyclic changes in hormones, domestic violence, and emotional or physical trauma are contributed to PMS (5). Furthermore, the use of opium, increased aldosterone and renin-angiotensin activities, impaired secretion of internal opioids, higher prolactin secretion, and prostaglandin disorders are the other risk factors for PMS development (6). Several lines of studies demonstrated a relationship between several anthropometric indices such as body mass index (BMI), obesity, and physical activity with PMS (7).

Recent evidences have revealed that lack of dietary intakes of some specific nutrients and micronutrients such as trace elements, vitamins, and antioxidants can be considered a major risk factor for PMS development (8-10). For example, nutritional deficiencies of iron, zinc (3), calcium (11), magnesium (12), potassium (13), thiamin, riboflavin

(14), vitamin B (14), and vitamin D (11) have been reported to be correlated with the risk of PMS development. However, the exact mechanism in which these nutrients affect PMS development is not well-understood.

Vegetables are a major source of various micronutrients such as trace elements, antioxidants, vitamins, fibers, oligosaccharides, and carotenoids (15). A great number of studies have considered the beneficial effects of vegetables in treatment and prognosis of different diseases. For example, many studies showed the positive effect of vegetable intake in prevention of diabetes and obesity management (16). Some studies demonstrated that vegetable intake is strongly accompanied by decreased cardiovascular disease (CVD) risk factors such as triacylglycerol and high cholesterol, as well as blood pressure (17). Increased consumption of cruciferous vegetables has been reported to decrease the risk of multiple cancers such as bowel, intestinal, pancreatic, thyroid, and lung cancer (18). Park et al. indicated that consumption of vegetables prevents osteoporosis due to their rich sources of calcium and other vitamins, which are critical for bone health (19). A high intake of vegetables was negatively correlated to the risk of chronic obstructive pulmonary disease and respiratory symptoms (20).

Green leafy vegetables were suggested to have a protective effect against lung cancer (21). Based on these evidences, a significant relationship between vegetable intake and different diseases has been well elucidated; however, to the best of our knowledge, the protective effect of vegetable intake against PMS was not investigated.

2. Objectives

Given the critical role of vegetable intake against various diseases, we assume that consumption of vegetables may be effective against PMS. Thus, we designed this study to compare vegetable intake in nurses with and without PMS.

3. Methods

3.1. Subjects

This study is part of a case-control study, which aimed to compare dietary patterns between nurses with PMS and healthy nurses. A total of 156 female nurses with PMS and 151 healthy nurses who work in eight hospitals affiliated to ' Tehran university of medical science, were entered into the study from March to October 2014. These eight hospitals were randomly selected from 17 hospitals. The Premenstrual Symptoms Screening Tool (PSST) was applied to identify women who suffer from PMS (22). This case-control study was approved by the Ethical Committee of ' Islamic Azad University- Science and Research Branch. The objective and protocol of the study were explained to the participants and all individuals signed written informed consents. All participants filled a questionnaire containing demographic data (e.g. age, education, marital status, job experience, shift-working, menstrual cycle, and hemorrhage duration) before the study. The inclusion criteria for subjects were: (i) age range from 20 to 45 years and (ii) personal satisfaction to participate in this research. Individuals who met the following criteria were excluded from the study: (i) BMI $\geq$ 40 kg/m^2; (ii) drug use (e.g. contraceptives, hormones, thyroid regulators, weight reducer, anti-depressants, anti-anxiety, and drugs affecting metabolism and appetite) within the last month; (iii) history of other diseases (e.g. diabetes mellitus, liver and kidney diseases, cardiovascular disease, cancer, and etc.); (iv) women with premature menopause and polycystic ovary syndrome (PCOS); (v) use of any type of supplements, vitamins, and minerals in the last month; (vi) pregnant or lactating women; and (vii) opiate using.

3.2. Anthropometric Measure

Anthropometric measurements were performed for all nurses using standard methods. Standing height was measured without shoes by the Omron electronic digital scale (Omron, BF508). Body weight was measured with minimal clothing and without shoes by a digital magnetic scale (Omron, BF508). BMI was calculated using the following formula: [BMI = weight (kg)/height (m)^2]. Waist circumference (WC) was estimated using a measuring tape with one millimeter precision. The midpoint between the inferior costal margin and the upper iliac crest were measured as WC.

3.3. Physical Activity Assessment

In the current study, the short modified and translated form of international physical activity questionnaire (IPAQ) was used for all participants' physical activity assessment during the previous week (23). The questionnaire includes seven items assessing vigorous and moderate intensity of activities and walking for at least 10 min/day during the previous week.

We calculated the metabolic equivalent task (MET) min/week for each category of physical activity that existed in the questionnaire. MET-metabolic equivalents were determined based on the IPAQ guidelines, as follows: for walking: MET = 3.3/min, moderate intensity activities: MET = 4/min, and for vigorous: MET = 8/min. To calculate the total physical activity per week, scores of walking (MET

× min × day), moderate (MET × min × day), and vigorous (MET × min × day) are summed. We also identified the severity of physical activity based on three categories including mild, moderate, and severe activities. Individuals who had physical activity at least three times per week (1500 MET/min or 3000 MET/week) were considered as highly active. Individuals who had physical activity three days/week (with at least 20 min/day) or five days/week (with at least 30 minutes vigorous, moderate or walking activities) were categorized as moderate active. Individuals without any physical activity are considered as inactive (23). Internal consistency of IPAQ in the study of Moghaddam et al. (23) using Cronbach's Alpha coefficient were calculated and was 0.7, which indicated a good instrument. Furthermore, Spearman Brown correlation coefficient of 0.9 showed respectable test-retest reliability.

3.4. Dietary Assessment

A dietitian evaluated the diet intake of all participants on the first visit at the clinic. A validated semi-quantitative food frequency questionnaire (FFQ), that included 147 food items, was used to assess dietary intake during the past years. All subjects were asked to state the consumption frequency for each food item in terms of daily, weekly, monthly, and yearly. Furthermore, the amount of food intake for each participant was recorded. The daily food intake was calculated by converting the information of the FFQ to g/day. The Iranian modified nutritionist IV software (First Databank, San Bruno, CA) was applied for the analysis of food energy and nutrients content. Vegetables were divided into multiple specific groups, including dark yellow vegetables, cruciferous vegetables, green leafy vegetables, and other vegetables (24, 25).

3.5. Statistical Analysis

Demographic and clinical information of all participants were reported as mean ± SD. The Kolmogorov–Smirnov test was applied to evaluate the normality of the data. An independent student *t*-test was used to compare the mean of several parameters between the two groups. Chi-square test was used to compare the frequency of each parameter between different categories. The mean values of the quantitative variables across the vegetables quartiles were compared using the ANOVA test. The ANCOVA was used to compare the mean vegetable intake in both groups after adjusting for potential confounders. The correlation between the vegetable intake and chance of PMS was analyzed by simple logistic regression. We applied multivariable models to evaluate the relationship between vegetable intake and PMS (model 2) in addition to the unadjusted analysis (model 1). SPSS software (version 19) were used for data analyzing and a $P < 0.05$ was considered as significant.

4. Results

Demographic data and characteristics of study participants, according to quartiles of total vegetable intake, are summarized in Table 1. Across increasing total vegetable quartiles, individuals had significantly higher energy intake ($P < 0.001$). There was no significant difference in the mean of BMI ($P = 0.21$), WC ($P = 0.052$), age ($P = 0.33$), and menstrual duration ($P = 0.73$) in the different quartiles of total vegetable intakes (Table 1). However, a significant difference was found in job duration ($P = 0.04$), working shift ($P = 0.02$), and physical activity ($P = 0.02$), according to the quartiles of total vegetables intake.

No collinearity and interaction between models independent variables was detected. The comparison of vegetable intake between controls and women with PMS is shown in Table 2. A significant difference was observed in the mean of cruciferous vegetable intake between cases and controls ($P = 0.001$). Healthy women had a significantly more cruciferous vegetable intake compared to PMS women (6.8 ± 3.9 vs. 4.0 ± 3.3). There was no significant difference in the mean of total vegetable intake ($P = 0.9$), dark yellow vegetables ($P = 0.4$), green leafy vegetables ($P = 0.5$), and other vegetables ($P = 0.3$) between cases and controls.

As shown in Table 3, the odds ratio (OR) of PMS across quartiles of vegetables intake, before and after adjustment for confounding factors, is presented in two different models. Before adjusting the confounders, individuals in the lowest quartile of cruciferous vegetables had a higher OR of PMS compared with those in the highest quartile ($P = 0.005$). After adjusting for the confounders, subjects in the highest quartile of cruciferous vegetables had a lower OR of PMS compared with those in the lowest quartile ($P = 0.002$). No significant relationship was found after testing PMS subjects across the quartiles of total vegetables ($P = 0.52$), dark yellow vegetables ($P = 0.33$), green leafy vegetables ($P = 0.55$), and other vegetables ($P = 0.73$).

5. Discussion

Although a large number of studies considered the relationship between diet intakes and the risk of PMS, little information is available about the relationship between vegetables consumption and PMS. Our data revealed that cruciferous vegetable intake is significantly correlated to PMS, in which higher intake of vegetables was negatively associated with the risk of PMS. We found that cruciferous vegetable consumption might have an ameliorative effect

Table 1. Characteristic of Study Participants According to Quartiles of Total Vegetable Intake[a,b]

Variables	Quartiles of Total Vegetable Intakes				
	1 (N = 76)	2 (N = 77)	3 (N = 77)	4 (N = 77)	P Value[c]
Energy intake, kcal/d	2303.5 ± 589.6	2683.3 ± 669.7	2722.9 ± 659.8	3099.6 ± 582.9	< 0.001
Body mass index, kg/m²	23.1 ± 3.7	22.9 ± 3.5	23.3 ± 3.3	24.1 ± 4.5	0.21
Waist circumference, cm	77.6 ± 8.1	76.0 ± 8.5	78.0 ± 7.5	79.9 ± 9.9	0.052
Job durationy	4.7 ± 3.9	4.8 ± 4.0	6.6 ± 5.7	6.0 ± 5.1	0.04
Menstrual duration, d	6.3 ± 1.7	6.2 ± 1.6	6.2 ± 1.7	6.5 ± 1.8	0.73
Groups					0.53
PMS[d]	35 (22.4)	44 (28.2)	40 (25.6)	37(23.7)	
Control	41 (27.2)	33 (21.9)	37 (24.5)	40 (26.5)	
Age, y					0.33
20 - 32	60 (26.8)	59 (26.3)	51 (22.8)	54 (24.1)	
33 - 45	16 (19.3)	18 (21.7)	26 (31.3)	23 (27.7)	
Working-shift					0.02
Morning	13 (30.2)	10 (23.3)	9 (20.9)	11 (25.6)	
Evening	9 (25.7)	15 (42.9)	7 (20.0)	4 (11.4)	
Night	16 (30.0)	7 (17.1)	5 (12.2)	13 (31.7)	
Rotatory	38 (20.2)	45 (23.9)	56 (29.8)	49 (26.1)	
Marital status					0.74
Single	35 (23.5)	38 (25.5)	35 (23.5)	41 (27.5)	
Married-divorced	41 (25.9)	39 (24.7)	42 (26.6)	35 (22.8)	
Menstrual status					0.12
Regular	67 (26.9)	63 (25.3)	63 (25.3)	56 (22.5)	
Irregular	9 (15.5)	14 (24.1)	14 (24.1)	21 (36.2)	
Physical activity[e], met/min/week					0.02
Mild	39 (29.1)	31 (23.1)	37 (27.6)	27 (20.1)	
Moderate	35 (23.0)	42 (27.6)	37 (24.3)	38 (25.0)	
Severe	2 (9.5)	4 (19.0)	3 (14.3)	12 (57.1)	
Educational status					0.24
Bachelor	70 (24.2)	74 (25.6)	75 (26.0)	70 (24.2)	
Master	6 (33.3)	3 (16.7)	2 (11.1)	7 (38.9)	
Job					0.35
Nurse	72 (24.4)	76 (25.8)	75 (25.4)	72 (24.4)	
Supervisor-head nurse	4 (33.3)	1 (8.3)	2 (16.7)	5 (41.7)	

[a]Values are expressed as mean ± SD and No. (%).
[b]Total vegetables were defined, as shown in Table 2.
[c]Obtained by the use of ANOVA or the χ^2 test. $P < 0.05$ was considered as statistically significant.
[d]Premenstrual syndrome.
[e]Mild; lower than 600 met-min/week, moderate; 600 - 3000 met-min/week, severe; more than 3000 met-min/week.

on PMS, while green leafy vegetables, dark yellow vegetables, and other vegetables did not show any significant relationship with PMS.

The underlying mechanism behind the negative relationship between cruciferous vegetables consumption and PMS is not well understood. Cruciferous vegetables such as cauliflower, cabbage, garden cress, broccoli, and brussels sprouts are rich sources of micronutrients, in-

Table 2. Vegetable Intake in Controls and PMS Subjects[a,b]

Daily Intake, g	Controls (N = 151)	PMS (N = 156)	P Value[c]	P Value[d]	P Value[e]
Total vegetables	295.5 ± 16.6[f]	305.9 ± 17.1	0.5	0.9	0.9
Dark yellow vegetables	14.0 ± 5.3[f]	12.2 ± 4.5	0.3	0.2	0.4
Green leafy vegetables	45.1 ± 5.0[f]	45.6 ± 5.8	0.2	0.4	0.5
Cruciferous vegetables	6.8 ± 3.9[f]	4.0 ± 3.3	0.006	0.003	0.001
Other vegetables	214.6 ± 13.5f[e]	228.6 ± 15.6	0.3	0.5	0.3

[a]Values are expressed as mean ± SD.
[b]Cruciferous vegetables include white and red cabbage, broccoli, and cauliflower. Green leafy vegetables include spinach, lettuce, and green vegetables such as basil, parsley, cress, leek, spearmint, origany, coriander, and scallion. Dark yellow vegetables include carrot and yellow squash. Other vegetables include cucumber, tomato, zucchini, eggplant, celery, green pea, green bean, garlic, onion, green pepper, turnip, mushroom, olive, and corn.
[c]Unadjusted, Student *t*-test.
[d]Adjusted for energy intake; ANCOVA test.
[e]Adjusted for job duration, physical activity, working shift, intake of energy also red meat, saturated fatty acid, dietary fiber and total fruit intake. In addition, for each vegetable sub-group other vegetable subgroups were adjusted; ANCOVA test.
[f]Geometric mean ± SEM.

cluding potassium, calcium, zinc, magnesium, vitamin K, and antioxidants (e.g. vitamin C, E, and carotenoids), (26) which may be a main reason for lower risk of PMS.

Estrogen dominance happens when an unhealthy balance between estrogen metabolites are present. An estrogen metabolite identified as 16-hydroxy is known to be carcinogenic, whereas estrogen metabolite 2-hydroxy has positive effects. Previous studies show that levels of the 16-hydroxy metabolite are high in cases of breast, ovarian, cervix, uterine, and other hormone-sensitive cancers. This dangerous metabolite levels increases in women suffering with PMS and perimenopause. Estrogen concentration and a hormone known as pregnenolone sulfate are elevated in women with PMS. Pregnenolone sulfate plays an important role in memory procedure, however, if levels are too high, it causes anxiety. Furthermore, researchers have isolated a constituent in cruciferous vegetables called Indole-3-Carbinol (I3C), which is especially helpful for improvement of estrogen metabolism. By combining I3C with stomach acid, 3,3-Diindolylmethane, or DIM is formed. The metabolism of DIM intersections with estrogen metabolism, thus, it promotes healthy estrogen metabolism resulting in an appropriate ratio of 2-hydroxy to 16-hydroxy (27, 28). Furthermore, cruciferous vegetables have a high content of glucosinolates (29), which separate them from other vegetables. Glucosinolates known as a class of sulphur-containing glycosides, present at considerable amounts in cruciferous vegetables, and their breakdown products such as the isothiocyanates, are thought to be responsible for their health benefits (30). Due to these properties, it may be correlated to a lower risk of PMS in the current study.

Many studies reported a negative relationship between the intakes of these micronutrients and the risk of PMS (31, 32). Our findings are consistent with the results of previous studies that indicated a significant association between diet intake and the risk of PMS. For instance, Chocano-Bedoya et al. (3) demonstrated that higher intakes of non-heme iron and zinc can be related to a lower risk of PMS, whereas a low potassium intake may be associated with a higher risk of PMS. Several studies reported a significant association between dietary intakes of certain micronutrients such as calcium, thiamin, riboflavin, and vitamin D with the risk of PMS (11, 14). Similarly, Saeedian Kia et al. (32) reported a significant relationship between vitamin D, Ca^{2+}, and Mg^{2+} nutritional status and the risk of PMS. Some studies demonstrated a positive and significant relationship between PMS with food intake such as fried foods, sweet drink, and fast food (33). For example, Rad et al. (6) showed an inverse relationship between PMS with fried foods, fast foods, sweet drink, and fruit. A previous study demonstrated that women with PMS had a significantly more intake of energy and macronutrients such as cereals, cakes, desserts, and high-sugar foods compared to healthy women (10). In contrast, some studies did not find a relationship between some types of foods and PMS. For example, Houghton et al. (31) considered the relationship between carbohydrate and fiber intake with the risk of PMS in female nurses. They reported that carbohydrate and fiber consumption were not linked to PMS risk. Another study showed that fat intake was not associated with higher PMS risk (34). Purdue-Smithe et al. (35) showed that caffeine intake is not associated with PMS. However, the pervious data indicated that there is a relationship between PMS and some dietary factors; however, the exact mechanism of food action on PMS is unknown.

This study does have some limitations that may affect the interpretation of our findings. First, although sampling was done from different parts of hospitals, no authorization was given for special sections such as operating

Table 3. Odds Ratio (95% CI) of PMS According to Quartiles (Q) of Vegetable Intakes[a,b]

Variables	Q2 (76)		Q3 (77)		Q3 (77)		P Value[trend c]
	OR	95% CI	OR	95% CI	OR	95% CI	
Total vegetables							
Model 1	1.56	(0.82 - 2.96)	1.23	(0.65 - 2.32)	1.11	(0.59 - 2.10)	
P value		0.2		0.5		0.7	0.91
Model 2	1.30	(0.62 - 2.54)	0.87	(0.41 - 1.78)	0.72	(0.35 - 1.72)	
P value		0.4		0.7		0.4	0.52
Dark yellow vegetables							
Model 1	1.04	(0.55 - 1.97)	0.87	(0.46 - 1.66).	0.73	(0.39 - 1.38)	
P value		0.90		0.70		0.3	0.34
Model 2	1.00	(0.51 - 1.96)	0.84	(0.38 - 1.63)	0.71	(0.31 - 1.50)	
P value		1.0		0.5		0.3	0.33
Green leafy vegetables							
Model 1	0.95	(0.50 - 1.79)	1.05	(0.56 - 1.98)	1.27	(0.67 - 2.41)	
P value		0.9		0.9		0.5	0.42
Model 2	1.02	(0.52 - 2.09)	1.10	(0.57 - 2.38)	1.18	(0.52 - 2.70)	
P value		0.7		0.6		0.6	0.55
Cruciferous vegetables							
Model 1	0.77	(0.41 - 1.45)	0.79	(0.39 - 1.61)	0.40	(0.22 - 0.76)	
P value		0.4	0.5		0.005		0.005
Model 2	0.74	(0.38 - 1.45)	0.67	(0.31 - 1.45)	0.33	(0.16 - 0.67)	
P value		0.4	0.3		0.002		0.002
Other vegetables							
Model 1	1.08	(0.57 - 2.04)	1.17	(0.62 - 2.20)	1.23	(0.65 - 2.31)	
P value		0.8		0.6		0.5	0.51
Model 2	0.92	(0.47 - 1.90)	1.00	(0.48 - 2.08)	1.02	(0.43 - 2.30)	
P value		0.7		0.9		0.8	0.73

[a]Model 1: unadjusted. Model 2: Adjusted for job duration, physical activity, working shift and energy intake. Also red meat, saturated fatty acid, dietary fiber, total fruit intake were adjusted. In addition, for each vegetable sub-group other vegetable sub-groups were adjusted.
[b]Vegetables were defined, as shown in Tables 2.
[c]tests for trend were performed by entering the categorical variables as continuous parameters in the models.

rooms, emergency rooms, neonatal intensive care units, infection, and cancer wards. The personnel of these wards were too busy to spend time to cooperate with us, and these wards were not safe for non-medical personnel for a long period stay. As previously proven, occupational stress has a positive correlation with the symptoms of PMS. A number of nurses who are more likely to be exposed to stress in these wards were not studied. Second, individuals with PMS were aware about their problems, which might affect their dietary pattern, and were reported differently than controls. Third, in trying to record food intake among nurses over the previous year, both the portion sizes quantification and the consumption frequency may have been subject to remember errors. Therefore, information bias cannot be completely ruled out, and this issue can lead to a dilution of our study results. However, in spite of these errors that can occur with the use of FFQ, they are still considered the best and valid questionnaire for collecting dietary data in the large population. Despite these limitations, this study is among few studies to evaluate the relationship between vegetables intake and PMS occurrence risk.

In addition, one of the strengths of this study is the large sample size. Subsequently, the samples were selected from eight hospitals and selected from different departments, the obtained results have high generalizability in nurses working in hospitals. Although we cannot completely reject the residual confounding effect, it is unlikely that evaluation of confounder's mistake plays an important role in our study; due to the fact that in this study, the confounding factors were moderated by the ANCOVA test.

In conclusion, we have considered the relationship between vegetable intake and PMS occurrence risk in a nurse population that have high job pressures and responsibilities. Our findings have shown that higher consumption of cruciferous vegetables might be associated with a lower OR of PMS. Further studies are needed for confirming of these findings and clearing of the precise mechanisms.

Footnotes

Authors' Contribution: Khatereh Babakhani and Gity Sotoudeh contributed to the design and implementation of the study, analysis and interpretation of data and was involved in drafting the manuscript. Mostafa Ghorbani and Gity Sotoudeh contributed to the design and implementation of the study, interpretation of data and was involved in drafting and revising the manuscript. F.S contributed to the conception and design of data and drafting the manuscript. All authors reviewed and approved the final version to be published and declare that the content of this study has not been published elsewhere.

Conflict of Interests: None.

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