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Dietary supplement intake and sleep quality among pregnant women in Johor, Malaysia: A cross-sectional study

(Pengambilan suplemen diet dan kualiti tidur dalam kalangan wanita hamil di Johor, Malaysia: Satu kajian keratan rentas)

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Abstract

The use of dietary supplements to improve well-being, including sleep quality, is increasing. This study aimed to describe dietary supplement use and determine the association between supplement intake and sleep quality among pregnant women in Johor, Malaysia. In this cross-sectional study, 131 pregnant women aged 18-49 years in Johor Bahru were recruited through purposive sampling. Data collected included socio-demographic characteristics, anthropometric measurements, lifestyle factors, pregnancy status, supplement intake, and sleep quality, which were assessed using the Pittsburgh Sleep Quality Index (PSQI). Most subjects (93.9%) consumed at least one to two types of supplements, with prenatal supplements being the most common (51.2%). Most micronutrient intake from supplements was below the Recommended Nutrient Intake for Malaysia 2017, except for folic acid. Approximately half of the subjects (49.6%) exceeded the tolerable upper intake level for folic acid. Subjects who took supplements had a mean PSQI score of 7.1 ± 3.3, with a significant association between the intake of vitamin B12, vitamin C, or zinc and good sleep quality. In conclusion, most pregnant women in Johor consume one to two types of supplements daily. The intake of vitamin B12, vitamin C, and zinc was associated with good sleep quality in pregnant women. The findings of study raise concerns about the overconsumption of folic acid among pregnant women and underscore the need for healthcare professionals to provide accurate information and discuss potential risks related to supplement overconsumption.

Keywords: Pregnant women, dietary supplement, sleep quality, PSQI

Abstrak

Penggunaan suplemen diet untuk meningkatkan kesejahteraan, termasuk kualiti tidur, semakin meningkat. Kajian ini bertujuan untuk menerangkan penggunaan suplemen diet dan menentukan hubungan antara pengambilan suplemen dan kualiti tidur dalam kalangan wanita hamil di Johor, Malaysia. Dalam kajian keratan rentas ini, 131 wanita hamil berumur 18-49 tahun di Johor Bahru direkrut melalui persampelan bertujuan. Data yang dikumpulkan merangkumi ciri-ciri sosiodemografi, ukuran antropometri, faktor gaya hidup, status kehamilan, pengambilan suplemen, dan kualiti tidur yang dinilai menggunakan Indeks Kualiti Tidur Pittsburgh (PSQI). Sebilangan besar subjek (93.9%) mengambil sekurang-kurangnya satu hingga dua jenis suplemen, dengan suplemen pranatal merupakan paling biasa (51.2%). Sebahagian besar pengambilan mikronutrien daripada suplemen adalah di bawah Saranan Pengambilan Makanan untuk Malaysia 2017, kecuali asid folik. Kira-kira separuh daripada subjek (49.6%) melebihi tahap pengambilan atas yang boleh diterima untuk asid folik. Subjek yang mengambil suplemen mencatatkan skor PSQI purata 7.1 ± 3.3, dengan hubungan signifikan antara pengambilan vitamin B12, vitamin C, atau zink dengan kualiti tidur yang baik. Kesimpulannya, kebanyakan wanita hamil di Johor mengambil satu hingga dua jenis suplemen setiap hari. Pengambilan vitamin B12, vitamin C, dan zink dikaitkan dengan kualiti tidur yang baik dalam kalangan wanita hamil. Dapatan kajian ini menimbulkan kebimbangan tentang pengambilan berlebihan asid folik dalam kalangan wanita hamil dan menekankan keperluan bagi profesional kesihatan untuk memberikan maklumat yang tepat serta membincangkan risiko berkaitan dengan pengambilan suplemen secara berlebihan.

Kata kunci: Wanita hamil, suplemen diet, kualiti tidur, PSQI

INTRODUCTION

Sleep disturbances are prevalent during pregnancy, impacting approximately half of pregnant women, with insomnia, restless legs syndrome (RLS), and obstructive sleep apnoea (OSA) being among the most frequent issues (Sedov et al. 2018; Yang et al. 2020). Meta-analyses of global studies have reported pooled prevalence rates of 38% for insomnia (Sedov et al. 2021), 21% for RLS (Chen et al. 2018), and 15% for OSA (Liu et al. 2019). Poor sleep quality and disturbances negatively impact maternal health and foetal development and increase the risk of complications, such as pre-eclampsia, caesarean section, hypertension, and gestational diabetes (Lu et al. 2021). Additionally, these sleep issues can diminish quality of life and heighten the risk of depression during pregnancy (Tsai et al. 2016).

Pregnancy involves hormonal, physiological, and physical changes that heighten vulnerability to sleep disturbances (Mindell et al. 2015). Hormones like cortisol, melatonin, oxytocin, prolactin, oestrogen, and progesterone influence sleep behaviour (Deurveilher et al. 2011). The growing uterus, frequent awakenings, and other discomforts further disturb sleep quality. Recent research also connects sleep disturbances to micronutrient intake. Micronutrients influence sleep patterns via chemical signalling, neurotransmitter levels, and circadian gene expression. Deficiencies in vitamins B, folate, iron, zinc, and magnesium correlate with poorer sleep quality (Ji et al. 2017). A meta-analysis of 31 randomised controlled trials by Chan and Lo (2022) showed that melatonin, amino acids, and vitamin D improve sleep quality, as indicated by reduced Pittsburgh Sleep Quality Index (PSQI) scores. Common dietary supplements like vitamin B6, magnesium, zinc, and iron have been linked to better sleep (Jadidi et al. 2023; Kordas et al. 2009).

During pregnancy, the need for micronutrients such as vitamins A, B6, B9, B12, C, D, and minerals such as iron, zinc, iodine, copper, and selenium increases by up to 50% to support optimal maternal tissue growth and foetal development (Gernand et al. 2016). However, many pregnant women do not follow dietary guidelines or meet daily nutrient needs (Sauder et al. 2021; Saunders et al. 2019), leading to frequent micronutrient deficiencies (Gernand et al. 2016; Roos et al. 2019). Inadequate micronutrient intake during pregnancy may increase the risk of poor sleep quality, but research in this field is limited. The existing evidence is insufficient and inconclusive in recommending supplement use to enhance sleep quality in pregnant women.

Dietary supplement are widely used among pregnant women to address micronutrient deficiencies and potentially improve well-being and sleep quality (Keats et al. 2019). At such, supplement intake can serve as a proxy for assessing micronutrient intake, particularly during pregnancy, where micronutrient intake may be lower among non-users compared to users (Lee et al. 2020). However, misuse or overuse can result in excessive intake, posing health risks to pregnant women and foetuses. For instance, excessive vitamin A intake during pregnancy can lead to birth defects such as craniofacial anomalies and central nervous system malformations (Ishaq et al. 2024). In Malaysia, dietary supplements are readily available in pharmacies, retail stores, supermarkets, and online platforms without a doctor's prescription, increasing the risk of uncontrolled consumption (Liu, Zhang, et al. 2019). However, dietary supplement use by pregnant women in Malaysia has not been extensively researched.

This study aims to (1) describe the use and combination of dietary supplements and (2) determine associations between the type of supplement intake (as a proxy for micronutrient intake) and sleep quality among pregnant women in Johor, Malaysia. This is the first study in Malaysia to explore the association between micronutrient intake from dietary supplements and sleep quality in this population. The findings will provide insights for healthcare professionals and policymakers to develop targeted interventions to optimise sleep quality in pregnant women.

MATERIALS AND METHODS

Study design

This cross-sectional study was conducted at a baby fair in Johor Bahru, Johor, and utilised a purposive sampling method. The sample size was determined using the formula by Cochran (1977). Based on an estimated prevalence of dietary supplement intake among Malaysian pregnant women of 49.1% (Daud & Abd. Aziz 2020), a precision of 10%, and a z-score of 1.96 (corresponding to a 95% confidence interval), the calculated sample size was 96. To account for a 20% non-response rate, the minimum required sample size was increased to 120. The data collection occurred over a period of three months, spanning from September 2023 to November 2023. The inclusion criteria for this study included Malaysian citizens and pregnant women aged 18 to 49 years residing in Johor who were proficient in either the Malay or English language. The exclusion criteria were pregnant women with multiple pregnancies or those who were currently breastfeeding. Participation in the study was entirely voluntary, and no form of coercion was used at any stage of the study. Ethical approval for the study was obtained from the Research Ethics Committee of Universiti Kebangsaan Malaysia (Reference

number: JEP-2023-585). All subjects were informed about the purpose of the study, its objectives, and the scope of the questionnaire and were asked for their consent before completing the questionnaire.

Questionnaire

Prior to conducting the actual survey, a pilot test was administered to five subjects meeting the sampling criteria to assess the clarity of instructions and statements. Feedback led to the addition of brief definitions or explanations beneath questions containing challenging terms, such as "prenatal care." The final questionnaire was made available in Malay and English via Google Forms. Subjects who met the inclusion criteria and consented to participation completed the questionnaire with researcher assistance provided for clarification when necessary. The questionnaire comprised four parts: Part A Socio-demographic and Anthropometric Data, Part B Pregnancy Status and Lifestyle, Part C Dietary Supplement Intake, and Part D Pittsburgh Sleep Quality Index.

In Part A, subjects were queried on variables such as age, ethnicity, residence location, marital status, highest education level, employment status, monthly income, and household income. Additionally, self-reported anthropometric data, including height, pre-pregnancy weight, and current weight, were collected. Pre-pregnancy BMI was calculated and categorised as underweight (BMI <18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25.0-29.9), and obese (BMI ≥ 30.0) following WHO cutoff values. Part B addressed subjects' pregnancy status and lifestyle during pregnancy, focusing on gestational age, prenatal care, health issues, gravidity, parity, smoking status, exposure to second-hand smoke (at least 15 minutes daily on more than one day per week), and alcohol consumption.

In Part C, dietary supplement intake was recorded. Only subjects consuming dietary supplements were further queried about intake characteristics, including the number of supplements, full name and brand, frequency, and duration of use. Subjects could upload images of each supplement and its nutritional label to the Google Form to facilitate daily nutrient intake calculations. Daily nutrient intake was determined by multiplying nutrient content per dose by daily intake frequency. Total nutrient intake from all supplements was compared to the Recommended Nutrient Intake (RNI) and tolerable upper intake level (UL) based on the RNI 2017 for Malaysia (National Coordinating Committee on Food Nutrition 2017). Reasons for supplement intake during pregnancy, sources of supplementation information, and purchasing channels were documented. Subjects not taking supplements were asked for their reasons for abstention.

In Part D, both the English (Buysse et al. 1989) and Malay (Farah et al. 2019) versions of the PSQI were utilised to assess subjective sleep quality over the past month. The questionnaire encompassed subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, medication use, and daytime dysfunction. Scores for each component ranged from 0 to 3, summated to derive a total PSQI score from 0 to 21. A higher PSQI score signified poorer sleep quality. Sleep quality was classified as good with scores between 0 and 5, and poor with scores above 5.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics summarised the data, including mean, standard deviation (SD), frequency, percentages, median, and interquartile range (IQR). The data's normality was assessed using the Kolmogorov-Smirnov test. For continuous variables, the mean and SD were reported for normally distributed data, whereas the median and IQR were provided for non-normally distributed data. Chi-square analysis was used to determine the association between dietary supplement intake types and sleep quality among pregnant women in Johor. Statistical significance was set at $p<0.05$.

RESULTS

A total of 131 pregnant women aged 18 to 49 years from Johor were recruited for this study. The majority of subjects were Malays (71.8%), living in urban areas (87.0%), and holding a bachelor's degree (68.6%) (Table 1). Most were employed, with 35.1% reporting a monthly personal income between RM2500 and RM3969, and 53.4% having a monthly household income between RM4850 and RM10959. The mean pre-pregnancy BMI was 22.7 ± 3.7 kg/m², with 66.4% classified as having a normal weight. The mean gestational age was 26.9 ± 6.1 weeks, with 51.1% in the third trimester and 45.8% in the second trimester (Table 1). The first antenatal care visit occurred at a mean of 7.4 ± 3.2 weeks, with a mean of 7.1 ± 4.5 visits during pregnancy. Health problems were reported by 19.1% of subjects, including 8.4% with anaemia. Most subjects (64.1%) were primigravida, i.e., pregnant for the first time, and 71% were nulliparous (women who had never given birth to a live baby).

Table 1. Socio-demographic and anthropometric characteristics, pregnancy status and lifestyle (n=131)

Variable	Mean ± SD or n (%)
Age (years)	29.5 ± 3.9
Ethnicity	
Malay	94 (71.8)
Non-Malay	37 (28.2)
Place of residence	
Urban	114 (87.0)
Rural	17 (13.0)
Highest education level	
No formal education	1 (0.8)
Primary school	1 (0.8)
Secondary school	8 (6.1)
Pre-university	31 (23.7)
Bachelor's degree and above	90 (68.6)
Employment status	
Employed	107 (81.7)
Unemployed	24 (18.3)
Monthly personal income	
<RM2500	37 (28.2)
RM2500-RM3969	46 (35.1)
RM3970-RM4849	18 (13.7)
RM4850-RM 7099	19 (14.5)
>RM7110	11 (8.5)
Monthly household income	
B40 (<RM4850)	33 (25.2)
M40 (RM4850-RM10959)	70 (53.4)
T20 (>RM10959)	28 (21.4)
Height (cm)	157.2 ± 5.0
Pre-pregnancy body weight (kg)	56.3 ± 10.3
Current body weight (kg)	64.4 ± 10.9
Pre-pregnancy Body Mass Index (BMI), kg/m^2	22.7 ± 3.7
Pre-pregnancy body weight status	
Underweight	15 (11.5)
Normal weight	87 (66.4)
Overweight	23 (17.6)
Obese	6 (4.5)
Gestational age (weeks)	26.9 ± 6.1
Pregnancy trimester	
First trimester	4 (3.1)
Second trimester	60 (45.8)
Third trimester	67 (51.1)
Gravida	
Primigravida	84 (64.1)
Multigravida	47 (35.9)
Parity	
Nullipara	93 (71.0)
Primipara	24 (18.3)
Multipara	14 (10.7)
Antenatal care attendance	
In how many weeks did you have your first antenatal care? (weeks)	7.4 ± 3.2
Frequency of attending antenatal care (times)	7.1 ± 4.5
Health issues	
Yes	25 (19.1)
No	106 (80.9)
Type of health issues	
Gestational Diabetes	7 (5.3)
Anemia	11 (8.4)
Preeclampsia	2 (1.5)
Other	5 (3.8)
Non-smoker	131 (100)
Exposure to other people's tobacco smoke[2]	
Yes	23 (17.6)
No	108 (82.4)
Non-alcohol drinker	131 (100)

[1]Others included indigenous people.

[2]At least 15 minutes daily on more than one day per week.

Nearly all subjects (93.9%) took dietary supplements during pregnancy, with 65.0% using one to two types (Table 2). Prenatal supplements were most commonly taken (51.2%), followed by multivitamins/multiminerals (49.6%), vitamin supplements (39.8%), and food supplements (27.6%), including fish oil, probiotics, powdered milk products for pregnant women, chicken essence, and bird's nest products. Folic acid was the most popular (94.3%), followed by iron (85.4%) and vitamin B12 (80.5%), with nearly all subjects taking supplements daily (99.2%). Taking supplements was primarily for the health of the mother and foetus (87.8%). Other reasons included preventing deficiencies (55.3%), following doctor's advice (52.0%), increasing energy (26.0%), or improving sleep quality (9.8%). Information about supplements came from doctors (91.1%), family and friends (42.3%), and social media (29.3%). Supplements were mainly obtained, either purchased or provided, from hospitals or clinics (73.2%) and pharmacies (63.4%). For the eight women who did not take supplements (6.1%; data not shown in the table), the reasons included fear of side effects (n=6), concern about potential harm to the baby (n=2), or forgetfulness (n=1). The mean and median intakes of most micronutrients from dietary supplements were below the RNI and did not exceed the UL, except for folic acid (Table 3). The median folic acid intake was 1000 µg/d, with 49.6% exceeding the UL. Additionally, iron intake from dietary supplements exceeded the UL in 39.8% of subjects.

Table 2. Pattern dietary supplements use among users of dietary supplements (n=123)

Variable	n (%)
Number of supplements taken	
1 - 2	80 (65.0)
3 - 4	37 (30.1)
>4	6 (4.9)
Supplement category	
Prenatal supplement	63 (51.2)
Vitamin supplement	49 (39.8)
Mineral supplement	28 (22.8)
Multivitamin/mineral supplement (MVM)	61 (49.6)
Food supplement	34 (27.6)
Herbal supplement	4 (3.3)
Type of supplements	
Vitamin A	68 (55.3)
Vitamin B12	99 (80.5)
Vitamin C	98 (79.7)
Vitamin D	90 (73.2)
Vitamin E	40 (32.5)
Calcium	89 (72.4)
Folic acid	116 (94.3)
Iodine	68 (55.3)
Iron	105 (85.4)
Magnesium	51 (41.5)
Zinc	58 (47.2)
DHA	45 (36.6)
Frequency of supplement intake	
Every day	122 (99.2)
Others	1 (0.8)
Reasons for taking supplements during pregnancy	
For the health of mother and baby	108 (87.8)
To prevent nutrient deficiencies	68 (55.3)
Desire to put doctor's advice into practice	64 (52.0)
To increase energy	32 (26.0)
Fear of getting sick	19 (15.4)
Improved sleep quality	12 (9.8)
Improved memory	9 (7.3)
Beauty purposes	3 (2.4)
Sources of information about supplements	
Doctor	112 (91.1)
Family or friends	52 (42.3)
Social media	36 (29.3)
Advertisements	6 (4.9)
Others	8 (6.5)
Channels for purchasing supplements	
Hospital/clinic	90 (73.2)
Pharmacy	78 (63.4)
Health food store	14 (11.4)
Online purchase	11 (8.9)
Direct sales	8 (6.5)
Others	2 (1.6)

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Table 3. Daily micronutrient intake from dietary supplements alone (n=123)

Type of Nutrient	Dosage Consumption			RNI 2017		Frequency (%)
	Mean ± SD	Median	Interquartile Range (IQR)	RNI[1]	UL[2]	>UL[3]
Vitamin A (µg)	557.3 ± 710.3	480	0 - 900	800	2800	3 (2.4)
Vitamin B12 (µg)	22.5 ± 75.8	4	2 - 9	4.5	-	-
Vitamin C (mg)	201.6 ± 241.1	100	52 - 250	80	2000	0 (0)
Vitamin D (µg)	10.5 ± 12.5	10	0 - 12.5	15	100	0 (0)
Vitamin E (mg)	3.9 ± 9.0	0	0 - 3.5	7.5	1000	0 (0)
Calcium (mg)	357.6 ± 396.1	250	0 - 600	1000	2500	0 (0)
Folic acid (µg)[4]	1875.7 ± 1999.9	1000	700 - 2300	360	1000	61 (49.6)
Iodine (µg)	74.3 ± 109.6	75	0 - 100	200	1100	0 (0)
Iron (mg)	66.9 ± 79.9	30	10 - 105	-	45	49 (39.8)
Magnesium (mg)	56.9 ± 146.9	0	0 - 52.5	350	350	4 (3.3)
Zinc (mg)	6.8 ± 11.0	0	0 - 11	5.5 - 10	25	8 (6.5)
DHA (mg)	80.7 ± 132.0	0	0 - 125	200	1000	0 (0)

RNI: Recommended Nutrient Intake; RNI 2017: Recommended Nutrient Intakes for Malaysia 2017; UL: Tolerable upper intake level

[1]The RNI 2017 does not make any recommendation for iron during pregnancy as iron needs increase tremendously and generally beyond that can be adequately supplied by diets. It is recommended that iron supplements in tablet form be given to all pregnant women. In the non-anaemic pregnant woman, daily supplements of 100 mg of iron (e.g., as ferrous sulphate) given during the second half of pregnancy are adequate. In anaemic women higher doses are usually required.

[2] The RNI 2017 does not specify a tolerable upper intake level.

[3] >UL: Proportion of pregnant women exceeding the tolerable upper intake level

[4] RNI is presented in µg folic acid. The RNI presented in RNI2017 as µg of dietary folate equivalents (DFE) were converted to µg of folic acid using the equation set by the National Academy of Medicine, 1µg DFE= 0.6 µg of folic acid with meals.

The mean PSQI score for sleep quality was 7.1 ± 3.3, with 65.9% reporting poor sleep quality (Table 4). Table 5 shows the associations between sleep quality with vitamin B12, vitamin C, and zinc supplement intakes ($p<0.05$). Specifically, 39.4% of those who took vitamin B12 reported good sleep quality compared to 12.5% who did not take vitamin B12. Similarly, 39.8% of those who took vitamin C reported good sleep quality, compared to 12.0% who did not. Regarding zinc, 43.1% reported good sleep quality compared to 26.1% who did not take zinc supplements.

Table 4. Pittsburgh Sleep Quality Index score and assessment of sleep quality in pregnant women taking dietary supplements (n=123)

Variables	Mean ± SD or n (%)
Pittsburgh Sleep Quality Index score	7.1 ± 3.3
Sleep quality assessment	
Good	42 (34.1)
Poor	81 (65.9)

Table 5. Association between the type of supplement intake and sleep quality (n=123).

Type of Supplement	Supplement intake	Sleep Quality		p value
		Good	Poor	
Vitamin A	Yes	26 (38.2)	42 (61.8)	0.288
	No	16 (29.1)	39 (70.9)	
Vitamin B12	Yes	39 (39.4)	60 (60.6)	0.013*
	No	3 (12.5)	21 (87.5)	
Vitamin C	Yes	39 (39.8)	59 (60.2)	0.009*
	No	3 (12.0)	22 (88.0)	
Vitamin D	Yes	30 (33.3)	60 (66.7)	0.754
	No	12 (36.4)	21 (63.6)	
Vitamin E	Yes	17 (42.5)	23 (57.5)	0.175
	No	25 (30.1)	58 (69.9)	
Calcium	Yes	32 (36.0)	57 (64.0)	0.494
	No	10 (29.4)	24 (70.6)	
Folic acid	Yes	41 (35.3)	75 (64.7)	0.254
	No	1 (14.3)	6 (85.7)	
Iodine	Yes	26 (38.2)	42 (61.8)	0.288
	No	16 (29.1)	39 (70.9)	
Iron	Yes	39 (37.1)	66 (62.9)	0.091
	No	3 (16.7)	15 (83.3)	
Magnesium	Yes	20 (39.2)	31 (60.8)	0.318
	No	22 (30.6)	50 (69.4)	
Zinc	Yes	25 (43.1)	33 (56.9)	0.048*
	No	17 (26.2)	48 (73.8)	
DHA	Yes	16 (35.6)	29 (64.4)	0.802
	No	26 (33.3)	52 (66.7)	

The p-value was obtained by Chi-square test. *Significant at $p<0.05$.

DISCUSSION

In this study, nearly all pregnant women residing in Johor took at least one or two types of dietary supplements daily. Prenatal supplements were the most consumed category, followed by multivitamin/ multimineral supplements. Folic acid, iron, and vitamin B12 were the most frequently taken supplements, primarily for maternal and foetal health. Most pregnant women learned about supplements from their doctors and either purchased or obtained them from hospitals, clinics, or pharmacies. About two-thirds of pregnant women reported poor sleep quality, while taking vitamin B12, vitamin C, and zinc was associated with better sleep quality.

The prevalence of dietary supplement use (93.9%) observed in this study was significantly higher than in a previous Malaysian study (49.1%) (Daud & Abd. Aziz 2020) but consistent with other countries such as Spain (97.8%), Australia (93.8%), and Korea (88%) (Kim et al. 2013; Oliver et al. 2014; Shand et al. 2016). This suggests that the use of dietary supplements during pregnancy is not just a local phenomenon but reflects a consistent worldwide pattern in which pregnant women tend to adopt this practice. The widespread use of supplements by pregnant women can be attributed to the belief that supplements lead to better health outcomes for both mother and foetus. In the present study, the main reason pregnant women take supplements is to promote health for both the mother and child, aiming to reduce the risk of disease or health complications during pregnancy. This finding is supported by previous studies (Xiang et al. 2022), in which pregnant women believe that taking supplements is a more effective way to meet their nutrient needs than relying solely on food intake (Malek et al. 2018).

Although only a small proportion of the pregnant women in this study did not take supplements, the primary reason was their concerns about potential side effects associated with supplement use. For the most part, there is insufficient data and research on the safety or efficacy of supplements for pregnant women. Consequently, some supplement manufacturers add warnings to their products, advising pregnant women to reconsider their use (Brown & Wright 2020). These warnings could raise safety concerns, reducing confidence in supplements during pregnancy.

Consistent with previous studies, healthcare professionals, especially doctors, are the main source of information for pregnant women regarding dietary supplements, highlighting their crucial role (Le et al. 2023; Vogels-Broeke et al. 2022). The study by Vogels-Broeke et al. (2022) reports that over 80% of pregnant women considered information from professionals to be trustworthy and useful, whereas digital sources from the internet were deemed less reliable and helpful. Consequently, this also explains why the majority of pregnant women in this study obtained or purchased their supplements from healthcare facilities. This contrasts with a previous study conducted in the Chinese population, where Daigou or international online purchases were the major source of supplement acquisitions (Xiang et al. 2022). Non-healthcare-sourced supplements may lack adequate safety precautions or controls, posing risks and potential dangers, especially for pregnant women. Various factors, including cultural factors, purchasing habits, and local health practices, can influence differences in supplement sourcing.

Consistent with the study by Koivuniemi et al. (2022), most pregnant women in this study took one or two types of supplements simultaneously, with prenatal supplements preferred for their comprehensive nutrient content. These supplements include folic acid, zinc, calcium, vitamin D, and iron, meeting most increased nutrient requirements for pregnant women (Bailey et al. 2019). Prenatal supplements are also often recommended by healthcare professionals (Branum et al. 2013). Despite this, a considerable proportion of women in the study consumed three or more types of supplements, exceeding the UL for folic acid, iron, zinc, magnesium, and vitamin A. Notably, this study found that significant proportions of subjects exceeded the UL for folic acid and iron through dietary supplements alone. These findings align with previous studies by Bailey et al. (2019) and Savard et al. (2018).

The WHO recommends 400 µg of folic acid supplement daily for pregnant women to prevent anaemia, puerperal sepsis, low birth weight, and preterm birth (World Health Organization 2016). Administration of iron and folic acid supplements to pregnant women is part of antenatal care guidelines in most countries, including Malaysia (Ministry of Health Malaysia 2023). However, many commercial prenatal supplements contain high doses of folic acid (median of 800 µg; Q1-Q3: 400-1000 µg), with 30% exceeding the UL of 1000 µg (Adams et al. 2022), leading to excessive intake. About half of the pregnant women in this study exceeded the UL for folic acid, a higher proportion than reported in the United States (Bailey et al. 2019). It is important to note that excess unmetabolised folic acid can increase the risk of allergies and autism (Mcgowan et al. 2020).

Our results indicate a complex scenario regarding iron supplementation, iron deficiency, and anaemia. For iron, the WHO recommends daily oral iron supplementation with 30 mg to 60 mg of elemental iron (World Health Organization 2016). For Malaysian pregnant women, the RNI 2017 recommends a daily supplement of 100 mg of

iron for non-anaemic women and higher doses for anaemic women (National Coordinating Committee on Food Nutrition 2017). Although 85.4% of our subjects took iron-containing supplements, about two-thirds (65.9%) did not meet the recommended intake of 100 mg of iron. This is in line with the study by Milman (2015), which found that 80-90% of Malaysian pregnant women were iron deficient, with 38-42% suffering from anaemia. Our findings suggest potential issues related to bioavailability, adherence, and proper use of iron supplements. Further research on these issues is needed to understand these complex scenarios better.

About two-thirds of pregnant women reported poor sleep quality, consistent with a study by (Anbesaw et al. 2021), which also found 68.4% of pregnant women had poor sleep quality. Despite the high prevalence, only 9.8% of subjects reported taking supplements to improve sleep quality. Interestingly, the present study showed differences in sleep quality between pregnant women who took vitamin B12, vitamin C, and zinc supplements and those who did not.

This is potentially due to the effects of vitamin B12 deficiency on nighttime sleep difficulties (Sato-Mito et al. 2011). These findings are supported by observational studies by Zadeh and Begum (2011) and Al-Musharaf et al. (2021), who found a positive association between higher vitamin B12 intake and better sleep quality. A study by Khawaja et al. (2019), conducted among patients with OSA, found severe vitamin B12 deficiency and associated disturbances in daily routines, which were alleviated by vitamin B12 supplementation. However, this contrasts with several studies showing an inverse relationship between serum vitamin B12 levels and sleep duration (Beydoun et al. 2014; Xiong et al. 2022).

The finding that a significantly higher percentage of pregnant women who took vitamin C-containing supplements reported good sleep quality than those who did not suggest a possible role for vitamin C in promoting better sleep during pregnancy. These findings are consistent with Kanagasabai and Ardern (2015), who concluded that higher levels of vitamin C are linked to better sleep quality. One possible explanation is related to the antioxidant properties of vitamin C. Vitamin C deficiency has been shown to exacerbate sleep disorders and is linked to lower antioxidant levels in those who wake up frequently and struggle to fall back asleep. Taking supplements containing vitamin C may have antidepressant effects, improve mood, and alleviate insomnia symptoms (Otocka-Kmiecik & Krol 2020).

The study also found that pregnant women who took zinc supplements reported better sleep quality than those who did not. This finding is supported by a systematic review by Ji et al. (2017), showing a positive association between sleep duration and zinc intake. Zinc plays a central role in converting tryptophan to serotonin, subsequently converted to melatonin, regulating circadian rhythm and controlling sleep cycles. Zinc is often used to treat sleep disorders due to its calming effects and stress-reducing properties (Cherasse & Urade 2017).

The use of a self-administered online questionnaire could reduce bias as subjects were in a more private environment and under less pressure. However, micronutrient intake from supplements may be under- or overestimated due to recall and social desirability bias. Additionally, micronutrient intake from diet was not assessed in the current study, and the total daily intake for micronutrients may be higher than recommended levels. The data was collected at a baby fair in Johor, so the results may not be generalisable to all Malaysian pregnant women. Nevertheless, the study provides insights into dietary supplement use and its effect on sleep quality during pregnancy. Dietary micronutrient intake or adherence to supplement intake was not examined, which limits comprehensive understanding. However, the focus on supplements remains relevant as pregnant women often rely on them to meet nutritional needs due to poor diet quality (Sauder et al. 2021; Saunders et al. 2019). Furthermore, assessing the direct effect of supplements on sleep quality poses ethical challenges. By focusing on supplement intake, this study avoids these concerns and provides important insights into associations between micronutrient intake and sleep quality in pregnant women. In addition to micronutrient intake and supplement use, sleep quality may be influenced by various factors, including medical conditions, physical activity, and stress levels, suggesting the need for further research to investigate these other contributing factors.

CONCLUSION

The majority of pregnant women in Johor consume at least one type of supplement during pregnancy. Folic acid and iron are particularly the most commonly taken supplements. Our findings raise concerns that excessive intake of supplements with the same micronutrients could lead to exceeding the UL. Nevertheless, the present study shows that healthcare professionals are the primary source of information for pregnant women. This highlights the crucial role of healthcare professionals in providing accurate information and educating pregnant women about the potential risks of supplement overconsumption. A significant association was found between good sleep quality and the intake of supplements containing vitamin B12, vitamin C,

and zinc, suggesting that supplements with these micronutrients may be potential interventions to improve sleep quality in pregnant women. However, the effectiveness of these strategies should be validated in larger cohort studies and randomised controlled trials in which the effect of these supplements on sleep quality in pregnant women is evaluated.

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REFERENCES

Adams, J. B., Kirby, J. K., Sorensen, J. C., Pollard, E. L. & Audhya, T. 2022. Evidence based recommendations for an optimal prenatal supplement for women in the US: Vitamins and related nutrients. *Maternal Health, Neonatology and Perinatology* 8(1): 4-4.

Al-Musharaf, S., Alabdulaaly, A., Mujalli, H. B., Alshehri, H., Alajaji, H., Bogis, R., Alnafisah, R., Alfehaid, S., Alhodaib, H., Murphy, A., Hussain, S. D., Sabico, S., Mcternan, P. & Al-Daghri, N. 2021. Sleep quality is associated with vitamin b12 status in female arab students. *International Journal of Environmental Research and Public Health* 18(9): 4548-4548.

Anbesaw, T., Abebe, H., Kassaw, C., Bete, T. & Molla, A. 2021. Sleep quality and associated factors among pregnant women attending antenatal care at Jimma Medical Center, Jimma, Southwest Ethiopia, 2020: Cross-sectional study. *BMC Psychiatry* 21(1): 469.

Bailey, R. L., Pac, S. G., Fulgoni, V. L., Reidy, K. C. & Catalano, P. M. 2019. Estimation of total usual dietary intakes of pregnant women in the United States. *JAMA Network Open* 2(6): e195967-e195967.

Beydoun, M. A., Gamaldo, A. A., Canas, J. A., Beydoun, H. A., Shah, M. T., Mcneely, J. M. & Zonderman, A. B. 2014. Serum nutritional biomarkers and their associations with sleep among US adults in recent national surveys. *PLoS ONE* 9(8): e103490-e103490.

Branum, A. M., Bailey, R. & Singer, B. J. 2013. Dietary supplement use and folate status during pregnancy in the United States. *Journal of Nutrition* 143(4): 486-492.

Brown, B. & Wright, C. 2020. Safety and efficacy of supplements in pregnancy. *Nutrition Reviews* 78(10): 813-826.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R. & Kupfer, D. J. 1989. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research* 28(2): 193-213.

Chan, V. & Lo, K. 2022. Efficacy of dietary supplements on improving sleep quality: A systematic review and meta-analysis. *Postgraduate Medical Journal* 98(1158): 285-293.

Chen, S.-J., Shi, L., Bao, Y.-P., Sun, Y.-K., Lin, X., Que, J.-Y., Vitiello, M. V., Zhou, Y.-X., Wang, Y.-Q. & Lu, L. 2018. Prevalence of restless legs syndrome during pregnancy: A systematic review and meta-analysis. *Sleep Medicine Reviews* 40: 43-54.

Cherasse, Y. & Urade, Y. 2017. Dietary zinc acts as a sleep modulator. *International Journal of Molecular Sciences* 18(11): 2334-2334.

Cochran, W. G. 1977. *Sampling techniques. 3rd Edition.* New York: Johan Wiley & Sons.

Daud, N. A. A., Mukhlef, S. A. & Abd. Aziz, F. 2020. Awareness, attitude and behaviour related to the intake of dietary supplements among Malaysian pregnant women. *Malaysian Journal of Medicine and Health Sciences* 16: 51-55.

Deurveilher, S., Rusak, B. & Semba, K. 2011. Female reproductive hormones alter sleep architecture in ovariectomized rats. *Sleep* 34(4): 519-530.

Farah, N. M. F., Yee, T. S. & Rasdi, H. F. M. 2019. Self-reported sleep quality using the Malay version of the Pittsburgh sleep quality index (PSQI-M) in Malaysian adults. *International Journal of Environmental Research and Public Health* 16(23): 4750-4750.

Gernand, A. D., Schulze, K. J., Stewart, C. P., West, K. P., Jr. & Christian, P. 2016. Micronutrient deficiencies in pregnancy worldwide: Health effects and prevention. *Nature Reviews Endocrinology* 12(5): 274-289.

Ishaq, M. U., Kunwar, D., Qadeer, A., Komel, A., Safi, A., Malik, A., Malik, L. & Akbar, A. 2024. Effect of vitamin A on maternal, fetal, and neonatal outcomes: An overview of deficiency, excessive intake, and intake recommendations. *Nutrition in Clinical Practice* 39(2): 373-384.

Jadidi, A., Rezaei Ashtiani, A., Khanmohamadi Hezaveh, A. & Aghaepour, S. M. 2023. Therapeutic effects of magnesium and vitamin B6 in alleviating the symptoms of restless legs syndrome: a randomized controlled clinical trial. *BMC Complementary Medicine and Therapies* 23(1).

Ji, X., Grandner, M. A. & Liu, J. 2017. The relationship between micronutrient status and sleep patterns: A systematic review. *Public Health Nutrition* 20(4): 687-701.

Kanagasabai, T. & Ardern, C. I. 2015. Inflammation, oxidative stress, and antioxidants contribute to selected sleep quality and cardiometabolic health relationships: a cross-sectional study. *Mediators of Inflammation* 2015:824589.

Keats, E. C., Haider, B. A., Tam, E. & Bhutta, Z. A. 2019. Multiple-micronutrient supplementation for women during pregnancy. *Cochrane Database of Systematic Reviews* 2019(3): CD004905-CD004905.

Khawaja, I., Yingling, K., Bukamur, H. & Abusnina, W. 2019. Vitamin B12 deficiency: A rare cause of excessive daytime sleepiness. *Journal of Clinical Sleep Medicine* 15(9): 1365-1367.

Kim, H., Jang, W., Kim, K. N., Hwang, J. Y., Chung, H. K., Yang, E. J., Kim, H. Y., Lee,

J. H., Moon, G. I., Lee, J. H., Kang, T. S. & Chang, N. 2013. Comparison of dietary food and nutrient intakes by supplement use in pregnant and lactating women in Seoul. *Nutrition Research and Practice* 7(3): 199-206.

Koivuniemi, E., Hart, K., Mazanowska, N., Ruggeri, S., Egan, B., Censi, L., Roccaldo, R., Mattila, L., Buonocore, P., Löyttyniemi, E., Raats, M. M., Wielgos, M. & Laitinen, K. 2022. Food supplement use differs from the recommendations in pregnant women: A multinational survey. *Nutrients* 14(14): 2909-2909.

Kordas, K., Siegel, E. H., Olney, D. K., Katz, J., Tielsch, J. M., Kariger, P. K., Khalfan, S. S., Leclerq, S. C., Khatry, S. K. & Stoltzfus, R. J. 2009. The effects of iron and/or zinc supplementation on maternal reports of sleep in infants from Nepal and Zanzibar. *Journal of Developmental and Behavioral Pediatrics* 30(2): 131-139.

Le, Q. T., Trang Huynh, N. K. & Tuyet Hoang, T. D. 2023. Awareness of nutrition and supplements among pregnant and preconception women: A real-world study in Vietnam. *Women's Health Reports* 4(1): 506-516.

Lee, S. S., Subramaniam, R., Tusimin, M., Ling, K. H., Rahim, K. F. & Loh, S. P. 2020. Inadequate vitamin D intake among pregnant women in Malaysia based on revised recommended nutrient intakes value and potential dietary strategies to tackle the inadequacy. *Nutrition Research and Practice* 15(4): 492-503.

Liu, H., Zhang, S., Zou, H., Pan, Y., Yang, Q., Ouyang, Y., Luo, J. & Lin, Q. 2019. Dietary supplement use among chinese primary school students: A cross-sectional study in Hunan province. *International Journal of Environmental Research and Public Health* 16(3): 374-374.

Liu, L., Su, G., Wang, S. & Zhu, B. 2019. The prevalence of obstructive sleep apnea and its association with pregnancy-related health outcomes: A systematic review and meta-analysis. *Sleep and Breathing* 23: 399-412.

Lu, Q., Zhang, X., Wang, Y., Li, J., Xu, Y., Song, X., Su, S., Zhu, X., Vitiello, M. V., Shi, J., Bao, Y. & Lu, L. 2021. Sleep disturbances during pregnancy and adverse maternal and fetal outcomes: A systematic review and meta-analysis. *Sleep Medicine Reviews* 58: 101436-101436.

Malek, P. L., Umberger, P. W. J., Makrides, P. M., Collins, P. C. T. & Zhou, P. S. J. 2018. Understanding motivations for dietary supplementation during pregnancy: A focus group study. *Midwifery* 57: 59-68.

Mcgowan, E. C., Hong, X., Selhub, J., Paul, L., Wood, R. A., Matsui, E. C., Keet, C. A. & Wang, X. 2020. Association between folate metabolites and the development of food allergy in children. *The Journal of Allergy and Clinical Immunology: In Practice* 8(1): 132-140.e135.

Milman, N. 2015. Iron deficiency and anaemia in pregnant women in Malaysia? Still a significant and challenging health problem. *Journal of Pregnancy and Child Health* 2(03): 1-8.

Mindell, J. A., Cook, R. A. & Nikolovski, J. 2015. Sleep patterns and sleep disturbances across pregnancy. *Sleep Medicine* 16(4): 483-488.

Ministry of Health Malaysia 2023. *Perinatal Care Manual 4th Edition*. Putrajaya, Ministry of Health Malaysia.

National Coordinating Committee on Food Nutrition 2017. *Recommended Nutrient Intakes for Malaysia. A report of the Technical Working Group on Nutritional Guidelines*. Putrajaya, Ministry of Health Malaysia.

Oliver, E. M., Grimshaw, K. E. C., Schoemaker, A. A., Keil, T., Mcbride, D., Sprikkelman, A. B., Ragnarsdottir, H. S., Trendelenburg, V., Emmanouil, E., Reche, M., Fiocchi, A., Fiandor, A., Stanczyk-Przyluska, A., Wilczynski, J., Busacca, M., Sigurdardottir, S. T., Dubakiene, R., Rudzeviciene, O., Vlaxos, G. D., Beyer, K. & Roberts, G. 2014. Dietary habits and supplement use in relation to national pregnancy recommendations: Data from the EuroPrevall Birth Cohort. *Maternal and Child Health Journal* 18(10): 2408-2425.

Otocka-Kmiecik, A. & Krol, A. 2020. The role of vitamin C in two distinct physiological states: Physical activity and sleep. *Nutrients* 12(12): 1-29.

Roos, N., Ponce, M. C., Doak, C. M., Dijkhuizen, M., Polman, K., Chamnan, C., Khov, K., Chea, M., Prak, S., Kounnavong, S., Akkhavong, K., Mai, L. B., Lua, T. T., Muslimatun, S., Famida, U., Wasantwisut, E., Winichagoon, P., Doets, E., Greffeuille, V., Wieringa, F. T. & Berger, J. 2019. Micronutrient status of populations and preventive nutrition interventions in South East Asia. *Maternal and Child Health Journal* 23(1): 29-45.

Sato-Mito, N., Sasaki, S., Murakami, K., Okubo, H., Takahashi, Y., Shibata, S., Yamada, K. & Sato, K. 2011. The midpoint of sleep is associated with dietary intake and dietary behavior among young Japanese women. *Sleep Medicine* 12(3): 289-294.

Sauder, K. A., Harte, R. N., Ringham, B. M., Guenther, P. M., Bailey, R. L., Alshawabkeh, A., Cordero, J. F., Dunlop, A. L., Ferranti, E. P., Elliott, A. J., Mitchell, D. C., Hedderson, M. M., Avalos, L. A., Zhu, Y., Breton, C. V., Chatzi, L., Ran, J., Hertz-Picciotto, I., Karagas, M. R., Sayarath, V., Hoover, J., Mackenzie, D., Lyall, K., Schmidt, R. J., O'connor, T. G., Barrett, E. S., Switkowski, K. M., Comstock, S. S., Kerver, J. M., Trasande, L., Tylavsky, F. A., Wright, R. J., Kannan, S., Mueller, N. T., Catellier, D. J., Glueck, D. H. & Dabelea, D. 2021. Disparities in risks of inadequate and excessive intake of micronutrients during pregnancy. *Journal of Nutrition* 151(11): 3555-3569.

Saunders, C. M., Rehbinder, E. M., Lødrup Carlsen, K. C., Gudbrandsgard, M., Carlsen, K. H., Haugen, G., Hedlin, G., Jonassen, C. M., Sjøborg, K. D., Landrø, L., Nordlund,

B., Rudi, K., Skjerven, H. O., Söderhäll, C., Staff, A. C., Vettukattil, R. & Carlsen, M. H. 2019. Food and nutrient intake and adherence to dietary recommendations during pregnancy: A nordic mother–child population-based cohort. *Food and Nutrition Research* 63.

Savard, C., Lemieux, S., Weisnagel, S. J., Fontaine-Bisson, B., Gagnon, C., Robitaille, J. & Morisset, A. S. 2018. Trimester-Specific dietary intakes in a sample of French-Canadian pregnant women in comparison with national nutritional guidelines. *Nutrients* 10(6).

Sedov, I. D., Anderson, N. J., Dhillon, A. K. & Tomfohr-Madsen, L. M. 2021. Insomnia symptoms during pregnancy: A meta-analysis. *Journal of Sleep Research* 30(1): e13207.

Sedov, I. D., Cameron, E. E., Madigan, S. & Tomfohr-Madsen, L. M. 2018. Sleep quality during pregnancy: A meta-analysis. *Sleep Medicine Reviews* 38: 168-176.

Shand, A. W., Walls, M., Chatterjee, R., Nassar, N. & Khambalia, A. Z. 2016. Dietary vitamin, mineral and herbal supplement use: A cross-sectional survey of before and during pregnancy use in Sydney, Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 56(2): 154-161.

Tsai, S. Y., Lin, J. W., Wu, W. W., Lee, C. N. & Lee, P. L. 2016. Sleep disturbances and symptoms of depression and daytime sleepiness in pregnant women. *Birth* 43(2): 176-183.

Vogels-Broeke, M., Daemers, D., Budé, L., De Vries, R. & Nieuwenhuijze, M. 2022. Sources of information used by women during pregnancy and the perceived quality. *BMC Pregnancy and Childbirth* 22(1): 109-109.

World Health Organization. 2016. *WHO recommendations on antenatal care for a positive pregnancy experience.* Geneva: World Health Organization.

Xiang, C., Luo, J., Yang, G., Sun, M., Liu, H., Yang, Q., Ouyang, Y., Xi, Y., Yong, C., Khan, M. J. & Lin, Q. 2022. Dietary Supplement use during pregnancy: Perceptions versus reality. *International Journal of Environmental Research and Public Health* 19(7): 4063-4063.

Xiong, S., Liu, Z., Yao, N., Zhang, X. & Ge, Q. 2022. The independent association between vitamin B12 and insomnia in Chinese patients with type 2 diabetes mellitus: A cross-sectional study. *Nutrition and Diabetes* 12(1): 3-3.

Yang, Y., Li, W., Ma, T.-J., Zhang, L., Hall, B. J., Ungvari, G. S. & Xiang, Y.-T. 2020. Prevalence of poor sleep quality in perinatal and postnatal women: A Comprehensive meta-analysis of observational studies. *Frontiers in Psychiatry* 11.

Zadeh, S. S. & Begum, K. 2011. Comparison of nutrient intake by sleep status in selected adults in Mysore, India. *Nutrition Research and Practice* 5(3): 230-235.