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The relationship between sleep quality and dietary intake among pregnant women in Saudi Arabia

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ABSTRACT

Objectives: Sleep quality deteriorate during pregnancy due to hormonal and physical changes. Studies reported that poor sleep quality during pregnancy is associated with an increased risk of adverse pregnancy outcomes. This cross-sectional study aims to examine the factors associated with sleep quality and dietary intake and their relationship in Saudi pregnant women. *Methods:* Sleep quality was measured by the PSQI. Dietary intake was measured by using food groups and serving sizes from a validated Food Frequency questionnaire (FFQ) for Saudis. *Results:* 140 pregnant women living in Saudi Arabia were included. Pregnancy stage was significantly associated with PSQI, the higher the pregnancy stage (trimester) the higher the PSQI score (poorer sleep quality). In adjusted logistic regression, family income predicted a higher intake of the recommended number of fruits and vegetables ($p = 0.03$). No associations were observed between sleep quality and dietary intake. *Conclusion:* Our results may help in developing strategies to improve sleep quality and dietary habits among pregnant women. Prospective and clinical trials are warranted to draw conclusions.

Keywords: Diet quality, sleep quality, pregnancy, Saudi Arabia

1. INTRODUCTION

The recommended hours of sleep for healthy adults are between 7-9 hours per night to feel rested with optimal sleep quality (Hirshkowitz et al., 2015). Accumulating evidence has shown that quality and duration of sleep are important factors for overall health (Watson et al., 2015). Studies have shown that progressive declines in sleep (sleeping less than 7 hours per night regularly) is associated with an increased risk of obesity (Wu et al., 2014), type 2 diabetes (Cappuccio et al., 2010), hyperlipidemia (Zhan et al., 2014), high blood pressure (Wang et al., 2015) and increased risk of mortality from cardiovascular disease and coronary heart diseases (Itani et al., 2017). A study showed that Saudi adults sleep less than 7 hours per night and this was more noted in females (Ahmed et al., 2017). These studies show the necessity of assessing sleep quality and factors associated with sleep in Saudi adults.

Pregnancy is considered a vulnerable period in women's life. Pregnant women are more prone to poor sleep quality and reduced sleep continuity which may deprive them from getting the recommended hours of sleep (Sedov et al., 2018). Evidence from epidemiological studies have shown that poor sleep quality during pregnancy increased the risk of adverse outcomes such as gestational diabetes (GDM), gestational hypertension, caesarean section, preterm birth and low Apgar scores (a quick test performed on newborns at 1- and 5-minutes following birth to evaluate their vitals and overall health (O'Brien et al., 2013; Bin et al., 2016; Sharma et al., 2016; Facco et al., 2017). Women who slept less than 6 h per night are more susceptible to longer labors and were 4.5-fold more likely to have cesarean deliveries in contrary to women who slept at least 7 h per night (Lee and Gay, 2004). Similarly, sleep duration and quality of sleep may impact several aspects in pregnant women including the type of delivery, length of labor stages, as well as neonates' Apgar score and birth weight (Zafarghandi et al., 2012). Therefore, studying sleep quality and their associated factors in the pregnant population is essential.

The declining in sleep duration and quality during pregnancy is attributed to hormonal and physical changes such as nausea, vomiting, general discomfort and urinary frequency (Izci-Balserak and Pien, 2014). Moreover, changes in progesterone level during pregnancy can also cause sleepiness (especially during the first trimester). Whereas, in the late second and third trimesters, total nocturnal sleep time decreases due to the previous factors in addition to increased fetal movement and heartburn (Pien and Schwab, 2004).

Multiple studies in non-pregnant adults have found that sleeping fewer hours than the recommended and poor sleep quality are associated with excessive energy intake (Covassin et al., 2022; Capers et al., 2015), lower consumption of fruits and vegetables (Noorwali et al., 2019) and high intake of added sugar (Shahdadian et al., 2022). In contrast, good sleep quality/adequate sleep is associated with increased fruit and vegetable consumption (Noorwali et al., 2018; Noorwali et al., 2018), higher intakes of nuts, legumes and unsaturated fat, as well as lower intakes of energy and added sugars (Kruger et al., 2014; Zuraikat et al., 2020; Hur et al., 2021; Aldharrab et al., 2022). In addition, short sleep duration has been shown to enhance cravings for palatable foods and to increased hunger and appetite (Lv et al., 2018; Yang et al., 2019). The impact of short sleep duration on dietary intake can be associated with many potential mechanisms; shorter sleep may increase the opportunities for eating, stimulate hedonic hunger and changes in appetite-regulating hormones. Moreover, short sleepers have lower leptin and higher ghrelin concentrations which may increase appetite and dietary intake (Lundahl and Nelson 2015; Dashti et al., 2015).

In this context, we hypothesize that sleep in pregnancy may have an impact on diet quality. Few studies have examined the association between sleep and diet among pregnant women, including studies from Singapore (Lee et al., 2017), Brazil (Gontijo et al., 2019), Spain (Flor-Alemany et al., 2020) and the US (Duke et al., 2017). Each one of these studies highlighted different parts of sleep that may relate to diet during pregnancy, including poor sleep quality, later chronotype and short duration. However, no studies to date have focused on the relationship between sleep quality and dietary intake among pregnant women in Saudi Arabia. Therefore, this study aims to 1) assess sleep quality and factors associated with sleep quality 2) assess diet quality and factors predicting dietary intake. Finally, 3) investigate the relationship between sleep and dietary intake during pregnancy in Saudi women.

2. METHODS

Study design and Participants

This is a web-based cross-sectional study conducted between September 2021-April 2022. The sample for this study included pregnant women in different stages (trimesters) of pregnancy and aged between 18 and 50 years old residing in Western Region, Saudi Arabia. Sample size was calculated and estimated using Raosoft sample size calculator (Raosoft, 2020) the minimum recommended sample size was 96.

Exclusion criteria

Women who have medical conditions, such as diabetes mellitus, cancer, following therapeutic diet or with serious psychological disorders were excluded from this study.

Questionnaire

Due to COVID-19 pandemic precautions the assessment instruments such as the FFQ were difficult to be administered by routine clinic visits or direct interview. Therefore, an online questionnaire on Google form (https://forms.gle/Kbf1vcmBh8DHUAaR9) was distributed via WhatsApp™, Twitter™ and e-mails. The questionnaire was in the Arabic language and consisted of 4 pages, the first page contained a brief description of the study aims, the time expected to complete the full questionnaire (approximately 10 min)

and researchers contact information in case of any concerns or questions about the study and clarification that participation is anonymous including to the researchers and confidential.

Before proceeding with the questionnaire, participants consented on the following statement "By completing the questionnaire, I express my agreement to participate in this study. Before finishing the questionnaire, I can freely and without consequences terminate my participation". The second page of the questionnaire included socio-demographic questions about age, place of residence, nationality, job status and number of children. The third and fourth pages included dietary intake assessment and sleep quality data using the PSQI. This study was ethically approved by the Biomedical Research Ethics Committee at Umm Al-Qura University. Approval No (HAPO-02-K-012-2021-10-783).

Dietary intake

Dietary intake is difficult to be determined methodologically and there are no gold-standard methods that exist to date. Five food groups from a validated FFQ in a Saudi population Gosadi et al., (2017) were used to analyze dietary intake. Dietary intake assessment was self-administered and participants were asked to indicate the amount and frequency of consumption of five food groups since the beginning of their pregnancy. Five answering categories were provided to choose from. The categories range from "never or less than once/month" to "2+ times per day". Food groups include: 1) Vegetables and fruits group. 2) Meat and proteins, which includes the intake frequency and quantity of meat, lean meat, chicken, fish, egg, nuts and legumes. 3) Grains and cereals which includes the amount and the frequency of refined or whole grains, breads, cereals, rice, pasta, noodles. 4) Dairy products which include the intake frequency and quantity of milk, yoghurt, cheese. 5) Drinks, which includes the amount and the frequency of drinking tea, coffee and juices.

All food groups were divided into two categories for analyses: Inappropriate intake (either lower or higher) or appropriate intake (recommended intake) based on American Pregnancy Association, (2021) for recommended dietary intake during pregnancy (American Pregnancy Association) (Appendix A) which recommended at least 2-4 servings of fruit and 4 or more servings of vegetables per day, between 6-11 servings grains daily, at least 3 servings of protein daily and 3 servings of dairy products per day. Serving sizes were also based on the Epic FFQ (The EPIC-Norfolk Food Frequency Questionnaire and FETA Software, 2014). Household measurements (teaspoons, tablespoons, ounces, cups) were used to improve portion estimation.

Sleep Quality

The validated Pittsburgh Sleep Quality Index (PSQI) Arabic version was used to measure sleep quality (Suleiman et al., 2010). PSQI is a self-rated questionnaire used to assess sleep quality and patterns over a one-month period. It is composed of 19 items grouped to form 7 components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications and daytime dysfunction. Subjects score each component based on scale from 0 to 3 points, whereby '0' reflects no difficulty and '3' indicate severe difficulty. The sum-scores of the component yielded a global score from '0' to '21' points where '0' reflected no difficulty and '21' correlated with severe difficulties in all areas. Higher scores indicate lower sleep quality. A global PSQI score higher than 5 points indicates poor sleep quality (Buysse et al., 1989).

Statistical analyses

Data analysis was performed using Statistical Package for the Social Sciences, SPSS 23rd version. Frequency and percentages were used to display categorical variables minimum, maximum, mean and standard deviation. Independent t-test and ANOVA test were used to test for association. ANOVA test was followed by Tukey post-hoc test to determine where the exact difference between groups exists. Pearson's correlation was also used to test for correlation between continuous variables. Multivariate logistic regression models were used to determine the factors predicting appropriate intake for each food group respectively. In which sleep quality and other variables were the exposure and diet variables were the outcome. Each logistic regression model included the following confounding variables to adjust for; nationality, number of children, having a job, family income and pregnancy stage and the PSQI score. Level of significance was set at 0.05.

3. RESULTS

Participants' Characteristics

A total of 150 pregnant women participated in the online questionnaire. However, only 140 participants were included in the study. Ten participants were excluded due to having health problems such as diabetes mellitus and hypertension. The mean age was 30.04 ± 5.62. As for the place of residency, the majority were from Makkah and (92.1%) of the participants were Saudi, while 11 (7.9%)

were non-Saudi. Pregnant women who had no children were (36.4%) of the participants, the remaining had either 3 children or more. 47% of the participants were in their 3rd trimester. Approximately half of the sample (58.6%) reported not having a job. While only (10.7%) their current job includes shift work. As for the family income 58.6% had an income equal or more than 8000 SR.

Table 1 Socio-demographic characteristics of the participants (n=140)

Demographical Characteristics	N	%
Nationality		
Saudi	129	92.10
Non-Saudi	11	7.90
Place of residency		
Jeddah	42	30.00
Makkah	61	43.60
Taif	37	26.40
Number of children		
No children	51	36.40
3 children or less	58	41.40
More than 3 children	31	22.10
Pregnancy stage		
First trimester	32	22.9
Second trimester	42	30.0
Third trimester	66	47.1
Do you have a job?		
Yes	58	41.40
No	82	58.60
Does your current job include shift work?		
Yes	15	10.70
No	125	89.30
Family income (SR)		
Less than 3000 SR	8	5.70
3000-6000 SR	23	16.40
6000-8000 SR	27	19.30
8000-10,000	29	20.70
More than 10,000	53	37.90
Age		
Mean	30.04	
Standard deviation	5.62	
Minimum	19	
Maximum	46	

Dietary Assessment

Table 2 presents the dietary assessment profile for the 5 food groups included in the food frequency questionnaire. This represent whether the participant consumed lower than recommended intake, within or higher than the recommended amount (Figure 1) presents its interpretation. About (20%) of the participants had high consumption of the vegetables and fruits. Regarding the meat and protein group, over half of the sample (61.4%) consumed the recommended amount of meat and protein as for the grains and cereals (53.6%) had the recommended intake and 33 (23.6%) had higher than the recommended amount. For the dairy products and cheese group, majority of the participant (69.3%) consumed the recommended amount. Regarding the drink group (68.6%) of the pregnant women had intake within the recommended amount and only (20.7%) had higher than the recommended intake.

Table 2 Dietary assessment profile (n=140)

Dietary Assessment Profile (n = 140)		
Question	n	%
Vegetables and Fruits Group		
Fresh vegetable (serving =1 cup), cooked vegetable (serving =1/2 cup)		
Never or less than once/month	11	7.9
1-2 times/ week	51	36.4
3-5 times/week	47	33.6
Once daily	25	17.9
More than once/day	6	4.3
Fruit group (1 fruit medium serving)		
Never or less than once/month	17	12.1
1-2 times/ week	40	28.6
3-5 times/week	32	22.9
Once daily	41	29.3
More than once/day	10	7.1
Meat and Proteins		
Read meat (medium serving =60 g)		
Never or less than once/month	35	25
1-2 times/ week	71	50.7
3-5 times/week	24	17.1
Once daily	8	5.7
More than once/day	2	1.4
Chicken (medium serving =60 g)		
Never or less than once/month	3	2.1
1-2 times/ week	30	21.4
3-5 times/week	74	52.9
Once daily	28	20
More than once/day	5	3.6
Fish and sea food (medium serving =60 g)		
Never or less than once/month	92	65.7
1-2 times/ week	37	26.4
3-5 times/week	7	5
Once daily	4	2.9
Egg (serving= 1 egg)		
Never or less than once/month	25	17.9
1-2 times/ week	54	38.6
3-5 times/week	36	25.7
Once daily	22	15.7
More than once/day	3	2.1
Grains and Cereals		
Legumes such as lentils, beans, peas (serving=1/2 cup)		
Never or less than once/month	65	46.4
1-2 times/ week	61	43.6
3-5 times/week	7	5
Once daily	7	5

Bread (serving= 1 slice or 1/2 Arabic bread)		
Never or less than once/month	3	2.1
1-2 times/ week	8	5.7
3-5 times/week	29	20.7
Once daily	62	44.3
More than once/day	38	27.1
Rice (serving=1/2 cup)		
Never or less than once/month	4	2.9
1-2 times/ week	21	15
3-5 times/week	57	40.7
Once daily	54	38.6
More than once/day	4	2.9
Pasta (serving=1 cup)		
Never or less than once/month	24	17.1
1-2 times/ week	87	62.1
3-5 times/week	20	14.3
Once daily	9	6.4
Potatoes (1 medium serving)		
Never or less than once/month	20	14.3
1-2 times/ week	79	56.4
3-5 times/week	29	20.7
Once daily	11	7.9
More than once/day	1	0.7
Breakfast cereals and oat (serving=1 cup)		
Never or less than once/month	86	61.4
1-2 times/ week	34	24.3
3-5 times/week	10	7.1
Once daily	9	6.4
More than once/day	1	0.7
Pastries and biscuits (serving 1 since or biscuits)		
Never or less than once/month	35	25
1-2 times/ week	59	42.1
3-5 times/week	20	14.3
Once daily	24	17.1
More than once/day	2	1.4
Dairy products and cheese		
Milk and Dairy product (serving=1 cup)		
Never or less than once/month	11	7.9
1-2 times/ week	30	21.4
3-5 times/week	31	22.1
Once daily	53	37.9
More than once/day	15	10.7
Cheese (serving= 1 tablespoon/30g)		
Never or less than once/month	8	5.7
1-2 times/ week	39	27.9
3-5 times/week	41	29.3
Once daily	47	33.6

More than once/day	5	3.6
Coffee and tea (serving=1 cup)		
Never or less than once/month	17	12.1
1-2 times/ week	19	13.6
3-5 times/week	17	12.1
Once daily	58	41.4
More than once/day	29	20.7
Drinks		
Canned or Fresh Juices		
Never or less than once/month	21	15
1-2 times/ week	52	37.1
3-5 times/week	32	22.9
Once daily	31	22.1
More than once/day	4	2.9
Soft drinks (serving=1 can)		
Never or less than once/month	75	53.6
1-2 times/ week	34	24.3
3-5 times/week	14	10
Once daily	15	10.7
More than once/day	2	1.4

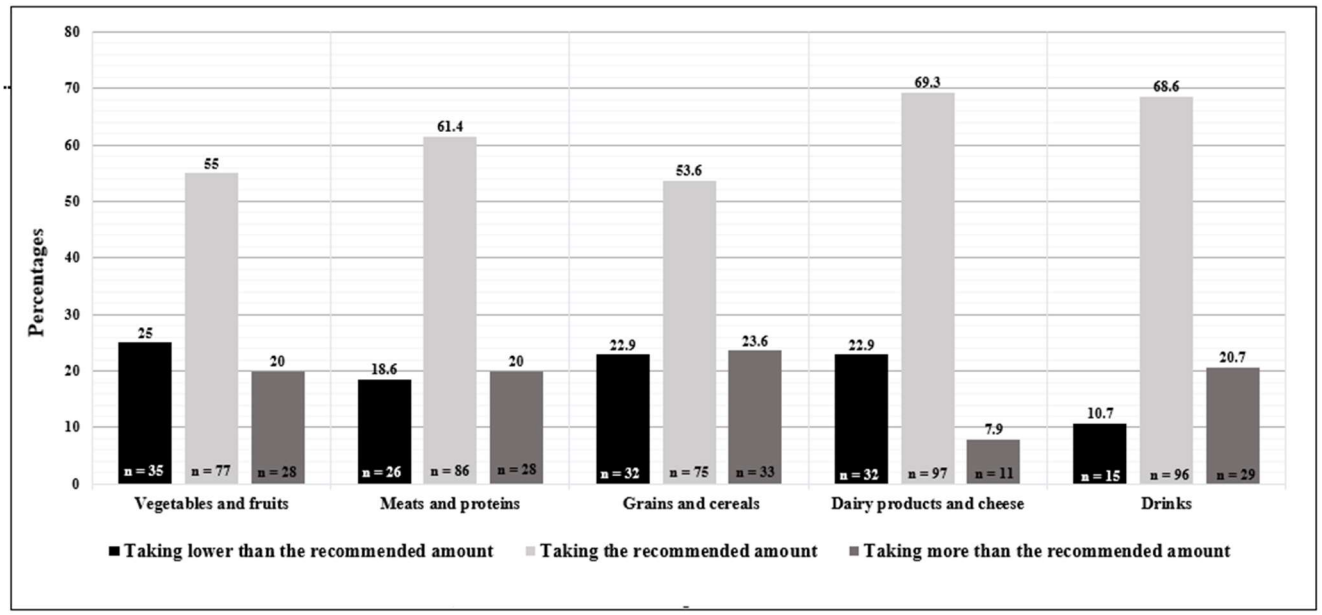

Figure 1 Interpretation of participant dietary assessment

Sleep Assessment

When assessing the participants sleep quality using the PSQI, mean scores was 6.9 ± 3.02. Pregnancy stage was the only factor significantly associated with PSQI ($p < 0.001$), where it was observed that the higher the trimester the higher the PSQI score. Nationality, place of residency, number of children, having a job, having a job with shifts, family income, vegetables and fruits intake, meat and protein intake, grains cereals intake, dairy products and cheese intake, drinks intake and age were all not significantly associated with PSQI.

Table 3 Factors Associated with Sleep Quality in Saudi pregnant women

Factor	(PSQI) score		P-Value
	Mean	Standard deviation	
Nationality			
Saudi	7.01	3.02	0.149
Non-Saudi	5.64	2.84	
Place of residency			
Jeddah	7.05	2.81	0.735
Makkah	6.67	3.03	
Taif	7.11	3.28	
Number of children			
No children	6.27	3.07	0.175
3 children or less	7.21	2.94	
More than 3 children	7.35	3.02	
Do you have a job?			
Yes	6.60	3.05	0.330
No	7.11	3.00	
Does your current job include shift work?			
Yes	6.20	3.26	0.340
No	6.98	3.00	
Family income (SR)			
Less than 3000 SR	6.75	2.05	0.195
3000-6000 SR	5.87	2.12	
6000-8000 SR	7.96	3.73	
8000-10,000	6.83	3.10	
More than 10,000	6.87	2.96	
Pregnancy stage			
First trimester	5.41	2.77	0.001*
Second trimester	6.71	2.81	
Third trimester	7.74	3.00	
Vegetables and fruits intake			
Taking lower than the requirement	7.37	3.28	0.333
Taking the requirement	6.56	2.92	
Taking more than the requirement	7.25	2.94	
Meats and proteins intake			
Taking lower than the requirement	7.23	3.36	0.825
Taking the requirement	6.84	2.94	
Taking more than the requirement	6.79	3.04	
Grains and cereals intake			
Taking lower than the requirement	6.72	2.67	0.902
Taking the requirement	6.91	3.33	
Taking more than the requirement	7.06	2.66	
Dairy products and cheese intake			
Taking lower than the requirement	6.81	3.37	0.817
Taking the requirement	6.87	2.97	
Taking more than the requirement	7.45	2.54	
Drinks intake			0.271
Taking lower than the requirement	5.73	3.35	

Taking the requirement	6.99	2.89	
Taking more than the requirement	7.21	3.25	
Age correlation with PSQI			
P-value	0.79		
Correlation coefficient	-0.02		

*Significant at level 0.05

Factors predicting dietary intake

The factors predicting the appropriate intake of each food group were tested using 5 regression models, 1 for each food group, Table 4 presents the multivariate logistic regression (factors predicting the appropriate intake of different food groups). As for the factors predicting appropriate vegetables and fruits intake, the only factor predicting a higher rate of appropriate intake of vegetables and fruits was a family income of 8000-10000 (p = 0.03, odds ratio = 7.65). When examining the appropriate meat and protein intake, being a Saudi predicted a higher rate of appropriate intake of meat and protein (p = 0.008, odds ratio = 7.71), while having a job predicted a lower rate of appropriate intake of meat and protein (p = 0.029, odds ratio = 0.38). As for the factors predicting appropriate grains and cereals intake, being a Saudi was observed that it predicted a lower rate of appropriate intake of grains and cereals (p = 0.03, odds ratio = 0.09). No factor predicted the appropriate intake of cheese and dairy products. As for the factors predicting appropriate intake of drinks, the only factor that was predictive of appropriate drinks intake was being pregnant at third trimester (p = 0.007, odds ratio = 5.19).

Table 4 Multivariate Logistic Regression (Factors Predicting the Appropriate Intake of different Food Groups)

Factor	P-Value	Odds Ratio	Confidence Interval	
Factors Predicting Appropriate Vegetables and Fruits Intake				
Nationality (Saudi vs. non-Saudi)	0.740	0.75	0.13	4.21
Number of children (No children is the referent)				
3 children or less	0.252	1.79	0.66	4.84
More than 3 children	0.372	0.62	0.21	1.79
Do you have a job? (yes vs. no)	0.535	0.75	0.30	1.88
Family income (SR) (less than 3000 SR is the referent)				
3000-6000 SR	0.240	2.82	0.50	15.93
6000-8000 SR	0.277	2.55	0.47	13.78
8000-10,000	0.03*	7.65	1.21	48.23
More than 10,000	0.157	3.26	0.63	16.72
Pregnancy stage (first trimester is the referent)				
Second trimester	0.972	1.02	0.34	3.09
Third trimester	0.414	1.57	0.53	4.68
PSQI score (sleep quality)	0.189	0.91	0.79	1.05
Factors Predicting Appropriate Meat and Proteins Intake				
Nationality (Saudi vs. non-Saudi)	0.008*	7.71	1.70	35.09
Number of children (No children is the referent)				
3 children or less	0.545	0.76	0.32	1.84
More than 3 children	0.211	0.51	0.18	1.47
Do you have a job? (yes vs. no)	0.029*	0.38	0.16	0.91
Family income (SR) (less than 3000 SR is the referent)				
3000-6000 SR	0.638	1.55	0.25	9.59
6000-8000 SR	0.609	0.63	0.11	3.63
8000-10,000	0.900	1.12	0.20	6.43
More than 10,000	0.355	2.27	0.40	12.91
Pregnancy stage (first trimester is the referent)				

Second trimester	0.063	2.70	0.95	7.72
Third trimester	0.132	2.11	0.80	5.58
PSQI score (sleep quality)	0.436	0.95	0.83	1.08
Factors Predicting Appropriate Grains and Cereals Intake				
Nationality (Saudi vs. non-Saudi)	0.03*	0.09	0.01	0.80
Number of children (No children is the referent)				
3 children or less	0.473	0.74	0.32	1.70
More than 3 children	0.235	1.85	0.67	5.06
Do you have a job? (yes vs. no)	0.736	0.87	0.40	1.92
Family income (SR) (less than 3000 SR is the referent)				
3000-6000 SR	0.545	1.71	0.30	9.69
6000-8000 SR	0.779	1.27	0.24	6.90
8000-10,000	0.934	1.07	0.20	5.80
More than 10,000	0.408	2.00	0.39	10.36
Pregnancy stage (first trimester is the referent)				
Second trimester	0.589	0.76	0.28	2.07
Third trimester	0.264	0.58	0.22	1.51
PSQI score (sleep quality)	0.470	1.05	0.92	1.19
Factors Predicting Appropriate Dairy products and cheese Intake				
Nationality (Saudi vs non-Saudi)	0.565	0.61	0.11	3.27
Number of children (No children is the referent)				
3 children or less	0.920	1.05	0.43	2.56
More than 3 children	0.567	0.74	0.26	2.10
Do you have a job? (yes vs. no)	0.216	0.59	0.26	1.36
Family income (SR) (less than 3000 SR is the referent)				
3000-6000 SR	0.291	0.29	0.03	2.90
6000-8000 SR	0.201	0.23	0.02	2.20
8000-10,000	0.652	0.59	0.06	5.95
More than 10,000	0.478	0.44	0.05	4.19
Pregnancy stage (first trimester is the referent)				
Second trimester	0.254	0.53	0.18	1.57
Third trimester	0.535	0.72	0.25	2.04
PSQI score (sleep quality)	0.936	1.01	0.88	1.15
Factors Predicting Appropriate Drinks Intake				
Nationality (Saudi vs. non-Saudi)	0.915	1.10	0.19	6.32
Number of children (No children is the referent)				
3 children or less	0.643	0.78	0.27	2.26
More than 3 children	0.361	0.57	0.17	1.90
Do you have a job? (yes vs. no)	0.144	0.48	0.18	1.28
Family income (SR) (less than 3000 SR is the referent)				
3000-6000 SR	0.728	1.43	0.19	10.81
6000-8000 SR	0.657	1.55	0.22	10.82
8000-10,000	0.591	1.72	0.24	12.40
More than 10,000	0.418	2.20	0.33	14.91
Pregnancy stage (first trimester is the referent)				
Second trimester	0.689	1.25	0.43	3.65
Third trimester	0.007*	5.19	1.57	17.21
PSQI score (sleep quality)	0.152	0.89	0.77	1.04

* Significance at level 0.05

4. DISCUSSION

This study presents results from an online survey collected from 140 pregnant women in Saudi Arabia. To our knowledge, it is the first to study the associations and relationships between sleep quality and dietary intake during pregnancy in Saudi Arabia. In addition, this study analyzed the factors that can predict the appropriate food intake during pregnancy. Results showed that the mean PSQI score was 6.9 ± 3.02 and higher pregnancy trimester was associated with higher PSQI scores (poorer sleep quality). High family income was associated with higher intake of fruits and vegetables. No other associations were observed between sleep quality and dietary intake.

Similar to our findings, Lee et al., (2017) reported no association was found between sleep duration and dietary intake in healthy pregnant women. However, they used a 24-h recall to assess dietary intake. Our findings are also in line with Chang et al., (2015) who investigated the role of sleep on fat intake, fruit and vegetable among 213 pregnant women recruited via Women, Infants & Children program (WIC) in Michigan and reported no associations between sleep quality using the PSQI and fat and fruit and vegetable intakes using 24-item rapid food screener. The study only included overweight or obese low-income pregnant women and did not consider their general diet or eating habits. Another study in the United States on pregnant women concluded no difference in diet quality between women with short and adequate sleep duration (Xiao et al., 2016). Although the previous studies represented different sample size and assessment methods, results were consistent. These findings could be reflective of how pregnant women experience similar hormonal changes pregnancy craving and disrupted sleep. Therefore, no associations were found as pregnancy does not reflect the normal habits of women and considered as a temporary stage. Our findings were in contrast to some of the previous findings Hoefelmann et al., (2012), Kruger et al., (2014) and Zuraikat et al., (2020) which found a positive association between diet quality, fruits and vegetables consumption, lower fat intake and sleep quality. The discrepancy could be related to many factors such as differences between study population (age, ethnicity), different dietary and sleep assessment methods and some of the studies were conducted in non-pregnant women.

Dietary intake

Overall, we found that Saudi pregnant women in our study had a general good adherence to the recommended dietary intake for most of the food groups, with approximately more than 50% consuming the recommended amount (serving/day), almost 20% had higher intake of vegetables and fruits group, meat and protein. Our findings are contrary to Jardí et al., (2019) they found that pregnant women did not consume the recommended amount of healthy food. The reason for this could be this study was done on Spanish population and they measured their adherence to the Mediterranean diet specifically.

In addition, a Saudi survey conducted on 5253 men and 5482 non-pregnant women found poor adherence to dietary recommendations among the Saudi population (Moradi-Lakeh et al., 2017). However, the study used the Saudi Dietary Guideline (Healthy Diet Palm) as the serving size reference. Our study found that the family monthly income (over 8,000 SR) was significantly associated with a better adherence to vegetables and fruits intake. Moreover, higher intake of protein and meat were associated with being a Saudi, this could be due to having a better access to food and grocery items. Another explanation is the differences in economic status or ethnicity. A Spanish study on pregnant women found that the country of origin is a factor significantly related to dietary intake and adequacy (Rodríguez-Bernal et al., 2013).

Sleep assessment

There was a significant association ($p < 0.001$) between the pregnancy stages and sleep quality. Our results found that the higher the pregnancy stage (trimester) the higher the PSQI score. These findings support several other studies which have found that sleep disruption is common among pregnant women and increase significantly as the pregnancy progresses (Smyka et al., 2020). Furthermore, pregnant women are more prone to encounter sleep disruptions that can prevent them from obtaining the recommended sleep hours (Duke et al., 2017). However, other factors were all not significantly associated with PSQI.

In the light of the findings observed in this study, increasing awareness for those who are involved in women care regarding sleep problems during pregnancy is crucial. Screening for sleep problems by assessing sleep quality can be part of the routine care during pregnancy specifically in the third trimester. In addition, altering the lifestyle practices can promote better sleep-in pregnant women. When giving nutrition education to pregnant women, dietitians need to put in consideration the income of the family since our study found that high income was associated with higher intake of fruits and vegetables.

Strengths and limitations

The main strength of this study is the substantiation of the contribution of pregnancy on diminishing sleep quality especially as the pregnancy progresses. This information can be used to develop targeted interventions aimed at improving sleep quality during pregnancy for curtailing adverse pregnancy outcomes such as gestational diabetes (GDM), gestational hypertension, caesarean section, preterm birth. Despite the small sample size, our study is the first study to investigate the associations between sleep quality and dietary intake in women living in Saudi Arabia. In addition, the study population included women at various stages of pregnancy and ages which helped in studying the associations between sleep and diet in different circumstances and situations.

Our study was subject to several limitations. First, the differences in methodology between our study and other studies which found a positive relationship between dietary intakes and sleep quality. This study used food groups obtained from an FFQ, while some of the previous studies used different methods such as Healthy Eating Index (HEI) (Xiao et al., 2016), 24-h recall (Lee et al., 2017), Validated Block Brief Food Frequency Questionnaire (FFQ) (Zuraikat et al., 2020). Moreover, we used the self-reported PSQI index to evaluate sleep quality, whereas other studies measured sleep duration alone or used sleep diaries or objective measurements (e.g., actigraph accelerometer). Collecting information through self-report has limitations as it relies on memory and personal interpretations and lacks technical precision. Another explanation might be the variance of confounders included in the statistical models.

Future directions/recommendations

This research has provided many questions in need of further investigation. More research is required to better understand the connection between sleep quality and dietary intake in pregnant women. In addition, the mechanisms underlying the interrelation between sleep quality and diet could be usefully explored in further research in pregnant women since it is a critical time and include numerous physical, mental, behavior and health changes. It would be interesting to evaluate the effects of pre-designed dietary pattern on the sleep quality of pregnant women in Saudi Arabia. In the light of the situation observed in this study, finding strategies to improve sleep quality and limit sleep disrupters in pregnant women is vital. Cleveland clinic (2019) provided several steps to get better sleep during pregnancy: 1) Adopt a relaxing bedtime routine. 2) Maintain a regular bed and wake time. 3) Limit the use of electronics devices for at least an hour before bedtime and turn down the screen's brightness. 4) Limit caffeine intake. 5) Elevate the head while sleep to limit breathing problems. 6) Drink plenty of water to stay hydrated and prevent cramping.

5. CONCLUSION

This study included pregnant women in Saudi Arabia and examined the associations between sleep quality and dietary intake. No associations were observed for sleep quality with diet. Despite the insignificant associations, it is still substantial to emphasize the importance of consuming a healthy high-quality diet that is high in fruit and vegetable low in saturated fat and with adequate protein intake during pregnancy. Our findings confirmed that pregnant women are at higher risk for poor sleep quality which has been linked to various adverse health outcomes for both mother and offspring. These results may help developing strategies to improve sleep quality for pregnant women.

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Authors' contributions

The authors' contributions are as follows: RQ contributed to data analyses, interpretation of findings and writing the manuscript. EN contributed to the study design, data analyses, interpretation of the findings, article revision and supervised the study. All authors read and approved the final version of the manuscript.

Ethical approval

This study was ethically approved by the Biomedical Research Ethics Committee at Umm Al-Qura University. Approval No: (HAPO-02-K-012-2021-10-783). Date: 1443-2-28.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

Appendix A Supplementary material

Recommended serving size for food groups according to the American Pregnancy Association

Food Groups	Number of Items	Foods	Less than Recommended intake	Appropriate intake (Servings/day)	Higher than Recommended intake
Vegetables and fruits group	2	Fresh vegetable (serving =1 cup), cooked vegetable (serving =1/2 cup) Fruit group (1 fruit medium serving)	Less than 4 servings/day	At least 4 servings/day	4 or more servings/day
Meat and proteins	4	Read meat (medium serving =60 g) Chicken (medium serving =60 g) Fish and sea food (medium serving =60 g) Egg (serving= 1 egg)	Less than 3 servings/daily	At least 3 servings of protein daily.	3 or more servings/day
Grains and cereals	6	Bread (serving= 1 slice or 1/2 Arabic bread) Rice (serving=1/2 cup) Pasta (serving=1 cup) Potatoes (1 medium serving) Breakfast cereals and oat (serving=1 cup) Pastries and biscuits (serving 1 since or biscuits)	Less than 6 serving/day	6-11 serving/day	6 or more servings/day
Dairy products and cheese	2	Milk and Dairy product (serving=1 cup) Cheese (serving= 1tablespoon/30g)	Less than 3 servings/day	2-3 serving/day	3 or more servings/day
Drinks	3	Coffee and tea (serving=1 cup) Soft drinks (serving=1 can) Fresh or canned Juices (serving= 1 cup)	-	1 serving/day	More than 1 serving/day

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