# The Association between Sweet Sugar Beverage Intakes and the Quality of Sleep in Working Age Adults

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**Abstract:** *Background*: This cross-sectional study investigates the relationship between daily sugar intake from sugar-sweetened beverages (SSBs) and sleep quality in working adults aged 18–45 years who do not have chronic illnesses or diagnosed sleep disorders. The primary objective is to determine whether high sugar consumption increases the risk of poor sleep when other risk factors are considered simultaneously. This study is significant as it adds to the growing body of evidence regarding the impact of dietary factors on sleep quality, highlighting the potential health implications of sugar consumption.

*Methods*: Participants were selected using consecutive sampling, and the study was conducted at Jomtien Hospital in Chonburi Province, Thailand. Data collection involved three key components: general demographic and health information records, a validated Thai questionnaire assessing sweetened beverage consumption, and the Thai version of the Pittsburgh Sleep Quality Index (PSQI). Sugar intake from SSBs was categorized into two groups: high (≥ 50 grams/day) and low (< 50 grams/day). Sleep quality was classified as poor (PSQI > 5) or good (PSQI ≤ 5). The relationship between sugar intake and sleep quality was analyzed using logistic regression, and the results were presented as odds ratios (ORs) with corresponding 95% confidence intervals (CIs).

*Results*: The study included 300 participants, 68% of whom were women, with an average age of 30 ± 7.6 years. A total of 58% of participants were found to have poor sleep quality. Those with poor sleep quality consumed an average of 131.9 ± 102.9 grams of sugar per day, compared to 99.8 ± 86.3 grams for those with good sleep quality, a difference that was statistically significant ($p = 0.005$). When sugar consumption was categorized, 79.3% of individuals in the high sugar consumption group (≥ 50 grams/day) had poor sleep quality, compared to 65.1% with good sleep quality in the same group. In contrast, 20.7% of individuals in the low sugar consumption group (< 50 grams/day) had poor sleep quality, compared to 34.9% with good sleep quality, also showing a statistically significant difference ($p = 0.008$). The crude odds ratio for high sugar consumption associated with poor sleep quality was 2.06 (95% CI: 1.22-3.45, $p = 0.006$). After adjusting for other variables, the odds ratio remained significant, with an adjusted OR of 2.02 (95% CI: 1.05-3.92, $p = 0.036$).

*Conclusion*: The findings indicate that high sugar consumption from sugar-sweetened beverages is significantly associated with an increased risk of poor sleep quality (adjusted OR: 2.02, 95% CI: 1.05–3.92, $p = 0.036$). Based on these results, it is recommended that individuals experiencing sleep issues consider reducing their sugar intake. Future research should explore the mechanisms underlying this relationship and evaluate public health strategies aimed at reducing high sugar consumption.

**Keywords:** Sleep Quality, Adult, Sugars, Sugar-Sweetened Beverages.

## INTRODUCTION

Sleep deprivation is a chronic and emerging worldwide public health problem of major magnitude that affects approximately one-third of the world's population, including a large proportion of young adults in the working population [1]. Due to the widespread prevalence of sleep disturbances, inadequate sleep is associated with a poorer quality of life as well as numerous adverse health outcomes and immediate effects such as cognitive and physical health problems, including a higher risk of metabolic syndrome, cardiovascular disease, hypertension, and diabetes [2].

Among the modifiable variables, they found that SSB consumption is one of the aspects becoming more and more related to sleep disruptions. Over the last few years, there has been an increased and alarming intake of SSBs that have been blamed for diabetes, obesity, and cardiovascular diseases. Consumption of these beverages is considered a key risk factor that requires public health intervention for the reduction of sugar consumption [3]. The awareness of the need to reduce the consumption of sugars, especially in beverages is important if people are to improve their health and prevent chronic diseases. It has been established that increased intake of SSBs leads to metabolic disorders, obesity, and insulin resistance all of which may affect the quality of sleep [4-6].

New research has suggested that SSBs, because of their GI and sugar content, may affect sleep quality through one or more biological mechanisms. Another factor is raised blood glucose levels, which can be induced by a large amount of consumed sugar and as a result, affect the cyclical organization of sleep [7]. One mechanism may be through increased levels of

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insulin and cortisol both of which are associated with changes in sleep regulation and increased sugar intake promotes inflammation and oxidative stress both of which have negative effects on sleep quality including insomnia and decreased sleep duration [8]. Furthermore, growing research evidence shows that high-sugar diets alter genes responsible for the biology of circadian rhythms, and chronic overconsumption of sugar has also been known to affect the secretion of melatonin which regulate the hormone responsible for regulating sleep cycles, which further exacerbates sleep quality issues [9].

This means that not only SSBs but all other foods that contain high glycemic foods can also disrupt sleep quality [10]. A previous study has also shown that those populations that take foods with a high glycemic index, including sugar and refined carbohydrates, experience short sleep duration and poor sleep quality among adults [11]. These and other similar studies point to the fact that the dietary impact is comprehensive and calls for an enhanced understanding of the effects of SSBs on sleep health in populations that have easy access to cheap sources of sugar.

Several works have analyzed the direct correlation between sugar intake and sleep in different populations of people. Another study showed that participants who had sugary beverages before bedtime were more likely to wake up in the night and overall reported worse sleep quality than the participants who avoided such beverages [12]. Also dietary sugar, especially that obtained from processed foods, negatively influences sleep quality and sleep disorders [13]. The timing of sugar consumption also matters given that evening consumption disrupted glucose metabolism in addition

On the other hand, there is accumulating data that indicates that limitation of sugar intake can enhance the quality of sleep. A cross-sectional study also showed that the subjects surveyed who had agreed to lower their sugar intake noted a marked improvement in their sleep duration and quality with a further increase in the same among participants who had lowered their consumption of SSBs [14]. Such research shows the possibilities of interventions that seek to curb the intake of sugar and promote health among working-age adults, who normally suffer from both inadequate sleep and unhealthy Based on the existing research recommendations, it is evident that increased sleep quality may also be pivotal to supporting reduced sugar intake, and thereby the reduced incidence of chronic diseases relating to high sugar and poor sleep.

The purpose of this research is to ascertain if increased consumption of sugar through sugar-sweetened beverages negatively impacts the sleep quality of working adults. This study will help to expand the knowledge on how diet may influence sleep and increase its significance to the population's health agendas related to lowering sugar intake and promoting healthy sleep.

## MATERIAL AND METHODS

### Study Design and Setting

This study is a cross-sectional observational investigation that employs validated questionnaires to examine the relationship between sugar-sweetened beverage (SSB) consumption and sleep quality among a working-age population. The study is conducted within the Health Promotion Department at Jomtien Hospital, Chonburi Province, Thailand.

### Selection of Participants

The study population includes male and female participants aged 18-45 years who meet specific inclusion criteria: they must be free from chronic diseases, sleep disorders, and pregnancy, and must be willing to complete the study questionnaire. Participants are required to provide informed consent and fully complete the questionnaire. Data collection is scheduled to occur from April 1, 2024, to May 31, 2024. The exclusion criteria for this study include incomplete questionnaire data, which would render the participant's data unsuitable for analysis.

### Data Collection

Data collection was performed using a comprehensive information record that included variables such as gender, age, weight, and height, the latter two used to calculate body mass index (BMI). Additionally, the record captured information on marital status, education level, occupation, exercise habits, smoking and alcohol consumption behaviors, shift work, working hours per day, number of days worked per week, living arrangements, family financial responsibilities, income sufficiency, and dietary habits, including the number of meals consumed per day and types of food frequently eaten. These variables will be used as covariates in the subsequent analysis.

The primary independent variable, sugar-sweetened beverage intake, was assessed using a questionnaire developed by Phulkerd S. *et al*. [15]. The dependent variable, sleep quality, was measured using the Thai version of the Pittsburgh Sleep Quality Index (PSQI), which has been translated and validated by Sitasuwan T. *et al*. [16]. To quantify daily sugar consumption from SSBs, the following method was used: the number of days per week a beverage was consumed was multiplied by the number of times it was consumed each day, followed by the amount consumed per serving, and then by the sugar content per serving. The total sugar content from all beverages was summed and divided by seven to obtain the average daily sugar intake. Participants were then classified into two categories based on their daily sugar intake: high sugar consumption (≥ 50 grams/day) or low sugar consumption (< 50 grams/day), according to the World Health Organization (WHO) recommendations. Sleep quality was evaluated using the Thai version of the PSQI, which produces a score ranging from 0 to 21. A PSQI score greater than 5 indicates poor sleep quality, while a score of 5 or lower indicates good sleep quality [17,19]. Accordingly, participants were classified as having either poor sleep quality (PSQI > 5) or good sleep quality (PSQI ≤ 5).

**Statistical Analysis and Sample Size Calculation**

The sample size for this study was determined based on a comparison of two independent proportions, drawing reference from the study conducted by Young DR et al. In their study [18], it was reported that 30% of individuals with poor sleep consumed high-sugar beverages, in contrast to 15% among those with good sleep.

Considering the population ratio of good to poor sleepers as 253:209, with a significance level (alpha) set at 0.05 and a power (beta) of 0.80 for a two-tailed test, the calculated sample size required 121 individuals with poor sleep and 147 individuals with good sleep, resulting in a total sample size of 268 participants for this study.

In the study data analysis was conducted using IBM SPSS Statistics for Windows (version 29). Continuous variables, such as age, BMI, daily working hours, frequency of sweetened beverage consumption, daily sugar intake, and sleep quality scores, were described using mean (SD) or median (IQR) as appropriate. Categorical variables were summarized using numbers and percentages (n, %). These included variables such as gender (male, female), BMI categories (underweight < 18.5 kg/m², normal 18.5-22.9 kg/m², overweight 23-24.9 kg/m², obese class 1 25-30 kg/m², obese class 2 > 30 kg/m²), marital status (single, partnered, separated/widowed/divorced), education level (high school or lower, vocational certificate, bachelor's degree or higher), occupation (private company employee, government officer/state enterprise, self-employed/trader, general laborer, others), exercise frequency (no exercise, 1-2 times per week, 3 or more times per week), smoking status (non-smoker or occasional smoker, regular smoker), alcohol consumption (yes, no), night shift work (yes, no), number of working days per week (< 5, 5, 6, 7 days/week), living situation (living alone, living with partner/children/parents/relatives/others), family financial responsibility (full responsibility, partial responsibility, no responsibility), income sufficiency (insufficient, sufficient), number of meals per day (1, 2, 3, more than 3 meals/day), and frequently consumed foods (> 4 times per week), such as vegetables and fruits, sweets, fried foods, processed foods, fast food (yes or no). The frequency of sweetened beverage consumption by type (≥ 2 times/week, once/week, not consumed), daily sugar intake from beverages (high ≥ 50 grams/day, low < 50 grams/day), and sleep quality (poor PSQI > 5, good PSQI ≤ 5) were also recorded.

For inferential statistics, hypothesis testing was performed using independent t-tests for normally distributed continuous variables, rank-sum tests for non-normally distributed continuous variables, and exact probability statistics for categorical variables. A p-value of < 0.05 was considered indicative of statistical significance. This study was cross-sectional, excluding causality since it only allows observation of associations but not cause-and-effect relationships. To establish causality one needs longitudinal (experimental) designs.

Hypothesis testing was carried out for inferential statistics using independent t-tests for normally distributed continuous variables, rank-sum tests for non-normally distributed continuous variables, and exact probability statistics for categorical variables. Statistical significance was considered if p < 0.05. Logistic regression analysis was done to assess the relationship between high daily sugar intake (≥ 50 grams/day) and poor sleep quality (PSQI > 5). Odds ratios crude and adjusted for potential confounders (individual characteristics, health behaviors, workload, family burden, dietary habits) were calculated. Statistical significance was p < 0.05.

## Statement of Ethics

The study protocol received approval from the Human Research Ethics Committee of Dhurakij Pundit University, with the Certificate of Approval: DPUHREC018/66FB COA No. COA028/66.

## RESULTS

The study included a total of 300 participants, with 68% being female and an average age of 30 years (SD = 7.6). Among these participants, 44.1% had a BMI above the normal range, with an average BMI of 23.1 kg/m², and 62.5% were single. Education levels were evenly distributed between those with less than a bachelor's degree and those with a bachelor's degree or higher. In terms of employment, 59.3% were employed in private companies, and 20.3% worked night shifts, with an average of 9.1 working hours per day. Additionally, 44.7% of participants worked six days a week. Regarding lifestyle habits, 61.7% did not engage in regular exercise, 11.7% were regular smokers, and 21.2% regularly consumed alcohol. Concerning living conditions, 23.9% of participants lived alone, 19.2% were fully responsible for family expenses, and 16.1% reported insufficient income. Dietary habits revealed that 4.7% of participants consumed more than three meals per day, 63.8% frequently consumed fried foods, 63.4% regularly ate vegetables and fruits, and 22.5% frequently consumed fast food.

The prevalence of poor sleep quality was 58%, with an average sleep score of 6.7. Significant differences were observed between the groups with poor and good sleep quality. Participants with poor sleep quality had a higher average BMI (23.8 vs. 22.1, p = 0.010) and a higher rate of regular alcohol consumption (26.9% vs. 13.2%, p = 0.006). There was also a trend towards significance in family financial responsibility, with a higher percentage of individuals in the poor sleep quality group having full financial responsibility (23.7% vs. 12.7%, p = 0.053). No significant differences were found in gender, age, marital status, education, occupation, exercise habits, smoking status, night shift work, living alone, or income sufficiency (Table **1**).

In terms of food and beverage consumption, participants who consumed more than three meals per day were more likely to have poor sleep quality compared to those with good sleep quality (7.5% vs. 0.8%, p = 0.013). Additionally, a higher proportion of participants with poor sleep quality frequently consumed fast food (28.9% vs. 13.6%, p = 0.002). No significant differences were observed in the frequent consumption of vegetables and fruits, sweets/bakery/bread, fried food, or processed food between the two groups. Regarding beverage consumption, individuals who consumed freshly brewed iced tea or coffee two or more times per week were more likely to have poor sleep quality (61.5%) compared to those with good sleep quality (47.6%) (p = 0.016). No significant differences were found between the poor and good sleep quality groups in the consumption of other beverages such as soda drinks, blended fruit juice, soured milk/yogurt, and sweet green tea (Table **2**).

There was a statistically significant difference in the average daily frequency of sweetened beverage consumption, with 2.7 times per day in the poor sleep quality group compared to 2.0 times per day in the good sleep quality group (p = 0.002). Additionally, there was a statistically significant difference in the average daily sugar intake, with 131.9 grams per day in the poor sleep quality group compared to 99.8 grams per day in the good sleep quality group (p = 0.005). When categorizing participants into high and low sugar intake groups, 79.3% of those in the high sugar consumption group (≥ 50 grams per day) had poor sleep quality compared to 65.1% in the good sleep quality group. In contrast, 20.7% of participants in the low sugar consumption group (< 50 grams per day) had poor sleep quality compared to 34.9% with good sleep quality, showing a statistically significant difference (p = 0.008) (Table **3**).

The study found that high sugar consumption (≥ 50 grams per day) was associated with a 2.06-fold increase in the risk of poor sleep quality (crude OR: 2.06, 95% CI: 1.22-3.45, p = 0.006) compared to low sugar consumption, without adjusting for potential confounding variables. After adjusting for confounders such as gender, age, BMI, alcohol consumption, family responsibilities, living situation, income sufficiency, number of meals per day, frequent consumption of fast food, and consumption of iced freshly brewed tea or coffee, high sugar consumption was still associated with a 2.02-fold increase in the risk of poor sleep quality (adjusted OR: 2.02, 95% CI: 1.05-3.92, p = 0.036) (Fig. **1**). Other factors contributing to poor sleep quality included an increased BMI, which raised the risk by 1.1 times per unit increase (p = 0.012) in unadjusted analyses and by 1.06 times per unit increase (p = 0.023) in adjusted analyses. Regular alcohol consumption increased the risk by 2.4 times

**Table 1: Clinical Characteristics**

| Clinical Characteristics | Sleep Quality | | p-value |
|---|---|---|---|
| | Poor (n=174) n (%) | Good (n=126) n (%) | |
| **Female** | 119 (68.4) | 85 (67.5) | 0.901 |
| **Age, (years) (mean±SD)** | 30.3±7.7 | 29.7±7.4 | 0.522 |
| **BMI (kg/m$^2$)** | | | |
| Underweight (BMI < 18.5) | 21 (12.4) | 26 (21.1) | 0.111 |
| Normal weight (BMI = 18.5-22.9) | 71 (41.7) | 58 (47.2) | |
| Overweight (BMI = 23-24.9) | 27 (15.9) | 15 (12.2) | |
| Obesity class 1 (BMI = 25-29.9) | 26 (15.3) | 12 (9.8) | |
| Obesity class 2 (BMI ≥ 30) | 25 (14.7) | 12 (9.8) | |
| **BMI, (kg/m$^2$) (mean±SD)** | 23.8±5.7 | 22.1±4.7 | 0.010 |
| **Marital Status** | | | |
| Single | 109 (63.4) | 76 (61.3) | 0.787 |
| Married | 57 (33.1) | 45 (36.3) | |
| Separated/Widowed/Divorced | 6 (3.5) | 3 (2.4) | |
| **Education** | | | |
| High School or Below | 56 (34.2) | 32 (27.8) | 0.351 |
| Vocational Certificate | 27 (16.5) | 26 (22.6) | |
| Bachelor's Degree or Higher | 81 (49.3) | 57 (49.6) | |
| **Occupation** | | | |
| Private Company Employee | 105 (61.4) | 65 (56) | 0.578 |
| Government/State Enterprise | 4 (2.3) | 1 (0.9) | |
| Self-employed/Trader | 16 (9.4) | 9 (7.8) | |
| General Labor | 26 (15.2) | 24 (20.7) | |
| Others | 20 (11.7) | 17 (14.7) | |
| **Exercise** | | | |
| No Exercise | 108 (62.4) | 74 (60.7) | 0.767 |
| 1-2 Times per Week | 34 (19.7) | 28 (22.6) | |
| More than 3 Times per Week | 31 (17.9) | 20 (16.4) | |
| **Regular Smoker** | 20 (11.8) | 14 (11.6) | 1.000 |
| **Regular Alcohol Drinker** | 46 (26.9) | 16 (13.2) | 0.006 |
| **Night Shift Work** | 39 (23.5) | 19 (15.8) | 0.136 |
| **Working Days per Week** | | | |
| Less than 5 Days | 16 (9.6) | 14 (12.0) | 0.931 |
| 5 Days | 57 (34.1) | 39 (33.3) | |
| 6 Days | 76 (45.5) | 51 (43.6) | |
| 7 Days | 18 (10.8) | 13 (11.1) | |
| **Working Hours per Day** (mean ± SD) | 8.9±2.6 | 9.3±1.8 | 0.256 |
| **Living Alone** | 44 (25.4) | 27 (21.8) | 0.493 |
| **Family financial responsibility** | | | |
| Responsible for All Expenses | 41 (23.7) | 15 (12.7) | 0.053 |
| Responsible for Partial Expenses | 103 (59.5) | 77 (65.3) | |
| Not Responsible for Expenses | 29 (16.8) | 26 (22.0) | |
| **Insufficient Income** | 32 (18.7) | 15 (12.5) | 0.196 |

**Table 2: Food and Beverage Consumption**

| Clinical Characteristics | Sleep Quality | | p-value |
|---|---|---|---|
| | Poor (n=174) n (%) | Good (n=126) n (%) | |
| **Number of Meals Per Day** | | | |
| 1 Meal Per Day | 5 (2.9) | 7 (5.7) | 0.013 |
| 2 Meals Per Day | 87 (50.0) | 55 (44.7) | |
| 3 Meals Per Day | 69 (39.6) | 60 (48.8) | |
| More Than 3 Meals Per Day | 13 (7.5) | 1 (0.8) | |
| **Food Consumed Frequently*** | | | |
| Fruits and Vegetables | 111 (64.2) | 78 (62.4) | 0.808 |
| Sweets/Bakery/Bread | 106 (61.3) | 68 (54.4) | 0.284 |
| Fried Food | 114 (65.9) | 76 (60.8) | 0.394 |
| Processed Food | 105 (60.7) | 63 (50.4) | 0.097 |
| Fast Food (Pizza, Burger) | 50 (28.9) | 17 (13.6) | 0.002 |
| **Freshly Brewed Iced Tea/Coffee** | | | |
| ≥ 2 times per week | 107 (61.5) | 60(47.6) | 0.016 |
| 1 per week | 16 (9.2) | 24(19.1) | |
| Not drink | 51 (29.3) | 42(33.3) | |
| **Soda Drinks (325 ml can)** | | | |
| ≥ 2 times per week | 67 (38.5) | 46(36.5) | 0.739 |
| 1 per week | 32 (18.4) | 28(22.2) | |
| Not drink | 75 (43.1) | 52(41.3) | |
| **Blended Fruit Juice** | | | |
| ≥ 2 times per week | 60 (34.5) | 34(27.0) | 0.267 |
| 1 per week | 32 (18.4) | 31(24.6) | |
| Not drink | 82 (47.1) | 61(48.4) | |
| **Soured milk /Yogurt** | | | |
| ≥ 2 times per week | 64 (36.8) | 40(31.8) | 0.557 |
| 1 per week | 31 (17.8) | 21(16.7) | |
| Not drink | 79 (45.4) | 65(51.6) | |
| **Soda Drinks (550 ml bottle)** | | | |
| ≥ 2 times per week | 64 (36.8) | 43(34.1) | 0.671 |
| 1 per week | 19 (10.9) | 18(14.3) | |
| Not drink | 91 (52.3) | 65(51.6) | |
| **Sweet Green Tea** | | | |
| ≥ 2 times per week | 51 (29.3) | 35(27.8) | 0.809 |
| 1 per week | 19 (10.9) | 17(13.5) | |
| Not drink | 104 (59.8) | 74(58.7) | |

**Table 3: Amount of Sugar Intake from SSB Per Day**

| Clinical Characteristics | Sleep Quality | | p-value |
|---|---|---|---|
| | Poor (n=174) n (%) | Good (n=126) n (%) | |
| **Frequency of SSB, times/day median (IQR)** | 2.1 (1.1-4.0) | 1.7 (0.9-2.7) | 0.008 |
| **Amount of Sugar Intake from SSB (grams/day) median (IQR)** | 104.8 (54.6-188.4) | 77.3 (38.6-129.5) | 0.002 |
| **Sugar Intake from SSB (grams/day)** | | | |
| High Sugar Intake (≥50) | 138 (79.3) | 82 (65.1) | 0.008 |
| Low Sugar Intake (<50) | 36 (20.7) | 44 (34.9) | |

**Table 4: Crude and Adjusted OR for Poor Sleep Quality**

| Clinical Characteristics | Crude OR (95% CI) | Adjusted OR (95% CI) | p-value |
|---|---|---|---|
| **Sugar Intake from SSB (grams/day)** | | | |
| High Sugar Intake (≥50) | 2.06 (1.22-3.45) | 2.02 (1.05-3.92) | 0.036 |
| Low Sugar Intake (<50) | reference | reference | |
| **Female** | 1.04 (0.64-1.70) | 1.25 (0.67-2.32) | 0.486 |
| **Age (year)** | 1.01 (0.97-1.04) | 1.00 (0.96-1.04) | 0.915 |
| **BMI (kg/m$^2$)** | 1.06 (1.01-1.11) | 1.06 (1.01-1.12) | 0.023 |
| **Marital Status** | | | |
| Single | reference | - | - |
| Married | 0.88 (0.54-1.44) | - | - |
| Separated/Widowed/Divorced | 1.39 (0.34-5.75) | - | - |
| **Education** | | | |
| High School or Below | reference | - | - |
| Vocational Certificate | 0.60 (0.30-1.19) | - | - |
| Bachelor's Degree or Higher | 0.80 (0.47-1.41) | - | - |
| **Occupation** | | | |
| Private Company Employee | reference | | |
| Government/State Enterprise | 2.48 (0.27-22.64) | - | - |
| Self-employed/Trader | 1.10 (0.46-2.64) | - | - |
| General Labor | 0.67 (0.36-1.27) | - | - |
| Others | 0.73 (0.36-1.49) | - | - |
| **Exercise** | | | |
| No Exercise | reference | - | - |
| 1-2 Times per Week | 0.83 (0.47-1.49) | - | - |
| More than 3 Times per Week | 1.06 (0.56-2.00) | - | - |
| **Regular Smoker** | 1.02 (0.49-2.11) | - | - |
| **Regular Alcohol Drinker** | 2.42 (1.29-4.51) | 2.18 (1.05-4.51) | 0.036 |
| **Night Shift Work** | 1.63 (0.89-3.00) | - | - |
| **Working Days per Week** | | | |
| Less than 5 Days | reference | - | - |
| 5 Days | 1.28 (0.56-2.92) | - | - |
| 6 Days | 1.30 (0.59-2.90) | - | - |
| 7 Days | 1.21 (0.44-3.33) | - | - |
| **Working hours per day** | 0.94 (0.84-1.05) | - | - |
| **Living alone** | 1.23 (0.71-2.12) | 1.73 (0.92-3.26) | 0.09 |
| **Family financial responsibility** | | | |
| Responsible for All Expenses | 2.45 (1.11-5.42) | 1.54 (0.56-4.28) | 0.405 |
| Responsible for Partial Expenses | 1.20 (0.65-2.20) | 0.81 (0.39-1.68) | |
| Not Responsible for Expenses | reference | reference | |
| **Insufficient Income** | 1.61 (0.83-3.13) | 1.24 (0.56-2.71) | 0.596 |
| **Number of Meals Per Day** | | | |
| 1 Meal Per Day | 0.62 (0.19-2.06) | 0.54 (0.13-2.26) | 0.398 |
| 2 Meals Per Day | 1.38 (0.85-2.23) | 1.22 (0.69-2.14) | 0.492 |
| 3 Meals Per Day | reference | reference | |
| More Than 3 Meals Per Day | 11.3 (1.44-88.97) | 9.22 (1.09-78.00) | 0.041 |
| **Food Consumed Frequently** | | | |
| Fruits and Vegetables | 1.08 (0.67-1.74) | - | - |
| Sweets/Bakery/Bread | 1.33 (0.83-2.11) | - | - |
| Fried Food | 1.25 (0.77-2.00) | - | - |
| Processed Food | 1.52 (0.95-2.42) | - | - |
| Fast Food (Pizza, Burger) | 2.58 (1.40-4.74) | 2.69 (1.34-5.39) | 0.005 |
| Freshly Brewed Iced Tea/Coffee | 1.05 (1.00-1.11) | 1.02 (0.96 -1.09) | 0.560 |

(p = 0.006) in unadjusted analyses and by 2.18 times (p = 0.036) in adjusted analyses. Consuming more than three meals per day was associated with an 11.3-fold increase in risk (p = 0.012) in unadjusted analyses and a 9.22-fold increase in risk (p = 0.041) in adjusted analyses. Frequent consumption of fast food, including pizza and burgers, raised the risk by 2.6 times (p = 0.021) in unadjusted analyses and by 2.69 times (p = 0.005) in adjusted analyses. Although family financial responsibility was associated with a 2.5-fold increase in risk (p = 0.027) in unadjusted analyses, it was not significant in adjusted analyses (1.52 times, 95% CI: 0.56-4.12, p = 0.407) (Table **4**).

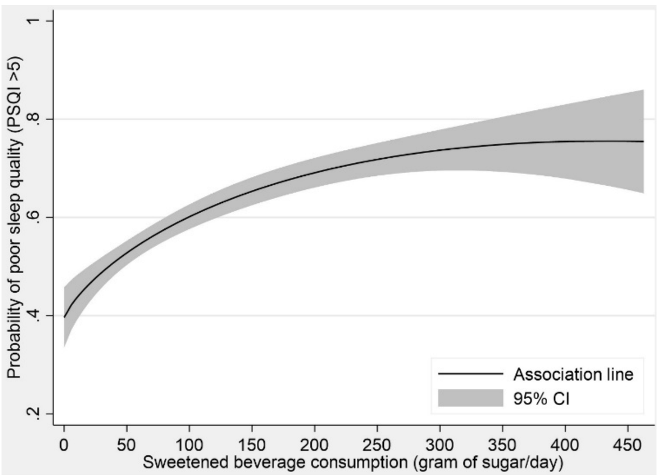


**Figure 1:** The relationship between amount of sugar consumption from sweet beverage and the probability of poor sleep quality (adjusted for gender, age, BMI, alcohol consumption, living situations, family financial responsibility, income sufficiency, number of meals per day, fast food consumption, Freshly Brewed Iced Tea/Coffee consumption).

## DISCUSSION

The consumption of sugar-sweetened beverages (SSBs) was found to significantly increase the risk of poor sleep quality by 2.02 times, even after adjusting for other variables. This study also identified several lifestyle factors that substantially influence sleep quality. Specifically, individuals consuming more than three meals per day exhibited a 9.22-fold increased likelihood of experiencing poor sleep. Frequent consumption of fast food was associated with a 2.69-fold increase in risk, while regular alcohol consumption raised the risk by 2.18 times. Additionally, each unit increase in BMI corresponded to a 1.06-fold higher risk of poor sleep quality.

The prevalence of poor sleep quality in this study was 58%, a rate higher than that reported in previous studies of working-age populations: 33.7% in Thailand [19], 42.5% in Singapore [19], and 28% in Japan [20]. Among students, the prevalence of poor sleep quality ranges from 40% to 45% [14]. These findings suggest that sleep disturbances are widespread and increasing, with significant negative implications for health and an elevated risk of workplace accidents.

In this study, 73.3% of the Thai working-age participants exceeded the recommended daily sugar intake, consuming more than 50 grams per day, with an average intake of 118.4 grams derived solely from beverages. Nationally, the average sugar consumption among Thais is approximately 100 grams per day, primarily from sodas and tea/coffee [16]. Additionally, 88% of Thais consume 500 milliliters of sweetened beverages daily, on average four times per week [21] University employees in Thailand have been reported to consume an average of 50 grams of sugar daily from beverages, a factor significantly correlated with increased BMI [22].

This study highlights the significant adverse health effects associated with the interplay between poor sleep quality and high sugar consumption, particularly from SSBs. To our knowledge, this is the first study to specifically examine this relationship within the working-age Thai population. The findings demonstrate that high sugar consumption from sweetened beverages increases the risk of poor sleep quality by 2.02 times, even after adjusting for multiple variables.

Similar studies conducted in Japan, Korea, Iran, and Saudi Arabia have also identified a significant impact of sweetened beverages on sleep quality [24-27]. However, contrasting results have been reported in Germany, Australia, and the United States, where no significant correlation was observed [23,27,28]. These discrepancies may be attributed to variations in study design, measurement tools, and population demographics.

Excessive sugar intake adversely affects sleep quality through various molecular pathways. SSBs cause rapid increases in blood glucose levels, leading to significant insulin release. Prolonged exposure to insulin can result in insulin resistance and hyperinsulinemia, which stimulate the autonomic nervous system, triggering the release of adrenaline and cortisol and ultimately disrupting sleep quality [29,30]. Additionally, the consumption of high-glycemic-index foods reduces nocturnal melatonin secretion, further impairing sleep quality [31].

Moreover, meta-analyses suggest a bidirectional relationship between sleep and sugar consumption: insufficient sleep duration is associated with increased sugar intake [21]. Poor sleep quality diminishes motivation to maintain health and increases cravings for sweets, leading to greater consumption of unhealthy foods and SSBs [30]. Inadequate sleep also suppresses leptin and stimulates ghrelin, hormones that regulate appetite, thereby increasing the risk of weight gain and obesity [31].

This study identified several lifestyle factors that significantly affect sleep quality, including the consumption of more than three meals per day, frequent fast-food consumption, high sugar and alcohol intake, and increasing BMI. We hypothesize that these factors may contribute to gut dysbiosis, an imbalance in the gut microbiota, which in turn disrupts circadian rhythms and the production of neurotransmitters and hormones essential for sleep regulation. This disruption can lead to metabolic disorders and inflammation, further impairing sleep quality [29,30]. These findings underscore the complex relationship between diet, gut health, and sleep, suggesting that future research should explore these interrelations to develop effective dietary interventions that promote gut microbiota balance and enhance sleep quality.

To improve sleep quality, it is crucial to limit the consumption of sugar-sweetened beverages. Employers can play a significant role by promoting healthier beverage options and educating employees about the adverse effects of high-sugar drinks. Public health initiatives should focus on raising awareness and encouraging healthier beverage choices to enhance overall well-being.

## CONCLUSION

This study demonstrates that high sugar intake, particularly from sugar-sweetened beverages, adversely affects sleep in working-age adults. The results show a relationship between greater consumption of sugar-sugared beverages and later sleep onset, shorter total sleep duration, and more frequent night wakings. In addition, a clear dose-response relationship was seen, with higher consumption of sugary drinks associated with more severe sleep disturbance. Limiting sugar-sweetened beverages, encouraging healthier choices in the workplace, and using public health measures to increase awareness about the negative impact of high sugar on sleep, will help to improve sleep and overall health and well-being.

## STRENGTHS AND LIMITATIONS

The strengths of this study include the use of validated tools and reliable measurements. However, future research should incorporate longitudinal or experimental designs to establish causality. Limitations of this study include its cross-sectional design preventing causality determination. Study designs that allow inferring causal relationships between sugar-sweetened beverage consumption and sleep quality are required, as such associations are observed only. A second limitation of this study is the possibility of recall bias in self-reported data. There may have been measurement errors due to inaccuracies in the participant’s reports of their sugar-sweetened beverage consumption or their sleep patterns. This may affect the relationship between sugary drink intake and sleep quality that is observed. The inclusion of blood biomarkers for hormonal and metabolic profiles would be essential to elucidate underlying mechanisms. Updated questionnaires reflecting current beverage trends and a comprehensive assessment of physical activity, diet, and stress levels are also recommended to provide a holistic understanding of the factors influencing sleep quality.

## FINANCIAL DISCLOSURE

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper. We confirm that we have no financial or personal relationships with other people or organizations that could inappropriately influence our work. All authors have reviewed and agreed upon the content of this manuscript, and there are no competing interests to disclose.

## AUTHOR CONTRIBUTIONS

Innachit C., Maiprasert M., Suvannamai V., Jiamjirachart P., and Lungkorn N. contributed to this research project in different capacities: Innachit C.: Conducted experiments, gathered data, and provided critical analysis throughout the research process. Innachit C. and Maiprasert M. Contributed to the discussion section. Suvannamai V.: Provided valuable insights and supported the discussions with relevant literature and analysis. Maiprasert M.: Conceptualized the research idea, designed the study, supervised data collection and analysis, drafted the manuscript and corresponding author. All authors have reviewed and approved the final version of the manuscript.

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