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The Association of Demographic and Clinical Characteristics and Self-Reported Sleep Duration among Patients with Prediabetes

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TABLE OF CONTENT

Abstract

Background: Sleep has been recognized as a critical component of healthy development and overall health. However, sleep duration has emerged as an important lifestyle factor that influences endocrine function and glucose metabolism. There remains a dearth of research to assess sleep duration among patients with prediabetes.

Objective: To evaluate the association between socio-demographic and clinical characteristics and self-reported sleep duration among patients with prediabetes.

Methods: Baseline data (n=599) was used from a diabetes prevention trial. A chi-square test was used to assess the differences between the groups of sleep duration for the categorical, whereas the t-test was used for the continuous variables. Logistic regression analysis was used to examine the relationship between socio-demographic and clinical characteristics and the likelihood of optimal sleep, defined as sleeping more than 7 to 9 hours per night.

Result: The mean age of the participants was 55.46±12.73 years with a BMI of 35.95±6.34 kg/m^2, and 61% were females. There was a significant difference between age, race, employment status, eating pattern, sleep pattern, and self-rate health was somewhat significant among optimal vs. non-optimal sleep. After the adjusted regression model, employment (adjusted odds ratio [AOR]= 0.59; CI: 0.37-0.92) and eating pattern (AOR= 0.926; CI: 0.85-0.99) were negatively associated with adequate optimal sleep. However, BMI, blood pressure, triglycerides, HDL, smoking status, and physical activity were not associated with adequate optimal sleep.

Conclusion: This study provides evidence that the prediabetic participants with employment and eating patterns were negatively associated with optimal sleep. Therefore, more studies are needed to understand better the association of sleep duration and prediabetes or diabetes.

Chapter 1-Introduction

Specific Aims

Sleep is an essential element in human life because it helps in reconstructing physical and emotional power, if proper sleep is maintained, then it results in preserving fitness and health (Ghorbani et al., 2015). According to the National Sleep Foundation (NSF), the recommended optimal sleep for young adults to adult's (18 to 64 years) ranges from 7 to 9 hours per day, and for non-optimal sleep, the sleep duration should be <7 or >9 hours per day (Hirshkowitz et al., 2015). Several studies have shown that altered sleep duration has an adverse impact on the cardiometabolic outcome, including weight gain, cardiovascular disease (CVD), and diabetes (Grandner et al., 2016). The mechanism of this relationship is that altered sleep duration activates dysregulation of metabolism, and increase immune response, thus, resulting in appetite dysregulation, and development of impaired glucose fasting which lead to prediabetes or diabetes (Rafalson et al., 2010; Beihl et al., 2009; Beccuti & Pannain, 2011; Knutson, 2010; and Mullington et al., 2009). Additionally, epidemiological studies have shown that those who sleep more or less are more likely to consume energy-rich food such as refined carbohydrate or fats, a fewer portion of the vegetables, and have irregular meal pattern (Peuhkuri & Korpela, 2012; Chaput, 2014; and Lopze-cepero et al., 2018). There have been limited studies focused on assessing the association of demographic and clinical characteristics, eating pattern, and sleep duration among patients with prediabetes.

Specific Aim 1: To assess the association between socio-demographic and clinical characteristics and self-reported sleep duration among patients with prediabetes.

Specific Aim 2: To compare eating pattern among patients with prediabetes between the optimal and non-optimal sleep.

Chapter 2 – Background

Sleep is a vital element in the healing process in metabolic homeostasis among human life (Ghorbani et al., 2015). The National Sleep Foundation (NSF) has recommended sleep duration for young adults to adults (18 to 64 years) ranges from 7 to 9 hours, and older adults (≥65 years) range from 7 to 8 hours. per day (Hirshkowitz et al., 2015). A report by the CDC suggested that approximately one-third of the US adults do not get the recommended amount of sleep (Liu et al., 2016). Inadequate sleep in the modern society is due to late-night entertainment (internet and television) as well as increased adverse lifestyle behaviors and change in work shift or night shifts that further promotes such activities (Ghorbani et al., 2015; and Yan et al., 2018).

Over several decades, various studies have shown that sleep has been considered one of the crucial factors in regulating the physiological functions related to endocrine function and glucose metabolism (Gronfier & Brandenberger, 1998; Schmid et al., 2007; and Grandner et al., 2016). Research has shown a direct or indirect link between sleep and endocrine functions and glucose metabolism (Carley & Farabi, 2016; and Schmid et al., 2009). Altered sleep precedes a higher level of sympathetic nervous system function, which leads to insulin resistance by inhibitions of insulin secretion (Stamatakis & Punjabi, 2010; Tentolouris, Argyrakopoulou & Katsilambros, 2008; and Lee, Ng & Chin, 2017).

A review by Golem and colleagues suggests that there has been a U-shaped association between sleep duration and weight status, suggesting that oversleep (≥9 h/night) and insufficient sleep (≤5 h/night) are associated with increased risk of overweight status in adults. Moreover, they observe that sleep duration was directly or indirectly associated with eating patterns (energy intake), age, gender, physical activity, and a risk factor for diabetes (Golem et al., 2014). A systematic review and meta-analysis by Lee and colleagues (2017), suggested that short and long sleeping hours is significantly associated with higher hemoglobin A1c (HBA1c). Similarly, studies have suggested that sleep duration, total sleep duration, and subjective sleep quality was significantly associated with HbA1c (Brouwer et al., 2020; Keskin et al., 2015; Nakajima et al., 2008 and Kim, Chang & Ryu, 2017).

Globally, the prevalence of prediabetes is increasing significantly, and it is estimated that more than 470 million people will have prediabetes by 2030 (Tabák et al., 2012). According to the Centers for Disease Control and Prevention (CDC), it is estimated that currently, more than 100 million U.S. adults are living with either diabetes or prediabetes (CDC, 2017). In 2015, about 33.9% of U.S. adults aged 18 years or older (84.1 million people) had prediabetes, based on their fasting glucose or A1C level (CDC, 2018). Prevalence of prediabetes was also seen among racial and ethnic groups, where the age-adjusted data for 2011-2014 indicated that more men (36.6%) than women (29.3%) had prediabetes (U.S. Census Bureau, 2015). Between 2013 – 2015, the prevalence of diagnosed diabetes was seen among various racial/ethnic populations like American Indians/Alaska Natives had the highest incidence of diagnosed diabetes for both men (14.9%) and women (15.3%) (National Diabetes Statistics Report, 2017).

American Diabetes Association defined prediabetes as a blood glucose level above normal (hemoglobin A1C more than 5.7%) but below diabetes thresholds (hemoglobin A1C less than 6.5%), is recognized as a risk state of having a high chance of developing diabetes (Tabák et al., 2012 and American Diabetes Association, 2016). Moreover, out of 84 million American adults, 1 out of 3 have prediabetes, and those with prediabetes, 90% are unaware of the disease (CDC, 2018). Approximately one- third of prediabetes progress to type 2 diabetes within 3-5 years, and 70% of prediabetes will develop diabetes within their lifetime (Tabák et al., 2012; Souza et al., 2012). Prediabetes increases the risk of developing type 2 diabetes, heart disease, and stroke (CDC, 2019). Various epidemiological studies revealed that the potential risk factors of diabetes and prediabetes are associated with genetic, sociodemographic factors, obesity, blood lipids, and lifestyle (Bocquet et al., 2019; Ligthart et al., 2016; Shahraz et al., 2016; Wang et al., 2017, and Murillo et al., 2019).

Approximately 11.6% (174,627) of the adult population in Nebraska have diagnosed cases of diabetes, and out of which approximately 45,000 were unaware of the disease (American Diabetes Association, 2016). Additionally, 35.8% (487,000) of the adult population have prediabetes. It is estimated that approximately 8,000 people in Nebraska are diagnosed with diabetes every year (American Diabetes Association, 2016). A report by Nebraska, Department of Health and Human Services (DHHS), in 2018, estimated that almost 1 in 11 (8.8%) Nebraskan adults diagnosed with diabetes and only 6% of Nebraskan adults were aware of having prediabetes in 2016. Diabetes prevalence among adults from 2012 to 2016 increased from 8.1% to 8.8%; thus, suggesting that diabetes burden is increasing in the community (Nebraska DHHS, 2018).

A study by Mokhlesi and colleagues suggested that sleep duration was independently associated with HbA1c in adults with prediabetes/recently diagnosed or untreated type II diabetes. This relationship was most evident in both short (<5hours) and long (>8hours) self- reported sleep duration (U-shaped relationship). Additionally, the study demonstrated that short and long self-reported sleep duration was associated with a higher level of measures of glycemia after controlling body mass index (BMI) and demographic characteristics (Mokhlesi et al., 2019). Similarly, a study by Engeda et al., have shown that after adjusting for socio-demographic characteristics and health behavior, sleep duration ≤5 hours per night were significantly associated with prediabetes (OR=2.06). Moreover, maintaining sleep for ≥5 times per month (OR=3.5) and waking up too early ≥5 times per month (OR=2.69) was significantly associated with increased risk of prediabetes (Engeda et al., 2013).

Research has shown that there is a relationship between sleep duration and diabetes, and their outcome is well recognized across withing different groups and contexts. Both men and women were affected by the negative effects of short sleep duration on diabetes. However, a study showed that relative risk for the development of diabetes was higher in men with short sleep duration (RR=2.8) or difficulties maintaining sleep (RR=4.8) after adjusting for age and other risk factors (Mallon, Broman, & Hetta, 2005). Additionally, in the United States, racial or ethnic minority groups are affected by the adverse effect of sleep duration on diabetes (Beihl et al., 2009). A paper by Zizi and colleagues, using National Health Interview Survey (NIHS) found that African American and Whites short and long sleeper was associated with a higher risk for diabetes (Zizi et al., 2012). Furthermore, studies have shown that insufficient sleep may lead to weight gain, obesity, diabetes, cardiovascular disease and stress which triggers the dysregulation of metabolism (Beccuti et al., 2011 and Knutson KL, 2010) and increase immune system resulting in appetite dysregulation and cardiometabolic disease (Grandner et al., 2010 and Knutson KL, 2010). A recent study using Florida's Behavioral Risk Factor Surveillance System (BRFSS) suggests that being overweight, obese, hypertensive, hypercholesterolemic, and arthritis have significantly associated with prediabetes (Okwechime et al., 2015).

Additionally, eating pattern has altered both sleep duration and sleep quality. Evidence has shown that sleep duration of 7 to 8 hours has been positively associated with better diet quality (Xiao et al., 2016), with a higher protein, fruits, and vegetable consumption along with low fat intake (Dashti et al., 2015). Similarly, good sleep quality has been associated with higher vegetable intake and negatively associated with fat consumption (Grandner et al., 2010). A recent meta-analysis, a prospective study observe that short sleep was associated with an increased risk of obesity by 45% compared with normal sleep duration (Wu, Zhai, & Zhang, 2014), and adherent to healthy diet pattern characterized by fruits, vegetables, legume, poultry, and fish is inversely associated with diabetes (Jannasch & Schulze, 2017). Moreover, studies have shown that unhealthy eating pattern has been associated with a higher risk of cardiovascular disease (Lopez-Cepero et al., 2018) among patient with type II diabetes (Herrera et al., 2017; and Liday & Kirkpatrick, 2019).

There is a notable lack of research on the relationship between the socio-demographic and clinical characteristics, and self-reported sleep duration, among patients with prediabetes. Therefore, the present study will help us to address the gap and increase our understanding regarding sleep duration and prediabetes.

Chapter 3 – Data and Methods

Study design

This is a cross-sectional, descriptive study used secondary data from a diabetes prevention trial (Predicts) which assess the effectiveness of digitally-delivered diabetes prevention program to reduce hemoglobin A1c and body weight of patients with prediabetes, compared to usual care.

Description of the Predicts trial

In the Predicts trial, the participants with prediabetes (n=599) were enrolled from Nebraska Medicine or greater Omaha community between September 2017 and March 2019. The inclusion criteria include (a) age 19 years or above; (b) at risk for diabetes, defined as a screening venipuncture HbA1c of 5.7%-6.4% (prediabetes); (c) not diagnosed with Type II Diabetes; (d) able to engage in physical activity and adapt eating habits; (e) medically stable and (f) willing to be randomized to either intervention group. The exclusion criteria included conditions that may interfere or restrict to implement the Omada Health Program (e.g., acute, unstable medical conditions). The research team distributed confidential paper-based/electronic survey at the healthcare sites. Participation in the survey was voluntary based on informed consent shared with the potential participants at the beginning of the survey. The survey was completed by the participants themselves or with the help of a research assistant when needed. The study was approved by the Institutional Review Board (IRB) at the University of Nebraska Medical Center.

Study sample

For our secondary data analysis, we limited the sample size to 578, who self-reported about their sleep duration and where further categorized as an optimal sleep with 7 to 9 hours of sleep per day, and non-optimal sleep as <7 hours and >9 hours. Our sub-sample consisted of approximately 97% of the full dataset.

Measures

Independent Variables

Baseline socio-demographic questionnaire collected information on age which was treated as a continuous variable; gender was categorized into male, female; race was categorized as Whites, African American; education was categorized as up to high school (high school graduate, never attended school, elementary, some high school) and some college or more (some college, college graduate and advanced degree); marital status was categorized as married (married or living with someone) and not married (divorced, separated, widowed and never married); employment status was categorized as employed (full-time, part-time and self-employed) and not employed (retired, student, a homemaker, unable to work due to disability, not currently working and seeking for employment); household income was categorized as ≤ $24,999, $25,000-$49,999, $50,000-$74,999, ≥ $75,000; smoking status was categorized yes, no; self-rated health was categorized as high (excellent, very good, and good) and low (fair and poor). The participant's medical record was reviewed for diabetes biomarker hemoglobin A1c (HbA1c), which is treated as a continuous variable; anthropometrics measures include BMI, blood pressure, HDL (high-density lipoprotein), and triglycerides used as a continuous variable. Sleep pattern was obtained from the medical outcome study sleep scale (MOS-sleep) (Stewart & Ware, 1992). The eating pattern was assessed by starting the conversation questionnaire (Paxton et al., 2011), and for the physical activity, we used Godin's leisure-time physical activity questionnaire (Godin, 2011).

Physical activity:

Physical activity was assessed by using Godin Leisure-Time Physical Activity Questionnaire (GLTPAQ): It is a 4-item self-administered questionnaire to assess leisure-time physical activity and to classify physical activities or exercises performed by the adults, and to determine their physical activity level. The survey seeks information on the numbers of times individuals engage in strenuous (heart beats rapidly), moderate (non-exhausting), and mild (minimal effort) of at least 15 minutes duration of per week. Additionally, each frequencies score is multiplied by a corresponding Metabolic Equivalent of Task (MET) score (i.e., 3 for mild, 5 for moderate, and 9 for strenuous intensity) and summed to obtained total leisure activity score expressed in the arbitrary unit (Godin, 2011). Physical activity was used as a continuous variable from leisure score, higher the score indicate the individual is active, and a lower score indicates insufficiently active/sedentary.

Eating pattern:

The eating pattern was assessed by Starting the conversation questionnaire: It is an 8-item self-reported questionnaire to assess the frequency of dietary patterns. Starting the conversation questionnaire ask eight questions to measure the frequency of eating pattern such as fast food (less than 1 time, 1-3 times, 4 or more times); beans, chicken or fish (3 or more times, 1-2 times, and less than1 time); chips or crackers (1 time or less, 2-3 times, and 4 or more times); dessert and other sweets (1 time or less, 2-3 times, and 4 or more times) per week, and fruits (5 or more, 3-4 times, and 2 or less); vegetables (5 or more, 3-4 times, and 2 or less); regular sodas (less than 1, 1-2 times, and 3 or more) per day, and quantity of margarine, butter or meat (very little, some, and a lot). The item scores are added to create a summary score, which ranges from 0-16, with a lower summary score reflecting a healthful diet and higher score reflecting the greater room for improvement (Paxton et al., 2011). The total summary score was used as an eating pattern, which was considered as continuous variables.

Outcome Variable

Sleep duration:

Sleep duration was assessed by Medical Outcomes Study Sleep Scale (MOS-Sleep): The MOS-sleep is a 12-item questionnaire which includes six dimensions evaluating sleep disturbance (items 7, 3, 8, and 1), sleep adequacy (items 4 and 12) somnolence (9,11 and 6), a quantity of sleep (item 2), snoring (item 10), and awakening short of breath or with a headache (item 5). Higher the score for individual dimension, sleep disturbance, somnolence, snoring, and awaken short of breath or with headache would indicate poor sleep outcome. However, for the sleep adequacy and quantity of sleep, higher the score indicates better sleep outcomes (Stewart & Ware, 1992). Sleep duration was assessed by the questions: "On the average, how many hours did you sleep each night during the past 4 weeks?" Using a recommendation from the National Sleep Foundation (NSF), sleep duration was categorized as optimal sleep when an individual sleeps 7-9 hours per day and non-optimal sleep as <7 or >9 hours (Hirshkowitz et al., 2015).

Data analysis

Descriptive statistics were used to characterize the sample at baseline, the continuous variable was expressed as mean ± standard deviation (SD), and the categorical variable was expressed as absolute values and percentages. A Chi-square test or Fischer's exact test was used to assess the significant differences between the groups for the categorical variables and t-test was used to evaluate the differences with respect to the continuous variable.

The association for predictive variables with the outcome (optimal versus non-optimal sleep) was examined initially with the bivariate logistic regression, and later multiple logistic regression was used to explore the association of socio-demographic information (age, gender, race, education, marital status, employment, and household income), cardiovascular risk factors (waist circumference, BMI, blood pressure, smoking status, triglycerides, HDL, eating pattern, and physical activity), and diabetic biomarker (HbA1c). The results were expressed as the odd crude ratio (OR) and adjusted odds ratio (AOR) and 95% confidence intervals (CI) of these outcomes associated with having an optimal sleep compared to non-optimal sleep. For all the interpretations, a significance level of alpha = 0.05 (two-sided) was used. Data were analyzed using statistical software IBM SPSS version 22 for windows.

Chapter 4 – Results

Socio-demographic and clinical characteristics of the participants

The socio-demographic and the clinical characteristics of the participants by their sleep duration (optimal versus non-optimal) are summarized in Table 1. Our analysis sample consisted of 578 participants, with 318 participants in optimal sleep, and 226 participants in the non-optimal sleep. The median age of the participants in the optimal sleep was older when compared with the non-optimal sleep group (56.69 ± 13.04 vs. 54.07 ± 12.24; p=0.012). More than 50% of the sample were females, the majority were Whites (94%), and had at least some college or more education (88%). There was a significant difference between race (Whites; African American), employment status (employed; not employed), and eating pattern among optimal vs. non-optimal sleep (p<0.05). Additionally, self-rated health status was borderline significant (p=0.055) among optimal vs. non-optimal sleep. Furthermore, most of the participants were obese with a mean BMI of 36.55 $kg/m^{2,}$ and the mean triglycerides in the sample population are 195.70 mg/dl.

Association between the independent variable and the outcome variable (sleep duration)

Table 2 displays the odds ratio and the adjusted odds ratio of factors associated with optimal sleep among patients with prediabetes. In the unadjusted model, optimal sleep was statistically significantly associated with age (OR=0.98), White (OR=2.53), and eating pattern (OR=0.92); and having high self-rated health was somewhat significant (OR=1.51; p=0.056).

After the adjusted regression model, employment (adjusted odds ratio [AOR]= 0.59; CI: 0.37-0.92) and eating pattern (AOR= 0.926; CI: 0.85-0.99) were negatively associated with optimal sleep. Prediabetic patients being White in the race were 1.98 times more likely to have an optimal sleep compared to African Americans (CI=0.88-4.46). Being female is 1.09 times more likely to have optimal when compared with men (CI= 0.69-1.71), and BMI is 1.02 times more likely to have an optimal sleep (CI= 0.97-1.07). Additionally, age (AOR=1.017; CI= 0.99-1.03), up to high school education (AOR=1.545; CI=0.89-2.66), high self-rated health (AOR= 1.252; CI= 0.76-2.06), and diastolic BP (AOR=1.020; CI=0.99-1.04) were more likely to have optimal sleep. Moreover, HbA1c level (AOR=0.560; CI=0.28-1.11) and physical activity (AOR=0.99;CI=0.98-1.0) were less likely to have optimal sleep. The participant's employment and the eating pattern was associated with optimal sleep. However, BMI, blood pressure, triglycerides, HDL, smoking status, and physical activity were not associated with optimal sleep.

Sleep pattern among patients with prediabetes by optimal sleep

The mean sleep disturbance, snoring, awaken short of breath or with headache, and somnolence was higher in non-optimal sleep when compared with optimal sleep. Moreover, the quantity of sleep and sleep adequacy were higher in optimal sleep when compared with non-optimal sleep (Table. 3). The sleep pattern is highly statistically significant with our outcome variables (optimal and non-optimal sleep).

Eating pattern characteristics

The sample population consumed an unhealthy diet, which includes fast food, chips, dessert, and butter. However, the participants moderately to high consumed fruits, veggies, soda, and beans (Table. 4). Additionally, there was a higher percentage of the unhealthy eating pattern observed in the non-optimal sleep when compared with the optimal sleep. There was a significant difference in the fast-food consumption between optimal and non-optimal sleep (p=0.025). Overall, the total score means of the eating pattern was lower in optimal sleep (7.88; SD=2.41), indicating better healthful diet, and higher in non-optimal sleep (8.30; SD=2.65) indicating unhealthy diet (p=0.047).

Chapter 5 – Discussion

Our study showed that age, race, and eating patterns were significantly associated with optimal sleep, and high self-rated health was somewhat significant in the unadjusted model. Additionally, in the multiple logistic regression, after adjustment for the potential confounding covariates, employment and eating pattern were significantly associated with optimal sleep. Moreover, sleep pattern was adequate in optimal sleep when compared with non-optimal sleep group. The study showed that an unhealthy eating pattern was observed in the non-optimal sleep group.

Sleep characteristics and prediabetes

Findings from our study suggest that despite optimal sleep, the participants were prediabetic. However, the result from the present study contradicts the previously published articles (Mokhlesi et al., 2019; Kowall et al., 2016; and Ghorbani et al., 2015). Epidemiological studies have evaluated the association between sleep duration and the risk of diabetes but with the inconsistent result. Even though some studies have shown the pattern of U-shaped for the relationship between impaired glucose tolerance (IGT) or diabetes, this inconsistency may be due to the effect of heterogenous population, racial/ethnic, and demographic characteristics (Yaggi et al., 2006; Engeda et al., 2013; Mokhlesi et al., 2019; Chao et al., 2011; Kowall et al., 2016; and Buxton & Marcelli, 2010).

Socio-demographic and clinical characteristics and sleep duration

In our study, Whites participants were more likely to have an optimal sleep when compared with African Americans, and these results were consistent with previous studies (Stamatakis et al., 2007; Ruiter et al., 2011; and Krueger et al., 2009). This result also could be due to the high proportion of whites (57%) compared to African Americans (34%) in our study. Previous studies have also documented that men have an increased risk of developing diabetes with altered sleep duration, which is similar to our study findings (Mallon, Broman, & Hetta, 2005). Additionally, we observe a large proportion of high self-rated health status (57%) in optimal sleep compared to non-optimal sleep (43%). This could be due to a high proportion of educated participants (56%) in optimal sleep group compared to non-optimal sleep (44%). Moreover, in our study sample, more than half of the participants had ≥ $75,000 annual income in the optimal sleep group and 42% in the non-optimal group. Surprisingly, the present study indicated that there was no significant association between sleep and cardiovascular disease risk (waist circumference, BMI, systolic and diastolic BP, HbA1c, smoking status, HDL, and triglycerides) factors among patients with prediabetes. This result was inconsistent with other studies in which they have shown that there is a significant association of inadequate sleep with cardiovascular risk factors (Buxton & Marcelli, 2010; Mokhlesi et al., 2019; Gottlieb et al., 2005; and Huang et al., 2020; and Zuraikat et al., 2020). Overall, the mean HDL was 49.21mg/dl which indicate that the participants were at a normal level (Singh & Rohtagi, 2018) and the mean triglycerides in the sample population were 195.70 mg/dl which indicate that the participants were at borderline risk for cardiovascular disease (Harchaoui et al., 2009). This result could be explained as both optimal and non-optimal sleep groups where mostly non-smoker, had optimal blood pressure, and adequate HDL levels.

Eating pattern and sleep duration

Our study showed a significant association between healthy eating patterns and optimal sleep, i.e., if a person has a healthy eating pattern, they tend to have an optimal sleep. This result was consistent with a review paper by Grandner & colleagues indicate that nontraditional eating habit leads to altered sleep, over time unhealthy eating pattern and non-optimal sleep result in chronic health conditions such as obesity, and cardiovascular disease (Grandner et al., 2016). There was a high percentage of the unhealthy eating pattern observed in the non-optimal sleep when compared with the optimal sleep in the present study, which was consistent with the previous studies (Xiao et al., 2016; and Dashti et al., 2015). The mechanism associated with the inadequate sleep and unhealthy eating pattern could be explained by three basic proposed mechanism (a) firstly, with an increase of leisure time, it is predicted that the individual could easily reach out to the food more frequently (b) short sleeper eat more food compared to the long sleeper (c) sleep restriction will cause tiredness which leads to decreased physical activity, thus, result in decreased calorie consumption (Brondel et al., 2010).

Strength and Limitations

Several limitations of our study are noteworthy, considering the results. First, reliance on the self-reported questionnaire can lead to potential recall bias. Secondly, there was a restricted range of HbA1c level as the sample only included patients with prediabetes. The present study uses a secondary dataset that is descriptive in nature; therefore, it is difficult to examine the causality. Finally, our data analysis was based on the quantitative study, not qualitative feedback from the participants, which has a limited depth of analysis and interpretation. Despite these limitations, the study revealed substantial gaps in sleep duration (optimal and non-optimal sleep) among patients with prediabetes and how these gaps might be related to the eating pattern.

Conclusion

This study provides evidence that prediabetic participants with employment and eating patterns were negatively associated with optimal sleep. Moreover, there was a racial difference. Whites participants were more likely to have optimal sleep when compared with African Americans. The result of the study provides useful information that would aid in the development of effective interventions to improve sleep quality, eating patterns among patients with prediabetes. However, a more longitudinal study is necessary to understand the association between sleep duration and prediabetes and other covariates.

Table 1. Sociodemographic and clinical characteristics of patients with prediabetes by sleep duration

Characteristics	Total n (%) or Mean (SD) N= 578	Optimal Sleep (7-9 hrs.) N=318	Non-optimal Sleep (<7 or>9 hrs.) N=260	P-valuee
Age (years)	55.46 (12.73)	56.69 (13.04)	54.07 (12.24)	0.012
Mean waist circumference (cm)	114.97 (14.54)	114.09 (14.53)	115.97 (14.52)	0.116
Gender				0.522
Male	223 (38.7)	119 (53.4)	104 (46.6)	
Female	353 (61.3)	198 (56.1)	155 (43.9)	
Race				0.009
Whites	525	299 (57)	226 (43)	
African American	35	12 (34.3)	23 (65.7)	
Education				0.120
Up to high school	73 (12.7)	34 (46.6)	39 (53.4)	
Some college or more	503 (87.3)	283 (56.3)	220 (43.7)	
Marital status				0.544
Married	423 (73.4)	236 (55.8)	187 (44.2)	
Not- married	153 (26.6)	81 (52.9)	72 (47.1)	
Employment				0.001
Employed	386 (67)	194 (50.3)	193 (49.7)	
Not- employed	190 (33)	123 (64.7)	67 (35.3)	
Household income				0.473
≤ $24,999	39 (6.9)	18 (46.2)	21 (53.8)	
$25,000- $49,999	117 (20.7)	65 (55.6)	52 (44.4)	
$50,000- $74,999	119 (21)	62 (52.1)	57 (47.9)	
≥ $75,000	291 (51.4)	168 (57.7)	123 (42.3)	
Self-rated health				0.055
High	472 (82.1)	269 (57)	203 (43)	
Low	103 (17.9)	48 (46.6)	55 (53.4)	
BMI (kg/m^2)	35.95 (6.34)	35.68 (6.56)	36.24 (6.08)	0.283
Blood Pressure (mmHg)				
Systolic BP	128.62 (15.10)	128.50 (15.27)	128.76 (14.93)	0.833
Diastolic BP	79.47 (10.63)	79.63 (10.41)	79.29 (10.90)	0.699
Smoking status				0.532
Yes	49 (8.5)	29 (59.2)	20 (40.8)	
No	528 (91.5)	288 (54.5)	288 (49.9)	
HbA1c Level (%)	5.821 (0.28)	5.80 (0.28)	5.83 (0.27)	0.295
HDL (mg/dl)	49.21 (12.512)	49.38 (12.812)	49.03 (12.185)	0.737
Triglycerides (mg/dl)	195.70 (115.906)	198.37(118.611)	192.68 (112.922)	0.550
Eating Pattern	8.08 (2.53)	7.88 (2.41)	8.30 (2.65)	0.047
Physical activity	18.94 (19.59)	18.57 (18.40)	19.38 (20.98)	0.623

Note:n= number; SD= standard deviation
Not all columns add up to n=578 due to missing value

Table 2. Multiple Logistic Regression Model of Optimal vs. Non-optimal sleep among patients with prediabetes

Characteristics	Optimal Sleep	
	Adjusted Odd Ratio (AOR)	P-value
Age (yrs.)	1.005 (0.990-1.020)	0.533
Race/Ethnicity		
Whites	ref	
African American	0.952 (0.890-1.018)	0.152
Employment		
Employed	ref	
Not- employed	1.503 (1.010-2.237)	0.045
Self-rated health		
High	ref	
Low	0.727 (0.464-1.140)	0.165
Eating pattern	1.005 (0.990-1.020)	0.533

Note: ref : reference category

Table 4. Eating pattern characteristics of the participants.

Eating characteristics	Total n (%) or Mean (SD)	Optimal sleep	Non-optimal sleep	P-value
Fast food				0.025
<1 time	115 (19.3)	74 (23.3)	41 (14.7)	
1-3 times	290 (48.7)	149 (47)	141 (50.5)	
≥ 4 times	191 (32)	94 (29.7)	97 (34.8)	
Fruit				0.373
≥5 times	13 (2.2)	6 (1.9)	7 (2.5)	
3-4 times	130 (21.8)	76 (23.9)	54 (19.4)	
≤2 times	454 (76)	236 (74.2)	218 (78.1)	
Veggies				0.635
≥5 times	24 (4)	11 (3.5)	13 (4.7)	
3-4 times	199 (33.3)	110 (34.6)	89 (31.9)	
≤2 times	374 (62.6)	197 (61.9)	177 (63.4)	
Soda				0.151
<1 time	408 (68.3)	219 (68.9)	189 (67.7)	
1-2 times	146 (24.5)	82 (25.8)	64 (22.9)	
≤2 times	43 (7.2)	17 (5.3)	26 (9.3)	
Beans				0.329
≥3 times	300 (50.3)	164 (51.6)	136 (48.7)	
1-2 times	232 (38.9)	125 (39.3)	107 (38.4)	
<1 time	65 (10.9)	29 (9.1)	36 (12.9)	
Chips				0.950
≤1 time	257 (43)	138 (43.4)	119 (42.7)	
2-3 times	253 (42.4)	135 (42.5)	118 (42.3)	
≥4 times	87 (14.6)	45 (14.2)	42 (15.1)	
Dessert				0.391
≤1 time	140 (23.5)	75 (23.6)	65 (23.3)	
2-3 times	261 (43.7)	146 (45.9)	115 (41.2)	
≥4 times	196 (32.8)	97 (30.5)	99 (35.5)	
Butter				0.209
Very little	178 (29.8)	95 (29.9)	83 (29.7)	
Some	346 (58)	191 (60.1)	155 (55.6)	
A lot	73 (12.2)	32 (10.1)	41 (14.7)	
Total score (mean, SD)	8.08 (2.53)	7.88 (2.41)	8.30 (2.65)	0.047

*Note: The total mean score, lower the better healthful diet and higher indicate unhealthy diet

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