ASSOCIATION BETWEEN CHRONIC DISEASE AND SLEEP QUALITY AND DURATION AMONG 18-59-YEAR-OLD ADULTS IN SOUTHERN CHINA

Yanyan Wu[1], Yucai Zhang[3], Yafei Wu[4], Liying Fu[1], Xiao Wu[1], Lingling Huang[5], Xiaoxiao Wang[6], Bingbing Li[1], Zhenzhen Su[1], Bo Li [1] and Peixi Wang[1,2]

[1]Institute of Chronic Disease Risks Assessment, School of Nursing and Health, Henan University, Kaifeng; [2] General Practice Center, Nanhai Hospital,Southern Medical University, Foshan; [3]The People's Hospital of Longhua Shenzhen, Shenzhen; [4]First People's Hospital of Shangqiu, Shangqiu,Henan Province; [5]Institute of Nursing and Health, Shanghai Lida University, Shanghai; [6]Nursing Department, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei Province, China

Abstract. Disordered sleep can have deleterious effects, both physical and mental. In this study we aimed to determine the prevalence of disordered sleep and the association between the quality and length of sleep and the presence of chronic disease among 18-59-year-old adults in southern China. This cross-sectional study was conducted during 2017. Study subjects were selected from 4,536 individuals aged 18-59 years. After applying inclusion and exclusion criteria, 4,257 subjects were included in the final analysis; 50.2% were male. Each subject was asked to complete a Chinese language version of the Pittsburgh Sleep Quality Index (PSQI). A PSQI score ≥7 was defined as poor sleep quality and sleep duration <7 hours was defined as inadequate sleep duration. Study subjects were also asked about chronic disease by the question "Has a doctor ever diagnosed you with a chronic disease?" We used univariate logistic regression analysis and clustered logistic regression analysis to assess responses to determine an association between disordered sleep and chronic disease. The mean [±standard deviations (SD)] age of study subjects was 42.62 (±8.24) years. The prevalences of poor sleep quality and inadequate sleep duration among study subjects were 15.6% and 23.1%, respectively. The prevalence of subjects with chronic disease was 16.7%. The most common chronic diseases reported were hypertension (12.6%), diabetes (3.6%), chronic pain (1.8%) and heart disease (1.5%). Among study subjects, chronic disease was significantly associated with poor sleep quality [crude odds ratio (cOR=1.50; 95% confidence interval (CI): 1.23-1.84; $p<0.001$] and inadequate sleep duration (cOR=1.30; 95%CI: 1.09-1.56; $p=0.004$) compared to those without chronic disease. In our study, the prevalences of poor sleep quality and inadequate sleep duration were high and were significantly associated with chronic disease. Further studies are needed to determine the relationship of this association, if it is etiological or associated with some other factors, in order to inform plans to reduce the prevalences of these chronic disease.

Keywords: sleep duration, sleep quality, chronic disease, young and middle-aged adults

Correspondence: Peixi Wang, [1]Institute of Chronic Disease Risks Assessment, School of Nursing and Health, Henan University, Kaifeng, 475004, China; [2]General Practice Center, Nanhai Hospital, Southern Medical University, Foshan 52800, China.
Tel:+86 18927539896; E-mail: peixi001@163.com

INTRODUCTION

Human sleep is important for human cognition (Walker, 2009), metabolism (Adamantidis *et al*, 2009) and immunity (Opp and Krueger, 2015). Poor sleep quality and inadequate sleep duration are public health problems (Colten *et al*, 2006). The Pittsburgh Sleep Quality Index (PSQI) has been validated in the Chinese population as an accurate, standardized measure of sleep quality and duration (Zhang *et al*, 2016). A previous study reported the prevalence of disordered sleep ranges from 10% to 50% (Ohayon, 2002). The Global Epidemiological Survey of Adult Insomnia reported 28.0% of Chinese adults have a sleep disorder (Soldatos *et al*, 2005). Another study reported 27.4% of adults in Switzerland complained of disordered sleep (Rössler *et al*, 2017). Disordered sleep can have a direct impact on human physical (Atkinson and Davenne, 2007) and mental disorders (Chee *et al*, 2008). Fewer than 15% of people with disordered sleep seek treatment (Morin *et al*, 2011).

Sleep quality has been reported to be associated with demographic variables and chronic disease (Ancoli-Israel and Roth, 1999; Ohayon and Smirne, 2002; Assari *et al*, 2013). Numerous studies reported an increasing prevalence of insomnia symptoms with increasing age (Ancoli-Israel and Roth,1999; Ancoli-Israel, 2009; Wong and Fielding, 2011). A population-based study found the prevalence of sleep disorders was lower in younger age groups (Wong *et al*, 2011), but increases with increasing age (Ancoli-Israel, 2009). Bixler *et al* (2009) reported factors associated with disturbed sleep varied by age group.

Han-Na *et al* (2015) and Beck *et al* (2013) found women had significantly more problems with disturbed sleep than man. Smoking (Mehari *et al*, 2013) and alcohol drinking (Simou *et al*, 2018) have also been reported to be associated with poor sleep quality. Other studies have reported an association between sleep quality and some chronic diseases, such as diabetes (Luyster and Dunbar-Jacob, 2011), stroke (Zhang *et al*, 2014) and cancer (Fortmann *et al*, 2018). One study from China reported poor sleep quality was associated with hypertension (Liu *et al*, 2016). Poor sleep quality has also been reported to be associated with cardiovascular and metabolic diseases (Bernert *et al*, 2014).

Factors reported to be associated with sleep duration include age (Krueger and Friedman, 2009), being married (Ferrie *et al*, 2007), employment status (Krueger and Friedman, 2009), socioeconomic status (Ferrie *et al*, 2007) and education level (Krueger and Friedman, 2009). Ursin (2008) reported sleep duration decreased when the number of cigarettes smoked per day increased. A meta-analysis of studies regarding sleep duration reported sleep duration did not increase with increasing exercise but sleep quality did (Yang *et al*, 2012). A meta-analysis of sleep duration and hypertension reported shorter sleep duration among those with hypertension (Wang *et al*, 2012). Studies have found

sleep duration to be associated with cardiovascular disease (Buxton and Marcelli, 2010; Sabanayagam and Shankar, 2010), diabetes (Buxton and Marcelli, 2010), obesity (Buxton and Marcelli, 2010) and depression (Akerstedt and Nilsson, 2003).

The prevalence of disordered sleep and associated factors among Chinese adults has not been much studied. In this study we aimed to determine the prevalence of inadequate sleep length and quality and their association with chronic disease among adults aged 18-59 years in southern China in order to guide further studies for modifying these factors to reduce the prevalence of chronic diseases in the study population.

MATERIALS AND METHODS

Study design and subjects

We conducted a cross-sectional community health survey in the Pearl River Delta region of China in 2017. The number of study subjects required for the study was determined as follows: we assumed the prevalence of poor sleep to be 20%, considering a maximal deviation of 1.25% and a type one error of 5%, the minimal sample size needed for the study was determined to be 3,934. Study subjects were chosen using a multistage stratified random sampling method, as previously described (Zhang *et al*, 2016). A family was the basic survey unit in this study. A total of 3,654 households comprised of 7,687 individuals were chosen for the study. Of these individuals, 4,536 were aged 18-59 years. After applying inclusion and exclusion criteria, the number of study subjects was 4,257 (93.8%). The inclusion criteria were: 1). living in the study area for at least 6 months; 2). being aged 18-59 years; 3). having no cognitive impairment and being able to communicate normally. The exclusion criteria were: 1). having severe cognitive impairment; 2). having an acute disease or emergency condition; 3). having a physical disability or being bed-ridden; 4). refusing to participate in the study or not responding when contacted; 5). filling out the questionnaire incompletely.

Procedures

Trained medical students and community health center staff conducted face-to-face interviews with all the study subjects using a standardized questionnaire asking about demographic data and other specific factors mentioned below. In addition to this data, each subject was also asked to complete a Chinese language version of the Pittsburgh Sleep Quality Index (PSQI) Questionnaire.

Sleep quality measures

The Chinese version of the PSQI is a scale used to evaluate sleep quality over the previous month (Buysse *et al*, 1989). The Chinese language version of the PSQI consists of 19 self-evaluation items and 5 other-evaluation items; 18 of these items are used for scoring and are divided 7 sub-categories: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each category is given a score ranging from 0 to 3 points. The global PSQI score is a sum of these subcategory scores. The higher the score, the worse the sleep quality (Buysse *et al*, 1989). A global PSQI score ≥7 points has a diagnostic sensitivity of 98.3% and a specificity of 90.2% for sleep quality (Liu *et al*, 1996). A single subcategory score >1 is considered abnormal for this subcategory.

Sleep duration measures

The PSQI scale asks "How many hours do you usually sleep per night?"

to assess their sleep duration. Studies of adequate sleep duration have varying definitions of inadequate sleep duration without an agreed upon common definition (Cappuccio *et al*, 2010). Based on 2 previous studies (Pergola *et al*, 2017; Xu *et al*, 2017) we defined inadequate sleep duration as <7 hours sleep per night.

Other measures

The general questionnaire consisted of questions about sociodemographic variables (age and gender), health-related factors (current smoking, alcohol drinking and physical exercise) and history of chronic diseases. Current smoker was defined as smoking at least one or more cigarettes per day for the previous six months. Alcohol drinker was defined as consuming at least 30 g of alcohol per week for the previous year. Physical exercise was asked with the question, "How many times do you exercise per week?". Body Mass Index (BMI) was calculated as the subject weight (kg) divided by the square of the height (m^2). Illness within 2 weeks was defined as being sick during the previous 2 weeks. The presence of chronic disease was asked about with the question, "Has a doctor ever diagnosed you with a chronic disease?" (Smith *et al*, 2008). The chronic diseases assessed for association with disordered sleep in this study were: hypertension, diabetes mellitus, chronic pain, heart disease, chronic gastrointestinal disease, osteoporosis and cancer.

Statistical analyses

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 13.0 (SPSS, Chicago, IL). Means and standard deviations (SD) were used for continuous variables, while frequencies and percentages were used for categorical variables. The two dependent (outcome) variables were poor sleep quality and inadequate sleep duration. Univariate logistic regression analysis was used to calculate odds ratios (OR) and 95% confidence intervals (95% CI) for associations between chronic disease and inadequate sleep quality and duration. Clustered logistic regression analysis was used to assess associations between sociodemographic factors, health related factors and chronic disease (three clusters) and sleep quality and duration (Nagelkerke, 1991). We used clustered logistic regression analysis due to multidirectional correlations that could exist between the three clusters and the dependent variables.

The independent effect of each cluster was assessed using the corresponding R^2 value between the two regression models. The independent contribution share of each cluster was calculated as individual R^2 change/total R^2 change in the final model×100%. In the logistic regression models, the R^2 was the Nagelkerke "pseudo" R^2 which is analogous to the classical R^2 in the linear regression models for data interpretation (Nagelkerke, 1991). A two-tailed p-value <0.05 were considered statistically significant.

Ethics and consent

The study protocol was approved by the People's Hospital of Longhua Shenzhen Medical Ethics Committee (2917055). Written informed consent was obtained from all study participants prior to being included in the study.

RESULTS

A total of 4,257 subjects were included in the study; 2,136 (50.2%) were males. The average (±SD) age of study subjects was 42.6 (±8.2) (range: 18-59) years. The prevalence of chronic diseases among

Table 1
Characteristics of study subjects (N =4,257).

Variables	Mean ± SD	*n* (%)
Cluster 1 sociodemographics		
Age in years	42.62 ± 8.24	
Male gender		2,136 (50.2)
Married		2,427 (57.0)
Education level		
High school or above		1,499 (35.2)
Middle school		2,112 (49.6)
Primary school or below		646 (15.2)
Employed		2,655 (62.4)
Cluster 2 health related factors		
Current smoker		726 (17.1)
Alcohol drinker		945 (22.2)
Exercise regularly		3,498 (82.2)
Illness within previous 2 weeks		476 (11.2)
BMI (kg/m^2)	23.27 ±2.87	
Cluster 3 history of chronic disease		
Hypertension		537 (12.6)
Diabetes mellitus		153 (3.6)
Chronic pain		75 (1.8)
Heart disease		65 (1.5)
Chronic disease		711 (16.7)
Number of chronic diseases		
0		3,546 (83.3)
1		563 (13.2)
≥2		148 (3.5)
Outcomes		
PSQI score	3.43±2.75	
Good (<7)		3,593 (84.4)
Poor (≥7)		664 (15.6)
Subjective sleep quality	1.01±0.94	
Sleep latency	0.67±0.78	
Sleep duration	0.29±0.58	
Sleep efficiency	0.29±0.59	
Sleep disturbances	0.29±0.60	
Use of sleeping medication	0.29±0.61	
Daytime dysfunction	0.29±0.62	
Sleep duration in hours	7.86±1.08	
<7		982 (23.1)
≥7		3,275 (76.9)

BMI, body mass index; SD, standard deviation.

Table 2
Association between chronic diseases[a] and sleep quality and sleep duration.

Variables	Poor sleep quality		Inadequate sleep duration	
	OR[b] (95 %CI)	*p*-value	OR[b] (95%CI)	*p*-value
Hypertension				
No	Reference	<0.001[e]	Reference	0.001[d]
Yes	2.61 (2.12-3.22)		1.95 (1.60-2.36)	
Diabetes mellitus				
No	Reference	<0.001[e]	Reference	0.801
Yes	2.49 (1.72-3.60)		0.95 (0.64-1.40)	
Chronic pain				
No	Reference	0.004[d]	Reference	0.004 [d]
Yes	3.32 (2.02-5.03)		2.01 (1.25-3.23)	
Heart disease				
No	Reference	0.02[c]	Reference	0.019[c]
Yes	1.94 (1.11-3.39)		1.85 (1.11-3.08)	
Chronic disease				
No	Reference	<0.001[e]	Reference	0.004[d]
Yes	1.50 (1.23-1.84)		1.30 (1.09-1.56)	
Number of chronic diseases				
0	Reference	0.001[d]	Reference	<0.001[e]
1	2.01 (1.61-2.49)	<0.001[e]	1.24 (1.01-1.53)	0.037[c]
≥2	4.92 (3.35-7.22)	<0.001[e]	2.62 (1.86-3.97)	<0.001[e]

BMI, body mass index; OR, odds ratio; CI, confidence interval.
[a]Chronic diseases included as predictor variables for poor sleep quality and inadequate sleep duration on univariate logistic regression analysis without adjusting for other variables.
[b]Crude OR of short sleep duration and poor sleep.
[c]$p< 0.05$, [d]$p< 0.01$, [e]$p< 0.001$.

the 4,257 subjects was 16.7%; 12.6% had hypertension; 3.6% had diabetes mellitus; 1.8% had chronic pain and 1.5% had heart disease. The mean (±SD) global PSQI score was 3.43 (±2.75) points and the prevalence of a PSQI score ≥7 points was 15.6%. The average (±SD) sleep duration was 7.86 (±1.08) hours. Twenty-three point one percent of subjects reported inadequate sleep duration (<7 hours) (Table 1).

On univariate analysis, chronic disease was significantly associated with poor sleep quality [(cOR)=1.50; 95CI: 1.23-1.84; p<0.001) and inadequate sleep duration (cOR=1.30; 95%CI: 1.09-1.56; p=0.004) compared to those without chronic disease (Table 2). Hypertension, chronic pain and heart disease more significantly association with poor sleep quality and inadequate sleep duration but diabetes

mellitus was only significantly associated with poor sleep quality but not inadequate sleep duration. The odds of having poor sleep quality and inadequate sleep duration increased significantly with increasing number of chronic diseases.

On multivariate logistic regression analysis of sociodemographic factors (cluster 1), gender, marital status and education level were significantly associated with poor sleep quality. On multivariate logistic regression analysis of health-related factors (cluster 2), alcohol drinking, physical exercise, BMI, and illness during the previous 2 weeks were significantly associated with poor sleep quality. The independent contributions of clusters 1 and 2 to poor sleep quality were 73.5% and

Table 3
Clustered logistic regression analysis of association between poor sleep quality by sociodemographic factors (cluster 1), health-related factors (cluster 2) and chronic diseases (cluster 3) among study subjects.

Predictor variables	OR (95%CI)	*p*-value*	Nagelkerke[a] R^2	Independent contribution (%)[b]
Cluster 1				
Gender				
Male	Reference	0.046		
Female	1.20 (1.01-1.44)			
Marital status				
Single	Reference	0.012		
Married	0.75 (0.60-0.94)			
Education level				
High school or above	Reference	0.024		
Middle school	1.34 (1.06-1.70)	0.017		
Primary school or below	1.49 (1.10-2.01)	0.010		
Total			0.125	73.5
Cluster 2				
Alcohol drinker				
No	Reference	0.033		
Yes	1.29 (1.02-1.64)			
Exercise regularly				
Yes	Reference	0.006		
No	1.36 (1.09-1.69)			
BMI (kg/m^2)	1.04 (1.01-1.07)	0.006		
Illness within previous 2 weeks				
No	Reference	<0.001		
Yes	2.01 (1.56-2.60)			
Total			0.147	12.9

Table 3 (Continued)

Predictor variables	OR (95%CI)	*p*-value*	Nagelkerke[a] R^2	Independent contribution (%)[b]
Cluster 3				
Hypertension				
No	Reference	0.014		
Yes	1.46 (1.08-1.97)			
Diabetes mellitus				
No	Reference	0.032		
Yes	1.54 (1.04-2.27)			
Chronic pain				
No	Reference	0.013		
Yes	1.96 (1.15-3.34)			
Number of chronic diseases				
0	Reference	<0.001		
1	1.42 (1.05-1.91)	0.021		
≥2	2.58 (1.59-4.17)	<0.001		
Total			0.170	13.5

BMI, body mass index; OR, odds ratio; CI, confidence interval.
[a]Nagelkerke R^2 is the variance of the dependent variable (poor sleep quality) explained by all independent variables included in the regression model.
[b]The independent contribution of each cluster of predictors to the variation in poor sleep quality was calculated as the individual corresponding R^2 change / total R^2 change in the final model×100%.
*Only variables with $p<0.05$ were included in the model.

12.9%, respectively. On multivariate logistic regression analysis of diseases (cluster 1), subjects with hypertension (OR=1.46; 95%CI: 1.08-1.97; $p=0.014$), diabetes mellitus (OR=1.54; 95%CI: 1.04-2.27; $p=0.032$) and chronic pain (OR=1.96; 95%CI: 1.15-3.34; $p=0.013$) had significantly greater odds of having poor sleep quality than those without these diseases. The independent contribution of cluster 3 to poor sleep quality was 13.5% (Table 3).

Among sociodemographic factors (cluster 1), only employment status was associated with inadequate sleep duration (Table 4). Among health related factors (cluster 2), alcohol drinking, BMI and illness during the previous 2 weeks were associated with inadequate sleep duration. The independent contributions of clusters 1 and 2 to inadequate sleep duration were 18.9%, 32.1%, respectively. Among diseases (cluster 3), hypertension and chronic pain were significantly associated with inadequate sleep duration. The independent contribution of cluster 3 to inadequate sleep duration was 49.1%.

DISCUSSION

To the best of our knowledge, this was the first study of the association

Table 4
Clustered logistic regression analysis of association between inadequate sleep duration by sociodemographic factors (cluster 1), health-related factors (cluster 2) and chronic disease (cluster 3) among study subjects.

Predictor variables	OR (95%CI)	*p*-value*	Nagelkerke[a] R^2	Independent contribution (%)[b]
Cluster 1				
Employment status				
Unemployed	Reference	<0.001		
Employed	1.61 (1.32-1.95)			
Total			0.010	18.9
Cluster 2				
Alcohol drinker				
No	Reference	0.002		
Yes	1.40 (1.16-1.68)			
BMI	1.05 (1.03-1.08)	<0.001		
Illness within previous 2 weeks				
No	Reference	0.003		
Yes	1.38 (1.11-1.72)			
Total			0.027	32.1
Cluster 3				
Hypertension				
No	Reference	0.028		
Yes	1.37 (1.03-1.81)			
Chronic pain				
No	Reference	0.032		
Yes	1.75 (1.05-2.93)			
Number of chronic diseases				
0	Reference	<0.001		
1	1.46 (1.10-1.95)	0.010		
≥2	2.98 (1.86-4.91)	<0.001		
Total			0.053	49.1

BMI, body mass index; OR, odds ratio; CI, confidence interval.
[a]Nagelkerke R^2 is the variance of the dependent variable (inadequate sleep duration) explained by all independent variables included in the regression model.
[b]The independent contribution of each cluster of predictors to the variation in inadequate sleep duration was calculated as the individual corresponding R^2 change/total R^2 change in the final model×100%.
*Only variables with $p<0.05$ were included in the model.

between chronic disease and poor sleep quality and inadequate sleep duration among adults aged 18-59 in southern China. In our study, chronic disease was significantly associated with poor sleep quality and inadequate sleep duration after adjusting for other variables. The independent influence of chronic disease on poor sleep quality was smaller than the influence of sociodemographic factors on poor sleep quality but larger than the influence of sociodemographic factors and health-related factors on inadequate sleep duration.

In this study, the prevalences of poor sleep quality (PSQI≥7) and inadequate sleep duration (<7 hours) were found in 15.6% and 23.1%, respectively. Previous studies reported that the prevalence of poor sleep quality varied from 20% to 40% (Ohayon and Smirne, 2002; Magee *et al*, 2008). The lower prevalence of poor sleep quality found in our study may be due to a different cut-off point used to define with poor sleep quality. In our study, age was not associated with poor sleep quality or inadequate sleep duration unlike the result of a study of Rössler *et al (*2017) among similar aged adults. This may be because the elderly were excluded from our study; the elderly being more likely to have age-related health problems that might affect sleep.

Women in our study were more likely to have poor quality sleep, similar to the finding of several previous studies (Hale and Do, 2007; Beck *et al*, 2013). It may be because women have the double pressure of caring for family and working. Health and mood problems have been reported to influence sleep quality among women (Beck *et al*, 2013). In our study, single individuals were more likely to have poor sleep quality, similar to the finding of a previous study (Ohayon and Smirne, 2002). Smoking, alcohol drinking and physical exercise were previously reported to be associated with poor sleep quality (Tseng *et al*, 2014; Zhang *et al*, 2016) but in our study, only alcohol drinking and physical exercise were significantly associated with poor sleep quality. In our study, BMI was also associated with poor sleep quality and and inadequate sleep duration, similar to a previous study (Garaulet *et al*, 2011).

Employees in our study were significantly more likely to have inadequate sleep duration. In our study, illness during the previous 2 weeks was associated with poor sleep quality and inadequate sleep duration. A previous study reported illness during the previous 2 weeks indicated poor health, which was related to poorer health-related quality of life, which is associated with disordered sleep (Cui *et al*, 2015).

In our study, chronic diseases were associated with poor sleep quality and inadequate sleep duration similar to previous studies showing chronic disease being associated with poor sleep quality (Buxton and Marcelli, 2010) and inadequate sleep duration (Lou *et al*, 2015). A previous study from China reported poor sleep quality was associated with hypertension (Liu *et al*, 2016). A systematic review and meta-analysis reported hypertension was associated with inadequate sleep duration (Wang *et al*, 2012). This could be because both sleep disorders and hypertension have physiological, psychological and environmental factors that influence them. Diabetes mellitus was previously reported to be associated with poor sleep quality and inadequate sleep duration (Lou *et al*, 2015); however, in our study diabetes mellitus was only associated with poor sleep quality but not inadequate sleep duration. Poor sleep quality has been reported to be

associated with heart disease (Bernert *et al*, 2014) and to be associated with inadequate sleep duration (Buxton and Marcelli, 2010). However, in our study, heart disease was not associated with poor sleep quality or inadequate sleep duration.

In our study, chronic pain was associated with poor sleep quality and inadequate sleep duration. Pain is commonly associated with chronic conditions and sleep problems as reported previously (Lamberg, 1999). More than 70% of people suffering from chronic pain have sleep disorders (Cheatle *et al*, 2016). Depression and anxiety caused by chronic illness could also be related to sleep disorders (Ohayon and Roth, 2003) but we did not evaluate this in our study.

Our study had several limitations. First, causation cannot be determined from a cross-sectional study. Second, the data in our study was from self-reports, which could have recall bias. Third, the factors examined in this study were not exhaustive. Mental health problems, which can have a major influence on sleep,were not assessed. Sleep quality, measured by the PSQI was self-reported and lacked an objective evaluation. Further studies are needed to explore cause-effect relationships.

In summary, the prevalences of poor sleep quality and inadequate sleep duration in our study were high and were significantly associated with chronic diseases among our study subjects. Further studies are needed to determined etiologies and if further modification will result in improve sleep quality and duration.

ACKNOWLEDGEMENTS

This study was supported by the Shenzhen Longhua District Science and Technology Innovation Project (2017055). We gratefully acknowledged all respondents who completed the surveys.

REFERENCES

Adamantidis A, Caster MC, de Lecea L. Optogenetic deconstruction of sleep-wake circuitry in the brain. *Front Mol Neurosci* 2009; 2: 31.

Akerstedt TA, Nilsson PM. Sleep as restitution: an introduction. *J Intern Med* 2003; 254: 6-12.

Ancoli-Israel S. Sleep and its disorders in aging populations. *Sleep Med* 2009; 10: S1.

Ancoli-Israel S, Roth T. Characteristics of insomnia in the United States: results of the 1991 National Sleep Foundation Survey. I. *Sleep* 1999; 22: S347.

Assari S, Moghani LM, Kazemi SD, Ahmadi K. Gender modifies the effects of education and income on sleep quality of the patients with coronary artery disease. *Int Cardiovasc Res J* 2013; 7: 141.

Atkinson G, Davenne D. Relationships between sleep, physical activity and human health. *Physiol Behav* 2007; 90: 229-35.

Beck F, Richard JB, Léger D. [Insomnia and total sleep time in France: prevalence and associated sociodemographic factors in a general population survey]. *Rev Neurol (Paris)* 2013; 169: 956-64.

Bernert RA, Turvey CL, Conwell Y, Joiner TE Jr. Association of poor subjective sleep quality with risk for death by suicide during a 10-year period: a longitudinal, population-based study of late life. *JAMA Psychiatry* 2014; 71: 1129-37.

Bixler EO , Papaliaga MN , Vgontzas AN, *et al*. Women sleep objectively better than men and the sleep of young women is more resilient to external stressors: effects of age and menopause. *J Sleep Res* 2009; 18: 221-8.

Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States.

Soc Sci Med 2010; 71: 1027-36.

Buysse DJ, Iii CFR, Monk TH, *et al*. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989; 28: 193-213.

Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. *Sleep* 2010; 33: 585.

Cheatle MD, Foster S, Pinkett A, *et al*. Assessing and managing sleep disturbance in patients with chronic pain. *Sleep Med Clin* 2016; 11: 531-41.

Chee MWL, Tan JC, Zheng H, *et al*. Lapsing during sleep deprivation is associated with distributed changes in brain activation. *J Neurosci* 2008; 28: 5519-28.

Colten HR, Altevogt BM, eds. Sleep disorders and sleep deprivation: an uname public health problem. Washington DC: National Academies Press, 2006.

Cui JY, Tang JX, Qin JM, *et al*.[Analysis on influencing factors of quality of life among the elderly in Hami area by multi-level model]. *Chin J Dis Control Prev* 2015; 19: 240-3 (in Chinese).

Ferrie JE, Shipley MJ, Cappuccio FP, *et al.* A prospective study of change in sleep duration: associations with mortality in the Whitehall II cohort. *Sleep* 2007; 30: 1659-66.

Fortmann J, Fisher A, Hough R , *et al*. Sleep quality, fatigue, and quality of life among teenage and young adult cancer survivors. *J Adolesc Young Adult Oncol* 2018; 2018: 0004.

Garaulet M, Ortega FB, Ruiz JR, *et al*. Short sleep duration is associated with increased obesity markers in European adolescents: effect of physical activity and dietary habits. The HELENA study. *Int J Obes* 2011; 35: 1308-17.

Hale L, Do DP. Racial differences in self-reports of sleep duration in a population-based study. *Sleep* 2007; 30: 1096-103.

Han-Na K, Juhee C, Yoosoo C, *et al*. Association between personality traits and sleep quality in young Korean women. *PLOS One* 2015; 10: e0129599.

Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol* 2009; 169: 1052-63.

Lamberg L. Chronic pain linked with poor sleep; exploration of causes and treatment. *JAMA* 1999; 281: 691-2.

Liu RQ, Qian Z, Trevathan E *et al*. Poor sleep quality associated with high risk of hypertension and elevated blood pressure in China: results from a large population-based study. *Hypertens Res* 2016; 39: 54.

Liu XC, Tang MQ, Hu L, *et al*. [Reliability and validity of the Pittsburgh Sleep Quality Index]. *Chin J Psychiatry* 1996; 29: 103-7. (In Chinese)

Lou P, Zhang P, Zhang L *et al*. Effects of sleep duration and sleep quality on prevalence of type 2 diabetes mellitus: a 5-year follow-up study in China. *Diabetes Res Clin Prac* 2015; 109: 178-84.

Luyster FS , Dunbar-Jacob J. Sleep quality and quality of life in adults with type 2 diabetes. *Diabetes Educ* 2011; 37: 347-55.

Magee CA, Caputi P, Iverson D, Huang XF. An investigation of the dimensionality of the Pittsburgh Sleep Quality Index in Australian adults. *Sleep Biol Rhythms* 2008; 6: 222-7.

Mehari A, Weir NA, Gillum RF. Gender and the association of smoking with sleep quantity and quality in American adults. *Women Health* 2013; 54: 1-14.

Morin CM, Leblanc M, Bélanger L, *et al*. Prevalence of insomnia and its treatment in Canada. *Can J Psychiat* 2011; 56: 540-8.

Nagelkerke NJD. A note on a general definition of the coefficient of determination. *Biometrika* 1991; 78: 691-2.

Ohayon M M. Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med Rev* 2002; 6: 97-111.

Ohayon MM, Roth T. Place of chronic insomnia in the course of depressive and anxiety

disorders. *J Psychiatr Res* 2003; 37: 9-15.

Ohayon MM, Smirne S. Prevalence and consequences of insomnia disorders in the general population of Italy. *Sleep Med* 2002; 3: 115-20.

Opp MR, Krueger JM. Sleep and immunity: a growing field with clinical impact. *Brain Behav Immun* 2015; 47: 1-3.

Pergola BL, Moonie S, Pharr J, Bungum T, Anderson JL. Sleep duration associated with cardiovascular conditions among adult Nevadans. *Sleep Med* 2017; 34: 209-16.

Rössler W, Ajdacicgross V, Glozier N, *et al*. Sleep disturbances in young and middle-aged adults-empirical patterns and related factors from an epidemiological survey. *Compr Psychiatry* 2017; 78: 83-90.

Sabanayagam C, Shankar AP. Sleep duration and cardiovascular disease: results from the National Health Interview Survey. *Sleep* 2010; 33: 1037-42.

Simou E, Britton J, Leonardibee J. Alcohol and the risk of sleep apnoea: a systematic review and meta-analysis. *Sleep Med* 2018; 42: 38-46.

Smith AW, Reeve BB, Bellizzi KM, *et al*. Cancer, comorbidities, and health-related quality of life of older adults. *Health Care Financ Rev* 2008; 29: 41-56.

Soldatos CR, Allaert FA, Ohta T, Dikeos DG. How do individuals sleep around the world? Results from a single-day survey in ten countries. *Sleep Med* 2005; 6: 5-13.

Tseng HC, Wang CJ, Cheng SH, *et al*. [Tea-drinking habit among new university students: associated factors]. *Kaohsiung J Med Sci* 2014; 30: 98-103.

Ursin, R. Lifestyle factors and sleep-a population study. *J Sleep Res* 2008; 17: 144.

Walker MP. The role of sleep in cognition and emotion. *Ann N Y Acad Sci* 2009; 1156:168-97.

Wang Q, Xi B, Liu M, Zhang Y, Fu M. Short sleep duration is associated with hypertension risk among adults: a systematic review and meta-analysis. *Hypertens Res* 2012; 35: 1012-8.

Wong W, Fielding R. Prevalence of chronic fatigue among Chinese adults in Hong Kong: a population-based study. *J Sleep Res* 2011; 127: 248-56.

Xu XL, Liu DY, Zhang Z, Sharma M, Zhao Y. Sleep duration and quality in pregnant women: a cross-sectional survey in China. *Int J Envinon Res Public Health* 2017 Jul 20; 14(7).pii:E817.

Yang PY, Ho KH, Chen HC, *et al*. Exercise training improves sleep quality in middle-aged and older adults with sleep problems: a systematic review. *J Physiother* 2012; 58: 157-63.

Zhang HS, Mai YB, Li WD, *et al*. Sleep quality and health service utilization in Chinese general population: a cross-sectional study in Dongguan, China. *Sleep Med* 2016; 27:9-14.

Zhang S, Chang C, Zhang J, *et al*. Correlation analysis of sleep quality and youth ischemic stroke. *Behav Neurol* 2014; 2014: 246841.