Association Of Diabetes With Sleep Duration and Quality in Urban and Rural Cameroonian Community Dwellers

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Abstract

Background Sleep disorders are known to be linked with numerous cardiovascular co-morbidities like diabetes. The prevalence and impact of sleep quality and duration on diabetes in the Cameroonian population is not well established. The aim of our study was to evaluate the separate and combined roles of sleep duration and quality on diabetes mellitus in the urban and rural Cameroonian population.

Methods This was a cross-sectional prospective survey conducted in 249 rural and 250 urban community dwellers in Cameroon aged 18 years and older. Sleep duration (SD) and quality were self-reported using the Pittsburg Sleep Quality Index (PSQI). Poor sleep quality was considered for PSQI score>5 and short SD was considered ≤6h. Diabetes mellitus was considered for fasting blood glucose≥126mg/dL and/or being on glucose-lowering medication(s). Multivariable logistic regression was used to determine the association of sleep duration and quality with diabetes.

Results mean age was 36±12years with 39.1% male participants. Frequency of diabetes was 8.2% and was similar between urban and rural participants (10% vs 6.4% respectively; p=0.188). Frequency of poor sleep quality was 50.3% and was similar in urban and rural groups (48.2% vs 52.4% respectively, p=0.395). Short SD represented 30.5% of the sample and was more frequent in the urban than rural group (36.1% vs 24.8% respectively, p=0.006). Short SD was significantly associated with diabetes (OR 2.62, 95%CI 1.38 – 5.00) while poor sleep quality was not significantly associated with diabetes. Poor sleep quality combined with short SD was strongly associated with diabetes (OR 2.67, 95%CI 1.23- 5.79).

Conclusion there is a necessity to take into account sleep duration and quality in the management of diabetes

Introduction

Insufficient sleep duration and chronic sleep disturbances are known in develop countries as important public health problems. They are endemic in both adults and children (1–3) and they have important consequences on patients, given that they have a great impact on health, work, and quality of life (4–5). Recent population studies show that sleep deprivation and disorders affect many more people worldwide than had been previously reported. Data on the united states population show an average 6.8 h sleep duration per night which is 1.5 h less than that of 100 years ago (6). About 20–30% of the general population is estimated to have various types of sleep disorders and approximately 50–70 million Americans chronically suffer from disorders of sleep (7–9). Factors involved in the increasing burden of sleep disorders are rapid urbanization, increased prevalence of shift work and longer working days, prolonged commute times and activities of multiple leisure time (10). All these factors are of greatest increase in low-and-middle income countries, particularly in sub-Saharan Africa.

Numerous previous studies have associated habitual short sleep duration to important adverse cardio-metabolic outcomes, including weight gain, hypertension, obesity, diabetes, metabolic syndrome as well as other cardiovascular diseases (11–13). As Concerns diabetes mellitus, recent meta-analysis show a 30% increase in the risk of diabetes in participants with short sleep duration (14–15). It had also been demonstrated in healthy adults that sleep restriction results in increased insulin resistance (16) and decreased insulin sensitivity (17). Poor sleep quality known as insomnia has been also linked with type 2 diabetes mellitus and insulin resistance (18).

Although there are many evidences linking short sleep duration with diabetes, most of the studies did not examine the separate role of various sleep aspects in the development of diabetes. Considering the fact that various sleep disturbances often concurrently occur, it is important to tell the exact contribution of each sleep aspect as well as the association of sleep duration with global sleep quality. We therefore aimed to evaluate the separated and combined role of two aspects of sleep i.e. sleep duration and sleep quality on diabetes mellitus in the urban and rural Cameroonian population.

Material And Methods

Study design and population

This was a cross-sectional prospective survey conducted from February to March 2015 in a rural and urban population of the littoral region Cameroon. Urban participants were recruited in the Douala V health district and rural participants were recruited in the Njombe-Penja health district. A total of 499 participants (249 in urban area and 250 in rural area) were randomly selected from the two communities using a three-stage cluster sampling with above-mentioned health districts as first stage, neighborhoods as second stage and households as third stage. Participants from both genders aged 18 years and older were included in the study. Other participants with the following characteristics were excluded: pregnant women, participants with previous diagnosis of obstructive sleep apnea syndrome or restless leg syndrome and those who were unable to cooperate with physical examination or interview due to mental disorder or physical disability. We finally included 499 participants; 249 participants in the rural area and 250 participants in the urban area.

Data collection and parameters measurements

Data were collected using a structured questionnaire administered to participants face to face. The following informations were collected: age, status of smoking and drinking, physical activity, fruits and vegetables consumption and profile of sleep. Status of smoking and drinking was evaluated from self-reported information. Physical activity was evaluated from responses to questions about type and frequency of physical exercise at work and during leisure time and was categorized into “active” (≥150 min/week aerobic exercise such as

jogging, swimming, climbing, etc.) and “inactive”. Fruit and vegetables intake was considered insufficient if consumption of either fruit or vegetables was < 5 servings per day (19). Sleep quality was evaluated using the standard Pittsburgh Sleep Quality Index (PSQI), which is a widely used measure of sleep quality (20). This questionnaire is self-rated and evaluates sleep quality and disturbances over a 1-month period. It has 19 individual items with seven "component" scores. The scores of each item of the index vary between 0 and 3. Total score of these seven components makes one score of 0–21. Poor sleep quality was defined for a total score >5 (20). Sleep duration was evaluated from responses to relevant questions about the actual sleep duration every day in the past month and was classified into "short" (≤ 6 h), "normal" (7 h ≤ sleep duration ≤ 8h) and "long" (>8 h) based on previous reports (21–22).

Parameters measurements

Physical examination included blood pressure (BP), waist circumference (WC), weight and height. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meter (kg/m^2). Overweight was defined as BMI ≥ 25 kg/m^2, and obesity as BMI >30 kg/m^2. Abdominal obesity was defined as WC ≥ 102 cm for men and ≥ 88 cm for women (23).

BP was measured after 15 minutes in the sitting position and in standardized conditions. Three consecutive BP measurements were taken at 5 minutes intervals using a validated automated sphygmomanometer (HEM–705 CP, Omron Corporation, Tokyo, Japan) with cuff's width adjusted to arm's circumference. A fourth measurement was obtained if the first three readings differed by ≥10 mmHg. The averages of the nearest three BP readings were considered in this study. Hypertension was defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg, and/or ongoing antihypertensive medication (23).

Participants were instructed to fast for at least 8 hours overnight and fasting blood glucose (FBG) was determined using a glucometer (Accu-Chek Aviva, Roche, Mannheim, Germany). Diabetes was defined according to American Diabetes Association (ADA) criteria (24). Diabetes mellitus was defined as FBG ≥ 126 mg/dL (≥7.0 mmol/L) and/or being on glucose-lowering medication(s),

Statistical analysis

Continuous variables were presented as mean ±1 standard deviation, and categorical data as percentages. Prevalence rates were presented with 95% confidence interval (CI). The significance of differences between proportions was assessed using Chi squared test (for categorical variables), whereas the significance of differences between continuous variables was assessed using Student's t test. Multivariable logistic regression was used to assess the association between diabetes and sleep quality and duration. Odd ratios were adjusted for age and gender. Statistical significance was set at $p<0.05$. All analyses were performed using SPSS 20 software (SSPS Inc, Chicago, Illinois, USA).

Results

Mean age of the sample was 36±12 years with 39.1% of men. Sociodemographic, anthropometric, bioclinical parameters, as well as cardiovascular risk factors are presented in table 1 and compared between urban and rural participants. Quantitative variables are presented as mean ± standard deviation and values in brackets represent percentages for qualitative variables. Mean age was slightly higher in rural than urban area (p = 0.037) and age was not significantly different between urban and rural participants (p = 0.971). Overweight/obesity, abdominal obesity, hypertension and diabetes mellitus; as well as their indicative parameters were not significantly different between urban and rural areas (p>0.05). Alcohol consumption and physical activity were more frequent in rural area (p = 0.047 and p = 0.029 respectively) whereas fruits/vegetables consumption was more frequent in the urban area (p = 0.0005).

Table 1: characteristics of participants

	All	Urban	Rural	p
Age, years	36 ±12	35 ±12	37 ±11	0.037
Male gender, %	195 (39.1)	97 (39.0)	98 (39.2)	0.971
Weight, kg	72.8 ±15.4	74.2 ±15.4	71.5 ±15.4	0.051
Height, m	1.66 ±0.08	1.66 ±0.08	1.66 ±0.08	0.227
BMI, kg/m^2	26.4 ±5.4	26.8 ±5.7	26.0 ±5.2	0.111
Overweight/obesity, %	268 (53.7)	144 (57.8)	124 (49.6)	0.079
Waist circumference, %	86 ±13	86 ±13	86 ±13	0.750
Abdominal obesity, %	144 (28.9)	74 (29.7)	70 (28.0)	0.506
Systolic BP, mmHg	119 ±19	119 ±19	120 ±19	0.326
Diastolic BP, mmHg	76 ±12	75 ±13	77 ±12	0.195
Hypertension, %	104 (20.8)	52 (20.9)	52 (20.8)	0.930
Blood glucose, mg/dL	105 ±33	106 ±35	104 ±30	0.506
Diabetes, %	41 (8.2)	25 (10.0)	16 (6.4)	0.188
Smoking, %	36 (7.2)	15 (6.0)	21 (8.4)	0.394
Alcohol, %	116 (23.2)	48 (19.3)	68 (27.2)	0.047
fruits/ vegetables, %	120 (24.0)	77 (30.9)	43 (17.2)	0.0005
Physical activity, %	323 (64.7)	149 (59.8)	174 (69.6)	0.029
Sleep duration, h	6.3±1.4	6.1±1.4	6.6±1.4	0.0002
PSQI global score	6.1±2.9	6.1±3.1	6.1±2.6	0.989

BMI: body mass index; BP: Blood pressure; PSQI: Pittsburgh sleep quality index

Figure 1 and figure 2 present the distribution of Pittsburg Sleep Quality Index (PSQI) score and subjective sleep duration (SD) among participants. Data are compared between urban and rural participants. Frequency of poor sleep quality (PSQI score > 5) was 50.3% and was not significantly different between urban and rural participants (48.2% vs 52.4% respectively; p = 0.395). Participants with short sleep duration (sleep duration ≤ 6h) represent 30.5% of the sample. Those with sleep duration between 7—8h and >8h represent 51.7% and 17.8% respectively. Frequency of short sleep duration in urban area was 36.1% and was significantly higher than rural area (24.8%); p = 0.006.

Figure 1: distribution of PSQI score in the sample

Figure 2: distribution of sleep duration in the sample

Table 2 present the association between sleep quality and duration with diabetes. Data are presented as counts and percentages of participants with diabetes in each group. Crude OR have been calculated and adjusted for age and sex.

In the whole sample, frequency of diabetes was significantly higher in participants with SD≤6h compared to those with SD >6h (p<0.001). Although the frequency of diabetes was higher in participants with poor sleep quality (PSQI > 5) when compared to those with PSQI ≤ 5 (10% vs 6.5% respectively), the difference was not significant (p<0.05). When combining sleep quality with sleep duration, participants with normal sleep quality associated with poor sleep duration (PSQI ≤ 5 + SD ≤ 6h) and those with poor sleep quality associated with poor sleep duration (PSQI > 5 + SD ≤ 6h) had a higher risk of diabetes compared to those with normal sleep quality and duration. Results were nearly the same in urban the area but no significant association has been found in the rural area. After adjustment for age and sex, we found in the whole sample a significant association of short sleep duration with diabetes (OR 2.53 95%CI 1.32–4.85 p<0.01). Associations of short sleep duration with poor and normal sleep quality were also significantly associated with diabetes (OR: 4.12 95%CI 1.18- 14.4 p<0.05 and OR 2.67 95%CI 1.22- 5.81 p<0.05 respectively).

Table 2: relationship between diabetes with sleep quality and sleep duration in the sample

		n (%)	OR (95% CI)	AOR (95% CI)
	All			
SD	**SD > 6h**	20 (5.8)	Ref	Ref
	SD ≤ 6h	21 (13.8)	**2.62 (1.38 - 5.00)***	**2.53 (1.32- 4.85)**
PSQI Score	**PSQI ≤ 5**	16 (6.5)	Ref	Ref
	PSQI > 5	25 (10.0)	1.60 (0.83 - 3.08)	1.68 (0.87- 3.25)
PSQI + SD	**PSQI ≤ 5 + SD > 6h**	12 (5.3)	Ref	Ref
	PSQI > 5 + SD > 6h	8 (6.7)	1.28 (0.51- 3.22)	1.41 (0.55- 3.56)
	PSQI ≤ 5 + SD ≤ 6h	4 (19.0)	**4.22 (1.23- 14.49)***	**4.12 (1.18- 14.4)***
	PSQI > 5 + SD ≤ 6h	17 (13.0)	**2.67 (1.23- 5.79)***	**2.67 (1.22- 5.81)***
	Urban			
SD	**SD > 6h**	10 (6.3)	Ref	Ref
	SD ≤ 6h	15 (16.7)	**2.98 (1.28- 6.95)***	**3.02 (1.29- 7.10)***
PSQI Score	**PSQI ≤ 5**	10 (7.8)	Ref	Ref
	PSQI > 5	15 (12.5)	1.70 (0.73- 3.95)	1.77 (0.76- 4.15)
PSQI + SD	**PSQI ≤ 5 + SD > 6h**	7 (6.2)	Ref	Ref
	PSQI > 5 + SD > 6h	3 (6.5)	1.06 (0.26- 4.28)	1.13 (0.28- 4.60)
	PSQI ≤ 5 + SD ≤ 6h	3 (18.8)	3.49 (0.80- 15.2)	3.61 (0.81- 15.9)
	PSQI > 5 + SD ≤ 6h	12 (16.2)	**2.93 (1.10- 7.84)***	**3.03 (1.12- 8.16)***
	Rural			
SD	**SD > 6h**	10 (5.3)	Ref	Ref
	SD ≤ 6h	6 (9.7)	1.91 (0.66- 5.48)	1.72 (0.59- 5.04)
PSQI Score	**PSQI ≤ 5**	6 (5.0)	ref	Ref
	PSQI > 5	10 (7.6)	1.56 (0.55- 4.42)	1.61 (0.56- 4.63)
PSQI + SD	**PSQI ≤ 5 + SD > 6h**	5 (4.4)	Ref	Ref
	PSQI > 5 + SD > 6h	5 (6.8)	1.58 (0.44- 5.66)	1.75 (0.48- 6.35)
	PSQI ≤ 5 + SD ≤ 6h	1 (20.0)	5.45 (0.51- 58.2)	4.66 (0.43- 50.8)
	PSQI > 5 + SD ≤ 6h	5 (8.8)	2.10 (0.58- 7.56)	1.98 (0.54- 7.25)

SD: sleep duration; OR: odd ratio; AOR: adjusted odd ratio (adjusted for age and sex); CI: confidence interval; *p<0.05; **p<0.01; ***p<0.001

Discussion

In this cross-sectional comparative study, we found some important results underlying the role of sleep quality on diabetes mellitus in urban and rural communities in the Cameroonian population. Mean sleep duration in the sample was 6.3h and was significantly higher in rural than urban participants, as well as frequency of short sleep duration was significantly higher in urban than rural area. Contrary to all expectations, frequency of poor sleep quality was similar in urban and rural area (25). As expected, short sleep duration was significantly associated with the risk of diabetes in the whole sample. Although poor sleep quality was not significantly associated with diabetes, a combination of short sleep duration with poor sleep quality was significantly associated with diabetes. Short sleep duration (≤6h) as well as poor sleep quality (PSQI > 5) has been described by many authors as a predictive factor of comorbidities such as hypertension (26), metabolic syndrome (27) and overweight/obesity (28).

Frequency of poor sleep quality found in our study was relatively high compared to other sub-Saharan African countries. A large study conducted on more than 40000 adults from 8 African and Asian countries shows that prevalence of poor sleep quality varies from 8.3% to 12.7% in Kenya, Ghana and Tanzania. In South Africa, the prevalence was 31.3% in female and 27.3% in male (29). On the contrary, our results are similar those of Tai et al. who found a prevalence of 46.6% on the Taiwanese population (30).

There is a bundle of literature on the association of diabetes mellitus with sleep disorders using different sleep quality evaluation tools. Many authors have demonstrated a high prevalence of sleep disorders in participants with diabetes mellitus compared to those without diabetes. Using the Pittsburg Sleep Quality Index (PSQI), Fiorentini and colleagues reported a higher prevalence of diabetes mellitus in participants with poor sleep quality (19.4%) compared to those with good sleep quality (8.8%) (31). More recently, Zubair and colleagues found that PSQI global score as well as PSQI score > 5 were higher in participants with diabetes compared to those without (32). We found in our study a 2.62 folds increase in the risk of diabetes in patients with short sleep duration (SD ≤ 6h) compared to those with normal sleep duration (SD ≥ 6h) which was consistent with results of Anothaisintawee et al who showed that short sleep duration is predictive of diabetes with relative risk of 1.18 (95%CI 1.10—1.26) (33). Short sleep duration has also been shown to be a strongly predictive factor of prediabetes. Engeda et al, found that individuals who reported short sleep duration had a 2.06 higher odds of prediabetes (95%CI 1.00–4.22) compared to individuals who reported 7h of sleep (34).

Mechanisms underlying the association of diabetes and glucose homeostasis with sleep disorders are not well established. These include higher evening cortisol levels, increased sympathic nervous system activity, and catecholamine production, as well as higher levels of inflammatory factors, which promote insulin resistance such as interleukin (IL)−1β, IL−6, IL−17, and CRP (35). In addition, several short term studies show that sleep fragmentation or restriction lead to insulin resistance (36–37) which appears to play a key role in the pathophysiology of diabetes. Although frequency of diabetes in our study was higher in participants with poor sleep quality (PSQI > 5) compared to those with normal sleep quality (10% vs 6.5% respectively), the association of sleep quality and diabetes was not significant. Hung and colleagues show that hyperglycemia is an independent determinant of the global PSQI score (27). In addition, other studies show that poor sleep quality is associated with poor glycemic control and the development of type 2 diabetes (14, 18).

When combining sleep duration with sleep quality, we found that participants with short sleep duration and normal sleep quality as well as those with short sleep duration and quality had a higher risk of diabetes compared to those with normal sleep duration and quality (OR 4.22, 95%CI 1.23- 14.49 and OR 2.67, 1.23- 5.79 respectively). The higher odd of having diabetes when combining sleep duration and quality than when taken separately emphasize the necessity of considering these two parameters together in the management of cardiovascular disorders. Our result was corroborated by some previous studies aiming to explore the interaction of sleep duration and sleep quality on impaired fasting glucose (13), hypertension (26) and cardiovascular events (38) which also indicated an additive effect of them. However, our work is the first report on the interaction of sleep quality and duration on diabetes in the Cameroonian population.

Our study presents several limitations as follow: The sample was collected in two local urban and rural communities and could not be representative of the Cameroonian population. As we conducted a cross-sectional survey, we could not conclude on the causal relation between sleep disorders and diabetes in our study. We could not measure primary sleep disorders such as Obstructive Sleep Apnea Syndrome and Rest Leg Syndrome which can have an unpredictable impact on our results.

Conclusion

Our cross-sectional study shows a high prevalence of short sleep duration and poor sleep quality in an urban and rural community in Cameroon. It also demonstrated a significant impact of short sleep duration as well as combination of short sleep duration and poor sleep quality on diabetes prevalence. Diabetes was not significantly associated with poor sleep quality; although diabetes prevalence was more frequent in participants with poor sleep quality compared to those with normal sleep quality.

Abbreviations

BMI: body mass index

BP: blood pressure

CI: confidence interval

FBG: fasting blood glucose

OR: odd ratio

PSQI: Pittsburg sleep quality index

SD: sleep duration

WC: waist circumference

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Declarations

Ethics approval and consent to participate:

all participants signed an informed consent and Ethical approval of the study protocol was granted by the Institutional Review Board of Douala University (Authorization N° CE-UD/088/02/2015/T)

Consent for publication:

Not applicable

Availability of data and materials:

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

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Authors' contributions:

DL and PVB designed the study protocol, planned analyses and corrected the manuscript. DL, TM, JND and ME contributed to data collection. ECBL led the statistical analyses, contributed data interpretation and wrote the first manuscript draft. MH, JPD, ML, HBM and WN contributed to data interpretation and the correction of the manuscript. All authors reviewed and approved the final manuscript draft.

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Figures

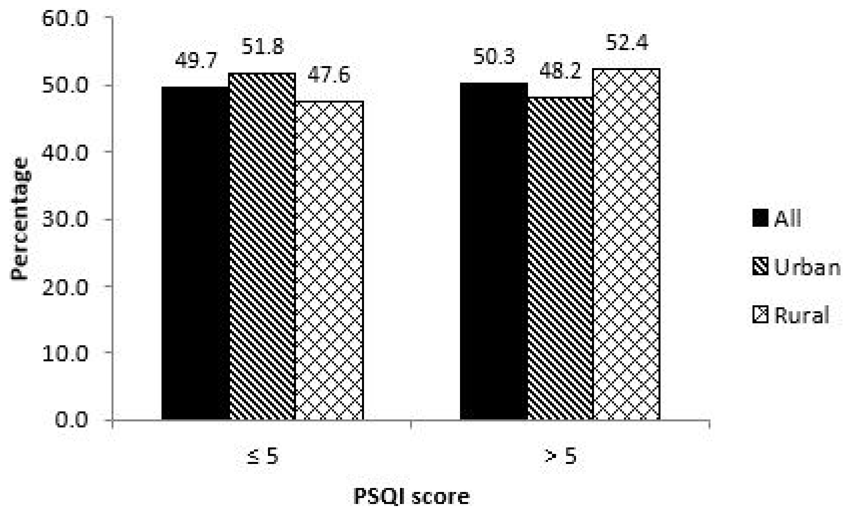

Figure 1

distribution of PSQI score in the sample

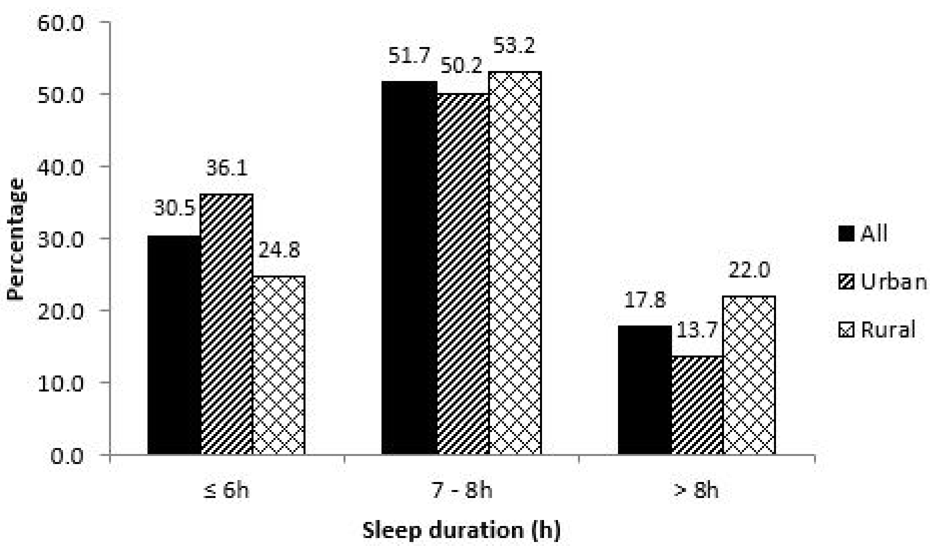

Figure 2

distribution of sleep duration in the sample