original article

Sleep problems in patients with Type 2 Diabetes Mellitus in Singapore

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Type 2 diabetes mellitus (T2DM) patients experience a range of illness related problems such as extreme thirst and complications as a result of poor glycemic control. While health psychologists commonly focus on self-management issues (e.g., medication adherence, eating and exercise behaviour), prevalent sleep problems in this population should also receive more attention. Patients with T2DM often present with sleep disturbances (Cuellar & Ratcliffe, 2008) including delayed sleep onset, frequent awakening, restlessness, and subsequent daytime sleepiness (Inkster et al., 2013). Obstructive sleep apnea (OSA) is one of the most common sleep disorders in patients with type 2 diabetes (Cass, Alonso, Islam, & Weller, 2013), leading to sleep disru-ptions and nocturnal arousals.

Poor sleep has been linked to adverse health and functioning outcomes including poor glycemic control (Kim et al., 2013; Ohkuma et al., 2013) and reduced quality of life in patients with type 2 diabetes (Chasens & Luyster, 2016; Seligowski et al., 2013). There are few studies to examine sleep problems in T2DM in tropical settings where consistent day length, light–dark cycle and temperatures may influence wake time schedule and hence sleep patterns (Reutrakul et al., 2015). In tropical countries, consistent long day length may encourage later bedtime and higher temperatures (year round average 27-34°C) could compromise sleep (Reutrakul et al., 2015).

To address this gap, we examined the rates and patterns of sleep problems in a sample of adults with T2DM and their associations with sociodemographic and clinical parameters. The focus of this research was on insomnia (i.e., difficulty falling and/or staying asleep), daytime sleepiness and sleep debt (i.e., measurable sleep deprivation related to varying day-to-day sleep schedules whereby reduced sleep over working days is alternated with sleep compensation over non-working days).

Methods

This study uses the results from the baseline of a prospective study that was conducted at the outpatient Endocrinology clinic of the National University Hospital. All adult patients aged 21-64 years, diagnosed with T2DM for at least 1 year, literate in English and able to consent and comply with the study protocol were included. Patients with active cardiovascular disease such as unstable angina or recent coronary artery bypass, liver

Table 1
Demographic, clinical and sleep characteristics of study sample

Demographics	N	(%)	Mean	SD
Gender				
Male	135	63.4		
Female	78	36.6		
Age (Years)			45.0	12.1
< 45 yrs	92	43.4		
≥ 45 yrs	120	56.6		
Ethnicity				
Chinese	106	49.8		
Malay	24	11.3		
Indian	62	29.1		
Other	21	9.9		
Marital Status				
Single	45	22.8		
Married	132	67.0		
Divorced/Separated	12	6.1		
Widowed	8	4.1		
Household Income (SGD)				
< 500	5	2.9		
< 2000	24	14.0		
2000 to 3999	47	27.5		
4000 to 5999	37	21.6		
> 6000	58	33.9		
Housing Type				
Small public housing	91	46.2		
Large public housing	64	32.5		
Private housing	42	21.3		
Educational Status				
< 7 yrs	16	8.1		
7 – 10 yrs	67	33.8		
> 10 yrs	115	58.1		
Living Status				
Living alone	8	4.1		
Living with family	187	95.9		

(continued)

disease defined as transaminase > 3 times upper limit of normal and renal disease with creatinine > 130 µmmol/L and those on treatment for psychological or psychiatric disorders were excluded. The study was approved by National Healthcare Group, and all participants provided informed consent.

Measures

Baseline data collection included questionnaire administration, assessment of current medication, anthropometric measurements [height (m) and weight (kg) for subsequent BMI calculation] and HbA1c levels (using high-performance liquid chromatography method).

Measures of sleep habits and sleep duration (e.g., insufficient sleep) were captured using validated questions from the Wisconsin Sleep Cohort Study (Young, 2009). "Insomnia" was accessed with the following 4 items: difficulty falling asleep; repeatedly waking up at night-time; waking up and finding it difficult to go back to sleep; waking up early in the morning and finding it difficult to get back to sleep. Response categories for all 4 items are 'never' or 'rarely' (once/month), 'sometimes' (2–4 times/month), 'often' (5–15 times/month), and 'almost always' (16–30

Table 1 (continued)

Demographic, clinical and sleep characteristics of study sample

Demographics	N	(%)	Mean	SD
Duration of Known Diabetes (Years)			9.3	7.6
1 to <5	64	33.5		
5 to <10	51	26.7		
10 to <15	32	16.8		
15 to < 20	23	12.0		
≥ 20	21	11.0		
Comorbidities				
None	64	30.0		
At least one	149	70.0		
Breakdown:				
Retinopathy	28	13.2		
Cardiovascular Disease	27	12.7		
Nephropathy	17	8.0		
Neuropathy	14	6.6		
Cerebrovascular Disease	12	5.6		
Anemia	13	6.1		
Peripheral Vascular Disease	6	2.8		
Hepatic	5	2.4		
Renal	1	0.5		
Hypertension				
Yes	99	46.5		
No	114	53.5		
Hyperlipidemia				
Yes	110	51.6		
No	103	48.4		
Pharmacological Treatment				
Oral	122	59.8		
Insulin	7	3.4		
Combined (oral and insulin)	75	36.8		
Body Mass Index (kg/m^2)			29.1	5.5
< 18.5	1	0.5		
18.5 – 23	26	12.2		
23 – 27.5	68	31.9		
≥ 27.5	118	55.4		

(continued)

Table 1 (continued)

Demographic, clinical and sleep characteristics of study sample

Demographics	N	(%)	Mean	SD
HbA1c (%)			8.3	1.9
< 7	62	29.1		
7 – 8	55	25.8		
> 8	96	45.1		
Smoking History				
Non Smoker	139	72.4		
Previous Smoker	24	12.5		
Current Smoker	29	15.1		
Sleep Duration				
Workday night (hours)			6.5	1.4
Non-work night (hours)			7.6	1.8
Sleep Debt			1.2	1.6
Average sleep (hours)			6.8	1.3
Less than 7 hours sleep	115	57.2%		
Sleep Difficulties (Insomnia)				
Getting to sleep	30	14.2%		
Waking up at night and hard time getting to sleep	32	15.1%		
Waking up repeatedly during night	38	17.1%		
Waking up to early (am)and can't get back to sleep	25	11.3%		
Epworth Score > 10 (Sleepiness)	162	77.9%	14.9	5.3

times/month). For the analyses, each item was dichotomized into 'often/almost always' (≥5 times/month) versus 'sometimes/rarely' (<5 times/month) in line with previous work (Szklo-Coxe, Young, Peppard, Finn, & Benca, 2010).

Average daily sleep duration was estimated from the following two questions: "How many hours of sleep do you normally get on a typical workday night?; On a typical non-work night?". Average daily sleep duration was computed as [(5 × workday sleep) + (2 × weekend sleep)]/7. Insufficient sleep was defined as average daily sleep duration <7 hours/day, in accordance with previous work (Cappuccio, Cooper, D'Elia, Strazzullo, & Miller, 2011). Sleep debt was estimated in hours as the average amount of weekend sleep minus the average amount of weekday sleep (Roenneberg et al., 2007).

The Epworth Sleepiness Scale was used to assess subjective wake time sleepiness (Johns, 1991). Scores range from 0–24 with an Epworth score >10 used to define 'excessive sleepiness' in line with previous work (Gander, Marshall, Harris, & Reid, 2005; O'Connor et al., 2009).

Statistical analyses

Rates of sleep symptoms were compared using Statistics Calculator, version 4.0 (Stat Pac). Other statistical analyses were performed with SPSS 22 (Chicago, IL) with significance set at 0.05.

Descriptive statistics were performed to provide information on the characteristics of the total sample and prevalence of sleep problems. Univariate two-sample t-tests, ANOVAs or chi-square tests were used to examine the association of each demographic and clinical factor with the various sleeping patterns/behaviors (as appropriate for continuous or categorical variables).

Results

Baseline demographic, clinical and sleep characteristics of the 213 participants are shown in Table 1. The mean age (SD) of the population was 45.0 (12.1) years old, with 63.4% being males. There were 49.8% Chinese, 11.3% Malays, 29.1% Indians and 9.9% belonging to other ethnicities. For treatment regimen, 59.8% were on oral medications only and 36.8% on both oral and insulin. About 70% of patients had at least one comorbidity.

Rates of sleeping problems varied across sleep indicators. As shown in Table 1 insufficient sleep duration (i.e., <7 hours) and excessive sleepiness was reported by 57.2% and 77.9% of patients respectively.

There were significantly lower percentages of patients who reported sleeping difficulties indicative of insomnia (having difficulty falling or staying asleep during night; waking up early), i.e., 11.8% to 17.9% (ps < .05).

Sleep debt ranged between – 2.5 hours to 8.5 hours indicating contrasting practices in our sample.

Analyses indicated few significant associations between self-reported sleep with socio-demographic and clinical parameters.

Higher sleep debt was associated with younger age (r = -.23, p= .001) and less years of education (r =.15, p = .043).

Sleeping difficulties were associated with a higher BMI, and shorter sleep duration. There were no significant associations with self-report sleepiness, sleep debt or any other demographic and clinical parameter.

Analyses showed that BMI was significantly higher in those reporting difficulty getting to sleep (31.02 ± 5.85 vs. 28.68 ± 5.40, p = .031), those repeatedly waking up at night-time (30.81 ± 5.55 vs. 28.98 ± 5.01, p = .046) and those reporting awakenings and finding it hard to get back to sleep (30.91 ± 5.25 vs. 28.61 ± 5.54, p = .019) compared to those who did not report any of these insomnia symptoms.

Discussion

Study findings indicated that sleep disturbances among patients with T2DM are common. Yet, such symptoms typically are not elicited or addressed in routine consultations.

Of particular concern are the low/insufficient sleep duration and excessive daytime sleepiness shown to affect more than 50% of patients with type 2 diabetes mellitus in Singapore. Estimates are higher than those reported in population cohort studies in Singapore (Singapore Chinese Health Study) (e.g., Pan, De Silva, Yuan, & Koh, 2014; Shankar, Koh, Yuan, Lee, & Yu, 2008) but comparable to studies on DM (Plantinga, Rao, & Schillinger, 2012; Skomro, Ludwig, Salamon, & Kryger, 2001; Sridhar & Madhu, 1994). Symptoms typically associated with diabetes such as frequent nocturia (awakening at night due to the need to urinate) and obstructive sleep apnea that often coexists with DM may compromise sleep (Foster et al., 2009; Plantiga et al., 2012).

There was marked variability in sleep debt in our sample – sleep debt reflects the varying sleep duration across the week whereby insufficient sleep during weekdays is alternated with sleep compensation over weekends as shown in young adult population studies both in Singapore and western settings (Lo, Leong, Loh, Dijk, & Chee, 2014). While sleep debt has been examined in adolescents with DM (Ruiz, Rangel, Rodríguez, Rodríguez, & Rodríguez, 2014), this has been largely overlooked in adult patients with DM. The preliminary findings of our study show an average sleep debt of 1.2 hours but not uniformly across T2DM patients. The associations of increased sleep debt with age and education are likely to reflect the competing lifestyle/social demands among the

patient segments that are more likely to be occupational and socially active. As employment was not captured we could not explore this further. More work is needed to map sleep variations in this population and profile patients that may be more vulnerable to sleep deficits.

The rates of insomnia symptoms were substantially lower, yet far from negligible. Such symptoms were found to be associated with increased BMI, similar to findings in other T2DM studies (Arora et al., 2016) and epidemiological studies across all age segments (Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002; Sekine et al., 2002).

More work is needed to unravel determinants of sleep problems and sources of individual variability so as to guide development of interventions. The lack of significant associations to sociodemographic and clinical characteristics suggests that other variables are more important.

Some study limitations should be noted. First, the cross-sectional nature of the study does not provide causal evidence. As obesity is associated with both disturbed sleep and diabetes, it is not clear if these problems are to be attributed to diabetes. Second, all the sleep variables were not objectively measured, though they were based on standardized questionnaires. Lastly, as this is a clinic-based convenience sample excluding patients with severe cardiovascular and renal complications, whether the findings can be generalized to a larger population remains to be investigated.

In conclusion, the observed sleep disturbances highlight the need to increase awareness of patients and health care providers so as to better diagnose and manage these symptoms.

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