Diabetes & Metabolism 45 (2019) 306–317

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Research letters

The association between handgrip strength and sleep duration in Japanese patients with type 2 diabetes

Introduction

Sleep is essential to health in patients with type 2 diabetes [1]. A systematic review and meta-analysis has shown that quantity and quality of sleep predicts the incidence of type 2 diabetes [2]. An increase in duration of ≥ 2 h sleep was a significant risk factor of developing diabetes [3]. Leproult et al. [4] have also shown that extended duration of sleep in short sleepers can improve insulin sensitivity. Adequate sleep is closely related to the management of diabetes. On the other hand, type 2 diabetes has been shown to be associated with skeletal muscle weakness in older individuals [5]. Leong et al. [6] reported that muscle strength measured by handgrip strength was negatively associated with mortality. Recently, a cross-sectional study showed that older individuals with long sleep duration had decreased handgrip strength [7]. However, there are no previous studies investigating the association between handgrip strength and sleep duration in patients with type 2 diabetes. Thus, the aim of this study was to examine the association between muscle strength and sleep duration in patients with type 2 diabetes.

The author conducted a cross-sectional study of patients with type 2 diabetes treated at the National Center for Global Health and Medicine Kohnodai Hospital. Outpatients in whom handgrip strength and sleep duration were recorded at their first medical examination between April 2013 and December 2015 were included. Patients in whom handgrip strength could not be measured because of disabilities were excluded. The study protocol was approved by the Medical Ethics Committee of the National Center for Global Health and Medicine (Reference No. NCGM-G-002052), and the study was performed in accordance with the Declaration of Helsinki.

Height was measured using a rigid stadiometer (TTM stadiometer; Tsutsumi Co., Ltd., Tokyo, Japan). Weight was measured using calibrated scales (AD-6107NW; A&D Medical Co., Ltd., Tokyo, Japan). Body mass index (BMI) was calculated as body weight in kilograms divided by the square of height in meters. Waist circumference was measured at the umbilical level at the end of exhalation in the standing position. Blood pressure was measured in the sitting position using an automatic sphygmomanometer (HBP-9020; Omron Co., Ltd, Tokyo, Japan).

Handgrip strength was measured on both sides using a Smedley analog hand dynamometer (No. 04125; MIS, Tokyo, Japan) in the standing position. The measurements were first performed for the dominant hand. Subjects performed two maximum attempts for each hand with approximately 1-min rest period between. We calculated the average handgrip strength in kilograms.

Technicians at the Clinical Research Center of the National Center for Global Health and Medicine Kohnodai Hospital collected data at the outpatient clinic on the duration of diabetes, sleep duration, physical activity, smoking, drinking habits and history of cardiovascular disease. Sleep duration was calculated from the difference between usual time of sleep and awakening. The Brinkman Index (number of cigarettes per day multiplied by the number of years of smoking) was calculated to quantify smoking habits [8]. Alcohol consumption was evaluated by the type of alcoholic beverage and volume consumed per day. Exercise time per day was calculated as follows: Exercise time per session × number of sessions per week/7.

We measured plasma glucose, hemoglobin A_{1c} (HbA_{1c}), and C-peptide levels. Blood samples were drawn in the morning from the antecubital vein.

Statistical analysis was performed using SPSS version 24 (IBM Co., Ltd., Chicago, IL). Numerical values are expressed as mean ± standard deviation. Study participants were divided into groups according to their sleep duration as follows:

- short (<6 h);
- rather short (≥ 6 and < 7 h);
- normal (≥ 7 and < 8 h);
- rather long (≥ 8 and < 9 h);
- long (≥ 9 h).

One-way analysis of variance (ANOVA) or the χ^2 test was performed to detect significant differences between groups as functions of clinical parameters, as appropriate. Turkey's post hoc test was performed when ANOVA identified a statistically significant difference. Multiple regression analysis adjusted for age, BMI, duration of diabetes, history of cardiovascular disease, Brinkman Index, alcohol consumption, exercise time, and HbA_{1c} levels was performed to identify independent association between handgrip strength and sleep duration in all subjects, men, and women. A P value of < 0.05, determined by performing a two-sided test, was considered statistically significant.

A total of 1232 patients (677 men and 556 women) were enrolled. The mean patient age was 63.7 ± 13.9 years, the mean BMI was 25.5 ± 5.5 kg/m^2, and the mean duration of diabetes was 11.7 ± 11.1 years. One-way ANOVA revealed significant differences in age, BMI, and handgrip strength between groups, and χ^2 test showed a significant difference in the prevalence rate of cardiovascular disease (Table 1). In post hoc comparisons, long sleepers had weaker handgrip strength than patients with short, rather short, and normal sleep duration. Multiple regression analysis showed an inverse association between handgrip strength and sleep duration ($\beta = -0.084$, $P < 0.001$). This association was observed in men ($\beta = -0.121$, $P = 0.001$) and women ($\beta = -0.085$, $P = 0.039$).

This study showed that long sleepers with type 2 diabetes had weaker handgrip strength. To the best of my knowledge, this is the first study to investigate the association between handgrip strength and sleep duration in patients with type 2 diabetes. A systematic review and meta-analysis revealed that long (>8 or 9 h)

http://dx.doi.org/10.1016/j.diabet.2017.07.005

Table 1
Differences in clinical parameters between patients with short, rather short, normal, rather long, and long sleep duration.

	Sleep duration (h)						
	Total	<6	6–7	7–8	8–9	≥9	*P* value for χ^2 or ANOVA
n	1232	208	234	315	246	230	–
Men/women	677/566	105/103	140/94	163/152	146/100	123/107	NS
Age (years)	63.7 (13.9)	61 (12.6)	62.3 (13.1)	64.9 (11.9)	66 (14.3)	63.7 (13.9)	0.001
Duration of diabetes (years)	11.7 (11.1)	11.4 (10.6)	11.3 (10.7)	11.6 (11.1)	12.2 (10.9)	11.9 (12)	NS
Height (cm)	160.7 (9.7)	160.4 (10)	162.3 (9.7)	160.4 (9.6)	160.1 (9.2)	160.4 (9.8)	NS
Weight (kg)	66.3 (17)	68.4 (17.9)	67.8 (16.5)	64.7 (15.3)	64.9 (17.5)	66.6 (18)	NS
BMI (kg/m^2)	25.5 (5.5)	26.4 (5.9)	25.5 (5.3)	25 (4.7)	25.2 (6)	25.7 (5.5)	0.039
Waist circumference (cm)	92 (13.7)	92.7 (14.3)	91.7 (13.5)	90.9 (12.5)	94.2 (14.3)	92 (13.7)	NS
History of cardiovascular disease (%)	13.3%	8.7%	12.8%	12.7%	13%	19.1%	0.028
Brinkman index	326.8 (549.3)	280.3 (492.2)	321.9 (507)	353.6 (596.3)	342.2 (543.1)	320.7 (579.9)	NS
Alcohol consumption (g ethanol/day)	19 (32.7)	22.8 (39.4)	21.8 (33.5)	17.7 (24.3)	18.1 (36.7)	15.5 (30.4)	NS
Exercise time (min/day)	16.2 (46.2)	16.9 (47.2)	17.9 (52.3)	17.8 (48)	16.7 (43.7)	11.3 (38.2)	NS
Systolic blood pressure (mmHg)	131.3 (19.9)	129.5 (19.8)	131.2 (19.4)	131.6 (19.8)	132.3 (20.5)	131.5 (20.4)	NS
Diastolic blood pressure (mmHg)	73.7 (14.2)	74.1 (14.9)	74.4 (13.9)	73.6 (13.2)	73 (15)	73.7 (14.2)	NS
Plasma glucose (mg/dL)	158.7 (63.3)	158.1 (59.4)	158.1 (61.7)	162 (65.7)	156.1 (61.8)	158.2 (66.9)	NS
HbA_{1c} (%)	7.5 (1.7)	7.6 (1.7)	7.6 (1.7)	7.7 (1.8)	7.4 (1.7)	7.3 (1.7)	NS
Sleep duration (h/day)	7.2 (1.8)	4.6 (0.8)	6.1 (0.2)	7.1 (0.2)	8.1 (0.2)	9.8 (1.8)	<0.001
Handgrip strength (kg)	24 (9.6)	24.6 (10.5)	26.1 (10.1)	24.1 (8.8)	23.7 (9.5)	21.4 (9.2)	<0.001

Data are expressed as mean (*SD*) or percentage of subjects except for the number of subjects, sex, and history of cardiovascular disease. ANOVA: one-way analysis of variance; NS: not significat; BMI: body mass index; HbA_{1c}: hemoglobin A_{1c}.

sleep was associated with a 30% greater risk of death compared with normal sleep duration [9]. A recent study demonstrated that individuals with long sleep duration had weaker handgrip strength regardless of muscle mass in Asian population [7]. A number of studies have shown that handgrip strength could be a prognostic marker for mortality [6,10,11]. The underlying mechanism behind decreased handgrip strength in long sleepers with type 2 diabetes is unknown. However, walking time was shorter in long sleepers with type 2 diabetes compared with that in patients with normal sleep duration [12]. Physical inactivity due to long sleep may cause skeletal muscle weakness. Auyeung et al. [13] reported that testosterone levels decreased with sleep duration of more than 9.9 h per night. Crosstalk between the endocrine system and the circadian rhythm may be a key to elucidate the mechanism underlying the relationship between extended sleep duration and muscle weakness.

This study has several limitations. First, it is not possible to make causal inferences because of the study design. Second, sleep quality was not evaluated, and self-reported sleep duration could be different from objectively measured sleep duration. Third, potential confounding factors such as socioeconomic status and mental condition were not evaluated. Further research is required to evaluate these factors.

In conclusion, this study demonstrates that extended duration of sleep is associated with muscle weakness in patients with type 2 diabetes. Since both muscle strength and sleep duration are significant prognostic indicators, to maintain muscle strength and sleep adequately are important for the treatment of type 2 diabetes.

Role of funding source

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosure of interest

The author declares that he/she has no competing interest.

Acknowledgments

The author appreciates the support of Clinical Research Center, National Center for Global Health and Medicine Kohnodai Hospital.

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Received 6 July 2017
Accepted 15 July 2017
Available online 25 August 2015

http://dx.doi.org/10.1016/j.diabet.2017.07.005