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Relationship between visceral fat obesity, sleep duration, and lifestyle habits among Japanese occupational population (FUJITSU Cardiovascular and Respiratory Observational Study-3; FACT-3)

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ABSTRACT

Aims: We investigated the relationship of visceral fat obesity (VFO) with sleep duration and other lifestyle factors by gender.
Methods: This was a single-center descriptive epidemiological survey and cross-sectional survey that investigated and analyzed VFO for 24,279 white-collar workers aged 30 to 59.
Results: When 7-h sleepers were taken as the control, a U-shaped relationship between sleep duration and the comorbid VFO in male and a trend toward the higher the morbid VFO among female subjects with shorter sleep duration were found. Moreover, insomnia and poor activity strongly linked with VFO in male, on the other, high age strongly linked with VFO in female. In shorter sleepers, overtime work in male and insomnia in female were also associated with VFO.
Conclusions: In active workers, more short sleepers had comorbid VFO, which was related to insomnia, overwork, and absence of exercise habit in male; high age and insomnia in female. Even in long male sleepers, VFO tended to be comorbid, and it was related to the presence of insomnia and the absence of exercise habits.

1. Introduction

It has been pointed out that sleep duration and BMI have a U-shaped relationship, with BMI high for both short sleepers and long sleepers (Gangwisch et al., 2005). It is also known that the social backgrounds and lifestyle habits of subjects who sleep for short or long durations vary.

On the other hand, obesity is an important condition that results in the development of a variety of diseases. In particular, patients with visceral fat obesity (VFO) have a high risk of developing cardiovascular disease due to hypoadiponectinemia and elevated plasminogen activator inhibitor 1 (Shimomura et al., 1996; Pischon et al., 2004); therefore, it is regarded as a serious disease state (Examination Committee of Criteria for 'Obesity Disease' in Japan, 2002; Hiuge-Shimizu et al., 2012a). Accordingly, this study aimed to clarify the relationship of sleep duration and background of other lifestyle habits in active workers with VFO.

2. Materials and methods

2.1. Subjects

This study was performed as part of the FACT study (FUJITSU Cardiovascular and Respiratory Observational Study). Recruitment of the subjects for the FACT study was conducted by consecutive sampling beginning in April 2013. The FACT study is an observational study conducted to evaluate the relationship between lifestyle-related diseases, cardiovascular diseases, respiratory diseases, and metabolic syndrome, and lifestyle habits at annual intra-corporate medical checkups.

A regular medical checkup was performed on 25,987 staff members of FUJITSU Limited or affiliated companies between April 1, 2016, and March 31, 2017, at the Health Examination Center, FUJITSU Ltd. In this survey, 24,279 company employees (20,768 men and 3,511 women) aged 30 to 59, excluding retirees, shift workers, and subjects with insufficient data, were the final subjects of analysis. All subjects were non-shift and white-collar workers (Fig. 1).

Information regarding gender, age, height, weight, body mass index

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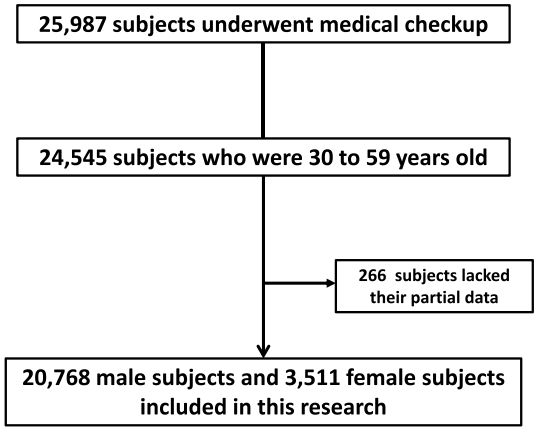

Fig. 1. Flowchart for inclusion criteria.

(BMI), waist circumference, use or non-use of antihypertensive agents, use of anti-diabetic medications (including insulin), and use of lipid metabolism disorder medications was collected at the medical checkup. Hypertension was defined as a systolic blood pressure (BP) of 140 mmHg, diastolic BP of 90 mmHg, and/or current use of antihypertensive medications. Diabetes mellitus was defined as a glucose level of 126 mg dL^{-1} in the fasting state or glycosylated hemoglobin level of 6.5%, according to the National Glycohemoglobin Standardization Program, and/or current use of anti-diabetic medications. Participants with a low-density lipoprotein-cholesterol level of 140 mg dL^{-1}, high-density lipoprotein-cholesterol level of < 40 mg dL^{-1}, or triglyceride level of 150 mg dL^{-1}, as well as participants who were receiving lipid metabolism disorder treatments, were defined as having dyslipidemia.

2.2. Obesity and visceral fat obesity

Height (m) and weight (kg) were measured in the standing position, and BMI (kg/m^2) was calculated. Waist circumference was measured at the level of the umbilicus with a non-stretchable tape in late expiration while standing. Obesity was defined as a BMI of ≥25 kg/m^2. Over waist circumference was defined as a waist circumference of ≥85 cm in men and of ≥90 cm in women (Examination Committee of Criteria for 'Obesity Disease' in Japan, 2002). Subjects with both obesity and over waist circumference were defined as having VFO.

2.3. Sleep duration and insomnia

Sleep habits during the most recent 2–3 months were recorded before the medical checkup. Average sleep duration and presence of sleep disorders were recorded. Presence or absence of sleep-onset insomnia, sleep maintenance insomnia, and sleep-offset insomnia were recorded. The criterion for insomnia was defined as the presence of a condition with the occurrence of at least one of the aforementioned signs of a sleep disorder.

2.4. Questionnaires about lifestyle

Lifestyle-related habits during the most recent 2–3 months were recorded before the medical checkup. The criterion for smoking habit was defined as current smoker with a regular smoking habit at the time of the medical checkup. The criterion for drinking habit was defined as alcohol consumption once a week or more, and the daily average alcohol consumption (g) was calculated. Exercise habit was defined as regular exercise of once a week or more.

The monthly average duration of overtime at work was recorded. A monthly average duration of overtime at work ≥40 h was defined as overtime work.

2.5. Statistical analysis

All patients were classified into the following four groups according to sleep duration: sleep duration ≤5 h, sleep duration of 6 h, sleep duration of 7 h, and sleep duration ≥8 h. All measurements were presented as the mean ± sd. Tukey's honest significance test and Pearson's χ^2 test were used to compare parameters among the four groups. The data are expressed as means ± standard deviation.

The association between sleep duration and VFO and the association between lifestyle habits and VFO were assessed by multiple regression analyses after adjusting for covariates that were significantly different among sleep duration groups (insomnia, current smoking, over drinking, exercise habit, and overtime work in male; age, insomnia and overtime work in female) in each sleep duration. Odds ratios (ORs) and 95% confidence intervals (CIs) of VFO were calculated versus a sleep duration of 7 h (reference) by multiple logistic regression analyses after adjustments for these covariates.

Statistical analyses were conducted using JMP R software for Windows (version 10.0; SAS Institute, Cary, NC, USA). Differences were considered significant when the p value < 0.05 for the hazard ratio Significant difference was set at p value for hazard ratio of < 0.05.

2.6. Ethical approval

This research was conducted in accordance with the Declaration of Helsinki. In conducting research, we made all information that could identify individuals anonymous and conducted the study under strict control with reference to the "Guidelines for Proper Handling of Personal Information by Medical Care/Nursing Care Service Providers" of the Ministry of Health, Labour and Welfare of Japan. The FUJITSU Clinic Ethics Committee deliberated this study, and we obtained approval from the Committee before conducting the study (Ethical Committee Approval Number 09).

3. Results

3.1. Sleep duration and subject backgrounds

In male subjects, the average age was 47 years old, BMI was 24 kg/m^2, and the rate of VFO was 32%. The rate of VFO was lowest in the 7-h sleepers (28%). Among the groups with the different sleep durations, all evaluation items, namely, comorbid hypertension rate ($P = 0.024$) and lifestyle habits (insomnia, $P = 0.025$; current smoker, $P = < 0.001$; alcohol consumption, $P = 0.006$; exercise habits, $P < 0.001$; and overtime work, $P < 0.001$), showed significant differences (Table 1).

In female subjects, the average age was 47 years old, BMI was 22 kg/m^2, and the rate of VFO was 11%. The rate of VFO was lowest in the ≥8 h sleepers (5%). Among the groups with the different sleep durations, all evaluation items, namely, comorbid dyslipidemia rate ($P = 0.025$) and lifestyle habits (insomnia, $P = 0.002$; and overtime work, $P < 0.001$), showed significant differences (Table 2).

3.2. Sleep duration and visceral fat obesity

In male subjects, when 7-h sleepers were taken as the control, the OR for comorbid VFO was 1.45 (95% CI: 1.33 to 1.58, $P < 0.001$) in the ≤5 h sleepers, 1.13 (95% CI: 1.04 to 1.22, $P = 0.003$) in the 6-h sleepers, and 1.10 (95% CI: 0.94 to 1.29, $P = 0.224$) in the ≥ 8 h sleepers (Fig. 2-A).

In female subjects, when 7-h sleepers were taken as the control, the OR for comorbid VFO was 1.34 (95% CI: 0.99 to 1.82, $P = 0.056$) in the ≤5 h sleepers, 1.05 (95% CI: 0.79 to 1.42, $P = 0.739$) in the 6-h sleepers, and 0.58 (95% CI: 0.25 to 1.17, $P = 0.134$) in the ≥ 8 h sleepers (Fig. 2-B).

Table 1
Sleep duration and male subject background.

Sleep duration	All male subjects	≤5 h	6 h	7 h	≥8 h	P value
Number of subject	20768	6181	8978	4728	881	/
Age (years)	47 ± 6	48 ± 6	48 ± 6	48 ± 6	48 ± 7	0.077
BMI (kg/m^2)	24 ± 4	24 ± 4	24 ± 4[a]	24 ± 3[ab]	24 ± 3[a]	< 0.001
Obesity (%)	7047 (34)	2341 (38)	2988 (33)	1428 (30)	290 (33)	< 0.001
Waist circumference (cm)	85 ± 10	86 ± 10	85 ± 10[a]	85 ± 10[a]	85 ± 10	< 0.001
Over waist circumference (%)	9690 (47)	3047 (49)	4091 (46)	2142 (45)	410 (47)	< 0.001
Visceral fat obesity (%)	6547 (32)	2179 (35)	2750 (31)	1347 (28)	271 (31)	< 0.001
Systolic blood pressure (mmHg)	120 ± 13	120 ± 13	120 ± 13	120 ± 13	120 ± 13	0.100
Diastolic blood pressure (mmHg)	75 ± 11	75 ± 11	75 ± 11	76 ± 11[ab]	76 ± 11[cd]	< 0.001
FPG (mg/dL)	103 ± 18	103 ± 19	103 ± 17	103 ± 17	103 ± 20	0.100
HbA1c (%)	5.6 ± 0.7	5.7 ± 0.7	5.6 ± 0.7[a]	5.6 ± 0.7[a]	5.6 ± 0.8[c]	< 0.001
LDL-C (mg/dL)	123 ± 29	123 ± 29	123 ± 29	123 ± 29	120 ± 30[d]	0.060
HDL-C (mg/dL)	57 ± 14	57 ± 14	57 ± 14	58 ± 15[a]	59 ± 17[ce]	< 0.001
TG (mg/dL)	129 ± 13	128 ± 131	128 ± 103	130 ± 102	141 ± 128[bcf]	0.010
Non-HDL-C (mg/dL)	148 ± 34	148 ± 35	148 ± 33	148 ± 34	147 ± 35	0.716
Comorbidity (%)						
Hypertension	4521 (22)	1277 (21)	1962 (22)	1069 (23)	213 (24)	0.024
Antihypertensive agents	2806 (14)	776 (13)	1252 (14)	660 (14)	118 (13)	0.069
Diabetes mellitus	1755 (8)	557 (9)	743 (8)	379 (8)	76 (9)	0.255
Diabetes drugs	915 (4)	299 (5)	373 (4)	198 (4)	45 (5)	0.130
Dyslipidemia	10742 (52)	3189 (52)	4660 (52)	2436 (52)	457 (52)	0.970
Hypolipidemic agents	1936 (9)	579 (9)	856 (10)	423 (9)	78 (9)	0.680
Lifestyle (%)						
Insomnia	5498 (26)	1713 (28)	2324 (26)	1213 (26)	248 (28)	0.025
Current smoker	5380 (26)	1578 (26)	2240 (25)	1295 (27)	267 (30)	< 0.001
Alcohol consumption	16225 (78)	4736 (77)	7091 (79)	3705 (78)	693 (79)	0.006
Ethanol 0–19 g/day	10925 (53)	3380 (55)	4772 (53)	2369 (50)	404 (46)	< 0.001
Ethanol 20 g or more/day	5300 (26)	1356 (2)	2319 (26)	1336 (28)	289 (33)	< 0.001
Exercise habits	8485 (41)	2207 (36)	3802 (42)	2089 (44)	387 (44)	< 0.001
Overtime work	6488 (31)	2774 (45)	2724 (30)	899 (19)	91 (10)	< 0.001

Abbreviations: BMI: body mass index, FPG: fasting plasma glucose, HbA1c: glycosylated hemoglobin.
LDL-C; low-density lipoprotein cholesterol, HDL-C: high-density lipoprotein cholesterol, and TG: triglyceride.
The values are presented as the mean ± s.d.
[a]p < 0.001 vs. ≤5 h by the analysis of Tukey's honestly significant difference test.
[b]p < 0.01 vs. 6 h by the analysis of Tukey's honestly significant difference test.
[c]p < 0.01 vs. ≤5 h by the analysis of Tukey's honestly significant difference test.
[d]p < 0.05 vs. ≤5 h by the analysis of Tukey's honestly significant difference test.
[e]p < 0.05 vs. 6 h by the analysis of Tukey's honestly significant difference test.
[f]p < 0.05 vs. 7 h by the analysis of Tukey's honestly significant difference test.

3.3. Lifestyle habits and visceral fat obesity

In both sexes, factors related to the subjects with VFO other than sleep duration were analyzed in each sleep duration group (Table 3). Among male subjects, in the ≤5 h sleepers, the ORs were 1.24 for insomnia (95% CI: 1.14 to 1.36, $P < 0.001$), 0.79 for exercise habit (95% CI: 0.73 to 0.86, $P < 0.001$), and 1.38 for overtime work (95% CI: 1.27 to 1.52, $P < 0.001$). In the 6-h sleepers, the ORs were 1.22 for insomnia (95% CI: 1.12 to 1.33, $P < 0.001$), 0.77 for exercise habit (95%CI: 0.72 to 0.83, $P < 0.001$), and 1.19 for overtime work (95% CI: 1.09 to 1.29, $P = < 0.001$). In the ≥8 h sleepers, the ORs were 1.22 for insomnia (95% CI: 1.07 to 1.39, $P = 0.002$) and 0.82 for exercise habit (95% CI: 0.73 to 0.92, $P = 0.001$).

Among female subjects, the ORs were 1.04 in the ≤5 h sleepers, 1.05 in the 6-h sleepers and 0.93 in the ≥8 h sleepers for age (95% CI: 1.02 to 1.07, $P = 0.001$; 95%CI: 1.03 to 1.08, $P < 0.001$; 95%CI: 0.85 to 0.99, $P = 0.025$). In the ≤5 h female sleepers, the ORs were 1.39 for insomnia (95% CI: 1.03 to 1.63, $P = 0.031$).

4. Discussion

This study was conducted based on intra-corporate regular medical checkups excluding retired employees, and it was considered that there was no difference in health awareness among the subjects. In this study, it was possible to investigate not only the relationship between VFO and sleep duration but also the relationship between VFO and lifestyle habits. It has been reported that the number of obesity-related cardiovascular risk factors (glucose intolerance, dyslipidemia, hypertension, and others) increases not with the increase in the subcutaneous fat area but with the increase in the visceral fat area (Hiuge-Shimizu et al., 2012a, 2012b). However, visceral fat is more likely to be reduced by weight loss compared with subcutaneous fat (Chaston and Dixon, 2008). In fact, reductions in body weight and visceral fat have been shown to comprehensively improve cardiovascular disease risk factors (Hiuge-Shimizu et al., 2012c). In the clinical setting, VFO is a very important pathological condition from the viewpoint of prevention of cardiovascular disease onset. In addition, since obesity has gender differences in comorbid rates of obesity and the pathology of obesity (Ministry of Health, 2017; Douchi T et al., 2002), we examined the relationship between sleep duration, lifestyle, and VFO by gender. However, because this was a cross-sectional survey, it was not possible to clarify the cause or morbid state of VFO.

4.1. Clinical characteristics and sleep duration

The sleep duration data used in this study were based on the results of medical interviews with the employees themselves. Therefore, assessments of self-reported sleep durations may be less objective, as

Table 2
Sleep duration and female subject background.

Sleep duration	All female subjects	≤5 h	6 h	7 h	≥8 h	P value
Number of subject	3511	1148	1437	765	161	/
Age (years)	47 ± 6	48 ± 5	47 ± 6[a]	46 ± 6[bc]	44 ± 6[bcd]	< 0.001
BMI (kg/m^2)	22 ± 4	22 ± 4	22 ± 4[a]	22 ± 4[b]	21 ± 3[a]	< 0.001
Obesity (%)	667 (19)	262 (23)	258 (18)	126 (16)	21 (13)	< 0.001
Waist circumference (cm)	78 ± 10	79 ± 11	78 ± 10[a]	78 ± 10[a]	76 ± 10[e]	0.012
Over waist circumference (%)	435 (12)	165 (14)	176 (12)	84 (11)	10 (6)	0.011
Visceral fat obesity (%)	393 (11)	156 (14)	154 (11)	75 (10)	8 (5)	0.002
Systolic blood pressure (mmHg)	114 ± 14	114 ± 14	114 ± 14	114 ± 14	112 ± 13	0.418
Diastolic blood pressure (mmHg)	70 ± 11	70 ± 11	70 ± 11	71 ± 11	69 ± 10	0.189
FPG (mg/dL)	95 ± 12	96 ± 13	95 ± 12	94 ± 10[e]	93 ± 10[a]	0.002
HbA1c (%)	5.3 ± 1.1	5.4 ± 0.9	5.3 ± 1.1[d]	5.2 ± 1.2[b]	5.0 ± 1.5[bc]	< 0.001
LDL-C (mg/dL)	120 ± 30	121 ± 30	120 ± 29	118 ± 29	116 ± 31	0.052
HDL-C (mg/dL)	71 ± 16	71 ± 16	72 ± 16	71 ± 16	70 ± 15	0.649
TG (mg/dL)	76 ± 44	78 ± 47	75 ± 44	76 ± 42	72 ± 39	0.182
Non-HDL-C (mg/dL)	135 ± 33	137 ± 34	135 ± 33	133 ± 33	131 ± 34	0.036
Comorbidity (%)						
Hypertension	353 (10)	123 (11)	142 (10)	76 (10)	12 (7)	0.611
Antihypertensive agents	189 (5)	69 (6)	76 (5)	36 (5)	8 (5)	0.647
Diabetes mellitus	88 (3)	34 (3)	38 (3)	15 (2)	1 (1)	0.225
Diabetes drugs	46 (1)	21 (2)	17 (1)	7 (1)	1 (1)	0.252
Dyslipidemia	1024 (29)	369 (32)	412 (29)	204 (27)	39 (24)	0.025
Hypolipidemic agents	119 (3)	44 (4)	50 (3)	20 (3)	5 (3)	0.538
Lifestyle (%)						
Insomnia	910 (26)	336 (29)	369 (26)	176 (23)	29 (18)	0.002
Current smoker	225 (7)	86 (7)	118 (8)	44 (6)	7 (7)	0.085
Alcohol consumption	2143 (61)	711 (62)	864 (60)	473 (62)	95 (59)	0.712
Ethanol 0–19 g/day	1777 (51)	588 (51)	719 (50)	395 (52)	75 (47)	0.631
Ethanol 20 g or more/day	366 (10)	123 (11)	145 (10)	78 (10)	20 (12)	0.800
Exercise habits	1210 (34)	371 (32)	510 (35)	277 (36)	52 (32)	0.223
Overtime work	392 (11)	218 (19)	138 (10)	32 (4)	4 (2)	< 0.001

Abbreviations: BMI: body mass index, FPG: fasting plasma glucose, HbA1c: glycosylated hemoglobin.
LDL-C; low-density lipoprotein cholesterol, HDL-C: high-density lipoprotein cholesterol, and TG: triglyceride.
The values are presented as the mean ± s.d.
[a]$p < 0.01$ vs. ≤5 h by the analysis of Tukey's honestly significant difference test.
[b]$p < 0.001$ vs. ≤5 h by the analysis of Tukey's honestly significant difference test.
[c]$p < 0.01$ vs. 6 h by the analysis of Tukey's honestly significant difference test.
[d]$p < 0.05$ vs. 7 h by the analysis of Tukey's honestly significant difference test.
[e]$p < 0.05$ vs. ≤5 h by the analysis of Tukey's honestly significant difference test.

people dissatisfied with their sleep or people with emotional and social stress may be evaluated as having short sleep durations (Vgontzas et al., 2013). On the other hand, it has been reported that sleep durations estimated based on self-reported sleep durations and actigraphy show good correlation (Lockley et al., 1999).

The recommended sleep duration for maintaining optimal health is seven to 9 h (Watson et al., 2015). For the workers in this survey, the sleep duration was ≤5 h in 7,329 subjects (30%) and 6 h in 10,415 subjects (43%), meaning that it was ≤6 h in 17,744 subjects (73%). Therefore, in order for the workers in this survey to maintain their health, it is necessary for them to extend their sleeping hours.

The comorbidity rate of hypertension in male subjects was higher for workers with longer sleep durations. This may be because there are potential diseases such as mental disorders and sleep disorders as the sleeping duration increases, or there may have been an influence of excessive drinking (Xin et al., 2001) or smoking (Niskanen et al., 2004) based on the results of this study.

The comorbidity rate of dyslipidemia in female subjects was higher for workers with shorter sleep durations. It was thought that shorter sleep duration, higher the average age and, higher the proportion of obesity (Ministry of Health, 2017) and VFO resulted in increasing the proportion of dyslipidemia.

4.2. Sleep duration and visceral fat obesity among an occupational male population

In this study, when the 7-h sleepers were taken as the control, male subjects showed a U-shaped relationship, with the VFO rate being high in short sleepers with a sleep duration of 6 h or less and long sleepers with a sleep duration of over 8 h. A similar U-shaped relationship has been reported for workers aged 30 to 60 (Hasler et al., 2004a) and for persons aged 32 to 49 (Gangwisch et al., 2005). This relationship may differ depending on the age group and working conditions of the study subjects (Gangwisch et al., 2005; Hasler et al., 2004b). It is that the difference in the lifestyle of the subjects and in sleep structure by age (Webb, 1989) cause the differences in the result.

Decreased serum leptin levels and elevated ghrelin levels have been reported in short sleepers (Taheri et al., 2004), and there is a theory that they are related to changes in appetite. Meanwhile, it is unclear why the long sleepers and obesity are related. However, there was a possibility that sleep apnea (Saaresranta et al., 2016), psychiatric disorders (Swencionis and Rendell, 2012) and sleep disorders (Saaresranta et al., 2016; American Academy of Sleep Medicine, 2014), which are associated with obesity, are often associated with long sleepers.

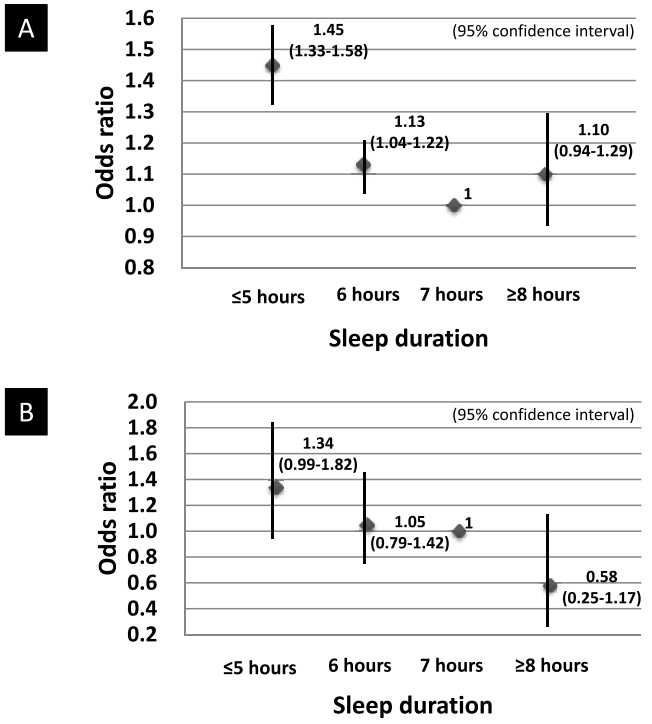

Fig. 2. Odds ratio for visceral fat obesity according to sleep duration in male (A) and female (B).
Adjusted odds ratios (ORs) were calculated in logistic regression models stratified by sleep duration. ORs were adjusted for insomnia, current smoker, over drinking, exercise habit and overtime work in male, and age, insomnia and overtime work in female by 7 h sleep as reference.

4.3. Sleep duration and visceral fat obesity among an occupational female population

In this study, as sleep duration became short, the rate of comorbid VFO and averages of age increased. In Japanese women aged 30 to 59, the proportion of obesity increases as the age increases (Ministry of Health, 2017). Our results might be thought to be due to aging, social backgrounds and sex hormones (Ministry of Health, 2017; Douchi T et al., 2002).

4.4. Inadequate lifestyle and visceral fat obesity among occupational population

In our study, in male subjects, the 7-h sleepers used as the control had the lowest comorbidity rate of VFO (28%), at the same time had the lowest percentage of insomnia (26%) and the highest number of employees with exercise habits (44%). In female subjects, as sleep duration became short, the rate of comorbid VFO become high (14%), at the same time had the highest percentage of insomnia (29%).

Cai GH et al. who conducted a study in subjects aged 45–78 years old (average 60 years old) reported that there was no association between insomnia and obesity at normal sleep duration of 6 h–8 h, but reported that obesity was more common in groups with insomnia less than 6 h and long sleepers over 9 h (Cai et al., 2018). The same result was obtained in this study that few long sleepers over 9 h conducted in. If comorbid insomnia is present in a short-time sleeper, effects (Fernandez-Mendoza et al., 2016) of hormones such as cortisol may be enhanced, or the proportion of subjects with disturbed lifestyle habits as the patient background may increase (Magee et al., 2009). On the other hand, in long male sleepers with insomnia it may also suggest the presence of comorbid sleep disorder (Saaresranta et al., 2016) such as sleep apnea. Such causes may increase the comorbidity of obesity.

Furthermore, it is well known that there is a relationship between obesity and physical activity (Levine et al., 2005; Koh-Banerjee et al., 2003). There is a report that shortening of the sleep duration is related to lower physical activity, a lack of exercise, and disturbed eating habit (Ohida et al., 2001; Stamatakis and Brownson, 2008). Also, long sleepers may have potential illness (Saaresranta et al., 2016; Swencionis and Rendell, 2012; American Academy of Sleep Medicine, 2014). Therefore, It was considered that the absence of exercise habits may be related to the increase in VFO (Koh-Banerjee et al., 2003).

In addition to them, overtime work was also significantly associated with comorbid VFO in short male sleepers. It is well known that long working hours or overtime work reduce the time for sleep (Wong K et al., 2019). As a result, there was a possibility that overtime work affected the occupational health of workers.

4.5. Study limitations

This was a retrospective, single-center, cross-sectional study. It is unclear whether the results of the present study would be applicable to general workers.

Insomnia in this study was not assessed daytime dysfunction and was different from insomnia disorders defined in ICSD-3 (American Academy of Sleep Medicine, 2014). In addition, evaluation of comorbidity of sleep disordered (American Academy of Sleep Medicine, 2014) and psychiatric disorders (Swencionis and Rendell, 2012), which are the causes of insomnia and obesity, had not been done.

Table 3
Multiple logistic regression analyses for visceral fat obesity.

Male subjects/Sleep duration	≤5 h		6 h		≥8 h	
Multivariate anlalysis	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Insomin (yes)	1.24 (1.14–1.36)	< 0.001	1.22 (1.12–1.33)	< 0.001	1.22 (1.07–1.39)	0.002
Current smoking (yes)	0.99 (0.90–1.08)	0.777	0.92 (0.85–1.00	0.053	1.00 (0.88–1.14)	0.949
Over drinking (yes)	0.98 (0.89–1.07)	0.617	1.00 (0.92–1.09)	0.928	1.01 (0.88–1.14)	0.937
Exercise habit (yes)	0.79 (0.73–0.86)	< 0.001	0.77 (0.72–0.83)	< 0.001	0.82 (0.73–0.92)	0.001
Overtime work (yes)	1.38 (1.27–1.52)	< 0.001	1.19 (1.09–1.29)	< 0.001	0.94 (0.81–1.10)	0.432
Female subjects/Sleep duration	≤5 h		6 h		≥8 h	
Multivariate analysis	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Age (1 year older)	1.04 (1.02–1.07)	0.001	1.05 (1.03–1.08)	< 0.001	0.93 (0.85–0.99)	0.025
Insomnia (yes)	1.39 (1.03–1.87)	0.031	1.10 (0.80–1.49)	0.550	0.70 (0.42–1.17)	0.169
Overtime work (yes)	1.06 (0.71–1.63)	0.788	1.07 (0.62–1.75)	0.794	0.45 (0.19–1.27)	0.123

Abbreviations: OR, odds ratio; CI, confidence interval.

Conflict of interest

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Declarations of interest

None.

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