Title

Relationship of work-related and leisure-based screen time with obesity: a cross-sectional study on adults including older adults

Authors

Hana Wakasa [a], Takashi Kimura [b], Takumi Hirata [b, c], Akiko Tamakoshi [b]

[a] Department of Public Health, Graduate School of Medicine, Hokkaido University, Sapporo, Japan

[b] Department of Public Health, Faculty of Medicine, Hokkaido University, Sapporo, Japan.

[c] Human Care Research Team, Tokyo Metropolitan Institute for Geriatrics and Gerontology, Tokyo, Japan

Corresponding author: Akiko Tamakoshi

E-mail address: tamaa@med.hokudai.ac.jp

Abstract

Purpose: The relationship between screen time (ST) and obesity has been demonstrated; however, few studies have differentiated between work-related and leisure-based use in Japanese adults, including older adults. This study aimed to examine the relationship between both work-related and leisure-based ST and obesity in adults.

Methods: This cross-sectional study was based on a questionnaire survey conducted in 2018. Overall, 9,947 adults were invited; 3,161 participants (31.8%) returned the questionnaire. Finally, 2,488 participants (597 younger men (YM), 792 younger women (YW), 542 older men (OM), 557 older women (OW)) were included. The main exposures were work-related, leisure-based, and total ST. The outcome was obesity (body mass index ≥25 kg/m^2). Log-binomial regression analysis was used to calculate prevalence ratios (PRs) and confidence intervals (CIs) for obesity with 1-h increments of each ST. Analyses were conducted in all participants and subgroups comprising YM, YW, OM, and OW.

Results: Total ST was significantly associated with obesity in all participants (PR (95% CI) 1.07 (1.04–1.10), YM (1.05 (1.01–1.10)), OM (1.13 (1.05–1.22)), and OW (1.13 (1.02–1.26)). Work–related ST was significantly associated with obesity in all participants (1.08 (1.04–1.12)), YM (1.06 (1.00–1.12)), and OM (1.24 (1.08–1.42)). Leisure–based ST was significantly associated with obesity in all participants (1.09 (1.04–1.14)), YM (1.09 (1.00–1.18)), and YW (1.10 (1.01–1.20)).

Conclusion: ST is associated with obesity in Japanese adults including older adults; particularly, work-related ST is associated with obesity in men, and leisure-based ST, in younger individuals.

Keywords

screen time, obesity, Japan, cross-sectional study, sedentary behavior, smartphone

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1. Introduction

According to the World Health Organization, the prevalence of obesity has been increasing worldwide and has nearly tripled since 1975. Furthermore, although obesity is preventable, a larger number of people die from obesity/overweight than from being underweight [1]. In Japan, “Health Japan 21 (the second term)” [2] is a program conducted for comprehensive public health promotion. The reduction of obesity prevalence along with an increase in the proportion of people maintaining appropriate weight has been set as one of the goals of the program. According to the National Health and Nutrition Survey, in 2019, obese men and women aged ≥20 years accounted for 33.0% and 22.3% of Japanese population, respectively, and the proportion of obese men has increased significantly since 2013 [3]. According to numerous studies, obesity can lead to some physical ailments, such as type 2 diabetes, coronary artery diseases [4], cancers [5], Alzheimer's disease [6], osteoarthritis [7], and COVID-19 severity [8]. Also, obesity has harmful effects on mental health, such as depression [9], anxiety [10], and personality disorders [11]. Obesity, therefore, causes many health problems. This is why the prevention of obesity is an important global issue, including in Japan.

The main cause of obesity is an imbalance between energy expenditure and energy intake. In older adults, this imbalance can be easily caused due to decreasing the amount of energy expenditure [12], and remarkable decreasing of physical activity. In addition, there are many other risk factors for obesity in adults, including older adults, for example lifestyle factors such as short sleep duration [13] and dietary patterns

or eating habits [14], [15], endocrines such as reducing testosterone or growth hormone [16], medical conditions or medications [17], and genetics[18].

Sedentary time, including screen time, is also considered one of the causes of obesity [19], [20]. Screen time is defined as time spent on activities performed in front of screens, such as watching TV and using computers or smartphones. The penetration rates of cellphones/smartphones and computers in Japan in 2021 were 95.8% and 78.5%, respectively [21]; this suggests that digital devices are more common these days. Digital devices are used in many ways, for instance, for work, communication with friends or families, or entertainment activities, such as playing games. Further, due to the coronavirus disease (COVID-19) pandemic [22], remote-working and teleworking were recommended, forcing people to stay at home or to restrict their activities, resulting longer screen time [23], [24]. According to the Ministry of Internal Affairs and Communications, from 2013 to 2020, Internet usage time, which is considered a type of screen time, increased from 100.8 min/day to 191.9 min/day on weekdays and from 123.4 min/day to 206.7 min/day on holidays in people aged 13–69 years [25]. The increasing trend in internet usage time is observed not only among young people but also among older adults [25]. Furthermore, in July 2020, the Japanese cabinet approved the declaration that identified Japan as the world's most advanced information technology (IT) nation [26]. This means that digital devices play an important role not only in the lives of individuals but also in the functioning of national systems. As digital devices have become more important, screen time will continue to increase.

According to a meta-analysis of 16 studies that considered the association between screen time and obesity among children younger than 18 years, the group with higher (≥2 h/day) screen time had significantly higher odds ratios for obesity than that with lower (<2 h/day) screen time [27]. In the case of young adults, computer use during leisure time reportedly influences obesity among Swedish youths aged 20–24 years [28]. Similarly, a study examining the relationship between physical activity, screen time (including TV viewing, internet use, and video game time), and obesity in Japanese adults aged <60 years reported a significantly higher risk of obesity in the inadequate physical activity/high screen time group than in the adequate physical activity/low screen time group in all participants, especially in men [29].

However, few studies have examined the relationship between screen time (including work-related screen time) and obesity in older Japanese adults. Therefore, this study aimed to investigate the association between screen time, including work-related use, and obesity in adults older than 20 years.

2. Materials and Methods

2.1. Study design, data collection, and study population

This study used the baseline data from the HEalth, Lifestyle, and LOcal community of Iwamizawa Study (HELLO study). The HELLO study was a questionnaire survey study conducted in October 2018.

A total of 9,947 people (aged ≥20 years as of August 1, 2018) were randomly selected from 69,646 residents living in the Japanese city of Iwamizawa and were stratified by sex, age, and junior high school district. We sent a self-administered questionnaire by mail in hard copies with a request letter to the

selected individuals, and 3,161 of them responded (31.8%). Individuals with missing information regarding screen time, height, or weight, those whose sum of sleep and screen time exceeded 24 h, and those with inconsistent information regarding work status and work-related screen time were excluded (e.g. Respondents who reported work-related screen time even though they were "not working"). Finally, 2,488 participants were included in the analysis (Fig. 1).

2.2. Screen time

Screen time was measured using a self-report questionnaire. Participants were required to answer the following two questions with responses indicating the continuous quantity. (a) “How many hours do you use a computer on average per day? Please provide separate responses for work-related and leisure-time use.” (b) “How many hours do you use your cell phone, smartphone, or tablet on average per day? Please indicate work-related use and leisure-time use separately.”. We calculated work-related and leisure-based screen time based on the answers to the two questions. In addition, we obtained the total screen time from the sum of work-related and leisure-based screen time. If participants answered that they were unemployed, only leisure-based screen time and total screen time were used in this study, as work-related use was set to 0 min.

2.3. Obesity

Self-reported height and weight were used to calculate the body mass index (BMI, kg/m^2). Obesity was defined as BMI ≥25 [30].

2.4. Basic characteristics and lifestyle factors

Data on sex, age, educational attainment, work status, sleep duration, and physical activity were collected using a questionnaire. Age was categorized as 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years. Educational attainment was chosen from "Junior high school, high school, junior college/college of technology/vocational school, university/graduate school, others"; thus, they were categorized as < 12 years, < 15 years, <16 years, ≥ 16 years, and other. Work status was assessed by asking the yes or no question, "Are you currently working (including a part-time job)?". The Japanese version of the Pittsburgh Sleep Quality Index [31] was used to assess sleep duration, and the answers were divided into five categories: <5 h, 5-6 h, 6-7 h, 7-8 h, and ≥8 h. Physical activity was assessed using the International Physical Activity Questionnaire [32], and according to the guidelines [33], it was classified into three categories: low, moderate, and high.

2.5. Statistical analyses

The characteristics of the participants were expressed as means and standard deviations (SD) or median and interquartile range (IQR) for continuous variables and percentages for categorical variables. Log-binomial regression analysis was used to obtain prevalence ratios (PRs) and 95% confidence intervals (95% CIs) for obesity per 1-h increment in total screen time, work-related screen time, or leisure-based screen time. In Model 1, the covariates were age and sex. In Model 2, educational attainment, sleep duration, and physical activity were added in addition to the covariates included in Model 1. An analysis

of work-related screen time was conducted in all participants apart from those who responded that they were not working. For all covariates, missing data were treated as a single category and included in the analysis. The following subgroup analyses by age and sex were also conducted: men aged <65 years, women aged <65 years, men aged ≥65 years, and women aged ≥65 years.

All analyses were performed using SAS software (version 9.4; SAS Institute Inc.). All statistical tests were two-sided, with a significance level of $p<0.05$.

2.6. Ethical approval

This study was approved by the Ethics Committee of the Graduate School of Medicine at Hokkaido University (18-054). The procedures used in this study adhere to the tenets of the Declaration of Helsinki. The purpose and methods of the study were explained to the participants in writing, and the return of the questionnaire was regarded as their consent.

3. Results

3.1. Characteristics of participants

The basic characteristics of the 2,488 participants (1,139 men, 1,349 women) are shown in Table 1. Participant age (mean ± SD) was as follows: 59.2 ± 15.9 years in the total participant group, 48.1 ± 12.3 years in men aged <65 years, 48.4 ± 12.3 years in women aged <65 years, 73.4 ± 6.2 years in older men, and 72.7 ± 6.6 years in older women. Screen time, there were no large differences in leisure-based screen

time between men and women (men aged < 65: 2.0, women aged < 65: 2.0, men aged ≥65: 0.5, women aged ≥65: 0.3); however, the amount of total screen time and work-related screen time was larger in men aged both <65 years (men: 3.0, women: 1.0) and ≥65 years (men: 0.5, women: 0.0). The proportion of participants with obesity was particularly large among men aged <65 years (34.2%) and small among women aged <65 years (19.1%). The proportion of men who slept for ≥8 h was larger than that of women. Younger participants had less sleep than older participants. Regarding physical activity, the proportion of participants with high levels was the largest. A greater number of men than women engaged in higher levels of physical activity. The proportion of participants who graduated from university/graduate school was larger among the younger participants than among the older ones. Moreover, men were more likely to graduate from university/graduate school than were women.

3.2. Associations between each category of screen time and obesity

The associations between each category of screen time and obesity are shown in Table 2. For total screen time, both sex- and age-adjusted and multivariate-adjusted PRs for obesity per 1-h increment were significantly higher in all participants, men aged <65 years, older men, and older women; the multivariate-adjusted PRs (95% CI) in these participant groups were 1.07 (1.04–1.11), 1.05 (1.01–1.11), 1.13 (1.05–1.22), and 1.13 (1.02–1.26), respectively. The PRs were higher in older adults than in those <65 years of age in the case of both men and women.

For work-related screen time, both sex- and age-adjusted and multivariate-adjusted PRs for obesity were significantly higher in all participants, men aged <65 years, and older men; the multivariate-adjusted PRs (95% CI) in these participant groups were 1.08 (1.04–1.12), 1.06 (1.00–1.11), and 1.24 (1.08–1.42), respectively.

There were significant relationships between leisure-based screen time and obesity in all participants, men aged <65 years, and women aged <65 years; the multivariate-adjusted PRs (95% CI) in these participant groups were 1.09 (1.04–1.14), 1.09 (1.00–1.18), and 1.10 (1.01–1.20), respectively.

4. Discussion

This study examined the relationships between each type of screen time—total screen time, work-related screen time, and leisure-based screen time—and obesity in adults. Leisure-based screen time was associated with obesity, especially among individuals aged <65 years, regardless of sex. Furthermore, work-related screen time was associated with obesity among men regardless of age.

Given the varied distribution of screen time caused by the participants' broad ages, we could not establish an appropriate cut-off point for excessive screen time. Thus, we used the continuous value for analysis to determine the effect of a 1-h increment of screen time on obesity.

In this study, the distribution of screen time was difference between sex: work-related screen time in men was longer than in women. In Japan, there is still a large difference between working styles of men

and women. For example, the paid working hours in men is extremely longer than in women [34] and the proportion of part-time worker in men is extremely lower than that in women [35]. In addition, the paid work hour in Japanese men is the second longest in the world [34], which could have an impact on shorter leisure screen time. Also, the total screen time was shorter in older adults. In 2017, penetration rate of smartphone was 44.6% in 60s, 18.8% in 70s, and 6.1% in 80s and older, while about 90% in young adults [36]. This difference probably causes the difference of distribution of screen time between adults aged < 65 and ≥65.

The results of the present study are consistent with those of previous studies that found an association between screen time and obesity [37], [38]. A previous Korean study of 19–69-year-olds found that total screen time, including TV watching and computer and game console use, was significantly and positively associated with obesity [39]. Moreover, in a study of TV viewing and computer use as screen time, the high screen time group (≥21 h/week) had higher ORs for overweight/obesity than the low screen time group in the case of both men and women aged ≥18 years [40].

One possible mechanism for the association between screen time and obesity is that screen time is often a sedentary activity that requires low energy. A meta-analysis has reported an OR of 1.33 (95% CI = 1.11–1.60) for overweight/obesity in adults in the long sitting group compared to in those in the short sitting group [41]. According to a cross-sectional study that examined the relationship between obesity and the combination of physical activity and sitting time (including TV use, game play, and reading) in

Australia, the longer sitting time group had a higher OR for obesity than the shorter sitting time group among adults in both the high and low physical activity groups [42]. These previous studies suggest that sitting time is associated with obesity independent of physical activity levels. The findings of the present study are in line with those of these studies, as they revealed significant positive associations between screen time and obesity, even after adjusting for physical activity levels.

Another possible reason is that people with high screen time may have unhealthy diets. Among American adults, the high total screen time group had a more unhealthy diet and consumed more fast food than the low total screen time group [43]. In addition, a previous study that considered TV viewing as screen time reported that the group that watched TV for ≥2 h per day was characterized by higher energy intake in the case of both men and women among American adults [44]. Moreover, a systematic review that considered TV viewing without advertisements related to meals and video gaming as screen time reported on a relationship between screen time and energy intake: people with longer screen time had higher energy intake [45]. Thus, increasing screen time can result in a lower-quality diet or higher energy intake, thereby increasing the risk of obesity.

Work-related screen time is significantly associated with obesity in men. In Australian adult workers, work-related sitting time was also significantly associated with obesity in men [46]. Hence, the effect of work-related screen time on obesity may vary according to sex.

4.7. Study limitations and strengths

This paper has important strengths. We examined the effects of work-related and leisure-based screen time separately for the same populations. Some previous studies have shown the relationship between work-related use only or leisure-based use only and obesity. Also, the participants were randomly chosen in this study. It may reflect the actual situation of the community. However, at the same time, this study had some limitations. First, causation of the association between screen time and obesity could not be determined because this was a cross-sectional study. An inverse causal relationship cannot be ruled out, as sedentary time may have increased after the development of obesity, which may have resulted in longer screen time. Second, some biases, such as reporting or selection bias, may have occurred because this study was based on self-reported data and a low response rate. According to a previous study, there are trends of underreporting weight and overreporting height (Connor Gorber et al., 2007), leading to the underestimation of obesity. Third, the validity and reliability of the questions regarding screen time in the questionnaire were not examined. To reduce the risk of misclassifications, we used a questionnaire that asked computer use and phone use separately and work-related use and leisure use separately, however, these types of screens may not be sufficient to accuracy reflect how the participants use screens. For example, we had no information on the time spent watching TV, even though it could also be regarded as screen time. People, especially older adults, spend some amount of time watching TV [25]. This is one of the possible reasons why the associations between screen time and obesity were weaker in older adults than in the other participants in this study. Fourth, the questionnaire used in this study did not enable us to

determine the status of eating and physical activity, including energy intake or sedentary behavior, during screen time; therefore, it was not possible to determine what specific activities were performed during screen time. For example, some participants may have used applications that encouraged physical activity such as GPS-based games [48] and active video games [49]. There were unmeasured factors affecting the association between screen time and obesity, and we were unable to examine their effects in this study.

5. Conclusion

In summary, screen time was associated with obesity in Japanese adults, including older adults. Work-related screen time was significantly associated with obesity in men. In adults aged <65 years, leisure-based screen time was significantly associated with obesity.

As digital devices become more common and their roles expand, screen time is expected to increase. Therefore, we believe that it is necessary to continue examining the relationship between screen time and health problems to implement appropriate preventive measures.

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7. Statements and declarations

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Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Author contributions

Conceptualization: Hana Wakasa, Takashi Kimura and Akiko Tamakoshi; Methodology: Hana Wakasa and Takashi Kimura; Formal analysis and investigation: Hana Wakasa; Writing - original draft preparation: Hana Wakasa; Writing - review and editing: Takashi Kimura, Takumi Hirata and Akiko Tamakoshi; Funding acquisition: Akiko Tamakoshi; Resources: Akiko Tamakoshi; Supervision: Akiko Tamakoshi.

Ethical approval

This study was approved by the Ethics Committee of the Graduate School of Medicine at Hokkaido University (18-054)

Consent to participate

The purpose and methods of the study were explained to the participants in writing, and the return of the questionnaire was regarded as their consent.

Consent to publish

Not applicable.

8. Figure legends

Fig.1 Flow chart of the selection of participants for the present study

9. Tables

Table 1 Basic Characteristics of Participants

		<65 years		≥65 years	
	All	Men	Women	Men	Women
Participants, n	2,488	597	792	542	557
Age (years)	59.2 ± 15.9	48.1 ± 12.3	48.4 ± 12.3	73.4 ± 6.2	72.7 ± 6.6
Total screen time (h/day) [a]	2.0 (5.0)	6.0 (6.8)	3.0 (6.0)	1.0 (2.4)	0.3 (1.0)
Work-related screen time (h/day) [a]	1.5 (6.0)	3.0 (6.1)	1.0 (5.2)	0.5 (3.5)	0.0 (1.2)
Leisure-based screen time (h/day) [a]	1.0 (2.3)	2.0 (2.5)	2.0 (2.0)	0.5 (1.7)	0.3 (1.0)
Obesity, n (%)	637 (25.6)	204 (34.2)	151 (19.1)	149 (27.5)	133 (23.9)
Sleep duration, n (%)					
<5 h	92 (3.7)	20 (3.4)	26 (3.3)	20 (3.7)	26 (4.7)
5-6 h	310 (12.5)	97 (16.3)	130 (16.4)	29 (5.4)	54 (9.7)
6-7 h	765 (30.8)	199 (33.3)	299 (37.8)	118 (21.8)	149 (26.8)
7-8 h	776 (31.2)	170 (28.5)	230 (29.0)	192 (35.4)	184 (33.0)
≥8 h	545 (21.9)	111 (18.6)	107 (13.5)	183 (33.8)	144 (25.9)
Physical activity, n (%)					
Low	619 (24.9)	130 (21.8)	218 (27.5)	128 (23.6)	143 (25.7)
Moderate	669 (26.9)	158 (26.5)	235 (29.7)	135 (24.9)	141 (25.3)
High	824 (33.1)	208 (34.8)	220 (27.8)	213 (39.3)	183 (32.9)
Educational attainment, n (%)					
< 12 years	223 (9.0)	19 (3.2)	14 (1.8)	75 (13.8)	115 (20.7)
< 15 years	1133 (45.5)	233 (39.0)	349 (44.1)	272 (50.2)	279 (50.1)
< 16 years	568 (22.8)	132 (22.1)	303 (38.3)	36 (6.6)	97 (17.4)
≥ 16 years	440 (17.7)	200 (33.5)	101 (12.8)	122 (22.5)	17 (3.1)
Others	46 (1.9)	3 (0.5)	6 (0.8)	13 (2.4)	24 (4.3)

[a] Median (interquartile range)

For each variable, the total was not 100% because of missing data.

Table 2 Prevalence Ratios for Obesity on Increasing Each Type of Screen Time by 1 h

		<65 years		≥65 years	
	All	Men	Women	Men	Women
Total screen time					
Participants, n	2,488	597	792	542	557
Obesity, n (%)	637 (25.6)	204 (34.2)	151 (19.1)	149 (27.5)	133 (23.9)
Model 1 [a]	1.07 (1.04-1.10)	1.06 (1.02-1.11)	1.04 (0.99-1.09)	1.12 (1.04-1.20)	1.12 (1.01-1.24)
Model 2 [b]	1.07 (1.04-1.10)	1.05 (1.01-1.10)	1.02 (0.97-1.08)	1.13 (1.05-1.22)	1.13 (1.02-1.26)
Work-related screen time					
Participants, n	1,385	536	552	187	110
Obesity, n (%)	364 (26.3)	178 (33.2)	95 (17.2)	60 (32.1)	31 (28.2)
Model 1 [a]	1.07 (1.03-1.11)	1.07 (1.01-1.12)	1.03 (0.97-1.11)	1.19 (1.06-1.33)	1.17 (0.97-1.40)
Model 2 [b]	1.08 (1.04-1.12)	1.06 (1.00-1.12)	1.03 (0.95-1.11)	1.24 (1.08-1.42)	1.18 (0.97-1.44)
Leisure-based screen time					
Participants, n	2,488	597	792	542	557
Obesity, n (%)	637 (25.6)	204 (34.2)	151 (19.1)	149 (27.5)	133 (23.9)
Model 1 [a]	1.09 (1.04-1.14)	1.09 (1.01-1.18)	1.11 (1.02-1.21)	1.06 (0.95-1.17)	1.11 (0.95-1.29)
Model 2 [b]	1.09 (1.04-1.14)	1.09 (1.00-1.18)	1.10 (1.01-1.20)	1.07 (0.96-1.19)	1.13 (0.96-1.32)

[a] Model 1: adjusted for age and sex

[b] Model 2: adjusted for age, sex, physical activity, educational attainment, and sleep duration.

10. Figures

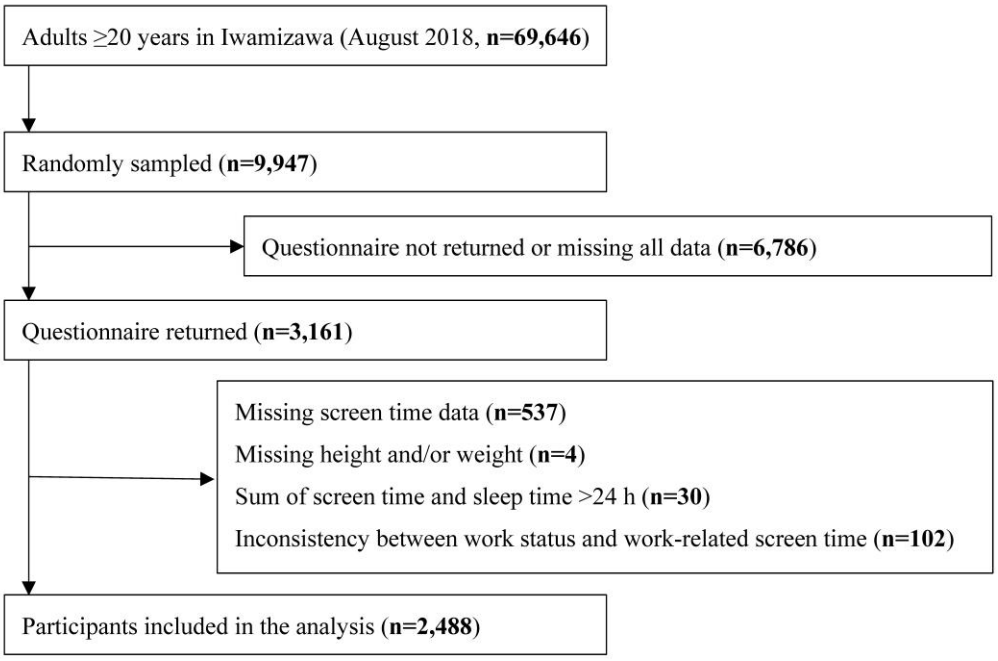

Fig. 1