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Association of self-efficacy for breaking up prolonged sitting with objectively measured sedentary behavior among office workers

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SUMMARY

Although self-efficacy is an important psychological factor for reducing sedentary behavior (SB), it is not clear whether current scales of self-efficacy in changing SB sufficiently reflect actual changes in SB. Here, we examined the stability of a newly developed self-efficacy scale, and the relationship between self-efficacy and objectively-measured SB among office workers.

We conducted two different surveys with office workers from companies located in Tokyo (n = 147). The newly-developed scale used an 11-point Likert scale and asked participants whether they felt it was possible to stand regularly to break up prolonged sitting during working time. Five levels of duration were provided (30 to 120 minutes). The overall and prolonged SB (30 consecutive minutes or longer) during working time were obtained by a tri-axial accelerometer.

The self-efficacy score showed moderate (0.53, 95% CI: 0.34–0.68) levels of stability at the duration level of 30 minutes, and other levels' stability tended to decrease with the increase of the level of duration measured (0.28 to 0.44). The self-efficacy scores for standing up at least once every 30 or 45 minutes were significantly correlated with the total time (r = −0.28 and −0.29, respectively), and with the number of bouts (r = −0.25 and −0.25, respectively) of objective prolonged SB. There were no significant correlations observed at longer levels of duration. The self-efficacy scores at every level of duration did not show any significant correlation with overall SB.

These findings suggest that the self-efficacy for regularly standing up every 30 or 45 minutes might be an important psychological factor for reducing prolonged SB among office workers. Based on the findings of the study, it is recommended to use the single item of the self-efficacy scale (i.e., level of 30 min) to assess one's perception for prolonged SB.

Key words: sitting behavior, standing behavior, behavioral change, self-efficacy, office work.

Introduction

Previous studies report that office workers spend more than half of their working time in a sitting position[1,2)], which is a type of sedentary behavior (SB). SB is defined as having an activity intensity of 1.5 metabolic equivalents (METs) or lower[3)]. Sitting consecutively for 30 minutes or longer constitutes prolonged SB, which is significantly related with various physical and mental health deteriorations[4,5)]. These findings suggest that monitoring the SB of office workers is an important and imminent health issue in modern society.

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Indeed, many office workers are forced to sit while working at a desk. To reduce overall sitting time, office workers can adopt height-adjustable or standing desks or limit their time spent at a desk. However, in a typical workplace, it is difficult to implement such environmental (i.e., installation of ergonomic desks) and policy changes (i.e., limit time spent at a desk). Thus, any intervention program targeted towards reducing SB in an office should be both practical and effective.

There are certainly expert recommendations for attenuating the effects of prolonged SB, including standing up every 30 minutes to break up prolonged SB[5,6]. To assess the feasibility of this recommendation, it is important to identify modifiable related factors with prolonged SB. In terms of individual psychological factors associated with SB, previous studies have suggested that "self-efficacy" might be a related factor[7] and proposed its inclusion in an intervention for SB change[8]. Self-efficacy is the belief that a person can successfully perform a certain behavior[9] and it is considered to be a determinant for initiating and maintaining physical activity (PA)[10–12]. Researchers have adequately examined the role of self-efficacy in PA and they have adopted such factors in intervention programs for behavioral change; however, it is not as clear whether self-efficacy could also be a related factor for SB change.

A few studies have examined the association of self-efficacy with SB among workers[13–17]. Of these, three studies used self-regulatory efficacy scales[13–15] and two studies used task efficacy scales[16,17]. Wilkerson et al. (2018) reported that self-regulatory efficacy (i.e., the confidence to stand up in a situation despite barriers such as being busy at work or feeling tired) was a related factor for overall SB at the workplace. On the other hand, Busschaert et al. (2016) examined the relationship between individual psychosocial factors and self-reported SB. They found that task efficacy for reducing SB (i.e., willingness to stand up for a while after a period of uninterrupted sitting) was not associated with sitting time at work. Other studies[13,14] confirm that self-efficacy was not associated with prolonged SB. For example, De Cocker et al. (2014) found no significant relationship between self-regulatory efficacy and self-reported sitting time. To date, regardless of efficacy type, previous studies report inconsistent results regarding the association between self-efficacy for improving SB and actual SB.

One potential reason for this inconsistency is that each study had different definitions of the duration of prolonged SB. Indeed, the studies mentioned above did not set a specific duration for defining prolonged SB in their self-regulatory[13–15] and task[16,17] efficacy scales. Thus, the concept of prolonged SB may vary among participants: for example, some participants might imagine prolonged SB as uninterrupted sitting for 30 minutes, while others might imagine it as lasting for a few hours. This individual variation might affect results of correlation analyses. In addition, as the exact duration most strongly associated with actual prolonged SB is not known, it is necessary to set several durations. Therefore, the self-efficacy for SB change by standing up should be examined at several, specific durations of prolonged sitting. Most previous studies did not develop scales specifically for SB, but simply adapted from PA scales. This study will clarify whether task efficacy is associated with actual SB and further developed a self-regulatory efficacy scale specifically for workplace SB. Self-efficacy is known as a core concept in social cognitive theory[18] and it has been incorporated into many behavioral change interventions. Thus, understanding the association between self-efficacy and actual behavior will be helpful for determining whether self-efficacy should be taken into account in behavioral interventions. The primary objectives of this study were to examine the stability of the self-efficacy scale developed for this study and to investigate the association between self-efficacy for SB change at specific durations with the objectively-

measured overall and prolonged SB among office workers.

Methods

A. Participants and procedures

Office workers (n = 71) were recruited as a convenience sampling from a single company in Tokyo that helps with insurance paperwork. The first survey was conducted in February 2018, which assessed participants' health status, work-related stress, and self-efficacy. The same participants completed the same questionnaire five months from the first survey as part of a retest. The company manager reported that there was no change in the participants' working conditions between the test and retest sessions.

Another 76 office workers were also convenience sampled from eight offices in a single manufacturing and sales company in Tokyo in November 2017. These participants were involved in our investigation in the association between one's self-efficacy for SB change and an objective measure of their SB. The survey was conducted as part of a baseline observational evaluation of office environment change[19].

The protocols of the surveys involved in this study were approved by the Ethical Committee of Meiji Yasuda Life Foundation of Health and Welfare (approval number: 29001, 29002). Informed consent was obtained from all individual participants included in the study.

B. Measures

1. Self-efficacy scale for breaking up prolonged sitting

A task efficacy scale was developed in this study to assess Japanese worker's self-efficacy for breaking up prolonged sitting. The scale assessed one's perception of prolonged SB at work by asking whether they felt it was possible to stand up regularly to break up prolonged sitting during working time. Participants were asked to report their expectations of the behavior without considering whether they actually perform the behavior. To avoid individual differences in conceptualizing prolonged SB, we indicated five specific levels of duration for standing up (i.e., 30, 45, 60, 90, and 120 minutes). Studies reported that the mean longest sitting duration was 98 ± 34 min (range from 43 to 201 min)[20] and uninterrupted sitting for 30 min or more accounted for approximately 30 % of workplace sitting[1] in office workers. Another study targeting office workers showed that approximately half of the participants sat uninterrupted more than 60 min for over 70 % of total sitting time[14]. Based on these previous studies, the five levels of the scale appeared suitable for office workers.

Responses were provided on an 11-point Likert scale, which is widely used[21]: completely impossible = 0, neither agree nor disagree = 5, completely possible = 10. This scale was developed by experts from the fields of exercise epidemiology, occupational health, and exercise psychology. Specifically, it was inspired by a previously developed self-efficacy scale for performing physical tasks[22]. The developed scale is in Appendix 1.

2. Objective measurement of SB

In line with previous work[23], we measured SB using a tri-accelerometer. The tri-axial accelerometer used in this study was the Active style Pro HJA-750C (Omron Healthcare Co. Ltd., Kyoto, Japan) with an epoch length of 60 seconds. The device was an updated model of a previous one (Active style Pro HJA-350IT) that has comparable accuracy for detecting SB as ActiGraph™ GT3X+ (ActiGraph LLC, Pensacola, Florida, USA)[24], which is commonly used for SB research.

Participants were instructed to wear the tri-accelerometer for two weeks on their waist during waking hours, except while swimming or bathing. In data processing, non-wear time was defined as an interval of at least 20 consecutive minutes of no detectable intensity in the accelerometer. A "valid day" was defined as a day when records of activity were obtained for 10 hours or more[25]. Data from participants who had four

or more valid days during the assessment period of two weeks were treated as valid data[26]. Of the valid data, activities recorded during the standard working hours (8:40−17:20) in the company on weekdays were used.

The total times for both overall and prolonged SB were calculated. Overall SB included all activities with 1.5 METs or lower, while prolonged SB included SB that took place over 30 consecutive minutes or longer. The number of prolonged SB bouts was also calculated. Based on the company's standard working hours (8:40−17:20; 8.67 hours), all SB variables were converted into units of "minutes or time/working-hours" in weekdays using the following formula: minutes or time/working-hours = observed duration or time/wear-time × working-hours.

3. Demographic variables

Age, gender, body mass index (BMI), and job type (manager, office clerk, or professional) were the demographic variables. BMI was calculated using self-reported height and body weight for each participant.

C. Statistical analysis

Demographic variables and SB characteristics are reported using mean ± SD for the proportional variables, and numbers and percentages for categorical variables. Self-efficacy scores are shown using median and interquartile scores (Q1: first quartile, and Q3: third quartile).

The stability of the self-efficacy scale developed in this study was examined by the test-retest analysis. Intraclass correlation coefficients (ICC) for each level of duration were calculated using self-efficacy scores that were repeatedly measured during the five-month interval.

To examine the relationship between self-efficacy for SB change and actual SB, Spearman's correlation

Table 1. Characteristics of all participants.

Variables	Participants of test re-retest stability (n = 71)	Participants of correlation analysis (n = 76)
Age, mean±SD	46.1 ± 11.3	40.8 ± 12.2
Gender, n (%)		
Male	33 (46.5)	40 (52.6)
Female	38 (53.5)	36 (47.4)
Body mass index, kg/m^2 †	23.2 ± 4.5	22.4 ± 3.6
Job type, n (%)		
Manager	9 (12.7)	15 (19.7)
Office clerk	50 (70.4)	40 (52.6)
Professional	12 (16.9)	21 (27.6)
Objectively measured SB variables		
Wear-time of accelerometer during working hours, min/working-hours	Not applicable	507.8 ± 17.0
Overall SB		
Total SB time, min/working-hours		394.5 ± 50.6
Mean continuous time of SB, min/working-hours		10.9 ± 5.0
Prolonged SB		
Total prolonged SB time, min/working-hours		139.2 ± 90.3
Mean continuous time of prolonged SB, min/working-hours		41.4 ± 14.4
Number of bouts, time/working-hours		2.8 ± 1.6

† One participant had missing data. SB; sedentary behavior.

Prolonged SB was defined as sitting time lasting for 30 minutes or longer. Working-hours indicate the standard working hours of the company (i.e., 8.67 hours; 520 min).

Table 2. Intraclass correlation coefficients for test-retest stability.

Variables	Test	Retest	Test re-test ICC (95 % CI)
	Median (Q1 – Q3)	Median (Q1 – Q3)	
Self-efficacy for breaking up prolonged sitting			
30 minutes	7 (5 – 10)	5 (3 – 8)	0.53 (0.34 – 0.68)
45 minutes	8 (5 – 10)	7 (5 – 9)	0.44 (0.23 – 0.61)
60 minutes	10 (7 – 10)	9 (7 – 10)	0.33 (0.11 – 0.52)
90 minutes	10 (8 – 10)	10 (9 – 10)	0.28 (0.05 – 0.48)
120 minutes	10 (10 – 10)	10 (10 – 10)	0.34 (0.12 – 0.53)

ICC; intraclass correlation coefficients.

Table 3. Correlation between self-efficacy scores and objectively measured SB variables.

Variables	Self-efficacy for breaking up prolonged sitting				
	30 min	45 min	60 min	90 min	120 min
Overall SB					
Total SB time, min/working-hours	−0.05	−0.06	−0.04	−0.03	−0.14
Prolonged SB					
Total prolonged SB time, min/working-hours	−0.28 †	−0.29 †	−0.23 †	−0.15	0.02
Number of bouts, time/working-hours	−0.25 †	−0.25 †	−0.22	−0.15	0.05

SB; sedentary behavior.

† Indicates significant association ($P < 0.05$).

Prolonged SB was defined as sitting time lasting for 30 minutes or longer. Working-hours indicate the standard working hours of the company (i.e., 8.67 hours; 520 min).

coefficients (r) were calculated in each domain of SB and for each level of duration.

IBM SPSS Statistics version 25 for Windows was used for the analyses, and the statistical significance was set at $P < 0.05$.

Results

Table 1 presents the demographic information of all participants. The mean wear-time of the accelerometer was 507.8±17.0 min/working-hours, and all participants wore the accelerometer at least 80% of the wear-time during working hours.

Table 2 shows the stability of the test at each level of duration. ICC of self-efficacy scores between the two tests show moderate (0.53, 95% CI: 0.34 - 0.68) levels of stability at the duration of 30 minutes. ICC at other durations (45, 60, 90, and 120 minutes) revealed low stability (0.28 - 0.44).

Table 3 reveals the correlation between self-efficacy scores and the objectively-measured SB at each level of duration. The median and quartile scores of self-efficacy in each level are as follows: 30 minutes: 6 (Q1: 4, Q3: 10); 45 minutes: 7 (Q1: 5, Q3: 10); 60 minutes, 9 (Q1: 6, Q3: 10); 90 minutes, 10 (Q1: 8, Q3: 10) and 120 minutes, 10 (Q1: 9, Q3: 10). None of the self-efficacy scores at each duration showed significant association with overall SB time. Regarding prolonged SB, the self-efficacy scores showed significant but weak associations with the total time at the duration of 30 minutes ($r = -0.28$), 45 minutes ($r = -0.29$), and 60 minutes ($r = -0.23$), and with the number of bouts at the duration of 30 minutes ($r = -0.25$) and 45 minutes ($r = -0.25$). The self-efficacy scores at 90 and 120 minutes showed no significant correlation with any prolonged SB.

Discussion

This is the first study examining the relationship between self-efficacy for breaking up SB at specific durations and actual SB at the workplace. The results of this study showed that the self-efficacy for standing up at least once every 30 or 45 minutes was associated with the objective prolonged SB, but not with overall SB. These findings suggest that the self-efficacy for regularly standing up at least once every 30 to 45 minutes might be an important psychological factor for reducing prolonged SB among office workers.

The stability of the self-efficacy scale tended to decrease with the increase of the level of duration measured (i.e., the correlation between the duration and ICC was −0.76, not shown in the results). One potential reason for the weaker stability in longer levels of durations might be due to the difficulty of correctly judging one's belief in breaking up prolonged SB in longer durations. Based on these results, we recommend defining the break-up of SB as having shorter durations (i.e., less than 45 minutes) when assessing individuals' self-efficacy for SB change. Indeed, the significant relationship between self-efficacy and prolonged SB was not observed at levels of duration longer than 60 minutes, suggesting that the self-efficacy scores at these durations may not be useful.

We also found significant correlations between one's self-efficacy scores and their prolonged SB within shorter levels of duration (30 to 60 minutes). This result was different from that of previous studies, which reported no significant relationship between self-efficacy and SB[13,14,16,17]. The results of these previous studies might be due to the fact that they did not specify the duration of breaking up prolonged SB. Indeed, the concept of prolonged SB may vary among participants and such individual variation may affect the detection of such relationship. By resolving this issue, we found a significant relationship between self-efficacy and actual SB. Therefore, we speculate that enhancing self-efficacy within the range of shorter durations (30 to 60 minutes) could contribute to reducing prolonged SB at the workplace.

Although the correlational coefficient in this study was higher than that found in a previous study (r = −0.16)[15], it was still quite low (r = −0.23 to −0.29). Therefore, focusing on a task efficacy or adopting a single strategy of enhancing self-efficacy may not be enough to reduce prolonged SB in the workplace. In addition to task efficacy, self-regulatory efficacy improves understanding of self-efficacy for SB change. Self-regulatory efficacy assesses one's self-efficacy for certain behaviors in situations with barriers such as time constraints or bad weather. Previous review suggested that barriers to self-regulatory efficacy should fit target behaviors, participants, and situations[21]; thus, such barriers should be carefully and specifically investigated. However, current self-regulatory efficacy scales[13–15] were not developed specifically for SB, but simply adapted from PA scales. Future study needs to clarify specific barriers to prolonged SB change at work and include them in a self-regulatory efficacy scale. Such a scale should specify the duration (i.e., 30 min) of breaking up prolonged SB.

In addition to self-efficacy for SB change, other psychosocial factors such as having intention to reduce SB, receiving social support, and experiencing the norm of PA[7] should be considered. To reduce SB in the workplace, it is necessary to promote other strategies, such as providing information and counselling, making changes to the office environment (e.g., modification of office layout, or adoption of height-adjustable desks), and modifying office policies regarding PA and SB. These strategies have been used for improving PA and reducing SB in many intervention studies.

In contrast to prolonged SB, the self-efficacy for SB change did not show any significant correlations with overall SB at any duration. Although the reasons for these results are not clear, it may be due to the fact that

the duration of standing during work is short and it may not affect total sitting time（which covers most of the working time in the office）. These results suggest that it is necessary to distinguish between overall and prolonged SB when investigating the relationship between self-efficacy and actual SB.

This study has some limitations. First, the stability of the self-efficacy scale developed in this study was examined by a test-retest period of five months. Since some psychological changes during this period might have occurred, it is unclear whether the results of our analysis reflect the exact consistency of this scale. Thus, it is necessary to reexamine the stability of the scale using a shorter test-retest period. Second, we examined the relationship between the self-efficacy score and actual SB using Spearman's correlation coefficient, but there might be some confounding factors between these variables. Future studies are needed to identify these confounding factors, and to adjust for such confounding factors, in order to clarify the exact relationship between these variables. Finally, the number of participants in this study was relatively small, and all participants were recruited from the same company in Tokyo. The current findings should therefore be replicated in a future study using a larger number of participants with various job types and workplace characteristics.

Conclusions

Worker's self-efficacy for prolonged SB change might contribute to their practice of regularly standing up to break up sitting during work. Therefore, enhancing worker's self-efficacy for SB change could be an important psychological target for reducing prolonged SB during work. Based on the stability of the test and the association with objectively measured SB, it is recommended to use the single item of the self-efficacy scale（i.e., standing up at least once every 30 min）for the assessment of worker's perception for prolonged SB.

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Conflict of interest statement

The authors declare no conflict of interests for this article.

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Appendix 1.

Self-efficacy scale for breaking up prolonged sitting

連続座位中断セルフエフィカシー尺度

この質問は，現在のあなたの勤務中に立ち上がることに対する考えを調べるものです。
実際に行っているかどうかは別です。あなたの考えに最も当てはまる数字1つに○をつけてください。

勤務中の座りすぎを解消するために，定期的に立ち上がることができると思いますか。

	完全にできないと思う					どちらともいえない					完全にできると思う
30分に1回以上立ち上がる	0	1	2	3	4	5	6	7	8	9	10
45分に1回以上立ち上がる	0	1	2	3	4	5	6	7	8	9	10
60分に1回以上立ち上がる	0	1	2	3	4	5	6	7	8	9	10
90分に1回以上立ち上がる	0	1	2	3	4	5	6	7	8	9	10
120分に1回以上立ち上がる	0	1	2	3	4	5	6	7	8	9	10