

# Occupational sitting time, its determinants and intervention strategies in Malaysian office workers: a mixed-methods study

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## Abstract

Adults who accumulate a lot of sedentary time per day are at an increased risk of metabolic syndrome, type 2 diabetes, and hypertension. Prolonged sitting is also associated with depression, anxiety, bipolar disorder and schizophrenia. With the increase in desk-based office work, many office workers spend long hours sitting at the workplace. The aim of this study was to assess occupational sitting time in Malaysian government office workers, and investigate determinants of occupational sitting time and potential strategies to interrupt sitting time. We conducted a mixed-methods study consisting of a survey and focus group discussions (FGDs). A total of 1338 office workers from 24 Malaysian ministries completed the Occupational Sitting and Physical Activity Questionnaire. Twenty-nine office workers who spent at least 7 h per day sitting at work participated in FGDs. We enquired about knowledge, awareness and perceptions related to prolonged sitting time, barriers and facilitators to sitting time at work, and potential intervention strategies. Mean daily sitting time at work was 5.96 h (standard deviation = 1.37 h). FGDs confirmed barriers and facilitators to sitting time in accordance with the social-ecological model for health. Intrapersonal, social and physical environmental factors as well as organizational culture and organizational policy were mentioned to affect occupational sitting time. The results show that Malaysian government office workers spent a significant amount of time sitting at work and we identified multi-level factors influencing sitting time. A smartphone-based intervention to interrupt sitting time at work was suggested and is currently being tested.

## Lay Summary

Sedentary behavior is associated with adverse health outcomes including non-communicable diseases and mental disorders. With the increase in desk-based office work, many office workers spend long hours sitting at the workplace. Our study assessed occupational sitting time in Malaysian government office workers, and investigated determinants of occupational sitting time and potential strategies to interrupt sitting time. We conducted a survey and focus group discussions (FGDs). A total of 1338 office workers completed the Occupational Sitting and Physical Activity Questionnaire. Twenty-

nine office workers who spent at least 7 h per day sitting at work participated in FGDs. We enquired about knowledge, awareness and perceptions related to prolonged sitting time, barriers and facilitators to sitting time at work, and potential intervention strategies. The mean daily sitting time at work was 5.96 h (standard deviation = 1.37 h). FGD participants mentioned that intrapersonal, social and physical environmental factors as well as organizational culture and organizational policy affected occupational sitting time. They suggested a smartphone-based intervention to interrupt sitting time at work.

**Key words:** sedentary behavior, Asia, health behavior, office workers, determinants, social-ecological model

## INTRODUCTION

One of the greatest challenges that current health care systems face is the sharp rise of non-communicable diseases (NCDs) such as cardiovascular disease, type 2 diabetes and cancer (Naghavi *et al.*, 2017). In Malaysia, NCDs contribute to an estimated 71% of premature deaths with cardiovascular disease associated with 34.8% of premature deaths (Institute for Public Health, 2019).

Changes in lifestyles and increased life expectancy are key contributors to the rising NCD burden (World Health Organization, 2016). In terms of movement behaviors, physical activity has commonly been highlighted as a significant predictor of NCD risk (World Health Organization, 2016). However, there is mounting evidence that sedentary behavior (SB), independent of physical activity, is associated with adverse health outcomes including NCDs (Owen *et al.*, 2011; Wilmot *et al.*, 2012; Ekelund *et al.*, 2016) making it an emerging public health issue. SB refers to any waking behavior such as sitting, reclining or lying down characterized by low energy expenditure, commonly below 1.5 metabolic equivalents (METs) (Tremblay *et al.*, 2017). Research shows that adults who accumulate high amounts of sedentary time per day were at an increased risk of metabolic syndrome (Petersen *et al.*, 2014), type 2 diabetes and hypertension (Dempsey *et al.*, 2018). Prolonged sitting is also associated with low mental well-being (Atkin *et al.*, 2012), depression and low quality of life (Biddle *et al.*, 2021). Finally, prolonged sitting time is related to musculoskeletal disorders, especially on upper extremities such as neck and shoulders (Danquah *et al.*, 2016).

Increased desk-based office work by many adults means that large amounts of SB, in the form of sitting, are accumulated in the occupational domain (Church *et al.*, 2011). In fact, many office employees can work prolonged hours without having to leave their desk that results in high occupational sitting (Hendriksen *et al.*, 2016). Data from both high-income and non-high-income countries indicate that long hours of sitting at the workplace is common (Straker

and Mathiassen, 2009), and that workplace sitting accounts for most total daily SB time among office workers (Bennie *et al.*, 2015). For example, office workers in the UK and Australia spent more than 60% of their daily working hours sitting (Healy *et al.*, 2008; Buckley *et al.*, 2015). Further, office workers in Europe were reported to sit for more than 7.5 h per day at work (Loyen *et al.*, 2016). Although limited research is available, data from Asian countries mirror these findings with some suggesting that occupational SB is particularly high (Waters *et al.*, 2016; Daneshmandi *et al.*, 2017; Kurita *et al.*, 2019).

According to the Behavioral Epidemiological Framework, a key step toward addressing health behaviors is to identify its influencing factors (Sallis *et al.*, 2000). Using the social-ecological model (SEM) for health, a variety of factors were found to influence occupational sitting: intrapersonal, interpersonal/social, environmental and organizational/policy-related factors (Sallis *et al.*, 2015). For example, in terms of organizational-level factors, Cole *et al.* (Cole *et al.*, 2015) revealed that perceived pressure of getting a task completed forced workers to sit for a long period of time. Apart from this, types of tasks to be completed and working procedure also contribute to prolonged sitting time. The importance of the organizational culture was also highlighted by other studies (Munir *et al.*, 2018; Taylor *et al.*, 2018). The physical environment is also a significant contributor to prolonged sitting (Cole *et al.*, 2015; Waters *et al.*, 2016). For example, workstation design and cramped office space make it difficult for employees to move around.

Despite these results, there is limited research on SB, especially occupational sitting, in Asia which is home to more than 60% of the global population. A recent systematic review on SB correlates in Asian adults included 49 studies of which only four included some research on occupational sitting; none had a qualitative component (Müller *et al.*, 2020). As such, research on occupational SB in the continent is lacking. Given the health implications of SB, the lack of data on occupational SB in Asia

and the need to understand which strategies could be adopted to address SB at work, this study was conceived. The primary aim of this study was to employ a mixed-methods approach to (i) investigate the amount of occupational sitting time of government office workers in multi-ethnic Malaysia and (ii) identify factors influencing office-based sitting time. Our secondary aim was to explore strategies to interrupt and reduce sitting time in this population. The results of this study would provide the basis for future research and help policy makers address the growing issue of SB in many settings that increasingly offer jobs that are primarily desk-bound.

## METHODS

### Design

We conducted a mixed-methods study consisting of a cross-sectional quantitative survey and focus group discussions (FGDs). The Universiti Malaya Research Ethics Committee approved this study (UM.TNC2/UMREC-174). All research procedures were performed in accordance with the ethical standards set by the Declaration of Helsinki and its later amendments.

### Participants

#### Survey study

We included male and female government office workers aged between 18 and 60 years old who had regular working hours from 7:30 a.m. to 5:30 p.m. and were fluent in the Malay language (the official language of the country). Those who reported being confined to a wheelchair were excluded.

#### Focus group discussions

We purposively sampled participants from the survey study who reported office-based sitting time of more than 7 h per day as measured by the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) (Chau *et al.*, 2012); we introduce the instrument below. According to the OSPAQ, sitting 7 h or more at work indicates large amounts of sitting and increased risk of contracting an NCD.

### Measures and procedure

#### Survey study

In addition to capturing socio-demographic information, we measured occupational sitting time using the OSPAQ (Chau *et al.*, 2012). OSPAQ is a six-item self-report questionnaire that measures time spent sitting, standing, walking and doing heavy labor at work in the

previous 7 days. Data on sitting time were captured based on the total duration of time spent sitting regardless of the length of sitting bouts.

Three bilingual translators used the back-translation method to translate the OSPAQ from English to Malay language (Brislin, 1970). Following a check for accuracy of words and phrases by the first author, three subject experts established content validity of the draft OSPAQ (Malay version). A linguist then reviewed and verified language consistency. Next, we established face validity by administering the OSPAQ (Malay version) to 18 office workers. Finally, we established test–retest reliability by asking 54 government office workers to complete the OSPAQ (Malay version) twice within 2 weeks. Pearson Correlation Coefficients ranged between 0.74 and 0.97 with all being above 0.7 indicating acceptable reliability (Salkind, 2010). A summary of the test–retest reliability assessment can be found in [Supplementary Material 1](#).

Between November 2017 and February 2018, we emailed government office workers from 24 ministries to invite them to complete an online survey. The email contained information about the study and a consent form, which participants signed electronically by clicking a link provided in the email. Upon consent, participants were routed to the questionnaire.

#### Focus group discussions

We developed an interview guide for the FGDs and used it to explore three broad areas: perceptions, awareness and knowledge related to sitting time/SB; barriers and facilitators to sitting time in the office; and potential intervention strategies to interrupt/reduce office-based sitting time. Enquiries related to barriers and facilitators to sitting time were based on the SEM for health (Owen *et al.*, 2011; Sallis *et al.*, 2015). As such, we enquired about intrapersonal, interpersonal/social, environmental and organizational/cultural/policy factors. The FGD interview guide is presented in [Supplementary Material 2](#).

We sent invitation emails to eligible participants from the survey study and arranged FGDs with those who indicated interest. FGDs were conducted in meeting rooms at the participants' workplace. Before each FGD, we briefed participants on the procedures, answered questions and asked them to sign a consent form. FGDs were facilitated by the first author and assisted by a trained note taker. The sessions were conducted in the Malay language and lasted between 45 and 60 min. We digitally recorded all FGDs upon permission of all participants in the group. FGDs were conducted until thematic saturation was reached.

## DATA ANALYSIS

### Survey study

We carried out all quantitative analysis using IBM SPSS 24 (Armonk, NY, USA). Only participants with complete OSPAQ and socio-demographic data were included in the analyses. We conducted descriptive analysis for socio-demographic variables and OSPAQ variables using proportions, means and standard deviations (SD) where appropriate. We divided office workers into two categories: (i) management and professionals and (ii) administrative and support. Typically, the work nature of management and professional staff in Malaysian government working system provides more opportunity to move around due to more spacious workstations and often working offsite. In contrast, administrative and support staff typically have desk-bound work including clerical and other desk-bound activities. We then used two-sided analysis of variance (ANOVAs) to compare occupational sitting time between different groups: age, sex, ethnicity, job status and service category. A  $p$ -value of  $<0.05$  was considered statistically significant.

### Focus group discussions

We transcribed FGDs verbatim and conducted thematic analysis (Braun and Clarke, 2006). We employed framework analysis (Rabiee, 2007) and grouped responses into predefined themes which were partly informed by the SEM (Owen et al., 2011; Sallis et al., 2015). We arrived at our coding tree following iterative line-by-line coding including constant comparison. Within each transcript, salient words, phrases and sentences about barriers and facilitators to prolonged sitting behavior in the office were identified. Representative quotes of the barriers and facilitators in the five themes (interpersonal, social environment, physical environment, organizational culture and policy) were used to illustrate findings. We explored the data to identify potential intervention strategies to reduce/interrupt office-based sitting and grouped codes based on emergent themes. Themes, quotes and resulting analyses are discussed throughout.

## RESULTS

### Survey study

Of the 26 647 office workers invited to participate in the survey, 1338 (5% response rate) completed it. We excluded two participants as they reported unrealistic working hours ( $>90$  h per week), leaving 1336 participants for inclusion in the analyses. Table 1 shows

participants' socio-demographic characteristics in an age-stratified manner. Briefly, participants had a mean age of 37.7 years; and most were of Malay ethnicity (90.51%), female (65%), permanent staff (90.86%) and worked in the administrative and support sector (67.73%). The mean weekly working hours reported was 51.37 (SD = 11.29). Figure 1 shows the mean occupational sitting time stratified by age.

On average office workers reported 5.96 h (SD = 1.37) of occupational sitting per day with 9.65% reporting sitting time of more than 7 h daily. The mean sitting time daily for both categories of office workers was 5.95 h (management and professional; SD = 1.41 and administrative and support; SD = 1.37). Overall, office workers spent 74.4% of their working day in a seated position. Table 2 summarizes results of mean occupational sitting time based on socio-demographic characteristics; none were significantly associated with occupational sitting time.

### Focus group discussions

We conducted five FGDs in five ministries involving 29 office workers (mean age 34.31 years, range: 24–45 years) between May and July 2018. Each FGD consisted of between five and eight participants. Of the 29 participants, 12 were male (41%) and 17 were from the administrative and support group (59%). Participants' years of service ranged from 2 to 17 years (mean: 8.82 years).

### Perceptions, awareness and knowledge related to occupational sitting time

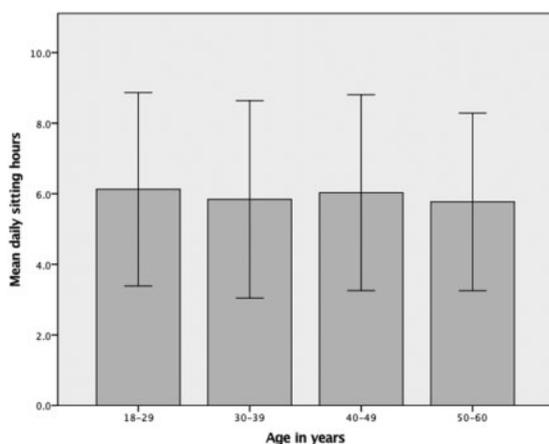
Participants reflected that they have excessive sitting time based on their job description and daily workload. All participants were aware of their general occupational sitting. Most encountered information on sitting time in social media, newspapers and educational material such as posters and pamphlets. Participants were aware that prolonged sitting could have negative health effects. A few mentioned an association between prolonged sitting and obesity, cardiovascular disease, diabetes, muscle pain and stress. However, they could not explain what prolonged sitting time is and were not sure when and how they should interrupt prolonged sitting.

### Barriers and facilitators to occupational sitting time

Intrapersonal factors identified by participants were nature of job, workload and lack of awareness of occupational sitting time. For example, 'As a customer service officer, it is my duty to ensure all calls and walk-in guests are entertained accordingly. I have very limited

**Table 1:** Socio-demographic characteristics of the survey study participants

Variables	Total ( <i>n</i> = 1336)	18 – 29 years ( <i>n</i> = 269; 20.1%)	30 – 39 years ( <i>n</i> = 501; 37.5%)	40 – 49 years ( <i>n</i> = 459; 34.4%)	50 – 60 years ( <i>n</i> = 107; 8.0%)
Sex, <i>n</i> (%)					
Male	468 (35.0)	88 (32.7)	185 (37.0)	159 (34.6)	36 (33.6)
Female	868 (65.0)	181 (67.3)	316 (63.0)	300 (65.4)	71 (66.4)
Ethnicity, <i>n</i> (%)					
Malay	1209 (90.5)	236 (87.7)	457 (91.2)	421 (91.7)	95 (88.8)
Others	127 (9.5)	33 (12.3)	44 (8.8)	38 (8.3)	12 (11.2)
Job status, <i>n</i> (%)					
Permanent	1214 (90.9)	221 (82.2)	451 (90.0)	437 (95.2)	105 (98.1)
Contract	122 (9.1)	48 (17.8)	50 (10.0)	22 (4.8)	2 (1.9)
Service category, <i>n</i> (%)					
Management and professional	431 (32.3)	66 (24.5)	145 (28.9)	160 (34.9)	60 (56.1)
Administrative and support	905 (67.7)	203 (75.5)	356 (71.1)	299 (65.1)	47 (43.9)

**Fig. 1:** Mean occupational sitting time of the 1336 study participants stratified by age group.

time to move around except during toilet breaks and lunch breaks' (A6, female, 27 years old, administrative and support group). In terms of workload, one participant mentioned 'Sometimes you are forced to sit because attending a meeting. It can last the whole day' (E2, female, 41 years old, management and professional group). Another participant reported 'Occasionally I am not aware that I spent so much time sitting' (D3, female, 33 years old, administrative and support group).

Another factor that contributes to occupational sitting is the social environment. Participants mentioned that sitting breaks occur mostly for a specific purpose. Furthermore, sitting has become a normative behavior

**Table 2:** Differences in mean sitting time in hours of Malaysian government office workers based on sociodemographic characteristics

Sitting time at work					
Characteristics	<i>n</i>	%	Mean	SD	<i>p</i> value
Total	1336		5.97	1.38	
Age (years)					0.113
18 – 29	269	20.1	6.13	1.36	
30 – 39	501	37.5	5.84	1.39	
40 – 49	459	34.3	6.03	1.38	
50 – 60	107	8	5.77	1.25	
Sex					0.981
Male	468	35.1	5.87	1.45	
Female	868	64.9	6.00	1.34	
Ethnicity					0.393
Malay	1209	90.5	5.94	1.377	
Others	127	9.5	6.05	1.429	
Job status					0.452
Permanent	1214	90.9	5.94	1.383	
Contract	122	9.1	6.04	1.372	
Service category					0.950
Management and professional	431	32.3	5.95	1.414	
Administrative and support	905	67.7	5.95	1.367	

Note: Mean occupational sitting hours per day.

in the office. For example, 'I take a break only when my head of department wants to see me or whenever I need to go to the bathroom or refill my water' (C2, female,

32 years old, management and professional group). Another participant mentioned that she 'rarely see colleagues take sitting breaks unless they have to go see their boss or going to the bathroom. Usually most just sit at their place' (B1, female, 36 years old, administrative and support group).

In addition to the social environmental, the physical environment was also mentioned as one of the factors that contribute to occupational sitting time. Participants commented on limited office space compounded by old files and non-functioning office equipment which have not been cleared. One participant reported 'We see bundles of old files or unused furniture being placed in the hallway. We can't simply move it because we realize it's the problem that we are facing by having a small office' (C5, female, 32 years old, administrative and support group).

Under organizational culture, participants stated that taking sitting breaks is not regular practice, and they worried it will create a bad impression. In addition, there was lack of support from the management to be active workers. One participant commented that 'I don't think we are able to have sitting breaks and walk around as it will give a negative impression to my boss and colleagues' (D3, female, 33 years old, administrative and support group). Another participant commented 'To me, if the boss or top management in the organization consists of highly active and motivated people, it will also influence workers to act in a similar way' (B3, male, 42 years old, management and professional group).

Lastly, participants felt that as programs to encourage workers to be active were not structured and usually one-off, they were not encouraged to be more active. A female employee commented 'We had organized a few physical activity programs but that was not very structured due to lack of resources like manpower and budget. Plus, the program is not interesting and the content almost similar every time' (E1, female, 39 years old, management and professional group).

#### Potential strategies to interrupt occupational sitting time

When asked about potential strategies to interrupt and/or reduce prolonged sitting in the office, participants suggested using technology to deliver messages that would encourage them to take frequent breaks from sitting. Most participants felt that smartphones would be the best option. As many participants used instant messaging services, they proposed that WhatsApp, a popular messaging app in Malaysia, would be a feasible and convenient delivery channel. They suggested multiple message formats (texts, GIFs, images, videos and voice

messages) be used to increase interest and engagement. However, they would prefer texts to be short, clear and simple, creative, and non-formal. They felt that too many messages would be annoying and said that three to four messages a week would be appropriate.

## DISCUSSION

The average sitting time of Malaysian government office workers was 5.96 h per day. This is similar to the daily occupational sitting time of 5.8 h in 20 high-income and non-high-income countries (Bauman *et al.*, 2011), and to the 5.75 h per day reported in Saudi Arabia (Albawardi *et al.*, 2017). Total sitting time of more than 4 h a day was linked to health risks and increased mortality (Saunders *et al.*, 2012). Assuming that office workers work 8 h per day, our study suggests office workers spent almost 75% of their total working hours sitting. Likewise, Thorp *et al.* (Thorp *et al.*, 2012) and Kazi *et al.* (Kazi *et al.*, 2014) also found that office workers spent up to 71% of their working day sitting.

In our study, none of the socio-demographic characteristics emerged as significant correlates of workplace sitting. Previous work in Western countries showed that daily sitting time in the office was associated with age (Bennie *et al.*, 2015), sex and ethnicity (Hadgraft *et al.*, 2016). However, such a consistent picture did not emerge in studies conducted in Asia (Müller *et al.*, 2020), where only female sex was associated with more occupational sitting in two studies. In the current study, we assume that regardless of socio-demographic factors that were assessed, sitting time is much more influenced by nature of job and office environment as revealed by participants in the FGDs.

In addition to exploring socio-demographic correlates, we enquired about intrapersonal, interpersonal, social and physical environment, organizational culture, and policy factors related to office-based sitting time using focus groups methods. All participants were aware of prolonged sitting time and the potential harms associated with it. This could be the result of nationwide awareness campaigns by the Ministry of Health Malaysia, such as the Active Living Campaign on sedentary lifestyles which has a particular focus on prolonged sitting time. Despite such awareness, participants lacked knowledge on what sitting time constitutes and how it is accumulated. Interestingly, such knowledge gaps were observed among the administrative and support staff as well as the management and professional group.

Multi-level barriers and facilitators to occupational sitting included job nature, workload, how employees influenced each other's behavior, office space and organization,

and organization policy. For example, customer service officers or data entry officers are required to spend most of the time sitting at their workstation with limited physical movement. This is in line with Owen *et al.* (Owen *et al.*, 2011) who stated that computer-based work was the most significant contributor to prolonged occupational sitting time. Operational and administrative assistants (who deliver letters and documents) have more tasks that require physical activity which enables them to take frequent sitting breaks. Job-related factors were also reported to influence movement behavior in a recent study in Singapore (Wang *et al.*, 2020). In agreement with previous work by Owen *et al.* (Owen *et al.*, 2011) and Wang *et al.* (Wang *et al.*, 2020), the social environment in the office was reported to influence sitting behaviors because of unwritten social norms. In our study, participants reported that the behaviors of colleagues would affect the social environment. Participants felt that if most office workers were active and spent less time sitting, it would influence other colleagues to act in similar ways; and as such lead to a shift in social norms in the office. This was also reported by Cole *et al.* (Cole *et al.*, 2015) and Wang *et al.* (Wang *et al.*, 2020) who found that social support and peers' behavior (i.e. role modeling) had a strong influence on office workers' sitting time. Participants also mentioned that the physical environment such as furniture layout, and spatial configuration contributed to prolonged sitting time in the office. These factors were different from those reported in a previous study from Singapore in which office-based healthcare workers suggested that lack of access to facilities and equipment such as standing desks inhibits their ability to reduce occupational sitting time (Wang *et al.*, 2020). As we have shown in our study, Malaysian government office workers are aware of SB to some degree, but addressing this issue is rare. In fact, there are currently no concerted efforts. As such, many were not aware of such adjustable office furniture. Lastly, the organizational culture as shaped by the senior management was suggested by Wang *et al.* (Wang *et al.*, 2020) to play a significant role. Waters *et al.* (Waters *et al.*, 2016) also suggested that the senior management play a vital role in setting and possibly leading a cultural shift in office norms especially when reducing prolonged sitting time.

Finally, when asked about potential strategies to reduce and/or interrupt sitting time in the office, participants suggested a smartphone-based intervention; they proposed using WhatsApp, a popular messaging service in Malaysia, to encourage less sitting. This finding is interesting because it highlights that participants had mainly individual-level strategies in mind, which suggests that they feel reasonably responsible for changing their sitting behavior in office. A digital intervention,

which primarily targets individual-level factors, to reduce office-based sitting has been reported in an earlier study. Bond *et al.* (Bond *et al.*, 2014) found that smartphone-based interventions can reduce daily occupational sitting time in office workers by up to 47 min. Support for such digital interventions to address SB at the workplace also comes from a recent meta-analysis that reported moderate effects in sitting time (Stephenson *et al.*, 2017). Such an approach might be successful in Malaysia considering the high smartphone use and that messaging accounts for more than 98% of all smartphone activities among Malaysians (Malaysian Communications and Multimedia Commission, 2018). Plus, the latest features on smartphones such as free messaging applications allows for more feasible and low-cost strategies to interrupt sitting time with minimum cost.

Although such strategies might impact office-based sitting time, stronger and more sustainable changes can likely only be achieved by employing multi-level interventions that also consider environmental and organizational/cultural factors (Robroek *et al.*, 2012). A previous meta-analysis reported such multi-level strategies to have the strongest effect size in terms of reducing occupational sitting (Chu *et al.*, 2016). However, such strategies are more time- and resource-consuming and are, as such, more difficult to implement and sustain.

## STRENGTHS AND LIMITATIONS

A key strength of the current study is that it provides, for the first time, an overview of occupational sitting time and its multi-level determinants among office workers in Malaysia. Secondly, we conducted a mixed-methods study, which allowed us to contextualize results from our quantitative survey. Finally, this study can serve as a baseline to develop interventions that aim to address sitting time in the office. Despite these strengths, some limitations exist. First, we used a self-report questionnaire to measure sitting time. Such an approach comes with various biases such as recall and social desirability bias (Grimm, 2010) leading to likely underreporting of sitting time. Nevertheless, it was not feasible to use objective instruments due to the cost involved. Second, the response rate from the office workers in the survey was low (~5%). Third, although survey participants were mainly of Malay ethnicity, it reflects the ethnic composition of government office workers in Malaysian. Lastly, participants from the management and professional as well as administrative and support groups were in the same FGD. There might have been a tendency for participants from the

management and professional group to influence the answers of the administrative and support group, which is ranked lower in the organization structure. However, we did not observe evidence of such influence.

## CONCLUSION

This study demonstrates that sitting time among Malaysian government office workers is relatively high and at par with previous studies. We found office-based sitting time to not be associated with socio-demographic factors. Similar to other studies and in accordance with the SEM, our findings suggest that occupational sitting time is influenced by various factors operating on different levels. Utilizing smartphone-based messaging services to deliver intervention material aimed at interrupting/reducing prolonged occupational sitting might be a viable and effective option. Such an intervention is currently being tested with a cluster-randomized controlled trial.

## SUPPLEMENTARY MATERIAL

[Supplementary material](#) is available at *Health Promotion International* online.

## ETHICAL APPROVAL

Ethics approval for this study was obtained from the University of Malaya Research Ethics Committee (UM.TNC2/UMREC-174). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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## CONFLICT OF INTEREST STATEMENT

None declared.

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