The Awareness of Human's Sedentary Behavior in the Workplace and Product Design Guidelines

Dosun Shin and Yue Huang

Abstract Americans spend a considerable amount of their waking-hours in sedentary behavior. Among the different places where sedentary behavior occurs, the workplace is one of the primary settings for prolonged sitting which is associated with poor health outcomes. This study aimed at understanding the needs and wants of office workers in relation to the products that help sedentary employees reduce their sitting time. The research was conducted using a holistic design approach, including IRB application, online survey, and data analysis methods. The primary goal of this study was to understand the barriers and motivators to sit less in the office, and explore the employees' attitudes and experiences of using products to reduce their sitting time. Based on the findings, the design guidelines of product design in the workplace were proposed to improve their sedentary behaviors that cause public health-related outcomes.

Keywords Workplace sedentary behavior · Health and promotion · Product design guideline · Public awareness

1 Introduction

Sedentary behaviors can be identified as any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents (METs) while in a sitting or reclining posture [1]. Americans spend a considerable amount of their waking-hours in sedentary behavior, which associated with poor health outcomes (chromic conditions, notably cardiovascular disease, etc.). Most adults in developed countries spend time sitting in three domains: workplace, leisure, and transport [2]. Among these

D. Shin (✉) · Y. Huang
Arizona State University, Tempe, Arizona, USA
e-mail: dosun.shin@asu.edu

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different places the sedentary behavior occurs, workplace is a key setting for prolonged sitting time where an average of 8 h is spent per day. Meanwhile, workers in desk-based occupations are considered a key target group for workplace sitting reduction strategies [3, 4].

To date, a large amount of research studies focus on increasing light-intensity activities (standing and walking slowly) as the primary outcome of interests, which is good for health [2]. Whereas, Healy et al. [5] proposed that prolonged sedentary time are independent of time spent exercising. Therefore, it is also important to conduct interventions with the aim of reducing sitting and breaking prolonged bouts of sedentary behaviors.

In recent years, several interventions (e.g. standing at a desk, and walking work stations in office environments) were conducted aiming at reducing sitting time. However, little research focused on the effectiveness of the interventions from a design standpoint. In this study, researcher aimed at understanding the needs and wants of office workers in relation to the products that help sedentary employees reduce sitting time. The research was conducted using a holistic design approach, including IRB application, online survey, and data analysis methods. The goal was to understand the barriers and motivators to sit less in office and explore the employees' attitudes and experiences of using products to reduce sitting time. Based on the findings, the design guidelines of products in workplace were proposed for improve office sedentary behaviors.

2 Research Design

An online questionnaire was employed in this study. By including close-ended and open-ended questions, the goal was to provide findings with a wider perspective and reduced bias.

Regarding broader, less biased findings, according to O' Leary, close-ended questions in surveys can "generate standardized, quantifiable, empirical data", while open-ended questions can provide a great diversity of responses. Open-ended questions tend to be more objective and less leading than closed-ended questions, because it allows people to fully express their opinion instead of merely having to select an answer from a predetermined set of response categories. Therefore, the survey, combined with close-ended and open-ended questions, could help research get a big picture of the target group, meanwhile, collect in-depth data to understand the needs of the target group thoroughly.

The data collection process was implemented after getting approval from the Arizona State University Institutional Review Board and all participants gave written informed consent.

2.1 IRB

Since the research focus of this study referred to human behaviors in the workplace, and involved human subjects, research protocols and related materials were required to be submitted and approved by the Arizona State University Institutional Review Board (IRB) before conducting research. Research protocol should include purpose and background of the study, criteria and recruitment methods of participants, research procedures, potential risks and benefits, privacy protection and the consent process, etc. The related material in this study included recruitment scripts and questions for survey participants. By reviewing all of these materials, the Institutional Review Board sought to protect human subjects from physical or psychological harm during the research process.

2.2 Data Sampling Strategy and Subjects

To recruit participants, two sampling strategies were adopted in this research: handpicked sampling and snowball sampling. Handpicked sampling refers to the selection of a sample with a particular purpose in mind; snowball sampling is a strategy that builds a sample through referrals. The potential participants, current full-time employees, were asked whether they want to participate in this research via emails. Once an initial respondent was identified, he or she was asked to recommend others who met the study criteria.

The selected subjects were adults who met the inclusion/exclusion criteria which included (1) full-time US employment; (2) working in desk-dependent and predominantly sedentary occupations; (3) sitting at least 4 h a day during one typical workday.

2.3 Questionnaire

An online questionnaire was administered to 50 male and female volunteers to collect quantitative data by multiple-choice questions and five Likert-scale responses. Also, the survey provided qualitative data by open-ended questions. The questionnaire was composed of 4 parts: (1) demographic information; (2) Workplace Sedentary Behaviors; (3) Attitude and experience of related products.

2.4 Data Analysis

The quantitative data collected from close-ended questions in survey was analyzed at www.qualtrics.com. Text analysis methods, including coding and context

interpretation were adopted to analyze qualitative data collected from open-ended questions. Reflecting on the development process outlined in this paper, the guidelines for product design were proposed.

3 Results

3.1 Demographic Information

A total of 50 survey participants, aged 21–65 years, were recruited, including 23 males (46 %) and 27 females (54 %). The participants, aged 21 to 30 years, were the main age group involved and made up 52 % of the (total) survey population. In terms of the 50 employees' occupations, 20 participants worked in design, 8 in the field of education, another 8 in computer science, and the remaining participants from other fields (e.g. administration, business, engineer).

3.2 Sedentary Behaviors in Workplace

Overview. Of the 50 employees surveyed, the average workday expressed was 9.5 h (including lunch break); and the average sitting time was 7.5 h. As shown in Fig. 1, the 50 employees estimated the percentage of time they spent sitting, standing and walking during working hours. On average, participants spend more than three quarters of their working time in a seated position, while standing and walking time were divided equally the rest of working hours (Table 1).

Sitting Time.

Regarding to the sitting time during work, the Fig. 1 shows that only 14 % of the respondents (N = 7) show their satisfaction with their sitting time, while half of the respondents (N = 25) are unsatisfied with their current sitting time. Corresponding to Figs. 1 and 2 shows that the majority of participants (N = 43, 86 %) would like

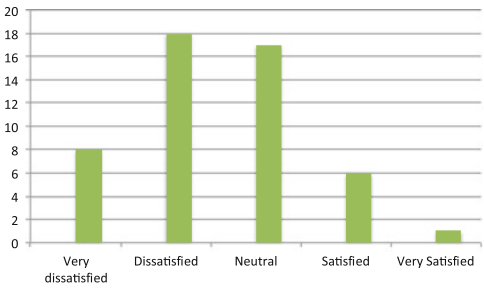
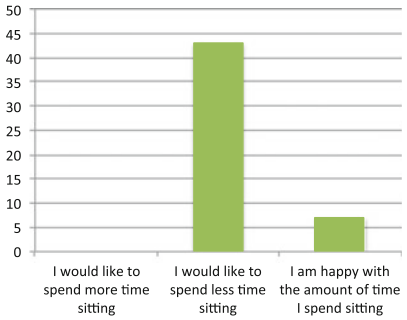


Fig. 1 Satisfaction regarding sitting time

Table 1 Percentage of time people spend sitting, standing, walking

Activities	Percentage
Sitting	76.56
Standing	12.27
Walking	11.17

Fig. 2 Willing to change the sitting time



to sit less during work, except for 7 participants who are happy with their sitting time. No one wanted to spend more time sitting.

Figure 3 demonstrates the results of a multiple choices question. It is obvious to see that two main reasons of long time sitting are both related to work. 54 % of respondents (N = 27) feel too busy to move and 42 % of respondents (N = 21) want to concentrate on work by sitting. In addition, 16 respondents provided their own reasons by selecting "others". There were 5 participants mentioned that they have to sit during work because it is job requirement to use desk, which don't allow them to stand while working. Some of the responds are shown as below: "My job requires a computer, my desk is not set up to allow me to stand while working", "Most of my work must be done at a desk, and the desk requires sitting to use", "I have everything on my desktop so it is not efficient to go anywhere else". Among the other options, "I feel tired while standing/comfortable while sitting" is also a reason of long sitting which chose by 7 participants.

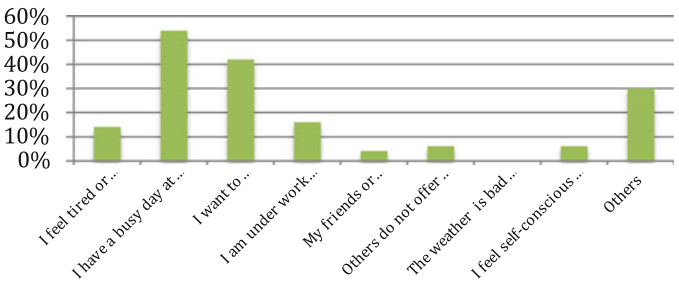


Fig. 3 Reasons of prolonged sitting

Fig. 4 Activities during sitting time

Employees were asked an open-ended question about what main activities they do while sitting at work. The frequency words appeared in their answers were counted and sorted, and the word cloud graph generated on infogr.am.com (see Fig. 4) was used to visualize the result. The bigger the texts, the higher frequency of the word were mentioned. Through the graph, it was clear to see that meetings represent one of the main activities of sitting time, which was mentioned seventeen times by respondents. Aside from meeting, writing, computer work, reading, emailing and designing composed a big part of the sitting activities. Also, researcher found that there was a relationship that was between occupations and activities. Figure 5 showed part of the answers that sorted by occupations. The designers mainly drew sketches at the desk or design using software, whereas, programming and coding were the main activities of software programmers.

Fig. 5 Example of answers of activities during sitting

Occupations	Main activities
Designer	Writing, Drawing, CAD and computer based design work
Designer	Meetings, emails, internet research, sketching, graphic work, video conferencing
Designer	Photo editing and layout design.
Software engineer	Programming
Software engineer	Coding
Professor	90% document and paper / 10% statistic
Professor	Writing by hand typing on laptop answering email reading journal
Business operation manager	Reading, super fine detail comparison of printed document,
Manager	Answer the phone/emails meeting

Non-sitting Time.

As shown in Fig. 6, the majority of people (86 %) stood up at least every 2 h, among which, 52 % of respondents stood up every 1–2 h. Figure 7 indicated that 70 % of participants stood for less than 10 min and only 6 participants (12 %) spent sitting more than 20 min.

In the Fig. 8, walking acted as a leading activity during non-sitting time. The activities with higher frequency included both work-related activities

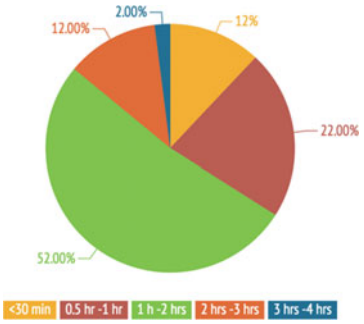


Fig. 6 Average frequency of standing

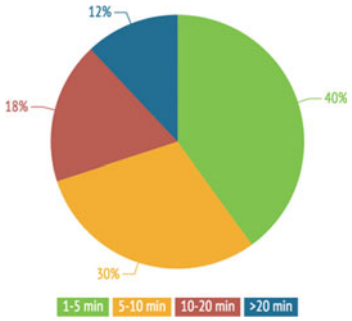


Fig. 7 Average length of each non-sitting time

Fig. 8 Activities during non-sitting time

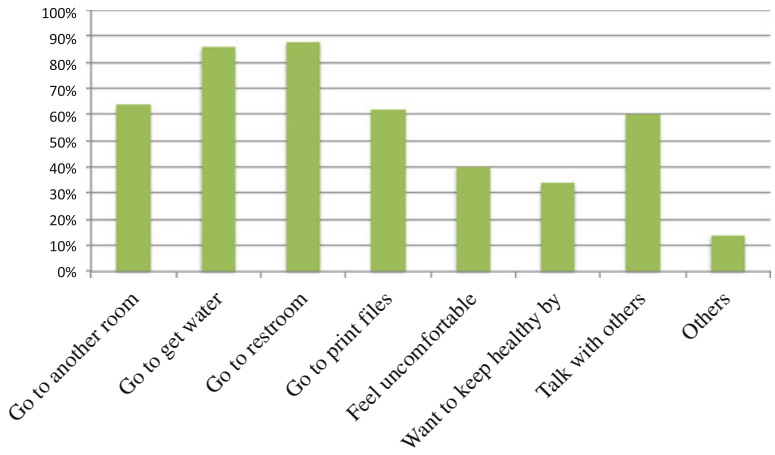


Fig. 9 Reasons of stop sitting

(e.g. printing, discussing with coworker) and relax activities (e.g. getting water, stretching body).

In regard to the reasons that stoped people from continuous sitting (Fig. 9), 86 and 88 % of the participants chose "go to get water" and "go to restroom". Besides, printing and going to another room were two secondary reasons. Aside of the extrinsic factors, two intrinsics reasons were identified: "feel uncomfortable" and "want to keep healthy".

3.3 Attitude and Experience of Product

Attitude.

In Fig. 10, 78 % of respondents showed their interests in using products to reduce sitting time, while only 44 % of respondents had knowledge of existing products. Figure 11 showed the reasons why people don't used product to sit less in workplace. More than 70 % of responsents selected "they don't know about the product". Also, a large number of participants thought "they don't have control of their office" and "the available products are too complicated to use". The reason "lacking of the knowledge of the harmfulness of sedentary behaviors" was also mentioned a lot.

When asked what kinds of product they preferred, 71 % of participants expressed their preference of physical products, and 28 % of respondents would like to use mobile apps to help them reduce sitting. Only 3 people showed their interests on using software (Fig. 12).

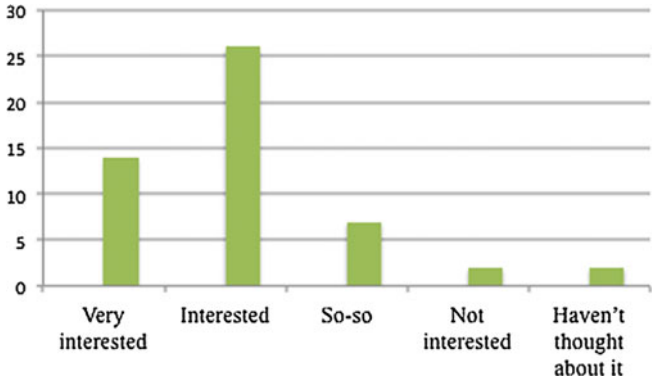


Fig. 10 Interests of product intervention

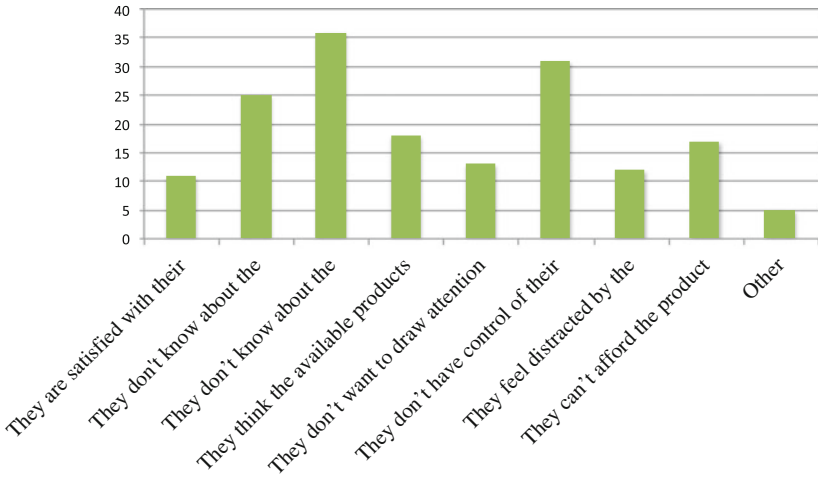


Fig. 11 Reasons of not using products in workplace

Experience.

At the end of this section, three open-ended questions were asked among the participants with knowledge of existing products: (1) Describe any features/functions you particularly like of this product; (2) Describe any features/functions you particularly dislike of this product; and (3) Describe the essential features/functions of a product that would persuade you to use to reduce sitting time. The participants without knowing any existing product only answered the third question.

By analyzing answers words by words, four categories of features were identified: cost, ergonomics, health, and work.

Experience.

Answers	Key words
timer, forced breaks	easy to use/easy to bring to work
reasonal price and stability	useful information and guide
cool, high tech; feedback	force break
Too many	timer/reminder
Have a clock, reminding people to stand up for 10 min every hour...	reasonal price/ cheap
Yes	stability
Timer	work efficiency
Easy to carry not take too much room	adjustable
accurate and some easy and helpful guide for their real life.	
don't sacrifice work efficiency	Manage pay for the product
just to make sure the products are really effective.	
Maybe a social component like doing a group activity.	more comfortable/ergonomic
making sit feel more comfortable	
alert, force me move	
comfortable /reminder/ vanessa	
The product has to be cool, it needs to motivate people and enhance there work experience. It fundamentally has to be better than conventional sitting.	
allow to work and exercise at the same time	
Must be relatively cheap and easy to use. Would probably be more likely to be implemented if came withinformation about the positive impacts on productivity and health	

Fig. 12 Screen capture of coding process

4 Conclusion

The results of the online questionnaires described the current situation of office workers' sedentary behaviors. The findings showed that the majority of participants were unsatisfied with their current sitting time experiences, and were interested in using products, especially physical products, to reduce sitting time during office working hours. Also, the survey indicated that the main barrier of standing during work was people did not want to sacrifice work efficiency, especially during demanding periods of time. However, available workstation designs often did not allow them to keep working while standing. Based on the results of the survey, extrinsic and intrinsic motivational factors to stand and worker preference findings helped the researcher develop further design guidelines to improve sedentary behavior related health outcomes.

Design guidelines were developed covering work, ergonomics, health and cost aspects as shown in Fig. 13.

In future research, different work contexts can be taken into consideration to enable a deeper understanding of the different, and/or related needs reflected across the spectrum of occupations. More specific design guidelines could be developed to help people in different occupations to be more motivated to stand more and sit less.

Work
Provide enough workspace for different types of work
Maintain work efficiency and reduce sitting at the same time

Ergonomics
Adjutable and stable at the same time
Comfortable to be used while standing
Easy to use with minimal effort and simple interface

Health
Allow to track the health status, body change
Provide more information of the benefit of sitting less and harmfulness of prolonged sitting, which could internally motivate people.
Help to keep good posture during both sitting and standing
Keep people physical active
Remind people stop sitting

Cost
Reasonable price
Provide different price level that more people can afford

Fig. 13 Design guidelines

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