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Do office workers adjust their chairs?

End-user knowledge, use and barriers to chair adjustment

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A B S T R A C T

A quantitative field study measured end-user availability, knowledge and use levels of adjustable office chair functions in Korea-based office workers, together with their perceived barriers towards making adjustments. Fifty-one English-speaking workers were interviewed and surveyed in a related design. Results showed that of the number of adjustable functions available on their office chair (M = 5.39, SD = 2.3), participants knew fewer than half of them (M = 2.51, SD = 1.52) and used even less (M = 1.86, SD = 1.21). Fifty-three percent of participants knew two or less and 73% had used only two or less. Ten percent had used none. Results suggested physical needs (such as increased comfort or postural change) were a strong driver for previous chair adjustment behavior. Perceived cognitive barriers played a more significant role in limiting chair adjustment knowledge and use than physical or organizational barriers. Highly adjustable office chairs have the possibility of satisfying the adjustment needs of most end-users. However, adjustable chair functions need to be both available and known in order to be used.

Keywords: Office chair adjustment; Chair controls; Chair adjustment barrier

Introduction

Many office workers spend most of their working day sitting in their chairs yet several studies have shown that a high proportion of them never make adjustments to them, nor do they know how to adjust them correctly for their comfort, body size or working tasks (Hedge, 2016; Vink et al, 2007). The reasons for this, although known to be complex, have received minimal attention in the recent literature.

This quantitative field study measured levels of knowledge and use of the adjustable office chair functions available to Korea-based office workers, together with their perceived barriers towards making adjustments. A review of the office chair adjustment literature will provide the framework for introducing this study's research hypotheses.

1.1. Chair adjustment, sitting and health

To be considered ergonomic, a chair should provide adjustability in seat pan height, depth and tilt; lumbar support and backrest recline (Hedge, 2016). Adjustability of the headrest and armrests in height and pivot position also support the body's ability to maintain comfort (Allie and Kokot, 2005).

Adjusting the body to the chair rather than adjusting the chair to fit the body may result in discomfort, or worse, musculoskeletal injury (Hedge and Breeuwsma, 2008). The deleterious health effects of sitting have received recent attention in the literature and been linked to several illnesses including diabetes and cardiovascular disease (Dunstan et al, 2012). Further, prolonged sitting at a sub-optimal workstation (which includes the office chair) has been associated with musculoskeletal symptoms including discomfort and muscle tension in the cervical, shoulder and lumbar regions (van Niekerk et al, 2012). The authors of that study noted the role of an adjustable chair in reducing muscle activity in the neck, shoulders and back. They also found evidence linking correct adjustment of the seat pan height and depth to the user's body size with a reduction in inter-vertebral disc pressure and spinal discomfort. Regular adjustment of the backrest function from a fixed to a reclining setting allows the worker to stretch and extend their spine to reduce back discomfort and was noted by Gscheidle et al (2004) to have biomechanical benefits. An earlier study by Amick et al (2003) found that a highly adjustable chair (and office ergonomics training) reduced musculoskeletal symptom growth over the workday, particularly in the neck and shoulders. These findings supported a direct association between chair adjustability and the musculoskeletal system. They also highlighted the role of chair adjustment as a useful first step in reducing discomfort, compared with the practical and economic challenges of adjusting the work surface height.

1.2. Office chair adjustment drivers

When provided with a new office chair, the worker may seek to make certain immediate adjustments to it to optimize it for their body size and comfort. The need to provide adequate support for the feet on the floor, for example, may promote a search for the seat height control (Vink et al, 2007). Indeed Groenesteijn et al (2009a) found that chair adjustment was more common in initial chair use compared with later use. Osvalder and Colmsjö (2015) suggested this may be because chair users, once comfortable, feel less need to readjust. Comfort is clearly an adjustment driver, particularly if the user links the chair with perceived discomfort. Helander (2003) identified that the desire to increase comfort is different from the need to decrease discomfort. Differing working postures and daily tasks may promote more frequent use of control settings (Groenesteijn, 2014). Some users may prefer to lower their chair's armrests for keying tasks, for example, but elevate them to support the forearms and elbows for extended reading of documents. Seeking to reduce musculoskeletal symptoms is another driver, such as the worker seeking to relieve back discomfort by reclining their backrest (Gscheidle et al, 2004). Organizational issues also play a role. Office workers subjected to unassigned seating ('hot-desking') may be required to use a different workstation – and office chair – every day (Kim et al, 2016). Individual differences and increased workforce diversity suggest that sitting in a chair previously adjusted for someone else's body size and working needs may result in physical discomfort (from an excessively high seat pan, for example) which may drive some chair adjustment behavior.

1.3. Knowledge and use of adjustable chair functions

Vink et al (2007) suggested that many office chairs are designed without realistic knowledge of their users, and users are presumed to possess knowledge they do not have. Indeed, the presence of a highly adjustable chair is no guarantee its user has been trained to use it – or does. Nor is the busy office worker likely to prioritize studying the 42-page chair user guide reported by Vink et al (2007). Groenesteijn et al (2009b) suggested that most users do not invest effort in learning their chair's adjustable functions. Results of a Dutch-Spanish office chair field study by Vink et al (2007) showed that 24% of 246 Spanish office workers and 61% of 100 Dutch office workers had never adjusted their chair. A later field study by Robertson et al (2009) noted the role of chair training in significantly improving chair adjustable function use. Moreover, Helander et al (1987) posited that office chairs will not be adjusted without training. This suggests that users fail to initiate making their own chair adjustments.

1.4. Barriers to chair adjustment

The literature suggests the existence of barriers that may limit or prevent office workers from adjusting their chairs. To date, these have not been widely explored from the end-user's perspective. Nor have chair adjustment barriers been investigated within an ergonomics framework. In this study, the physical, cognitive and organizational ergonomics domains (International Ergonomics Association, 2018) will be used to categorize and explore end-users' perceived barriers towards chair adjustment behavior.

Physical barriers to chair adjustment include broken or stiff chair controls and the perceived lack of a physical need to adjust. Allie and Kokot (2005) and Hedge and Breeuwsma (2008) suggested that controls that require the user to get out of the chair to operate may present barriers by limiting physical feedback. Helander and Zhang (2001) reported that people have difficulty distinguishing between incremental adjustments in the same chair. Further, Helander (2003) identified that users could not distinguish between subtle changes in seat height, and backrest and seat pan angles. These difficulties could be described as 'gulfs of evaluation' for the end-user (Norman, 2013). Perceived cognitive barriers include the absence of instructions and issues of complexity such as confusing instructions (Hedge and Breeuwsma, 2008; Vink et al 2007). Multiple or poorly mapped controls may pose cognitive challenges. Allie and Kokot (2005) posited that many end-users do not know how or why they should adjust their office chair and Vink et al (2007) suggested that some users may not even recall whether they have used specific adjustable functions. A further cognitive barrier is lack of curiosity towards chair adjustment. Curiosity levels are considered low in Korea, partly attributed to the rigid education system which emphasizes rote learning over critical thinking and creativity (Kim, 2009). Examples of organizational barriers to chair adjustment include providing workers with sub-standard office seating with few adjustable functions or failure to provide chair adjustment training.

Vink et al's (2007) study design utilized three questions loosely based on Prochaska and Velicer's (1997) model of health behavioral change: *Thinking about a specific chair adjustment, is it possible? Is this possibility known to the user? Does the user use the possibility?* Vink et al's results showed that in each phase the percentages dropped. For example, 98% of subjects' chairs had seat height adjustability, 89% knew this but only 41% had used it. These questions were used as the framework for this study in measuring levels of available, known and used adjustable chair functions.

1.5. Study objectives and hypotheses

The objectives of this study were to measure differences between levels of knowledge and use of the adjustable chair functions available in the sample population, and to explore perceived barriers towards chair adjustment behavior in relation to knowledge and use levels of adjustable chair functions.

Four hypotheses are proposed from the foregoing discussion:

Hypothesis 1: Office workers will report knowledge of fewer adjustable functions on their chair than they have available.

Hypothesis 2: Office workers will report use of fewer adjustable functions on their chair than they have knowledge of.

Hypothesis 3: There will be a negative correlation between the level of self-reported barriers perceived by office workers towards chair adjustment behavior and their reported level of adjustable chair function knowledge.

Hypothesis 4: There will be a negative correlation between the level of self-reported barriers perceived by office workers towards chair adjustment behavior and their reported level of adjustable chair function use.

2. Materials and Method

2.1. Study design

A quantitative field study was conducted to measure levels of knowledge and use of the office chair adjustable functions available to English-speaking office workers in Korea, together with the strength of their self-reported barriers towards chair adjustment behavior. Semi-structured interviews and written questionnaires were used with all participants in a related design. A field study design ensured all available adjustable chair functions could be confirmed by the interviewer, providing greater validity than an online survey method where the number available to participants (a core independent variable) could not be verified. To increase internal validity in measuring knowledge and use levels, ten possible adjustable chair functions were described to participants by the interviewer through hand gestures, without touching their chair. Verbal responses were elicited from participants to measure their knowledge and use of possible adjustable functions, and participants were asked not to touch or explore their chair to search for them. The study design was quasi-experimental as the number of adjustable chair functions available could not be controlled. All interviews were conducted by one of the authors (Underwood).

2.2. Participants

Office worker participants were recruited from English-speaking workplaces in Korea to which the interviewer had access. Stratified sampling was used to include workplaces of different sizes and functions e.g. small and medium enterprises, multi-national companies and non-government organizations. Workplace organizations were invited to participate in the study via email and to provide their informed consent. Inclusion criteria for participants required they be office-based workers aged 18 years or older, fluent in English and of any ethnicity and level of organizational seniority. Individuals who had previously received a workstation evaluation from the interviewer (an office ergonomics consultant) were excluded. Convenience sampling was employed initially with organizations inviting employees who met the inclusion criteria to participate. Part-way through the data collection period, the interviewer requested participating organizations use purposive sampling to better balance the sample for individual factor levels (gender, age, nationality and seniority level).

2.3. Materials

Using Vink et al's (2007) study questions as a framework, a set of verbal interview questions and a written questionnaire were developed to investigate the study's hypotheses.

Participants were asked if they knew whether their chair had each of ten possible adjustable functions: seat height, seat depth, lumbar support, seat tilt angle, backrest height, backrest angle, backrest pressure, armrest height, armrest angle and headrest position. For example, participants were asked 'Do you know whether the seat height can be adjusted up and down?' Binary (yes / no) responses were recorded for adjustable chair function knowledge. For all adjustable functions known, participants were asked if they had ever used them. If a participant reported their chair had seat height adjustment, they were asked 'Have you ever adjusted the seat height?' (The operational definition of use was active adjustment behavior e.g. to increase comfort. Accidentally knocking a chair control was not considered 'use'). Yes / no responses were recorded for adjustable function use. The availability of adjustable functions was determined later by the interviewer through an examination of the user's chair.

Participants were asked their satisfaction with the number of adjustable functions on their chair and if they had ever received chair adjustment training. They were invited to mark any of ten possible reasons why they may have previously adjusted their chair (which were measured using nominal variables).

Thirteen individual physical, cognitive and organizational barriers to chair adjustment behavior were measured as interval variables. Each barrier was presented as a statement using a 7-point rating scale (Likert, 1932). Participants were asked to mark their level of agreement with each statement on a scale ranging from 1 ('I strongly disagree') to 7 ('I strongly agree'). Higher scores represented stronger perceived barriers towards chair adjustment. Two physical, seven cognitive and four organizational barrier statements were used. These 13 barriers were presented in randomised order. One was presented positively ('It is quite easy to figure out how to adjust most office chairs') and its data later transposed to match the other negatively phrased variables. Finally, the questionnaire asked participants to record personal information about themselves (gender, ethnicity, age group and level of organizational seniority).

2.4. Ethics

Ethics approval for the study was granted by the University of Derby (UK) in accordance with the British Psychological Society's Code of Human Research Ethics (2014). Written informed consent was obtained from all participating organizations and individuals. All data was treated confidentially and stored securely and no deception was deemed to have occurred. No participants withdrew from the study.

2.5. Procedure

Following consent from participating organizations, 53 eligible staff members were invited to take part in the study. The interviews were conducted from May to September 2016 at each participant's workstation or a nearby meeting room at their workplace with their usual office chair. The interview questions were presented. Knowledge and use levels were then measured for each of the 10 possible adjustable functions. Participants completed the written questionnaire while the interviewer confirmed and recorded all of their chair's possible adjustable functions (maximum of 10). Each interview took approximately 30 minutes.

2.6. Statistical analysis

IBM SPSS (version 23) statistical software was used for data analysis. A significance level of 0.05 was used for all statistical tests.

Testing Hypotheses 1 and 2 involved comparing differences between the levels of adjustable chair functions available, known and used within and between participants. The availability variable was calculated by counting the number of adjustable functions available on the participant's chair. The knowledge variable was calculated by counting the number of adjustable functions the participant indicated they knew about on their chair and the use variable was calculated by counting the number of adjustable chair functions the participant indicated they had used. From preliminary data testing, two outlier cases were removed from the data set for their distortion of the mean, skewness and kurtosis values (due to their extreme scores of 0 and 9 respectively in all three variables). This reduced the study sample (N) from 53 to 51.

Normality checks of the availability, knowledge and use variables showed low Shapiro-Wilk significance values ($\leq .002$). However, all skewness and kurtosis values were acceptable, mean values closely approximated their trimmed means, normal Q-Q plots appeared normally distributed and the mean and median values were within .5 of one standard deviation (see descriptive statistics in Table 1). All three variables were considered normally distributed and testing of Hypotheses 1 and 2 proceeded with parametric paired samples t-tests.

To test Hypotheses 3 and 4, thirteen self-reported barriers towards chair adjustment behavior were measured as described in section 2.3. These were grouped into Physical, Cognitive and Organizational barrier scales for analysis. Barrier scores were used individually, summed as group total scales and grand-summed as an overall total. Normality checks revealed excessive skewness in eight individual barrier variables and excessive kurtosis in four variables. Spearman's rho (*rs*) rank-order correlations were generated to measure the strength of the relationships between the 13 individual barrier scores, the summed Physical, Cognitive, Organizational and Overall barrier scales, and the number of adjustable chair functions known and used.

When summed into scales, the two Physical and four Organizational barrier variables produced low Cronbach's alpha values of .04 and .2, respectively, suggesting low internal consistency. The Cognitive barrier scale produced an acceptable Cronbach's alpha of .73. Several attempts were made to reorganise the barrier variables within physical, cognitive and organizational domain sub-groups for multiple regression, however Cronbach's alpha values remained too low to proceed with regression analysis.

3. Results

3.1. Descriptive statistics

The sample comprised 53 participants: 28 females (55%) and 23 males (45%). Participants' ages comprised 18–25 years (6%), 26–35 years (24%), 36–45 years (45%), 46–55 years (21%) and 56 years and older (4%). Six ethnic groups were represented: Korean (65%), Australian (22%), American (6%), Chinese (4%), Norwegian (2%) and German (2%). Five organizational seniority levels ranged from Intern / temporary staff member to Chief Executive Officer with all levels represented. Seniority modes were Junior / working level and Executive / Senior Management (both 31.4%). Participants came from 12 different workplaces including two foreign embassies, six multi-national companies, two non-government organizations and two small consulting firms. There were differences between the chair models used by participants between and within workplaces. These included brand, country of manufacture and the number and design of controls. The number of participants at each workplace ranged from one to eight.

Participants self-reported high levels of sitting during their working day. Seventy-five percent reported they sat in their own office chair on average for at least six hours per day. The results are displayed in percentages in Fig. 1.

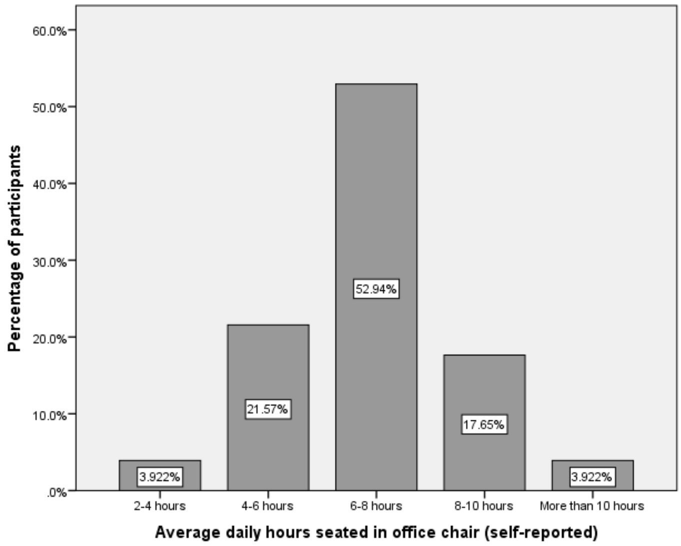

Fig.1. *Average daily hours participants spent sitting in their own office chair (self-reported).*

3.2. Hypotheses 1 and 2

Hypothesis 1: Office workers will report knowledge of fewer adjustable functions on their chair than they have available.

Hypothesis 2: Office workers will report use of fewer adjustable functions on their chair than they report knowledge of.

As shown in Table 1, participants' chairs had between two and nine different adjustable functions. The mean number known by participants (M = 2.51) was less than the mean number available to them (M = 5.39), resulting in a mean difference of 2.88. This decrease was statistically significant, $t(50) = 13.0$, $p < .001$, two-tailed. The mean difference was large, d = 2.88, 95% CI: 2.43 – 3.32. The effect size was also large, Cohen's d = 1.47. The mean number of adjustable functions used by participants (M = 1.86) was less than the number known (M = 2.51) by a mean difference of 0.64. This difference was significant, $t(50) = 6.21$, $p < .001$, two-tailed. The mean difference and effect size were medium, d = 0.64, 95% CI: 0.43 to 0.85, Cohen's d = 0.47.

The mean difference between the number of adjustable functions available and the number used was also measured (3.52). The difference was significant, $t(50) = 13.97$, $p < .001$, two-tailed, and large, d = 3.52, 95% CI: 3.02 to 4.03, Cohen's d = 1.92. In support of Hypotheses 1 and 2, these t-test results show that overall, participants knew fewer adjustable chair functions than they had available to them, and the level of their reported use of them was less than the level of their reported knowledge of them.

Adjustable chair functions	*N*	Minimum number	Maximum number	Mean (*SD*)	*SE*
Available	51	2	9	5.39 (2.30)	0.32
Known	51	0	6	2.51 (1.52)	0.21
Used	51	0	5	1.86 (1.21)	0.17

Notes. *SD* is standard deviation. *SE* is standard error of mean.

Table 1. *Descriptive statistics and normality tests for the number of available, known and used adjustable chair functions.*

In regard to knowledge of their chair's adjustable functions, four percent of participants reported knowing none, 29% knew one and 20% knew two. Ten percent of participants reported never having used any of them, 35% had used one and 28% had used two. In relation to participants' satisfaction with the number of their chair's adjustable functions, 55% reported it had 'about the right number', 43% reported it had 'too few' and 2% felt it had 'too many'.

3.3. Hypotheses 3 and 4

Hypothesis 3: There will be a negative correlation between the level of self-reported barriers perceived by office workers towards chair adjustment behavior and their reported level of adjustable chair function knowledge.

Hypothesis 4: There will be a negative correlation between the level of self-reported barriers perceived by office workers towards chair adjustment behavior and their reported level of adjustable chair function use.

In support of Hypotheses 3 and 4, there was a negative, non-significant correlation between Overall Barriers towards chair adjustment behavior and the number of adjustable functions known ($rs(49) = -.13$, $p = .380$). The relationship between Overall barriers and the number of adjustable functions used was also negative and non-significant ($rs(49) = -.15$, $p = .283$). As the strength of participants' self-reported overall barriers towards chair adjustment behavior increased, their knowledge and use of adjustable chair functions decreased as predicted.

Cognitive barriers had the strongest negative relationship with adjustable chair function use ($rs(49) = -.23$, $p = .109$), as shown in Table 2. This suggested that as participants' perceived cognitive barrier levels increased, their adjustable chair function use decreased. Cognitive barriers also had the strongest positive relationship with Overall barriers ($rs(49) = .93$, $p < .001$) compared with the moderate relationship Overall barriers had with Organizational barriers ($rs(49) = .57$, $p < .01$) and Physical barriers ($rs(49) = .53$, $p < .001$). The individual barrier with the strongest relationship with Overall barriers was the Cognitive barrier "I do not know how to adjust my chair" ($rs(49) = .79$, $p < .001$).

3.4. Reasons for making previous chair adjustments

Participants were asked to report all possible reasons why they had made previous adjustments to their office chair. Multiple reasons could be reported. The mode was 'To make my body more comfortable' (77%). The results are displayed as percentages in Fig. 2. Only four percent of participants ($N = 2$) reported receiving any previous office chair adjustment training. Both had used self-directed methods such as reading instructions.

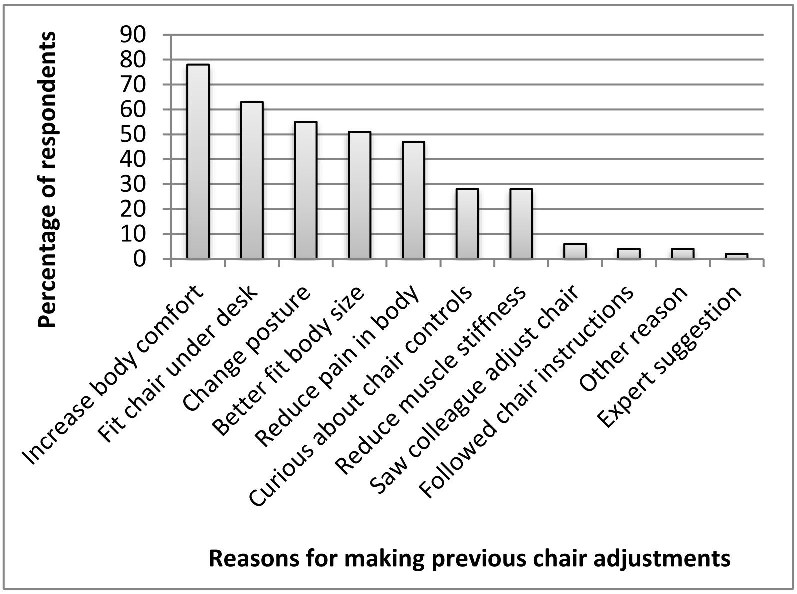

Fig. 2. *Reasons given by participants for making previous chair adjustments.*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Adjustable function knowledge																			
2. Adjustable function use	.88**																		
<u>Physical Barriers</u>																			
3. Body cannot tell difference	-.04	-.06		.09	.7**														.63**
4. Do not feel need to adjust	.21	.16			.71**														.19
5. Physical Barriers (Overall)	.11	.11											.35*					.12	.53**
<u>Cognitive Barriers</u>																			
6. Never thought about it	.01	-.05					.52**	.25	.04	-.06	.29*	.28 *	.55**						.52**
7. Do not know how to adjust	-.21	-.23						.72**	.48**	.15	.25	.55**	.86**						.79**
8. Too technical	-.5	-.05							.43**	.04	.44**	.49**	.7**						.7**
9. Most chairs not easy to adjust	-.24	-.27								.22	.14	.43**	.57**						.52**
10. No instructions	-.3*	-.29*									-.06	.08	.28*						.3*
11. Do not understand instructions	.09	.14										.2	.47**						.46**
12. My chair is difficult to adjust	-.17	-.22											.70**						.68**
13. Cognitive Barriers (Overall)	-.21	-.23																.37**	.93**
<u>Organizational Barriers</u>																			
14. I'm too busy	.08	.05													-.2	-.18	-.05	.43**	.29*
15. An expert should teach me	-.02	-.01														.03	-.01	.49**	.29*
16. May inconvenience colleagues	-.05	-.07															-.12	.28*	.31*
17. Never had training	-.14	-.25																.31*	-.06
18. Organizational Barriers (Overall)	-.01	-.08																	.57**
19. Adjustment Barriers (Overall)	-.13	-.15																	

Notes. Degrees of freedom for all correlations are *df*(49). ** $p < .01$. * $p < .05$.

Table 2. *Spearman's Correlation matrix of participants' perceived barriers towards knowledge and use of the adjustable functions on their office chair.*

4. Discussion

4.1. Knowledge and use of adjustable chair functions

The study's results showed that participants knew fewer than half of the adjustable chair functions available to them, and used fewer adjustable functions than they knew (see Table 1). This supports Hypotheses 1 and 2, and lends weight to Vink et al's (2007) research findings that availability, knowledge and use levels decreased significantly with each phase. In this study, 55% of workers perceived their chair had the right number of adjustable functions, although 53% knew two or less, and 73% had used only two or less. Ten percent had used none. These results are noteworthy, given that 75% of participants reported sitting in their chair for at least six hours each day and the documented benefits of making chair adjustments (Allie and Kokot, 2005). The results are consistent with previous studies however (Hedge, 2016; Groenesteijn et al, 2009a; Vink et al, 2007).

4.2. Reasons driving chair adjustment behavior

Several reasons that may drive adjustment behavior were identified in this study. The most prevalent reason for previous chair adjustment was 'To make my body more comfortable' (77%). Although Groenesteijn (2009b) questioned whether some users fail to link their discomfort to their chair settings, this study's results suggest that optimizing comfort drives at least some chair adjustment behavior. Although reasons for previous chair adjustment were not categorized within physical, cognitive and organizational ergonomics domains (IEA, 2018) in this study, the five most prevalent related to users' perceived physical needs such as a desire 'to reduce pain in my body', 'make my body more comfortable' or 'change my posture' (see Fig. 2). Reasons posited for adjustment that could be described as cognitive and organizational in nature were significantly less important to participants ('I was curious about my chair's controls'; 'an expert suggested I adjust my chair'). This was an interesting finding and suggests physical factors relating to pain, comfort and posture may be more important than cognitive or organizational factors in explaining previous adjustment behavior.

4.3. Barriers to chair adjustment

The negative correlations between participants' perceived level of overall barriers towards chair adjustment behavior and their respective levels of both adjustable chair function knowledge (-.13) and use (-.15) supported Hypotheses 3 and 4.

This study's results suggest that cognitive factors may play a more significant role than physical or organizational factors in limiting knowledge and use of adjustable chair functions. Cognitive barriers had the strongest relationship with adjustable function knowledge and use compared with Physical or Organizational barriers. Cognitive barriers also had the strongest relationship with Overall barriers (.93). The individual barrier with the strongest relationship with Overall barriers was the Cognitive barrier 'I do not know how to adjust my chair' (.79). This lends support to the idea that some workers may not adjust their chairs simply because they do not know how to. They may even tolerate discomfort in their office chairs because of their own cognitive barriers towards making adjustments. Another reason for non-adjustment may be that subtle changes to chair settings may not be easily felt by users, as Helander (2003) noted. This study's results support this. As the strength of the Physical barrier 'When I have adjusted my chair, my body cannot tell the difference between the different settings' increased, participants' knowledge and use levels of their adjustable chair functions both decreased (see Table 2).

No participants in this study shared their office chair so all had full control over adjusting it, theoretically. One participant suggested to the interviewer she would know all her chair's adjustments if she had purchased it herself. She reported feeling an absence of control over it because her company supplied it. This suggests organizational barriers could play a role in disengaging some office workers from their chairs and may have implications in unassigned seating environments. Only four percent of participants in this study had received training in how to adjust their chair (in all cases self-directed). Effective, participatory ergonomics training may help end-users overcome organizational and cognitive barriers and gain adjustment knowledge. It may also help drive adjustment use, as the results of Vink and Kompier's (1997) naturalistic study and Robertson et al's (2009) longitudinal field study suggested. The strong correlation between adjustable chair function knowledge and use levels in this study (.88; see Table 2) lends support to Robertson et al's finding that gains in office ergonomics knowledge, through effective training, may increase levels of adjustable chair function use.

At the meso and micro level, training methods need to give users the curiosity, confidence and skills to adjust. Some adjustable function knowledge needs to come directly from the chair, which highlights the importance of good user interface design. For example, in a study of chair adjustability controls by Helander et al (2007), controls with long levers were preferred to those with short levers or push buttons. In addition, when controls offered discernibility and feedback, their users' understanding of them improved significantly. At the macro level, manufacturers need to optimize adjustment availability and usability with a focus on end-users' individual differences. Sixty-five percent of participants in this study were Korean. Individual differences including culture could help explain why some Koreans may not learn chair adjustments, such as a lack of curiosity (Kim, 2009). To cater for increasing workplace diversity and differing learning needs, adjustable function design should strive to be universal. Vink et al (2007) proposed 'easy to adjust' chairs with intuitive controls – and training – to increase adjustment use. Our results suggest it may not be that simple. Multiple barriers may inhibit chair adjustment behavior, and learning preferences may differ. If chair maladjustment may cause harm to the ignorant user as McLeod et al (1980) posited, decreasing barriers towards making adjustments should be an end-goal.

4.4. Study strengths and limitations

The overall sample size of 53 participants was self-limited due to challenges in obtaining participants that met the inclusion criteria, such as English fluency. However, attempts were made to stratify the sample for factors such as age, gender and seniority level. The study's field design and use of subjective data posed validity threats, although efforts were made to increase internal validity in measuring knowledge and use levels of adjustable functions by not allowing participants to explore their chair to find them, and by confirming the number available. Frequency of chair adjustment was not included due to its complexity and because increased adjustment frequency is not always the end-goal. Refining and piloting the chair adjustment barrier statements may have better captured physical and organizational factors that could combine together for regression analysis. In regard to external validity, the sample was representative of English-speaking office workers in Korea but the results may not be transferable to other populations, including non-English-speaking Koreans.

4.5. Study context

Robertson et al (2009) and Vink et al (2007) measured availability, knowledge and use levels of office chair adjustable functions. Vink et al suggested reasons why users failed to adjust their chairs. This study extends that research in a different population by exploring a wider range of adjustable chair functions and by introducing and investigating end-user barriers towards chair adjustment knowledge and use. The use of an ergonomics framework to categorize and investigate barriers towards chair adjustment behavior also extends that work, adding further knowledge to the applied ergonomics literature.

The findings from this study may be useful at a macro level for chair designers and manufacturers, and at a meso level for organizations seeking to optimise worker comfort. Ultimately the findings may benefit end-users at the micro level. Future research could explore the role of cognitive barriers towards the mental workload of chair adjustment, organizational barriers towards chair training, and additional physical barriers. The categorization of end-user barriers within these ergonomics domains may have wider application. Field study research into natural chair adjustment behavior poses validity issues. However, further work in this area in the real world that expands knowledge about how these findings may apply to the rapidly changing office environment, such as unassigned seating, would help inform ergonomics practice.

5. Conclusion

The results of this field study suggest office workers know fewer than half of their available adjustable chair functions and use fewer than they have knowledge of. Reasons for lack of knowledge and use are complex and influenced by adjustment barriers and individual differences. Physical needs appear to be a strong driver for chair adjustment behavior. Perceived cognitive barriers towards adjustment appear to be a deterrent towards use.

Highly adjustable office chairs have the possibility of being adjusted to satisfy the needs of most workers. However adjustable functions need to be both available and known in order to be used. Availability is the ultimate factor in adjustment but is no guarantee of use, regardless of design. Knowledge of available adjustable functions will always be a prerequisite for use.

Increasing the availability, knowledge and use of adjustable chair functions and reducing barriers towards adjustment may help optimise the health and comfort of the office worker.

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Declarations of interest:

Diana Underwood has previously consulted to two companies which were participating organizations in this study. She owns shares in a company which also participated.

Ruth Sims: none.

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