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Are pressure measurements effective in the assessment of office chair comfort/discomfort? A review

Roland Zemp*, William R. Taylor, Silvio Lorenzetti

Institute for Biomechanics ETH Zurich, Wolfgang-Pauli Strasse 10, 8093 Zurich, Switzerland

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ABSTRACT

Nowadays, the majority of jobs in the western world involves sitting in an office chair. As a result, a comfortable and supported sitting position is essential for employees. In the literature, various objective methods (e.g. pressure measurements, measurements of posture, EMG etc.) have been used to assess sitting comfort/discomfort, but their validity remains unknown. This review therefore examines the relationship between subjective comfort/discomfort and pressure measurements while sitting in office chairs.

The literature search resulted in eight papers that met all our requirements. Four studies identified a relationship between subjective comfort/discomfort and pressure distribution parameters (including correlations of up to $r = 0.7 \pm 0.13$). However, the technique for evaluating subjective comfort/discomfort seems to play an important role on the results achieved, therefore placing their validity into question.

The peak pressure on the seat pan, the pressure distribution on the backrest and the pressure pattern changes (seat pan and backrest) all appear to be reliable measures for quantifying comfort or discomfort.

1. Introduction

1.1. Musculoskeletal disorders and sitting in office chairs

In modern societies, increasing amounts of time are spent in a seated position. Reinecke et al. (2002) and Treaster and Marras (1987) reported that approximately 75% of all employees in industrial countries have jobs that require them to work in a seated position. Low back pain (LBP) is particularly common, and almost everyone experiences it at one time or another (Hoy et al., 2010). A study by McBeth and Jones (2007) showed that approximately one-third of western populations suffered from LBP in the course of any given month. An increasing number of employees with back pain is clearly associated with the increasing number of day's sick leave. Here, Holtermann et al. (2010) analysed a group of Danish employees ($N = 5036$) in 2000 and found that approximately one-fifth of the employees who had neck-shoulder and LBP experienced long-term sick leave within the following two years. Videman et al. (1990) reported that either heavy or sedentary work is associated with a higher risk of developing back pain compared to occupations with mixed seating and loading regimes. Furthermore, low levels of seating comfort often lead to musculoskeletal complaints such as LBP (Vink and Hallbeck, 2012). Therefore, employers should be aware of the importance of providing a comfortable working environment for their employees to ensure their health and welfare (De Looze et al., 2003). Moreover, seated workers who suffer from discomfort are inefficient and error prone (Hertzberg, 1958). As a result, Christiansen (1997) concluded that users' subjective seating comfort is the decisive criterion that should guide purchase decisions. Despite the popular opinion, as described above, that occupational sitting is highly associated with LBP, several current literature reviews revealed that sedentary lifestyle by itself does not increase the risk of LBP (Hartvigsen et al., 2000; Kwon et al., 2011; Lis et al., 2007; Roffey et al., 2010). However, Lis et al. (2007) emphasised that the combination of sitting for longer than half a day in an awkward posture and/or with whole body vibration is capable of increasing the likelihood of suffering from LBP.

1.2. Sitting comfort/discomfort

Seating comfort/discomfort is based on a subjective sensation and thus is difficult to quantify. There are three main methods upon which it is possible to gain an indication of the level of sitting comfort and discomfort (Vergara and Page, 2002): anthropometry,

* Corresponding author. Tel.: +41 44 633 72 93.
E-mail address: zempr@ethz.ch (R. Zemp).

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subjective assessment and objective measurements. Vergara and Page (2002) reported that subjective evaluation is the only way to determine changes in comfort and pain, based on self-reported questionnaires including the "general comfort rating", the "body area comfort rating", the "method of adjustment", the "Chair Feature Checklist" or "personal comments" (Christiansen, 1997; Shackel et al., 1969). However, the use of subjective evaluations presents difficulties in terms of quantitative measurement versus interpretation (Branton, 1969; Helander et al., 1987). Firstly, chair users must be aware of their comfort/discomfort. It is more difficult to sense varying degrees of comfort compared to varying degrees of discomfort. Secondly, individuals may have difficulty verbalising their feelings of comfort/discomfort. Furthermore, a source of comfort or discomfort may be very difficult to associate with a specific design feature of a chair. Finally, it is difficult to memorise the sensation of comfort/discomfort, which is a necessary requirement for the comparison of different chairs.

1.3. Chair design and comfort/discomfort

It has been shown that the design of an office chair is able to strongly influence the sitting conditions for the user. Dreischarf et al. (2010) reported that spinal loading can be reduced by supporting the upper body using an armrest. The seat pan and backrest cushion properties can also play a decisive role on the chair-user interaction. For example, Mooney et al. (1971) observed an almost 50% reduction in the mean seat pressure in a wheelchair due to a different cushion. Furthermore, Bendix et al. (1996) highlighted the importance of the shape of the backrest, since it can influence lumbar lordosis as well as spinal loading. Similarly, Coleman et al. (1998) stressed the importance of adjustable lumbar support in order to provide a comfortable seat. Besides the office chair design, human factors also play an important role in terms of the loading conditions on the human body. Here, for example Nachemson (1976) showed the influence of different sitting positions on the pressure in the third lumbar disc. Andersson et al. (1974) and Andersson and Ortengren (1974) reported that the disc pressure of the third lumbar disc decreases while reclining backwards with the backrest. More recent studies highlighted the influence of upright and reclined (Zemp et al., 2013) as well as forward inclined (Baumgartner et al., 2012) sitting on the shape of the spine by means of open MRI measurements.

1.4. Definitions and models of comfort/discomfort

There are several definitions and models of comfort and discomfort available in the literature that are presented in this section. The aim of this review is to analyse the degree to which comfort/discomfort provided by chairs can be quantified, and not the feelings of comfort and/or discomfort experienced by a person. For the purpose of the current study, chair users act as channels of information about chairs (Branton, 1969). Several factors influence feelings of comfort/discomfort (Vink et al., 2005); Personal factors include the user's physical and psychological state as well as the history of the user's comfort/discomfort experience. External stimuli, such as visual input, smell, noise, temperature, humidity, pressure/touch, posture and movement, can also form an important part of the evaluation of comfort/discomfort. Thus, comfort/discomfort can be divided into visual comfort/discomfort (Kooi and Toet, 2004), thermal comfort/discomfort (Cena and de Dear, 2001), olfactory comfort/discomfort (Kempski, 2005), and so on. Sitting comfort/discomfort is a combination of these factors. In particular, external stimuli of pressure and touch play a decisive role (De Looze et al., 2003; Mergl, 2006; Verver, 2004).

According to Richards (1980), "Comfort is a continuous dimension of experience — varying from strongly positive (very comfortable) to strongly negative (very uncomfortable). It involves a transition region which would be described as neither comfortable nor uncomfortable, but neutral. … Comfort depends on multiple physical inputs and discomfort may arise from any of several causes." Hertzberg (1958) did not define comfort and discomfort as two distinct states of consciousness. Instead, he reported that there is only "discomfort" because "comfort" is only the absence of discomfort. Hence, it is not possible to provide comfort; it is only possible to eliminate the source of discomfort. Branton (1969) adopted a similar point of view concerning the definition of comfort, suggesting that comfort varies along a continuum ranging from a state of indifference to a state of extreme discomfort. He noted that it is very difficult to envisage deriving extreme feelings of well-being while sitting in a chair, regardless of how comfortable the chair may be. Despite this, some studies have attempted to measure degrees of positive comfort (Oborne, 1978). Branton (1969) reported that the absence of discomfort is synonymous with a state of no awareness of sensation and does not necessarily represent a positive sensation. Similarly, the absence of pain does not automatically imply the presence of pleasure. However, more recent studies contradict prior definitions. For example, Kleeman (1981) and Kamijo et al. (1982) reported that comfort and discomfort are influenced by different variables. Zhang et al. (1996) proposed a model of discomfort and comfort as two different entities (Fig. 1). Discomfort, in this model, is related to biomechanical factors that lead to pain, tiredness, soreness and numbness, whereas comfort relates to well-being and the aesthetic impression of the chair (Helander and Zhang, 1997; Zhang et al., 1996). The intersection of the axes represents the possible transition from discomfort to comfort and vice versa. For example, if the discomfort is low, comfort can be experienced. Conversely, if comfort is reduced, discomfort may be enhanced. The influence of the aesthetic appeal on the comfort experience, at least during the first encounter with a chair, was demonstrated by Knoll (2006), who noted that the haptic impression prevails over time; thus, the physical characteristics of the chair become increasingly important.

Based on the model by Zhang et al. (1996), Paul (1997) highlighted the need for different strategies in ergonomic interventions to reduce discomfort (nurturing) and increase comfort (pampering). Nurturing designates a strategy that aims to decrease discomfort by promoting an active and dynamic use of the body during the workday to maintain health. Pampering is a comfort strategy that concentrates on enhancing comfort through aesthetics and plush environments. Many other studies (Andreoni

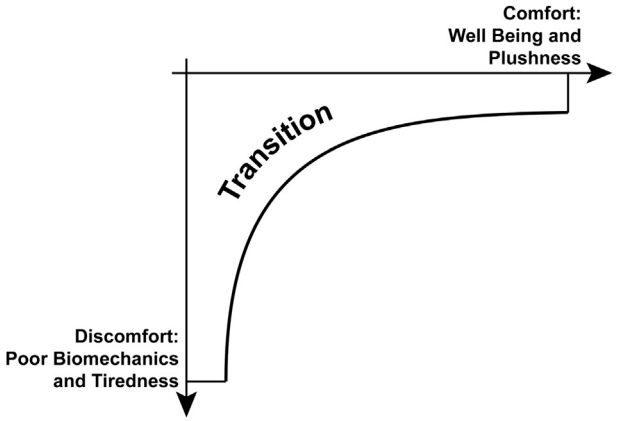

Fig. 1. Model of comfort and discomfort of Zhang et al. (1996).