

SITTER-SELECTED POSTURES IN AN OFFICE CHAIR WITH MINIMAL TASK CONSTRAINTS

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ABSTRACT

Studies of office workers' postures indicate that reclined postures are less common than upright or forward-leaning postures. Laboratory studies have shown that back extensor activity and internal pressure in the lumbar intervertebral disks are lower in reclined postures. Given these advantages, why don't workers recline more often? Postural constraints imposed by their work, particularly vision and hand-reach requirements, may preclude more upright postures. In a study at a large office facility, side-view photographs were used to measure the postures that 80 men and women chose when sitting in an office chair without a work task. All sitters chose substantially reclined postures, with backrest angles averaging 25 degrees from vertical. The findings provide evidence that office work should be designed such that workers can sit more frequently with the reclined torso postures that they would choose if they were not working.

INTRODUCTION

Observational studies have shown that office workers usually perform their tasks in upright or forward leaning postures (Dowell et al. 2001). Reclined postures with substantial engagement between the sitter's torso and the chair backrest account for only about 15 percent of work postures for workers performing a range of office tasks. Yet, reclined postures reduce the load on the lumbar spine and paraspinal musculature (e.g., Andersson et al. 1974), so increasing the percentage of time that workers recline may reduce the prevalence of back discomfort and related disability. People who sit in office chairs without a task to perform with their hands rarely sit with an upright or forward-leaning torso. For example, a person in a meeting listening to a speaker will usually use the chair backrest for torso support. The contrast between the typical "meeting" and "office work" postures suggests that (1) seated people recline unless prevented from doing so by the nature of their work, and (2) the nature of typical office work, including computer use, prevents people from sitting in the manner that they otherwise would.

Given this observation, and the biomechanical advantages of reclined postures, a vigorous effort should be made to examine and correct the features of office work that lead to people sitting in reclined postures only a small percentage of their work hours. One step in this process is to document quantitatively the postures that people choose when sitting in office chairs in the absence of work-related constraints. These preferred postures are a more appropriate target for office work design than the idealized postures typically used for workstation design.

In the current study, the postures of 80 men and women who work in an office environment were measured as they sat in an Aeron® office chair without a work task. They were instructed to select a comfortable posture, adjusting the height and recline angle of the chair as desired. The sitters

also demonstrated the maximum recline angle that they found comfortable. This report presents a quantitative analysis of these preferred- and maximum-recline office-chair postures. The results provide a foundation for a new approach to designing the office environment around workers' preferred postures.

METHODS

Participants

Forty men and forty women who work in an office environment at one U.S. company were recruited to participate. Data from one woman were excluded because of recording errors, leaving observations from 79 participants for analysis. Table 1 lists summary statistics for selected descriptors. Both the male and female groups were taller and heavier, on average, than the general U.S. population, but the sample included a wide range of both stature and weight. Approximately 30 percent of the participants were obese, having a body mass index (BMI) greater than 30 kg/m².

Test Facility

Testing was conducted using an Aeron office chair (Herman Miller, Inc.) that was modified so that the backrest could recline up to 30 degrees from its neutral (nominally upright) orientation. The armrests were removed during testing. The Aeron chair has a synchronized recline mechanism that moves the seat pan and backrest together during recline, with the angle of the seat pan changing at about one-third the rate of change of the backrest angle. The mechanism is designed so that the front edge of the seat pan does not rise during recline, so no change in chair height is necessary to accommodate reclined postures. However,

participants were free to adjust both the height and recline angle of the chair.

Test Procedure

The testing was conducted on-site in an office workplace at a large company. Participants were recruited by word of mouth to participate in what was described as a “seating study.” The chair was initially set to the neutral position. The participants were instructed to sit in the test chair and to adjust the chair to a comfortable height. Visual targets were placed on the sitter’s clothing at the shoulder (acromion), waist (approximate location of the iliac crest landmark), and the side of the knee. The participants were then asked to adjust the recline angle to obtain their “preferred posture for watching a video.” The goal was to require horizontally directed vision but to impose no other task constraints. The experimenter assisted the participant in adjusting the recline tension to achieve the sitter’s preferred recline angle. The angles of the backrest and seat pan were recorded using an electronic inclinometer. A side-view digital photo was taken.

The side-view images from each trial were analyzed to obtain additional posture data. Eighteen landmarks on the participant and six reference points on the chair were digitized in each image as shown in Figure 1. The known distance between reference points on the chair was used to scale the coordinate values.

Two variables were defined using the digitized points. Two points on the upper surface of the backrest defined the angle of support that the sitter received in the upper lumbar and lower thoracic regions of the back. The angle of the line connecting these two points, with respect to vertical, was termed *backrest angle*. The overall recline of the sitter’s upper body was quantified by a line connecting the seat pivot point with the sitter’s eye. The angle of this line with respect to vertical is termed *recline angle*. The seat pivot point is approximately coincident, in side-view, with the sitter’s hip location, so recline angle is an estimate of the angle with respect to vertical of a line from hip to eye.

RESULTS

Figure 2 shows the distribution of backrest angles in preferred postures. The median backrest recline angle was 24.0 degrees, with 90 percent of preferred backrest angles less than 30.4 degrees. Backrest angle did not vary significantly with gender, stature, or body mass index, although there was a weak trend toward more reclined backrest angles for men (mean 26.0 degrees for men and 24.1 degrees for women). The distribution of backrest angles is approximately log-normal, with mean log (backrest angle) = 3.21. The overall arithmetic mean is 25.0 degrees. Using the log-normal approximation, the 95th percentile is 32.5 degrees.

Recline angle (hip-to-eye angle) was approximately normally distributed, as shown in Figure 2. The means for both men and women were 6.6 degrees and the standard deviation was 5.4 degrees. Recline angle was not significantly

related to stature or BMI, although there was a weak trend toward more upright recline angles for shorter stature and higher BMI.

Figure 3 shows side-view images of selected participants with backrest angles from 23.5 to 24.5 degrees. The images show that typical preferred-recline postures are characterized by substantial engagement between the sitter and backrest. The sitter’s shoulders are rearward of the hips, indicating that the torso is resting against the backrest rather than being held upright by the sitter’s back muscles.

DISCUSSION

Primary Findings

The results from this study provide a quantitative description of sitter-selected postures in an office chair when the only task constraint is forward-directed vision to a distant target. The data show that:

- Preferred postures are substantially reclined, with average preferred backrest angles (the angle of the primary support surface of the backrest with respect to vertical) of 25.0 degrees.
- Because of torso flexion (primarily in the lumbar spine), the angle of side-view line from hip to eye is an average of about 18 degrees more upright than the angle of the backrest.
- Reclined postures do not differ substantially between men and women and are not strongly associated with stature or weight.
- Sitter-preferred postures differ substantially across individuals.

The findings contradict some widely held beliefs about seated posture. In particular, the preferred recline angles of men and women do not differ significantly. Across men and women, the correlation between stature and preferred recline angle is 0.00, indicating no linear relationship, and a scatter plot of the data reveals no nonlinear relationship. This suggests that the widespread belief that men recline more than women is not likely due to inherent differences in preference. If men recline more than women in office work, these findings suggest that task-related constraints, rather than differences in preference, may account for the difference. Specifically, fixed-height furniture is effectively higher for women than it is for men, a factor that might cause women to sit more upright when working.

Limitations

The findings from this study are limited by the scope of the test conditions and participant pool. Although the participants spanned a wide range of age and body size, a larger sample of office workers might yield slightly different results. The non-significant trends in these data suggest that a study with a larger sample might find statistically significant

effects of stature and gender on backrest angle. However, the small magnitude of the trends indicates that these effects, even if statistically significant in a larger sample, are not important for chair and workstation design.

A more important limitation is that the current study was conducted with only one chair. The design of the chair and the lack of armrests (removed to provide better visualization of the postures) may have affected the participants' preferred postures, and the backrest and recline angle definitions used in this study are not fully generalizable to other chairs, because they rely on particular chair features as reference points. Similar studies with alternative chair designs should be conducted. Sitters also might have chosen different postures (or, more likely, a range of postures) if the sitting trial duration were extended.

Future Work

This study demonstrated that office workers will recline if they are not prevented from doing so by their work task. Given the biomechanical advantages of reclined postures, the challenge for workstation design is to structure the working environment in such a way that reclined postures are not precluded. The components of the task that constrain hand and eye location (particularly keyboards, mice, and computer monitors) must be moved into positions that can be accessed easily from reclined postures.

REFERENCES

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Table 1
Participant Characteristics*

Variable	Men	Women
Number of Participants	40	39
Stature (mm)	1800 (1524-1955)	1676 (1524-1803)
Stature (in)	71.0 (60-77)	66 (60-71)
Weight (kg)	92 (59-132)	79 (46-115)
Weight (lb)	201 (130-290)	174 (100-253)
BMI (kg/m ²)	28 (19-39)	28 (18-44)

* mean (min-max)

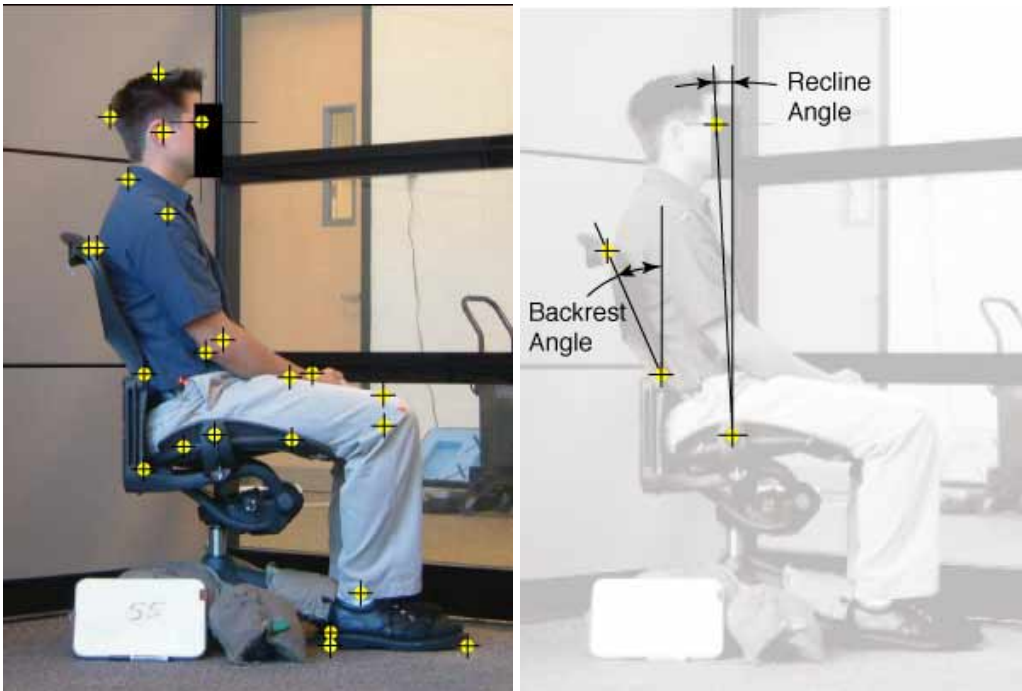


Figure 1. Points digitized on side-view images (left) and posture variable definitions (right).

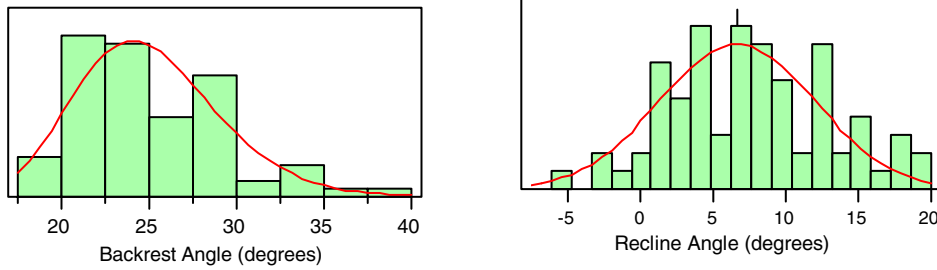


Figure 2. Distributions of backrest angle and recline angle in **preferred** postures. Backrest angle is log-normal with mean $(\log(\text{backrest angle})) = 3.21$ and standard deviation $\log(\text{backrest angle}) = 0.164$. Recline angle is normally distributed with mean 6.7 degrees and standard deviation 5.4 degrees.



Figure 3. Postures of some of the women (top) and men (bottom) who selected preferred recline angles within 0.5 degree of the overall median.