ELSEVIER

Applied Ergonomics 37 (2006) 297–304

APPLIED ERGONOMICS

www.elsevier.com/locate/apergo

Biomechanical evaluation of four different mattresses

James W. DeVocht[a,b,*], David G. Wilder[b], Eric R. Bandstra[b], Kevin F. Spratt[c]

[a]*Palmer Center for Chiropractic Research, 741 Brady Street, Davenport, IA 52803, USA*
[b]*University of Iowa, Iowa City, IA, USA*
[c]*Dartmouth Medical School, Hanover, New Hampshire, USA*

Received 29 December 2003; accepted 15 July 2005

Abstract

This study provided an objective, biomechanical comparison of four "top of the line" mattresses from four different manufacturers using two different measurements. One, which has been used in other studies, was pressure distribution patterns—evaluating maximum pressures generated by an individual lying supine on the mattresses. The other was a novel approach developed specifically for this study—quantifying the degree of spinal distortion induced when in the side posture position. Eighteen normal adult males of similar height but in three different weight groups were tested using both of these approaches on each of four mattresses. As expected, greater maximum pressure directly related to subject's weight group and was greater in the pelvic compared to the thoracic region. One mattress did induce significantly lower maximum pressures than the other three in both the pelvic and thoracic regions. Spinal distortion was not reliably different across the four mattresses in five of the seven spine regions evaluated. However, at the T1/T3 and the T6/T8 spinal segments, inconsistent but statistically significant separation between some mattresses was observed.

Keywords: Biomechanical evaluation; Mattress

1. Introduction

Beds come in a wide variety of sizes, styles, quality, and cost. They also have many uses. Parsons' (1972) classic and extensive paper covering all aspects of beds and their environment listed uses included: watching TV, reading, sexual activity, sitting, and sleeping. However, out of all of the many uses of the bed, during the course of every day living in industrialized western cultures virtually everyone spends more time sleeping in a bed than in any other single activity in life. In spite of this, as Parsons pointed out over 30 years ago, it remains true to this day that the literature regarding the objective evaluation of mattresses is sparse. Most of the identified studies that have dealt with objective measurements were concerned with the healing of wounds or the prevention of bed sores for those who are bedridden. Since pressure is a major factor in the development of such sores (Defloor and De Schuijmer, 2000), those papers evaluated mattresses on the basis of pressure levels generated by the person lying on the bed and/or by the number or severity of bed sores (Bale et al., 1999; Knowles and Horsey, 1999; Shelton et al., 1998).

In an effort to study normal individuals in good health, Koul et al. (2000) monitored medical residents sleeping on two types of mattresses. It was determined that sleeping on a foam mattress was associated with the appearance of backache that was relieved after using a regular cotton mattress. Defloor (2000) measured interface pressures with healthy volunteers lying in different positions on two different kinds of mattresses and found that a Tempur polyethylene–urethane mattress induced 20–30% lower pressures than a standard hospital mattress.

*Corresponding author. Palmer Center for Chiropractic Research, 741 Brady Street, Davenport, IA 52803, USA. Tel.: +1 563 884 5158; fax: +1 563 884 5227.
E-mail address: devocht_j@palmer.edu (J.W. DeVocht).

0003-6870/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.apergo.2005.07.002

Some studies have also tried to address issues of comfort or functionality for individuals with special needs. Collier (1996) considered several factors such as nutritional status, skin condition, and weight as they relate to comfort while Evans et al. (2000) studied the comfort of beds for individuals with pressure ulcers. Functionality, as in ease of repositioning individuals, has also been studied in conjunction with comfort and the ability to relieve interface pressure in the evaluation of a single type of mattress (Beldon, 2002). Buckle and Fernandes (1998) found no significant associations between comfort ratings and peak body contact pressures, suggesting that multiple factors are involved in determining comfort. Furthermore, Goetz et al. (2002) found no consistent correlation between interface pressures and body mass index.

Price et al. (2003) conducted a pilot study using adult out patients with chronic pain and found that the use of an inflatable mattress overlay led to improvements in sleep and pain reduction. Kovacs et al. (2003) evaluated mattress firmness through a randomized controlled trial and found that a mattress of medium firmness reduced pain and disability in adult patients with chronic but non-specific low back pain.

Some efforts have been made using electromyographic (EMG) activity levels of lumbar erector spinae muscles while lying supine on a mattress (Derman et al., 1995). However, this was oriented toward distinguishing between use of a lumbar body support and lying directly on the mattress rather that distinguishing between mattresses. It has also been noted that care must be taken in interpreting the meaning of comparisons of mattresses when performance indices are used because it is possible for a biased study to "tailor-make" a performance index in such a manner as to cause any chosen mattress to rank the best (Bain et al., 2003).

The study described in this paper was developed in an effort to provide an objective biomechanical evaluation of mattress performance in response to an industry initiative. The literature review indicated that the only objective measurement that seemed somewhat reasonable and had been done in previous studies concerned the pressure distribution of someone lying on a mattress. It was noted that considerable advertising has been done regarding the ability of mattresses to maintain good spinal alignment during sleep. However, no method was found in the literature for providing a quantified metric for the degree of spinal distortion. The outcomes of interest in this study were the magnitude of the highest points of pressure or maximum pressures that occurred throughout the entire distribution pattern and spinal distortion based on an assessment approach developed specifically for this study. It was hypothesized that mattresses that generated lower maximum pressures and lesser degrees of spinal distortion were superior.

2. Methods

2.1. Participants

Male subjects were solicited by an announcement approved by the University of Iowa Institutional Review Board and published in the daily news sheet of the University of Iowa Hospitals and Clinics. Those who responded were screened via a telephone interview to determine if they were in good general health, had no known spinal deformities, were within one inch of six feet tall, and were within 10 pounds of 160, 190, or 220 pounds. The intent was to have the participants be as uniform as possible with the exception of body build. By having the participants be only males and divided evenly within each of three different body builds, it would be possible to determine if one mattress is better suited for a particular body build than the other three mattresses. The nature of the study was also explained to them including being notified that they would receive $35.00 compensation and a pass to cover the cost of their parking.

2.2. Mattresses

Four different "top of the line" queen sized mattresses from four different major manufacturers were tested, one at a time, by each participant. The specific mattresses used were Perfect Contour Extraordinaire Dorchester by King Koil (King Koil Licensing Company, Inc. Hinsdale, IL) labeled as A in this study; Beautyrest Calibri Firm by Simmons (Simmons Company, Atlanta, GA) labeled as B; Posturepedic Afton Plush by Sealy (Sealy Corporation, Trinity, NC) labeled as C; and Perfect Sleeper Southdale by Serta (Serta, Inc. Itasca, IL) labeled as D. Due to limited space in the lab, the same box spring (from King Koil) was used for all four mattresses. It was assumed that the box spring under the mattress would not make a significant difference in the measurements obtained in this study.

The research design for this study was structured to eliminate bias on the part of participants or investigators. Accordingly: (1) mattresses were covered with form-fitting sheets and were identified only by the label they were given (i.e., A, B, C, and D), (2) participants as well as individuals performing the tests were blinded as to which label corresponded to which mattress until data collection was complete, and (3) those involved with analysis of the data were similarly blinded until the analysis was completed.

2.3. Procedure

2.3.1. Postural distortion

In the development stage of the protocol, a local chiropractor was brought in on two different occasions