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Body mass as a factor in stature change

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Abstract

Background. Back pain is a common condition which has been described as a serious public health problem. Spinal shrinkage has been used as an index of spinal loading in a range of tasks. Epidemiological evidence shows that body mass index (BMI: 30 kg/m^2) is related to the development of low back pain however, no studies have described the stature change patterns of obese individuals. This study aimed to compare changes in stature after an exercise task in obese and non-obese individuals.

Methods. Twenty volunteers were divided into two equal groups; obese: BMI > 30 kg/m^2, non-obese: BMI < 25 kg/m^2. Stature was measured at 3 min intervals during a 30 min walking task and a 30 min standing recovery period. Tests were performed on two occasions, once with participants loaded during the walking task (10% body mass) and once unloaded. The influence of obesity and load condition on the magnitude and rate of stature change were compared by a two-way ANOVA.

Findings. In both groups the stature loss was greater in the loaded than unloaded condition (mean (SD)) (6.52 (1.45) mm and 3.55 (0.93) mm non-obese; 8.49 (1.75) mm and 7.02 (1.32) mm obese: $P = 0.016$). The obese presented a greater reduction in stature in both task conditions. The obese group were unable to recover stature regardless of the task condition during the recovery period (loaded: 0.06 (0.3) mm; unloaded: 0.32 (0.6) mm; $P = 0.013$).

Interpretation. It was concluded that the acute response of the spine to loading may represent a risk factor for low back pain in the obese, in addition to the chronic adaptations previously reported. A greater period of recovery may be necessary for obese individuals to re-establish intervertebral disc height. These findings may help to explain the high incidence of back disorders in obese individuals.

Keywords: Obesity; Spinal shrinkage; Intervertebral disc; Back pain

1. Introduction

Back pain is a common condition which has been described as a serious public health problem in many industrialised countries (Panjani, 2003). Low back pain causes severe disruption for the sufferer's quality of life by limiting his/her professional, quotidian and laboural tasks (Takeyachi et al., 2003), and for industry due to the costs involved in replacing and qualifying staff (Webster and Snook, 1994). It is also a concern for National Health Services because of the costs involved in treating and medicating low back pain and premature retirement (Deyo et al., 1991). Despite this, the mechanisms of low back pain remain unclear (Norcross et al., 2003), although mechanical stress has been pointed out as one of the main causes (Adams et al., 2000).

Loading the spinal column causes the intervertebral discs to lose height by the radial bulging of the annulus fibrosus and by expelling fluid from the nucleus pulposus and annulus fibrosus (Adams and Hutton, 1983; Adams and Dolan, 1995). These two mechanisms result

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in the decrease of the discs' height and in a shortening of the spinal column (also called spinal shrinkage). Spinal shrinkage can be quantified by measuring variations in the whole body length and has been used as an index of spinal loading in a range of tasks (McGill et al., 1996). Reducing the intervertebral disc height decreases its ability to absorb/transmit forces and causes increased or abnormal loading on other structures of the spine e.g. facet joints, spinal ligaments etc. (Dunlop et al., 1984; Pollintine et al., 2004). Therefore, continuous spinal loading such as that sustained during certain occupational tasks (e.g., postal carriers, workers) may be a contributory factor to the development of low back pain (Rodacki et al., 2003; Kostova and Koleva, 2001).

Another continuous loading condition is that experienced by obese individuals. Obesity, described by a significant gain in corporal fat mass, may constitute a risk factor for the development of low back pain (Kostova and Koleva, 2001; Kaila-Kangas et al., 2003) due to the "chronic" loading of the spinal column. Although some studies (Webb et al., 2003) have provided some epidemiological evidence that body mass index (BMI: 30 kg/m^2) is closely related to the development of low back pain, no studies have been performed to describe the mechanical behaviour of the intervertebral discs of obese individuals.

In a study performed with pregnant women (which represents a similar mechanism of chronic loading through increased body mass) (Rodacki et al., 2003) the relationship between low back pain and stature loss and recovery was analysed. It was reported that low back pain was more closely related to the inability of the intervertebral discs to regain height rather than to the magnitude of the height loss. It is not known if the continuous loading of spine affects the ability of the obese individuals to loose and recover their stature.

This study aimed to compare changes in stature (loss and regain) during and after a simple exercise task (walking with and without a hand weight of 10% body mass) performed by obese and non-obese individuals using measurements of stature variations as a criterion. It was hypothesised that obese individuals will experience greater spinal shrinkage, which will occur at faster rate than their non-obese counterparts. It was also hypothesised that non-obese individuals will recover from loading faster and to a greater extend than those who are obese.

2. Methods

2.1. Participants

Twenty healthy males volunteered to participate in this study. Participants were recruited according to their body mass index (BMI) to produce two groups. The first group was formed by individuals with BMI greater than 30 kg/m^2 to represent the obese group (OBG: $n = 10$), while the second group was formed by those with BMI smaller than 25 kg/m^2 (18.5–25 kg/m^2) to represent a non-obese group (NOG: $n = 10$) (Table 1). Volunteers were screened and those with current back pain or injury, a history of back pain or injury within the past 12 months, smokers, diabetes or any circulatory disease were excluded from the study. Before participating in the study written informed consent was obtained.

Table 1
Physical characteristics of the participants

Group	Age (years)	Body mass (kg)	Stature (cm)	BMI (kg/m^2)
OBG	23.0 (3.7)	113.62 (12.52)	177.6 (5.9)	36.56 (4.69)
($n = 10$)		[102.00–140.31]	[165.1–187.0]	[30.79–41.14]
NOG	22.4 (3.9)	72.13 (8.21)	176.8 (5.8)	23.1 (1.1)
($n = 10$)		[55.00–83.10]	[167.2–187.3]	[18.81–24.78]

Note: values are mean ± standard deviation (SD in parentheses); values between square brackets are the minimum and maximum values, respectively.

2.2. Experimental procedures

Each participant attended the laboratory on three separate occasions. All sessions were performed in the morning (8:00–11:00 AM) to reduce the effects of circadian variation (Reilly et al., 1984). On the first visit, participants were familiarised and trained with procedures in the stadiometer (Fig. 1) to obtain repeatable measurements of changes in stature. They were deemed trained when a standard deviation (SD) of less than 0.5 mm for 10 consecutives measurements was obtained (Rodacki et al., 2001). The second and third visits were designed to assess stature changes during and after the physical activity task.

At the beginning of each session participants were asked to lie in a supine position with their hip and knees flexed and ankles supported on a comfortable surface (Fowler's position) for 30 min to allow for a period of controlled spinal unloading. This posture aimed to eliminate the effects of physical actives that may have occurred prior to arrival in the laboratory (Fowler et al., 1997). After the resting period, participants remained in a standing position for 1.5 min to minimise the effect of soft tissue creep deformation of the lower limbs (Foreman and Linge, 1989). Following this the first measurement on the stadiometer was conducted and used as a baseline (PRE). The complete description of the procedures in the stadiometer is provided by Rodacki et al. (2001).

After determining the baseline measurement participants performed the simulated daily physical task. This consisted of walking with and without a 10% body weight hand-load (5% each hand) at a self-selected pace for 30 min. The task was performed on an indoor course