Effect of a weightlifting belt on spinal shrinkage

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Spinal loading during weightlifting results in a loss of stature which has been attributed to a decrease in height of the intervertebral discs – so-called 'spinal shrinkage'. Belts are often used during the lifting of heavy weights, purportedly to support, stabilize and thereby attenuate the load on the spine. The purpose of this study was to examine the effects of a standard weightlifting belt in attenuating spinal shrinkage. Eight male subjects with a mean age of 24.8 years performed two sequences of circuit weight-training, one without a belt and on a separate occasion with a belt. The circuit training regimen consisted of six common weight-training exercises. These were performed in three sets of ten with a change of exercise after each set of ten repetitions. A stadiometer sensitive to within 0.01 mm was used to record alterations in stature. Measurements of stature were taken before and after completion of the circuit. The absolute visual analogue scale (AVAS) was used to measure the discomfort and pain intensity resulting from each of the two conditions. The circuit weight-training caused stature losses of 3.59 mm without the belt and 2.87 mm with the belt ($P>0.05$). The subjects complained of significantly less discomfort when the belt was worn ($P<0.05$). The degree of shrinkage was significantly correlated ($r=0.752$, $P<0.05$) with perceived discomfort but only when the belt was not worn. These results suggest the potential benefits of wearing a weightlifting belt and support the hypothesis that the belt can help in stabilizing the trunk.

Keywords: Weightlifting belt, spinal shrinkage, circuit training

Weightlifting belts are marketed commercially with the aim of preventing back injuries while lifting heavy weights. It is thought that they do so by helping to support and stabilize the spine. They may also have an effect upon intra-abdominal pressure, the mechanism widely held responsible for reducing spinal compressive forces[1].

Harman *et al.*[2] and Lander *et al.*[3] have analysed the effect of a weightlifting belt during performance of the dead-lift and squat, respectively. Results confirmed that a weightlifting belt can aid in supporting the trunk by increasing intra-abdominal pressure.

McGill *et al.*[4] examined the effects on intra-abdominal pressure of wearing abdominal belts as prescribed to industrial workers. Subjects demonstrated a significant increase in intra-abdominal pressure on wearing the belt (compared with lifting without a belt) while lifting loads of 72.7–90.9 kg, both with the breath held and continuously expiring on the lifting effort. Wearing a belt did not augment the reduction in muscle activity of the erector spinae when lifting with the breath held.

Spinal loading during weightlifting is reflected in changes of stature, a phenomenon known as 'shrinkage'. The loss of height is due to extrusion of water through the disc wall when the applied compressive force exceeds the imbibition pressure of the nucleus pulposus complex and the osmotic gradient across the disc membranes[5]. Shrinkage is measured using a purpose-built stadiometer: the technique has been applied successfully in studies of weightlifting[6,7], in ergonomics[8,9], and sports training (Leatt *et al.*[10] on running and Boocock *et al.*[11] on plyometrics). Shrinkage, as an index of spinal loading, allows further investigation of the effectiveness of a weightlifting belt in attenuating the load on the spine. The purpose of this study was to investigate the effect of a standard weightlifting belt on spinal shrinkage during circuit weight-training. Six common weight-training exercises were chosen which load the spine to differing degrees.

Patients and methods

Eight men aged mean(s.d.) 24.8(2.3) years, weighing mean(s.d.) 73.1(5.7) kg and measuring mean(s.d.) 175.5(7.2) cm in height acted as subjects. All were experienced (5.75 years) in the use of weights but not in competitive weightlifting. They did not habitually wear belts when training. Before participating, subjects filled in voluntary consent forms: subjects with a history of back pain or neurological disorder were excluded from the study. The project was approved by the Ethics Committee of Liverpool Polytechnic.

Measurements of stature were carried out using a stadiometer as described by Boocock *et al.*[11]. The equipment is illustrated in *Figure 1*. The stadiometer was sensitive to within 0.01 mm.

The angle of inclination of the stadiometer was 13°, thus eliminating in large part the muscular effort required to maintain the body in an upright position. A BBC microcomputer was interfaced with the stadiometer, providing 'on-line' data capture. To use the stadiometer the subjects were first familiarized with the apparatus. This took on average 50–60 min until each subject obtained a standard deviation of less than 0.5 mm in ten consecutive measurements.

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For each subject to undergo a standardized weight-training protocol, the ten repetition maximum (10RM) criterion was used[12]. This meant that, for each exercise, the predetermined 10RM load was lifted ten times. Six common weight-training exercises were specifically chosen to load the spine to varying degrees. These were carried out in the form of a circuit which consisted of three sets of ten repetitions with a change of exercise after each set of ten. The order in which the exercises were performed and the mean loads lifted are shown in *Table 1*.

Individual 10RM scores were determined by direct practice of a set or sets of ten repetitions of increasing load until the precise weight was obtained. This had three major advantages: (1) it enabled an exact determination of the 10RM; (2) it represented a commonly used number of repetitions recommended for strength improvement; and (3) it accustomed the subjects to performing an average of two to three sets of each exercise.

The subjects underwent two weight-training sessions on separate occasions, with at least 5 days, and on average 7 days, separating them. Measurements for each individual were taken at the same time of day (15.30–18.30 h) to control for circadian variation in stature[6,7]. Subjects were instructed to follow their normal daily routine, avoiding any excessive physical or sporting activity on the day of testing.

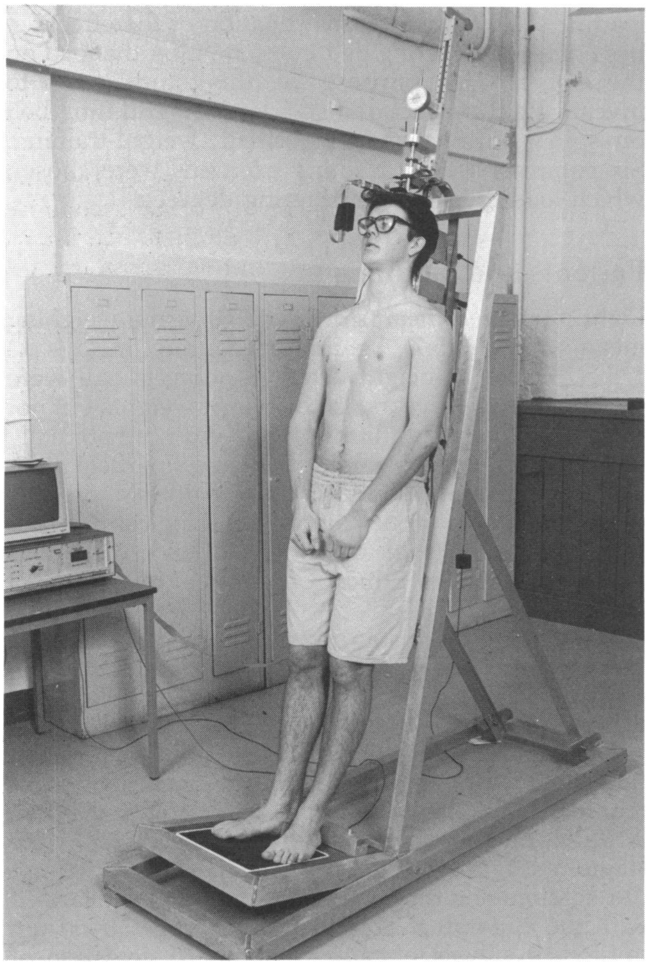

Figure 1. Stadiometer – apparatus for measuring stature

On the days of measurement, before beginning the circuit, the subjects were required to stand for a period of 20 min with their weight evenly distributed. This attempted to standardize and control for any spinal loading or unloading that may have directly preceded testing[11]. Following this period, each subject was measured on the stadiometer. Five consecutive measurements were recorded, with the computer program calculating the mean value.

The circuit training followed immediately, with each subject being randomly assigned to lift first with, or without, the belt. The weightlifting belt was chosen for its approximation to the belt used by Harman *et al.*[2] and is typical of those used by recreational weightlifters. It consists of a single layer of leather 5 mm thick, being 120 cm long, 152 mm wide in its centre section and tapering to 51 mm at either end. The belt was worn with the thickest portion positioned over the lumbar spine. The belt was tightened fully for each individual, allowing for comfort and ease of respiratory movement.

Observation and verbal input during the circuit ensured that all lifts were performed according to standard technique. A 2-min rest was taken at the completion of the first and second set of six exercises. The mean(s.d.) duration of the total exercise period was 32.6(5.8) min (with belt) and 31.4(4.0) min (without belt).

The subjects' breathing had returned to normal within 3 min of completing the circuit. This allowed measurements to be performed after exercise on the stadiometer at that time (i.e. 3 min after exercise).

In addition to measurement of stature, the absolute visual analogue scale (AVAS) was used as a measure of discomfort and pain intensity[13]. The AVAS scale consisted of a 20-cm horizontal line with the headings of no discomfort–pain at either end. Each individual's subjective rating of pain/discomfort was marked off before and after completion of the circuit with no opportunity to compare values with previous estimates.

Statistical analysis

Differences in shrinkage occurring while wearing a belt and between degrees of discomfort and pain were examined using *t* tests. Correlations between back discomfort and degree of shrinkage along with weights lifted (10RM) and degree of shrinkage were examined using the Pearson Product Moment correlation coefficient.

Table 1. The order of exercises performed and load lifted

Order	*Exercise*	*Load (kg)*
1	Dead-lift	51.1(13.4)
2	High pull	32.1(4.8)
3	Squat	61.1(20.5)
4	Clean	37.4(6.8)
5	Bent-over rowing	32.1(5.7)
6	Biceps curls	26.8(5.7)

Values of load are mean(s.d.)

Results and discussion

Mean(s.d.) alterations in stature for the two conditions, with and without a belt, are given in *Table 2*. Six of eight subjects showed greater shrinkage without the belt. Despite the greater absolute mean loss in height (0.72 mm) for the condition with no belt, the difference in shrinkage between the two conditions was not significant ($P>0.05$).

Comparison of discomfort experienced in the two conditions revealed significantly less discomfort ($P<0.05$) for the belt condition. This reduction in discomfort through wearing the belt may reflect its protective function.

The higher pain values in the 'no belt' condition were due mainly to raised levels of pain in only two subjects. No reason was apparent for this response. The two most experienced lifters had no complaints of pain or discomfort under either condition.

In the 'no belt' condition, perceived discomfort was significantly correlated with height loss ($r=0.752$, $P<0.05$), but this relationship was not significant when the belt was worn ($r=0.596$, $P>0.05$). Height lost when not using the belt was not significantly correlated with the weight lifted (10RM) for either the squat ($r=0.42$, $P>0.05$) or the dead-lift ($r=0.37$, $P>0.05$). It is possible that individual variation in the loads lifted by each subject and variations in efficiency of technique contributed to this lack of significance. As a prerequisite for inclusion in the study, and for obvious reasons of safety, the subjects were all experienced in the use of weights. However, individuals had different levels of experience in lifting as well as different 10RM values. Those subjects who had the higher 10RM values may have been better able to compensate for spinal loading by greater muscle strength. Wilby *et al.*[7] showed that height losses were inversely correlated with isometric back strength in female subjects.

The mean shrinkage values observed in this study were less than those previously observed despite the similarities in regimen and exercise duration. Wilby *et al.*[7] and Leatt *et al.*[10] both reported a mean loss of 5.4 mm during circuit weight-training for 20-min and 25-min exercise periods, respectively. It is possible that the greater experience and skill of subjects in this study contributed to the lower shrinkage. The time of day may also have contributed to the lower values in the present study: Wilby *et al.*[7] have shown that the greatest shrinkage owing to weight-training occurs first thing in the morning.

Table 2. Shrinkage, perceived discomfort and pain for the two conditions (with belt and no belt)

Effect	*Condition*	
	With belt	No belt
Shrinkage (mm)	2.9(1.65)	3.6(3.3)
Perceived discomfort	16.6(15.2)	63.4(58.7)
Perceived pain	0.8(2.12)	8.9(16.9)

Values are mean(s.d.)

Furthermore, a possible explanation for the failure of the effect of the weightlifting belt to reach significance can be gained by examining the findings of Harman *et al.*[2] and Lander *et al.*[3] on the effects of a weightlifting belt upon intra-abdominal pressure. Lander *et al.*[3] found that most differences were observed during the 90% maximum lift (1RM) condition. As the 10RM represents about 61% of the 1RM[14], it is possible that the significant effect of increasing intra-abdominal pressure may not occur to the same extent during repetitions of the 10RM. The belt may, however, have a cumulative protective effect when used when lifting weights of submaximal load with a high number of repetitions.

The extent that the weightlifting belt increases intra-abdominal pressure in particular exercises, apart from the squat and dead-lift, remains to be investigated. Possible benefits of the belt during the squat and dead-lift may have been obscured by the other exercises in the circuit.

While it has been demonstrated that the use of a weightlifting belt significantly increases intra-abdominal pressure[2–4], the exact mechanism through which this increase may attenuate the load on the spine remains to be defined. What is apparent is the significant effect of a weightlifting belt in reducing discomfort as found in this study along with improving perceptions of trunk stability[4].

In summary, the main findings of this study were as follows.

1. The circuit weight-training regimen was found to induce stature losses of 3.59 mm without the belt and 2.87 mm with the belt. Despite the greater absolute mean loss of height (0.72 mm) for the 'no belt' condition, the difference did not reach significance ($P>0.05$).
2. Comparison of discomfort experienced in the two conditions revealed significantly less discomfort ($P<0.05$) in the weightlifting 'with belt' condition. This suggests that the belt afforded some protection.
3. The amount of shrinkage was significantly correlated ($r=0.752$, $P<0.05$) with perceived discomfort, but this was observed only in the weightlifting condition with 'no belt'.

Wearing a weightlifting belt tends to induce less absolute spinal shrinkage and causes significantly less discomfort compared to lifting without a belt. These observations suggest the potential benefits of wearing a weightlifting belt and support the hypothesis that the belt can help in stabilizing the trunk.

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