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Effects of industrial back supports on physiological demand, lifting style and perceived exertion

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Abstract

The industrial back support has seen widespread and increasing use in manual material handling activities in recent years. This paper reports the results of a laboratory investigation in which subjects performed manual lifting of 7 and 14 kg loads at frequencies of 3, 6, and 9 lifts/minute. The six lifting task combinations were repeated under both with-support and without-support conditions while a total of 17 physiological, kinematic, and psychophysical variables were recorded. Based upon analysis, several general conclusions were reached: (1) with the exception of blood pressure, industrial back supports did not affect physiological responses, including energy expenditure, during lifting; (2) significant increases in blood pressure (both systolic and diastolic) while wearing a back support may present long-term health concerns for some worker populations; (3) lifting style in the sagittal plane was not altered by the support; and (4) subjects did not perceive less effort in lifting with a back support versus without. Overall, these results suggest that the demands of lifting are not reduced with the use of an industrial back support. The lack of rationale for the use of these devices based upon ergonomic criteria should call into question the continued prescription of the devices under the presumption of hazard control.

Relevance to industry

A study of several lifting tasks has failed to reveal ergonomic justification for the use of industrial back supports. Their use may be contraindicated for some workers. Engineering controls, together with effective administrative controls and training, remain the preferred approach for reducing low-back pain and injury since back supports do not offer any identifiable hazard control.

Keywords: Industrial back support; Lifting belt; Back belt; Ergogenic corset; Low-back pain; Low-back injury; Manual material handling

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1. Introduction

Manual material handling (MMH) activities have been consistently recognized as a major hazard in the workplace (Waters et al., 1993). Recent data from the largest private carrier of workers' compensation insurance in the U.S. indicate that MMH activities result in 37% of total claims and 40% of total claim costs (Leamon and Murphy, 1994). Ergonomic approaches to control MMH-related injuries have traditionally involved engineering design/redesign to

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more adequately fit the task to worker capabilities, proper training in safe handling, and worker selection and screening. As with other forms of industrial hazards, personal protective equipment can play a role in this process provided there is an identifiable reduction in MMH hazard exposure. Referred to by a variety of names in the literature such as 'external lifting support', 'lifting belt', or 'ergogenic corset', the industrial back support has seen increasing use in the performance of MMH activities. Kumar and Godfrey (1986) speculated that this increase has been due, at least in part, to the clinical relief of lower back pain from partial immobilization and support to the lumbar region.

At the present time, however, there are discrepancies regarding the effectiveness of industrial lifting supports in reducing or controlling work-related, low back disorders (Reddell et al., 1992). A recent review of the literature by the U.S. National Institute for Occupational Safety and Health Back Belt Working Group resulted in the conclusion that back supports do not prevent injuries to healthy workers and should not be considered personal protective equipment (NIOSH, 1994). Their conclusions were based upon a variety of objective and subjective measurement criteria.

Biomechanical criteria generally involve intra-abdominal pressure (IAP), electromyogram (EMG) activity in the supporting musculature, spinal forces, or range-of-motion during lifting. Some researchers have demonstrated increases in IAP while performing weight lifting and have speculated that this effect could reduce potentially injurious forces on the spine (Bartelink, 1957; Kumar and Godfrey, 1986; and Harmon et al., 1989). It has also been suggested that external supports can further increase IAP, a notion that has also been advanced based on some EMG studies during weight lifting (Hemborg et al., 1985; McGill et al., 1990).

However, in recent years the role and significance of IAP has been questioned, particularly in industrial MMH activities which typically involve much lower lifting loads than in weight training. Kumar and Godfrey (1986) found that when subjects lifted modest loads (7 to 9 kg) and with a variety of support designs, there were no appreciable increases in IAP. Amendola (1989) also examined three different support designs with respect to compressive forces at L5/S1 and found no significant difference between any of the supports and controls (no support).

Reduced range-of-motion of the trunk due to back supports has also been observed (Grew and Deane, 1982; Kaplan and Sinaki, 1993; Lavender et al., 1994; and McGill et al., 1990). Restricted motion has been suggested as a factor behind compliance problems in the field (Kaplan and Sinaki, 1993). Compliance, or the willingness of the user to wear a back support properly over long periods, has been cited as major concern in their potential effectiveness (Reddell et al., 1992). These authors stated that in one large industry, 58% of back support users discontinued wearing them within 8 months, specifically complaining that the supports rubbed, pinched, caused bruised ribs, and were hot to wear.

Kumar and Godfrey (1986) also stated that various support types may produce differing physiological costs. Previously, Petrofsky and Lind (1978) had observed that trunk movements involved in lifting with repeated abdominal compression may restrict the ability to move larger volumes of air in and out of the lungs. Such an effect could be amplified with additional abdominal compression produced by an external support device. Thus, it is unclear as to whether or not back supports reduce metabolic and/or respiratory efficiency and would ultimately lead to earlier onset of fatigue.

Some psychophysical aspects of back supports have been addressed with mixed findings. McCoy et al. (1988) studied two support designs using the psychophysical method of adjustment. They found that use of either support leads to a significantly higher maximum acceptable weight of lift (MAWL) when compared to controls (no support). However, Amendola (1989) also used this psychophysical method and found no significant difference between support use or controls with regards to MAWL. He also reported that subjective ratings failed to elicit significant differences between support features, though most subjects felt that the devices would offer some assistance in task performance versus no support.

Epidemiological studies have also suggested mixed results regarding back support effectiveness. Walsh and Schwartz (1990) examined 90 male warehouse workers divided into one of three groups: (1) no training, no support (controls); (2) back school only; and (3) back school plus custom molded lumbosacral orthoses. Results showed no significant difference between groups in strength assessment or low back incident rates after a 6-month period. There was, however, a significant reduction in lost work time in groups 2 and 3 versus controls. It is unclear whether this latter trend would continue beyond 6 months or if the effect was due to training or support use. Further, the fiscal practicality of custom made supports for many organizations would be questionable. In a similar study, Reddell et al. (1992) added an additional experimental group: back support only. They noted in 642 baggage handlers no significant difference between groups in total injury rate, restricted workday rate, total lost workdays, and workers' compensation rate. They did find that workers who discontinued use of back supports after a period of time had a higher lost workday rate than those who had not worn supports.

Asundi et al. (1993) tracked over 1300 workers assigned to one of three groups: (1) those who had experienced back injury or pain and were required by medical department to wear a support; (2) those who wore supports voluntarily; and (3) those who wore no support. Results indicated that the initial time to onset of low back injury was lengthened for those who wore back supports, but, there was no significant difference in the incidence rate or time to re-injury.

This brief review of the literature examined several factors which have been used to qualify the use and effectiveness of industrial back supports. Conclusive evidence that these devices reduce work-related low back injury risk seems lacking and several questions still remain concerning their influence upon physiological demand, body mechanics, and psychophysical variables. Therefore, the goal of this research was to simultaneously examine a more extensive set of variables than previously studied regarding the effects of back supports.

2. Methods

2.1. Subjects

Eight college-age males served as subjects for this experiment. They were all in good general health and were not recruited on the basis of any relevant industrial experience. Table 1 provides the basic descriptive statistics of this population.

Table 1
Descriptive statistics of subject population

Variable	Mean	SD	Range
Age (years)	26.88	5.46	22–39
Height (cm)	175.88	6.15	163–183
Weight (kg)	72.63	11.25	55–93
Max.VO_2 (mL/min)	3069.63	485.03	2183–3692

2.2. Apparatus

A SensorMedics 2900c Metabolic Measurement System was used for assessing all respiratory functioning and gas exchange data. A Polar Vantage XL telemetric pulse monitor was used to record heart rate and a Marshall Deluxe sphygmomanometer was used to assess brachial blood pressure. Video-based motion analysis was accomplished using the Ariel Performance Analysis System. The back support used in this experiment was the ProFlex^{TM} (Ergodyne Corp.) Personal Back Support. It was selected on the basis that it is a commonly used brand/model and has general characteristics similar to other supports on the market.

2.3. Lifting tasks and protocol

Six symmetrical (sagittal plane) lifting tasks were performed, both with and without the back support, so as to examine a relatively robust set of lift conditions. These tasks were lifting a tote filled with either 7 or 14 kg of lead shot at frequencies of 3, 6, and 9 lifts/minute. All tasks were performed with a 40 cm wide by 25 cm deep (sagittal) by 16 cm high tote lifted from the floor to a 76 cm high platform. The horizontal distance at lift origin was specified at 38 cm (measured from a mid-point between the ankles forward to the load center).

During a familiarization period, subjects were introduced to the general preference of 'squat' lifting (straight back, bent knees) over 'stoop' lifting (straight knees, bent back). This was not a 'back school' per se, but was meant to provide a consistent level of training. Subjects were also instructed as to

Table 2
Mean (standard deviation) of physiological, kinematic and psychophysical parameters

	Load					
	7 kg			14 kg		
Variable	Frequency: 3	6	9	Frequency: 3	6	9
Without support						
VO_2 (mL/min)	657.6	936.3	1191.2	733.4	1125.1	1443.8
	(141.4)	(182.9)	(285.8)	(219.7)	(189.4)	(313.4)
VCO_2 (mL/min)	597.1	848.8	1119.6	632.1	1039.1	1414.9
	(126.0)	(169.7)	(272.3)	(185.4)	(145.3)	(262.2)
TV (Liters)	0.80	0.96	1.53	0.84	1.10	1.28
	(0.16)	(0.20)	(0.13)	(0.25)	(0.23)	(0.22)
RR (breath/min)	24.2	26.8	29.4	25.9	27.8	30.7
	(4.4)	(4.2)	(9.6)	(8.1)	(5.7)	(4.8)
EE (Kcal/min)	3.2	4.6	5.9	3.5	5.6	7.3
	(0.7)	(0.9)	(1.5)	(1.1)	(0.9)	(1.5)
HR (bpm)	96.4	109.7	121.1	99.5	115.6	136.7
	(10.7)	(9.3)	(10.7)	(6.4)	(10.9)	(11.1)
SBP (mmHg)	141.6	156.3	164.9	154.5	171.8	191.3
	(5.3)	(6.7)	(6.1)	(6.6)	(3.5)	(4.4)
DBP (mmHg)	77.3	79.0	80.0	79.2	80.9	83.0
	(1.8)	(1.4)	(1.2)	(1.8)	(0.8)	(0.9)
D-H	69.9	73.3	75.3	77.5	76.5	71.1
	(11.9)	(14.6)	(10.9)	(15.8)	(15.9)	(12.8)
D-K	97.3	96.5	105.3	102.4	100.0	100.6
	(24.1)	(24.1)	(11.9)	(18.1)	(16.8)	(16.9)
PPV-H	251.8	247.9	307.8	267.3	276.8	259.4
	(24.1)	(67.3)	(106.4)	(52.0)	(95.3)	(76.9)
PPV-K	221.8	235.3	237.8	244.5	254.6	229.2
	(65.8)	(96.2)	(71.4)	(57.4)	(51.4)	(61.9)
APV-H	206.2	195.7	255.5	202.7	212.5	205.4
	(58.7)	(46.7)	(105.1)	(52.9)	(63.4)	(57.9)
APV-K	178.7	182.4	184.8	176.3	194.7	163.3
	(56.4)	(77.2)	(50.6)	(35.4)	(33.1)	(39.3)
PPA-H	130.4	97.0	218.2	37.9	59.5	35.4
	(112.6)	(186.1)	(303.3)	(74.6)	(69.9)	(67.8)
PPA-K	79.9	120.2	60.9	54.9	36.4	81.7
	(89.8)	(184.2)	(135.4)	(76.4)	(58.4)	(96.4)
RPE	8.8	10.6	12.5	11.1	13.6	15.5
	(2.2)	(1.6)	(2.5)	(2.4)	(1.4)	(2.8)
With support						
VO_2 (mL/min)	629.1	946.9	1263.1	692.6	1149.9	1470.8
	(219.8)	(256.2)	(372.1)	(181.3)	(244.9)	(275.4)
VCO_2 (mL/min)	554.9	867.4	1213.6	609.9	1051.2	1433.1
	(203.5)	(235.2)	(332.1)	(151.6)	(201.7)	(156.3)
TV (Liters)	0.74	0.95	1.14	0.80	1.09	1.29
	(0.19)	(0.19)	(0.30)	(0.19)	(0.25)	(0.27)
RR (breath/min)	26.3	27.6	30.2	26.5	28.5	32.8
	(5.9)	(4.9)	(3.8)	(6.4)	(5.2)	(7.1)
EE (Kcal/min)	3.1	4.7	6.3	3.4	5.7	7.4
	(1.1)	(1.3)	(1.8)	(0.9)	(1.2)	(1.3)

Table 2 (continued)

	Load					
	7 kg			14 kg		
Variable	Frequency: 3	6	9	Frequency: 3	6	9
HR (bpm)	97.9	106.7	121.5	99.5	114.3	135.4
	(9.6)	(10.4)	(8.2)	(11.3)	(5.5)	(10.0)
SBP (mmHg)	144.0	159.1	168.8	158.4	173.5	193.9
	(4.9)	(7.1)	(6.2)	(6.8)	(5.1)	(5.5)
DBP (mmHg)	77.8	80.4	82.0	80.3	82.4	84.8
	(1.9)	(1.4)	(0.9)	(1.3)	(0.5)	(0.7)
D-H	78.1	73.8	74.6	72.8	79.3	78.3
	(15.6)	(14.0)	(16.1)	(13.6)	(19.3)	(14.4)
D-K	101.1	94.9	96.0	100.4	103.8	111.1
	(16.2)	(21.3)	(18.7)	(25.6)	(22.9)	(13.9)
PPV-H	247.5	268.8	338.4	254.1	234.0	319.2
	(80.5)	(60.6)	(222.3)	(69.1)	(50.5)	(92.7)
PPV-K	214.7	250.1	328.8	233.4	224.4	261.9
	(41.5)	(86.9)	(207.6)	(72.1)	(83.8)	(95.9)
APV-H	188.1	199.3	243.1	202.9	183.6	249.3
	(68.7)	(42.6)	(117.9)	(63.2)	(33.9)	(86.4)
APV-K	160.7	179.5	225.3	168.7	168.4	205.4
	(39.5)	(54.8)	(120.2)	(47.9)	(53.9)	(83.5)
PPA-H	117.1	149.4	146.9	215.5	57.4	232.1
	(203.3)	(172.9)	(240.5)	(337.8)	(95.1)	(306.4)
PPA-K	43.8	139.6	247.9	107.0	45.1	83.9
	(69.5)	(139.5)	(299.7)	(153.0)	(88.6)	(125.3)
RPE	9.0	10.6	12.5	11.4	13.0	15.0
	(2.3)	(2.5)	(1.9)	(2.3)	(2.0)	(2.1)

Note: D-H = Displacement angle of Hip (deg); D-K = Displacement angle of Knee (deg); PPV-H = Peak Positive Velocity of Hip (deg/sec); PPV-K = Peak Positive Velocity of Knee (deg/sec); APV-H = Average Positive Velocity of Hip (deg/sec); APV-K = Average Positive Velocity of Knee (deg/sec); PPA-H = Peak Positive Acceleration of Hip (deg/sec^2); PPA-K = Peak Positive Acceleration of Knee (deg/sec^2).

how to properly wear the back support according the manufacturer's recommendations and were fitted with the appropriate size (small, medium, large). With the support properly fitted, marks were made on the Velcro adjustment straps so that approximately the same tension force could be achieved during each subsequent lifting task for a given subject. All subjects were encouraged to lift 'as they felt appropriate and comfortable' based upon their perception of the task demand. This command was repeated for each lifting task condition. It was felt this was an important point of instruction in order to later document the lifting style adopted under each condition.

The total of twelve task combinations (2 × 2 × 3) were each performed according to a randomized schedule developed for every subject for a 15 minute lifting session. Measures of heart rate (HR), oxygen consumption (VO_2), carbon dioxide expiration (VCO_2), tidal volume (TV), respiration rate (RR) and rate of energy expenditure (EE) were monitored throughout the session and were averaged during the final five minutes. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded immediately following the completion of the session.

Subjects were also fitted with reflective markers at the major articulating joints and were video-taped by a single camera during the final five minutes of each task. A 2-dimensional model was specified since all lifting tasks were symmetric about the sagittal plane. Angular displacement of the knee and hip joints were recorded at the lift origin. In addition, values for average and peak positive angular velocity and acceleration during the cycle for both knee and hip were recorded. Metrics regarding the knee and hip joint were chosen for analysis as it was felt these would adequately reflect an alteration in lifting style. Finally, at the conclusion of each lifting session, subjects also ranked their perceived exertion during the task via Borg's 6–20 RPE scale (Borg, 1970). No more than three lifting sessions were performed by a subject during any day and at least 30 minutes of rest was allowed between sessions.

3. Results

All data were tabulated and analyzed using the SYSTAT for Windows statistical software (SYSTAT, 1993) on an IBM compatible PC. Table 2 provides a summary of the mean and standard deviation for the variables examined in this experiment. Table 3 provides a summary of the ANOVA models used to assess the experimental effects.

The factor of prime interest in this study was the Support effect. As can be seen from the summary of ANOVAs in Table 3, none of the physiological measures examined were affected by use of the back support with the exception of the blood pressure measurements. Wearing the back support resulted in significantly higher SBP and DBP as the overall average values were 166.3/81.3 (SBP/DBP) while wearing the support versus 163.4/79.9 without. There was also a significant interaction between Frequency and Load for HR and SBP. At 3 lifts/minute, there was no effect of Load on HR or SBP, while there was a significant effect at 6 and 9 lifts/minute. This was likely due to the longer recovery periods between lifts at the lower frequency.

The displacement data in Table 2 are reported in absolute values (no coordinate signs utilized). As with the physiological measures, there was also no significant main effect of Support for the kinematic measures. There were significant interaction terms involving Support, however. First, with regard to the

Table 3
Summary of F-ratio statistics for main effects in ANOVA models

	Main effect						
Variable	Back Support	Frequency	Load	Support × Freq.	Support × Load	Freq. × Load	Support × Freq. × Load
VO_2	0.08	104.77 **	19.41 **	0.43	0.04	1.69	0.05
VCO_2	0.20	132.14 **	22.22 **	0.43	0.14	2.88	0.12
TV	1.07	13.86 **	0.30	0.45	0.72	0.48	0.66
RR	2.73	18.29 **	3.47	0.11	0.01	0.23	0.35
EE	0.11	111.63 **	19.39 **	0.35	0.03	1.95	0.05
HR	0.11	134.40 **	28.25 **	0.36	0.01	5.61 **	0.11
SBP	9.66 **	[illegible]47.11 **	377.51 **	0.09	0.02	16.99 **	0.23
DBP	32.85 **	85.71 **	94.59 **	1.65	0.12	1.37	0.28
D-H	1.76	0.24	1.14	0.13	0.06	0.66	3.25 *
D-K	0.11	1.00	3.00	0.01	1.51	0.20	1.97
PPV-H	1.97	3.07	0.20	0.93	0.14	0.48	0.50
PPV-K	0.73	1.41	0.15	1.76	1.03	0.92	0.21
APV-H	0.02	4.01 *	0.16	0.46	0.28	0.42	0.97
APV-K	0.16	1.37	0.25	2.48	0.03	0.41	0.19
PPA-H	2.89	1.36	1.22	0.25	4.09 *	0.38	2.13
PPA-K	2.98	1.55	4.41 *	1.54	0.63	2.22	3.15 *
RPE	0.17	77.60 **	108.62 **	0.51	0.56	0.22	0.15

Note: A significant BLOCK effect ($p < 0.01$) was not included in this summary table as it was a nuisance factor. Degrees of freedom in model: Support (1,77); Frequency (2,77); Load (1,77); Support × Frequency (2,77); Support × Load (1,77); Frequency × Load (2,77); Support × Frequency × Load (2,77). * Significance at 0.05 level; ** significance at 0.01 level.

3-way interaction for displacement of hip (D-H), the without-support, 7 kg, 3 lift/minute task showed the least displacement angle (69.9 degrees) and was significantly lower than the with-support, 14 kg, 6 lift/minute combination (79.3 degrees). Second, analysis of peak positive acceleration of the knee (PPA-K) showed that the lower load tasks (7 kg) produced significantly lower values than observed in the 14 kg tasks (68.2 and 115.4 degrees/sec^2, respectively). Yet, the specific combination of 7 kg, 9 lifts/minute, with-support showed significantly greater peak acceleration than any other 3-way combination (resulting in a significant 3-way interaction for this term). Regarding the interaction of Support × Load for peak positive acceleration of hip angle (PPA-H), analysis showed that PPA-H was significantly greater while subjects wore the support than without at the 14 kg loads only (168.3 and 44.3 degrees/sec^2, respectively). The remaining significant main effect of Frequency for average positive velocity of hip (APV-H) revealed that, as might be expected, APV-H was significantly higher for 9 lifts/minute than for 3 or 6 lifts/minute (238.3, 199.9, and 197.8 degrees/second, respectively).

Finally, Table 3 clearly shows that there was no significant psychophysical effect of back supports as revealed through Ratings of Perceived Exertion. The mean RPE values were 12.0 and 11.9, respectively, for the without-support and with-support conditions. These values correspond to verbal ratings of between 'fairly light' and 'somewhat hard' on the RPE scale. Frequency and Load did show effects as increasing intensities resulted in significantly higher RPE values. The mean RPE values for frequencies 3, 6, and 9 were 10.1, 11.9, and 13.9, respectively, and for loads of 7 and 14 kg, RPEs were 10.6 and 13.3, respectively.

4. Discussion

4.1. Physiological measures

The physiological variables measured in this study indicated that the presence of a back support had no significant effects. Of particular note, the lack of a support effect on tidal volume, oxygen uptake and total energy expenditure indicates that task endurance would be unaffected by the use of the support. The only exception was noted for both steady-state systolic and diastolic blood pressure. Though a statistically significant rise was found while wearing the support during all lifting tasks, it is unclear whether this represents a 'meaningful' increase. It is therefore suggested that the health care professional may be consulted regarding some workers (e.g., hypertensive or borderline hypertensive) as to whether or not any additional circulatory load, beyond lifting demand itself, should warrant concern for such individuals. The NIOSH Working Group (NIOSH, 1994) had raised similar concerns for those who wore weight-lifting belts when they stated that "... individuals with a compromised cardiovascular system may be at greater risk when exercising or working with back supports" (p. 16).

Other significant main effects in the physiological variables showed generally expected trends. With increases in lift frequency and in lifting load, significant increases were documented for all measures with the exception of tidal volume and respiration rate which did not show a load effect. The overall implication from these findings is that there exists no physiological basis for any claim that back supports reduce the demand of lifting and, furthermore, their use may be contraindicated for some worker populations.

4.2. Kinematic measures

As described earlier, subjects were encouraged to adopt an appropriate posture while lifting, given a specific task demand. Overall, the kinematic data suggest that lifting style and body mechanics remain unaffected by the presence of a back support and there is no evidence to suggest that lifting style in the sagittal plane, while wearing a support, will change beyond what might be achieved through training and/or experience alone. In the task combination of lifting 14 kg, 6 lifts/minute, with-support, and only when compared to lifting 7 kg, 3 lifts/minute, without support, did subjects reveal a tendency to lift with a more upright back posture. Despite this particular interaction, however, the remaining kinematic data do not suggest any trend toward a 'safer' lifting posture with the support versus without. The data also suggest that subjects are not restricted in the sagittal plane when lifting with a back support, which is in agreement with Lavender et al. (1994). Conversely, there is no evidence that subjects are 'reminded' to lift more properly with a back support. Furthermore, recall that PPA-H was significantly greater when subjects wore a support and lifted the 14 kg loads. This could indicate that greater internal forces are generated on joints which correspond to articulation of the hip, including L5/S1, while wearing the support and lifting moderate to higher loads.

4.3. Perceived exertion

Based upon the RPE results, it was evident that subjects did not perceive less effort in lifting while wearing the back support. This should be viewed in light of the fact that subjects did adequately report significant changes in perceived exertion with task frequency and load. The lack of a support effect in perceived exertion is in agreement with Amendola's findings (1989). The NIOSH Working Group (NIOSH, 1994) had raised the concern that lifting belts may alter a worker's perception of their capacity and perhaps foster an unwarranted sense of safety. The psychophysical method used in this study (RPEs) did not directly assess a subject's perception of lifting capacity. However, the results do suggest that an individual would not select greater loads or otherwise overlift while wearing a back support as opposed to without one.

5. Conclusions

A wide variety of industrial back supports are available on the market, but most differ only in terms of convenience features or material usage. A variety of claims have been made about the effectiveness of back supports, both in the popular and scientific literature, and by manufacturers of the devices. In general, it has been stated that back supports may reduce the stress of lifting, remind workers to lift more safely, and provide support for the stomach and back musculature while lifting. Detractors of back supports have claimed that the devices are often uncomfortable to wear, restrict movement, are often not worn properly, and may encourage overlifting.

This paper reported the results of a laboratory investigation that concurrently examined an extensive set of objective and subjective parameters during 6 different lifting conditions to determine the effects of a typical industrial back support. Results indicate that whether the criteria are physiological, biomechanical, or psychophysical, there appears to be no clear positive ergonomic benefit from the use of back supports. Furthermore, their use by workers who are hypertensive, near-hypertensive, or who otherwise have a compromised cardiovascular system, may be contraindicated. It is evident that, while some workers may personally prefer to wear the devices, the results of this study add to the growing body of evidence which suggests back supports do not offer a reduction in the hazards or physical stress associated with manual lifting. Therefore, use of these devices under the guise of ergonomic intervention and/or hazard control is unjustified. Future research should continue with both field and laboratory investigations to address several issues such as back support effects in non-symmetrical lifting, the interaction of training, support usage and lifting habits, as well as various other psychosocial aspects of their use.

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