A SCIENTIFIC LOOK AT BACK BELTS

By Sean Gallagher[1] and Christopher A. Hamrick[2]

ABSTRACT

In recent years there has been a tremendous increase in the use of back belts by companies attempting to control back injury costs. Many claims have been made regarding the effectiveness of back belts; however, not many of these have been based on sound scientific evidence. In fact, there is contradictory information on the value of back belts. The U.S. Bureau of Mines reviewed literature relating to the effectiveness of back belts in the workplace.

INTRODUCTION

A tremendous increase in the use of back belts by companies attempting to control back injury costs has been seen in recent years. Numerous belt designs are being made available to industry, based on the premise that they reduce the risk of low back pain. Many claims have been made regarding the effectiveness of back belts; however, not many of these have been based on sound scientific evidence. In fact, there is contradictory information on the value of back belts. Some studies have supported the use of belts, while others have suggested that workers would be better advised to refrain from their use. As part of its program to enhance safety for the underground mine worker, the U.S. Bureau of Mines (USBM) has reviewed evidence relating to the effectiveness of back belts and provided some suggestions relating to the use of back belts in the workplace. This paper is largely based on a review of back belt literature by the noted spinal biomechanist S. M. McGill (*11*).[3]

There are several potential benefits and drawbacks associated with wearing back belts that should be considered before a responsible policy can be established. Let us first examine the hypothesized benefits associated with back belt usage and the related scientific evidence.

POTENTIAL BENEFITS OF BACK BELTS

The following list details the major benefits that might be provided by back belts:

1. Decrease the load experienced by the low back.
2. Help to "stiffen" the spine to make it stronger.
3. Restrict spine mobility and prevent hazardous movements.
4. Provide a safety margin by increasing an individual's tolerance to heavy loads.
5. Decrease back injury incidence when used in industrial settings.

The following sections will address the scientific evidence related to these hypothesized benefits.

[1]Research physiologist.
[2]Industrial engineer.
Pittsburgh Research Center, U.S. Bureau of Mines, Pittsburgh, PA.

[3]Italic numbers in parentheses refer to items in the list of references at the end of this paper.

Do back belts decrease the load experienced by the low back?

One of our best methods for establishing the answer to this question is to examine muscle activity. If back belts decrease the load on the low back, we would expect to see a decrease in the electrical activity of the powerful back muscles. However, studies have convincingly shown that there is no difference in back muscle activity when wearing a belt compared with not wearing one (*8, 13*). Thus, back belts do not appear to lessen the load experienced by muscles of the lumbar spine (low back).

Some have hypothesized that back belts help to reduce the load on the low back by increasing intra-abdominal pressure (IAP). Indeed, lifting while wearing a belt does appear to increase IAP (*5, 9*). Years ago, higher IAP was thought to be beneficial by adding supporting forces to the low back (*3, 14*). However, recent data have caused this theory to be reevaluated (*12, 16*). It now appears that increased IAP has little, if any, effect that would decrease the load on the spine.

Do back belts help to stiffen the spine (make it stronger)?

While it is generally believed that increased IAP does not reduce the spinal load, the possibility exists that higher IAP may assist the low back by increasing the stiffness of the spine. Unfortunately, this is a difficult claim to test scientifically. Current thinking is that even if higher IAP does provide some additional stiffness, the advantage gained is probably fairly small (*13, 19*). Thus, at the present time, most back injury experts feel that the justification for wearing belts based on increased IAP is probably not warranted.

Do back belts restrict spine mobility and hazardous movements?

There is evidence to suggest that certain types of belts restrict the amount of side-to-side bending and trunk twisting that a worker can perform (*19*). This may be in part responsible for the reported perception of increased stability of the trunk by wearers. However, belts currently available do not appear to restrict forward bending of the lumbar spine. This appears to be an important exception, because of the fact that the strength of the spine and its ability to tolerate loads are considerably lower when the worker is in a forward bent position (*1*). Furthermore, this posture is associated with increased risk of back injury (*15*). Therefore, while the reduction in side bending and twisting is viewed as generally positive, the fact that current belts do not restrict forward bending means that back belts still allow individuals to subject their spines to hazardous postures.

Do back belts improve an individual's load tolerance?

One possible benefit of back belts is that they might provide a "safety margin" by increasing the tolerance of individuals to heavy loads. However, data from recent studies have indicated that wearing a back belt does not increase an individual's ability to sustain additional loads in forward bending, side bending, or twisting (*19*). Thus, it does not appear that belts provide an additional safety margin by increasing a worker's tolerance to heavy loads.

Does use of back belts in industry decrease the incidence of back injuries?

Several recent studies have been performed that attempted to determine whether belts actually do reduce the incidence of injury (*2, 6, 18, 20*). Unfortunately, the studies performed thus far have been of widely varying quality. Only two back belt studies have been performed that use the method that provides the highest quality data (i.e., prospective studies using matched control groups). These studies were performed by Reddell (*18*) and Walsh (*20*).

The Walsh (*20*) study is the one pointed to most frequently by back belt proponents as evidence of the effectiveness of back belts. The investigators studied 81 workers in an industrial warehouse setting. Results of this study did, in fact, demonstrate a reduction in lost-time back injuries due to use of back belts, but careful scrutiny of the data indicates that the benefit was found *only* among workers who had experienced previous back injuries. No benefit was observed for previously uninjured employees.

The second of these studies examined the effectiveness of back belts, in which 642 airline baggage handlers were observed (*18*). These researchers found no differences in back injury incidence rates between groups using back belts and those not using belts. However, these researchers did discover a disturbing trend. Workers who started the study wearing back belts and dropped out (discontinued use of the belts) had a higher incidence of back injury than any other group. The researchers in this study concluded that back belt use may cause some physical dependency, leaving the back at increased risk when the device is withdrawn.

It is important to note that neither of the studies (*18, 20*) demonstrated that belt use had any benefits for uninjured workers. However, it is noteworthy that belts did seem to help workers who had experienced prior back injuries. This indicates that belts may have some usefulness in the workplace under certain circumstances.

POTENTIAL DRAWBACKS OF BACK BELTS

The following arguments are typical of back belt detractors:

1. Back belts may lead to weakened back muscles (muscle atrophy).
2. Back belt use causes workers to develop a "false sense of security."
3. Increased IAP observed during back belt use may result in adverse physiological changes.

Let us examine the evidence with regard to these issues.

Do back belts cause back muscles to become weaker (atrophy)?

Several studies have examined this issue, and all of these studies seem to agree that back belts do not lead to a decrease in muscle strength, at least over the short term. This is consistent with the observation that back muscle activity is not decreased with belt use, as mentioned above. However, a recent Swedish study suggested that while back belt use does not result in loss of strength, muscular endurance may be decreased with prolonged belt use (*6*).

Do back belts create a false sense of security?

There is some evidence that belts may lead to a false sense of security in workers. As noted above, lifting belts does not appear to increase an individual's load tolerance. However, studies have indicated that workers are willing to lift up to 20% more weight when wearing a belt (*10*). Thus, it appears that workers who use belts appear willing to place higher strain on the back and, in fact, are willing to work at a higher percentage of their maximum load tolerance. Therefore, workers who wear belts may be working with a decreased safety margin with regard to the low back.

Do back belts result in adverse physiological changes?

Back belts do seem to cause certain unwanted physiological changes to occur. The most significant of these is the increase in blood pressure that has been observed when lifting using a belt. Blood pressure has been shown to be elevated almost 15 mm Hg when lifting with a belt (*7*). Any individuals with a history of heart problems or those with significant cardiovascular risk factors should consult a physician prior to donning a back belt. An increase in blood pressure by 15 mm Hg may lead to serious health problems among those with a history of cardiovascular problems.

SUMMARY AND RECOMMENDATIONS

The foregoing information indicates a somewhat mixed bag of evidence—some in support of back belts and some in opposition. Evidence supporting use of back belts includes some restriction in end-range motion of twisting and side bending, clinical evidence of a decrease in lost-time back injuries among those with prior back injuries, and a suggestion of increased trunk stiffness that may be of some benefit. Evidence in opposition of back belt use includes an increased risk of injury upon discontinuing belt use, increased blood pressure, and a false sense of security that may lead workers to overstrain their backs.

This review of the literature indicates that the following approach to use of back belts should be followed (*11*):

1. **Back belts should be treated as a prescription item** and should be provided only to individuals having had a previous back injury. These workers should be weaned from the belts as soon as it is appropriate.
2. **Back belts should *not* be universally distributed to all workers at a worksite**, given the lack of demonstrated effectiveness among uninjured workers and a potential increased risk of injury after discontinuation of use.
3. **Individuals considered for a back belt prescription should be screened for cardiovascular risk** because of the increased blood pressure associated with belt use.
4. **Individuals using back belts should be required to participate in a mandatory exercise program** and should continue in the program after being weaned from the belt during the period of increased back injury risk.
5. **Workers using back belts should be exposed to a mandatory education program** to ensure that the back belts are used properly.
6. **A full ergonomic assessment of the workplace should be performed** to reduce any physical hazards that may increase the incidence of back injuries.

The evidence presented in this paper suggests that back belts have a rather limited role to play in controlling the costs and incidence of back injuries. Reliance on back belts as a sole method of combatting this problem clearly

does not provide an effective solution. Effective back injury control programs tend to emphasize job redesign, where the worker's job is changed to reduce the amount of manual lifting that has to be done (or the lifting that must be done is made easier) (*17*). Methods of job redesign applicable to the mining industry are contained in the USBM Information Circular 9235 (*4*). Employers who are interested in keeping the cost of back injuries down are encouraged to focus on job design as a primary method of injury control, and if back belts are to be used, careful consideration should be given to the factors discussed above.

REFERENCES

1. Adams, M. A., and W. C. Hutton. Mechanics of the Intervertebral Disk. Ch. in The Biology of the Intervertebral Disc, ed. by P. Ghosh. CRC Press, 1988, v. 2, pp. 39-72.

2. Asundi, P., J. L. Purswell, and D. Bowen. Evaluation of Back Belts in the Prevention of Manual Material Handling Injuries. Presented at Low Back Injury Symp., Columbus, OH, Apr. 14-15, 1993; available from S. Gallagher, BuMines, Pittsburgh, PA.

3. Bartelink, D. L. The Role of Abdominal Pressure in Relieving the Pressure on Lumbar Intervertebral Discs. J. Bone Jt. Surg., 1957, v. 39B, pp. 718-725.

4. Gallagher, S., T. G. Bobick, and R. L. Unger. Reducing Back Injuries in Low-Coal Mines: Redesign of Materials-Handling Tasks. BuMines IC 9235, 1990, 33 pp.

5. Harman, E. A., R. M. Rosenstein, P. N. Frykman, and G. A. Nigro. Effects of a Belt on Intra-Abdominal Pressure During Weight Lifting. Med. and Sci. Sports and Exercise, v. 21, No. 2, 1989, pp. 186-190.

6. Holmstrom, E., and U. Moritz. Effects of Lumbar Belts on Trunk Muscle Strength and Endurance: A Follow-up Study of Construction Workers. J. Spinal Disorders, v. 5, No. 3, 1992, pp. 260-266.

7. Hunter, G. R., J. McGuirk, N. Mitrano, P. Pearman, B. Thomas, and R. Arrington. The Effects of a Weight Training Belt on Blood Pressure During Exercise. J. Appl. Sport Sci. Res., v. 3, No. 1, 1989, pp. 13-18.

8. Krag, M. H., K. B. Byrne, L. G. Gilbertson, and L. D. Haugh. Failure of Intra-Abdominal Pressure To Reduce Erector Spinae Loads During Lifting Tasks. Pres. at the N. Am. Congr. on Biomech., Montreal, Canada, 1986, pp. 87-88; available from S. Gallagher, BuMines, Pittsburgh, PA.

9. Lander, J. E., R. L. Simonton, and J. K. F. Giacobbe. The Effectiveness of Weight-Belts During the Squat Exercise. Med. and Sci. Sports and Exercise, v. 22, No. 1, 1990, pp. 117-124.

10. McCoy, M. A., J. J. Congleton, W. L. Johnston, and B. J. Jiang. The Role of Lifting Belts in Manual Lifting. Int. J. Ind. Ergon., v. 2, No. 4, 1988, pp. 259-266.

11. McGill, S. M. Biomechanics and Lifting Belts. Pres. at Low Back Injury Symp., Columbus, OH, Apr. 14-15, 1993; available from S. Gallagher, BuMines, Pittsburgh, PA.

12. McGill, S. M., and R. W. Norman. Reassessment of the Role of Intra-Abdominal Pressure in Spinal Compression. Ergonomics, v. 30, No. 11, 1987, pp. 1565-1588.

13. McGill, S. M., R. W. Norman, and M. T. Sharratt. The Effects of an Abdominal Belt on Trunk Muscle Activity and Intra-Abdominal Pressure During Squat Lifts. Ergonomics, v. 33, No. 2, 1990, pp. 147-160.

14. Morris, J. M., D. B. Lucas, and B. Bresler. Role of the Trunk in Stability of the Spine. J. Bone Jt. Surg., v. 43A, 1961, pp. 327-351.

15. Mundt, D. J., J. L. Kelsey, A. L. Golden, H. Pastides, A. T. Berg, J. Sklar, T. Hosea, and M. M. Panjabi. An Epidemiologic Study of Non-Occupational Lifting as a Risk Factor for Herniated Lumbar Intervertebral Disc. Spine, v. 18, No. 5, 1993, pp. 595-602.

16. Nachemson, A., G. B. J. Andersson, and A. B. Schultz. Valsalva Manoever Biomechanics: Effects on Lumbar Trunk Loads of Elevated Intra-Abdominal Pressure. Spine, v. 11, No. 5, 1986, pp. 476-479.

17. O'Green, J. E., R. H. Peters, and A. B. Cecala. AEP Fuel Supply's Ergonomic Approach to Reducing Back Injuries. Pres. at the 23rd Annu. Inst. Min. Health, Saf. and Res., Blacksburg, VA, 1992, pp. 187-196; available from S. Gallagher, BuMines, Pittsburgh, PA.

18. Reddell, C. R., J. J. Congleton, R. D. Hutchingson, and J. F. Montgomery. An Evaluation of a Weightlifting Belt and Back Injury Prevention Training Class for Airline Baggage Handlers. Appl. Ergon., v. 23, No. 5, 1992, pp. 319-329.

19. Seguin, J., and S. M. McGill. The Effects of Abdominal Belts on Passive Stiffness of the Trunk About Three Axes. Pres. at Hum. Factors Assoc. Canada 25th Annu. Conf., Hamilton, Ontario, Canada, 1992, pp. 67-72; available from S. Gallagher, BuMines, Pittsburgh, PA.

20. Walsh, N. E., and R. K. Schwartz. The Influence of Prophylactic Orthoses on Abdominal Strength and Low Back Injury in the Workplace. Am. J. Phys. Med. & Rehab., v. 69, No. 5, 1990, pp. 245-250.

SPECIAL PUBLICATION 18-94

IMPROVING SAFETY AT SMALL UNDERGROUND MINES

Proceedings: Bureau of Mines Technology Transfer Seminar

Compiled by Robert H. Peters

United States Department of the Interior
Bureau of Mines
1994

U.S. Department of the Interior
Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

Special Publication 18-94

Improving Safety at Small Underground Mines

Compiled by Robert H. Peters

UNITED STATES DEPARTMENT OF THE INTERIOR
Bruce Babbitt, Secretary

BUREAU OF MINES