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Industrial Use of Back Belt for Preventing Low Back Injury : A Literature Review

Yoon Jang-whon, B.H.Sc., R.P.T.
Dept. of Physical Therapy, School of Education, New York University

국문요약

허리부상을 방지하기 위한 허리보호대의 작업현장 사용에 대한 연구 : 문헌고찰

윤장원
뉴욕대학교 대학원 물리치료학과

최근에 작업현장에서 널리 사용되고 있는 허리보호대는 그 예방적 효과에 대한 확실한 검증이 이루어지지 않고 있다. 작업현장에서의 허리보호대의 예방적 효과에 대한 8**편의 생체역학적**(biomechanical) **연구들과** 6**편의 역학적**(epidemiological) **연구들 그리고** 2**편의 종합적 연구들을 비교 정리하였다. 대부분의 생체역학적 연구들은 허리보호대의 기계적 작용과 그에 따른 예방적 효과와의 직접적인 상관관계를 보여주지 못하고 있다. 역학적 연구들은 일관성 없는 결과들을 발표하여 작업현장에서의 허리보호대의 예방적 효과에 대한 연구결과간의 비교를 어렵게 하고 있다. 좀더 확실한 결론을 얻기 위해서 앞으로 작업현장에서의 허리보호대의 예방적 효과에 대한 더 많은 연구가 있어야 할 것이다.**

핵심단어 : 허리보호대; 작업현장; 허리부상.

Introduction

Low back pain occurs frequently, and it is one of the most costly health problems affecting the individual, industry, and society. It is the third most common symptom in general and the second most frequent reason for physician referral. The prevalence of low back pain is very high: 70 90% in life, 20 60% in 1 year, and 1 0 30% at a point (U.S. Department of Health and Human Service). The prevalence rate for low back pain is highest for 35 to 60 years of age group. Total cost related to low back pain is estimated about 20 to 50 billion US dollars per year in the United States (U.S. Department of Health and Human Service). There are numbers of related factors to low back pain at work places: social status, work related physical exertion, handling requirement, prolonged posture, movement into extreme range of motion, repetitious work, vibration, and previous history of back pain. However, the exact injury mechanism of low back at work places is still unclear.

There have been four popular preventive interventions for low back pain: exercise, physical training, use of back belt, and risk factor modification. Worker training, job screening, and ergonomic modification are currently recommended by the national institute of occupational safety and health (U.S. Department of Health and Human Service). Back belt has been a most commonly used nonprescription device in occupational settings. Back belt is also called back support, lumbar support, lumbar orthosis, lumbar corset, and lumbar brace. Its popularity has been significantly increased in various occupations from warehouse workers to pizza deliverers. However, there are controversy regarding this increased use of back belts because neither the mechanism of injury prevention nor the efficacy of back belt for injury prevention has been established. According to the national institute of occupational safety and health, there is conflicting evidence whether back belt is effective for preventing or reducing the impact of low back problems in subjects who performs frequent lifting at work. There has been a variety of studies about the back belt in various approaches. In general, these studies can be classified into two categories: 1) studies in which the potential biomechanical and physiological bases for using back belt have been examined; and 2) studies in which epidemiological methods have been used to examine the efficacy of back belts in preventing injuries in various occupational settings.

The purpose of this review was to summarize and analyze the biomechanical and epidemiological studies on the use of back belts as a personal prophylactic device for the prevention of low back injuries in occupational settings.

Articles Reviewed

The MEDLINE database was searched for all relevant articles published in English between 1966 and 2000. Bibliographies of these articles were reviewed to identify additional citations. Thirty seven articles were identified, and 16 articles (eight biomechanical, six epidemiological, and two review articles) focused on using back belt as a personal protective device from low back pain were critically reviewed.

Biomechanical Studies

Possible preventive mechanisms of mechanical support by prophylactic use of back belt are as follows: 1) providing support of trunk; 2) preventing pain-producing events caused by movement into extreme range of motion; 3) reminding wearers to lift properly; and 4) increasing intra-abdominal pressure, decreasing intra-discal pressure, and reducing the likelihood of disk tears. It is generally believed that the back belt use in workplace may decrease the risk of injury and enhance the functional performance of the individual by increasing lifting capacity and decreasing muscular fatigue. On the other aspect, prolonged use of back belt is thought to be disadvantageous because it leads to trunk muscle weakness.

Reyna and his colleagues (1995) conducted a study to compare the isometric lumbar muscle strength and lifting capacity with and without a back belt with 22 subjects. The functional capacity evaluation was performed by progressively lifting weighted canisters from various levels. Heart rates were monitored to ensure that a maximum effort was achieved over the different test sessions. The isometric lumbar strength and functional lifting capacity were not significantly affected by the use of back belt in their study.

To evaluate the effectiveness of back belts use in preserving the endurance characteristics of the spinal musculature, thirteen male industrial workers were recruited for 4 hours of lifting. The findings revealed no significant differences in maximum isokinetic endurance and in the slope of median frequency when back belt was used. The subject of this study was asked to wear a back belt to perform a lifting task for only 4 hours, which might not be considered as a long-term use of back belt.

Majkowski and his associates (1995) also found no effect of wearing a back belt for the purpose of minimizing lumbar paraspinal muscle fatigue. Thirteen male and eleven female subjects performed a dynamic lifting task at a rate of 10 lifts per minute for 20 minutes with 20% load of their maximum isometric force. Muscular fatigue was indicated by a reduction on median power spectral frequency values of electromyographic data or decrease in isometric lifting force production. There was no significant difference in muscular fatigue. Ten lifts per minute for 20 minutes with 20% load of the maximum isometric force might not be enough for subjects to cause fatigue.

Whether the preservation of endurance characteristics is important in the prevention of low back injuries is unknown. Decreased isokinetic trunk muscle strength in trunk flexion by the use of back belt for an extended periods was observed in the study by Eisinger and her colleagues (1996) with six hospital employees and six matched control subjects. However, there were no statistical differences in concentric flexion, concentric extension, and eccentric extension. The duration of wearing back belt was not clearly reported, and sample size was too size to generalize the result.

Lavender and his colleagues (1995) conducted a study to determine if back belt provided a means for controlling trunk motion during asymmetric material-handling tasks. Sixteen nurses as experienced lifters were recruited and performed two sessions of 42 lifts in various testing conditions. An elastic back belt was worn for a week prior to this study during the subjects' routine work activities. Results indicated that lateral bending and twisting motion were reduced by both use of back belt and foot motion, while trunk motions in the sagittal plane were not affected by the use of back belt. They also found that much of the twisting and lateral bending motion could be eliminated by encouraging foot motion during lifting.

Three different back belt groups (leather weight belt, leather weight belt with a rigid abdominal pad, and elastic abdominal binder) and an unsupported group were compared to determine the effect of back belt on intra-abdominal pressure and lumbar kinetics during heavy lifting by Woodhouse and his colleagues (1995). Nine males participated in four different lifting tasks at 90% of their one-repetition maximum, and intra-abdominal pressures were measured. No statistically significant differences among the three back belt groups and the control groups were found. The authors concluded that the use of back belt did not necessarily provide more protection compared with lifting condition without back belt.

McGill and colleagues (1990) investigated the effect of back belt on reduction of trunk muscle activity and increment in intra-abdominal pressure. Six subjects lifted loads with and without wearing a weight lifters belt under two different breathing conditions. Statistically significant increase in intra-abdominal pressure with wearing the belt under both breathing conditions was observed. There was no significant difference in the electromyographic activities of elector spinae by wearing a belt.

McGorry and Hsiang (1999) investigated the effect of back belt along with breathing technique on trunk and pelvic coordination during lifting tasks. Six participants performed lifting and lowering tasks with a 23 kg load under elastic, rigid, and no belt conditions. Cinematography was used to track trunk and pelvis displacements. Significant differences between lumbar and pelvis phase angles were found during the initial stage of lifting because of the interaction of back belt and breathing. Lumbar range of motion decreased significantly with back belt use during lifting and lowering. It was difficult to make a conclusive statement regarding the effect of back belt on trunk support due to limited and conflicting results. More studies with larger sample size and longer following period will be needed.

Most of these studies failed to demonstrate the direct relationship between the benefits from the use of back belts and the prevention of low back injuries. Lack of standardized procedures and small sample size were also limiting the results to be generalized. Further investigations on these fields will be needed.

Epidemiological Studies

There have been several epidemiological studies to determine the efficacy of back belt use in various occupational settings. Because prevalence is the most significant and strongest measurement for an injury-prevention intervention and the hypothesized biomechanical mechanism of back belts could not be conclusively related to injury prevention, epidemiological studies are more powerful to demonstrate a evidence for or against the use of back belt. Each of studies was characterized by the design of study, workplace setting, sample size, period of study, type of belt used, and outcomes measured.

Randomly selected 90 out of 800 warehouse workers participated in the prospective randomized controlled study by Walsh and Schwartz (1990). Subjects were randomly assigned to three groups: the education and back belt group, education only group, and control group. Over 6 months of study period, 82 participants were able to finish the study. The outcomes measured were pre- and post-abdominal isometric strength, back injury questionnaire, work injury incidence, productivity, and the use of health care services during the study period. The authors found that the education and back belt group missed less work compared with the control group ($p=.03$). Levels of knowledge in the education and back belt group and education only group increased significantly (p=.003, p=.001). No significant differences were found in injury rate and muscle strength loss. They concluded that education and prophylactic use of back belt prevented back injury and reduce time lost from work without adverse effect. They suggested that the back belt might reduce fatigue of abdominal muscle by providing biomechanical assistance to muscle contractions and that wearing of back belt might provide the worker with a reminder to use proper body mechanics after training.

However, the actual days lost at the end of period were not different between control group and education and back belt group (.8 vs .5). The significant decrease in days lost due to low back pain of the education and back belt group compared with the control group could be related to the fact that days lost at the baseline for the control group was quite different than the other groups. Because a back belt only group in this study was not included, it was not clear whether the decrease in days lost due to low back pain of the education and back belt group was affected by the use of back belts or by the interaction between education and use of back belt. Lack of blindness in study design was also a limiting factor of this study, which might affected subjects' expectations and compliance.

Reddell and his associates (1992) investigated lumbar injury incident rate and severity of injuries over an 8-month period in the design of a randomized controlled trial. Six-hundred forty-two (70 female) baggage handlers in a major airline company (American Airlines) were randomly assigned to four groups: belt only group, 1-hour training group, belt and training group, and control group. After 8 months, belt questionnaire, number of lost workday per lumbar injuries, number of restricted workday case lumbar injuries, total workers compensation cost, and injury incident rate were compared among groups by ANOVA-Bonferroni adjustment. There were no significant differences for total lumbar injury incident rate, restricted workday per injury incident rate, lost workdays and restricted workday rate, and worker's compensation rates. There was, however, a marginal significant difference for lost workday per injury incident rate. Participants in back belt wearing groups (58%) who wore the belt for a while then discontinued its use had a higher lost day per injury incident rate compared with either the group receiving training only or the control group. Major complaint was that the belt was to hot. Three skin rashes were reported. They concluded the weight-lifting belt use could not be recommended for use in aid of lifting during daily work activities. Means of actual outcome were not reported in this study. Non-compliance issue might affected results and reduced the power of the study.

Mitchell and his associates (1994) investigated the effectiveness and cost-effectiveness of employer-issued back belt in population of high risk for back injury. A retrospective survey instrument was administered to 1,316 workers who performed lifting activities at Tinker Air Force Base. The authors found that the previous back problem and the amount of weight lifted per day were highly related factors to back injury. Without controlling for confounding factors regarding back belt use at the time of back injury during the study period, there was no correlation between the back belt use and the prevention of back injury. Use of back belts suggested a marginally protective effect (odd ratio=.60, p=.0508) when controlling for other pertinent related factors. However, costs of injury while wearing a back belt were substantially higher. The results of this study had a limitation such as a recall bias in relation to the nature of retrospective survey design. It was not clearly reported why the cost of treatment especially in specialist referral with the injured workers using belts was higher than those who did not use belts.

Alexander and his colleagues (1995) investigated the efficacy of back belts in reducing back injuries and improving employee perception of physical well-being. For 3 months, 60 workers (12 male and 48 female) in nursing and environmental services were participated, and they were randomly assigned to either back belt group or control group. Pre- and post-psychophysical questionnaire and work-related back injuries were compared. There were no statistically significant differences in the number of self-reported work-related back injuries between the two groups (p=.533) and in perceived pain between two groups during the test period. However, 100% of the back belt group felt the back belts provided additional support. Ninety-seven percent believed belts promoted awareness of proper lifting techniques; 97% said they would continue to wear after the study because belts made them "feel good." Positive effect by wearing back belt was emphasized. The number of self-reported work-related back injuries might not be a sensitive variable enough to capture the efficacy of back belts (Alexander et al, 1995).

Historical cohort study by reviewing medical record of 36,000 Home Depot workers for 6 years was conducted by Kraus and his associates (1996) to determine the effect of a change in back belt group on the occurrence of work-related low back injuries. Acute low back injuries at work, incident density rate/1,000,000 work hours, incident density rate ratio, amount of protection, and prevented fraction (%) were compared by use of back belt, exposure risk hours, and lifting intensity. Overall low back injury was 21.5/million hours. Higher rates were seen at male group and under 25 years of age group. Low back incident density rate/million hours of control group was 1.52 times higher than the group wearing back belt (p<.0001). Wearing back belt was effective in male, under 25 years of age group, and over 55 years of age group. Those whose jobs had low lifting requirements and who did not use back belt recorded a rate of low back injuries that was 4.2 times higher than the experimental group. The authors concluded that a back belt group reduced back injuries, and the results did not indicat that the use of back belt was harmful to any of the age groups. Statistical significance was not reported in outcome tables (Kraus et al, 1996).

Most recently, Van Poppel and his colleagues (1998) attempted a randomized controlled trial with factorial design in 1998. Randomly selected 312 airline cargo workers were assigned to four groups: education and back belt, education, back belt, and control groups. After 6 months of study period, 282 participants were followed up. The low back pain incidence, sick leave due to LBP in 6 months, and endurance and strength of abdominal and back muscles were compared. Compliance with wearing the back belt at least half the time was 43% overall. There were no statistically significant differences in low back pain incidence (p=.81) or in sick leave per month because of low back pain (p=.52) by wearing the back belt. For the subjects with low back pain at baseline, a reduction in the number of days with low back pain was found in the group with back belt compared with the group without back belt (p=.03). No effects of back belts on trunk muscle strength were reported, which indicates the use of back belts would not cause atrophy of trunk muscles. No increase in the incidence of back pain was found after complied participants discontinued wearing back belts. The authors concluded that back belt or education did not lead to a reduction in low back pain incidence or sick leave, therefore, the use of education or lumbar supports could not be recommended in the prevention of low back pain in industry. It was a well designed study, however, the number of days per month of sick leave and the number of days per month with low back pain might not be sensitive enough to detect the efficacy of interventions since the median values were zero in all groups. Lack of blinding and randomization in a given occupational setting might limit the generality of these results (Van Poppel et al, 1998).

None of any two epidemiological studies had used same methodology. It was difficult to make direct comparisons. There was conflicting evidence to make a conclusive statement on the efficacy of back belts on preventing low back injury in occupational setting based on these epidemiological studies. Although a randomized controlled trial would have been a research design of choice, the nature of most businesses prohibited randomized trials. Type of belt and the way of wearing belt might also be critical.

Review Articles

Two articles were found to be reviewed. Lahad and colleagues studied the effectiveness of four interventions for the prevention of low back pain. Four interventions were back and aerobic exercises, education, mechanical support, and risk factor modification. They concluded that it was currently insufficient to make a recommendation about the use of orthotic devices for back pain prevention. Smoking cessation, weight loss, and attention to psychological risk factors were suggested.

More recently, Kaplansky and his colleagues (1998) summarized the studies on education and training: exercise, ergonomics, risk factor modification, worker selection, and orthosis. Intra-abdominal pressure did not play a significant role in reducing load on spine and supporting back and abdominal muscle. Furthermore, lumbar corset did not have a significant effect on intra-abdominal pressure. No adverse effect was found on abdominal muscle strength. Increased worker complaints from wearing lumbar orthosis, attempting to lift more weight, and in- creased systolic blood pressure and heart rate were reported. They concluded that the efficacy of back belts in workplace was limited but that no adverse effect was proven (Kaplansky et al, 1998).

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