Effectiveness of a Back School Program in the Application of Body Mechanics Principles

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***Background*: Low back pain is one of the most frequent work related injuries in all occupations. Back school programs are therapeutic interventions directed towards treatment, prevention and rehabilitation of backaches. The purpose of this study was to 1) evaluate the test-retest reliability of the modified version of the Body Mechanics Evaluation Checklist (BMEC) and 2) examine the effectiveness of a back school program in terms of application of body mechanics during a lifting task.**

***Methods*: A sample of 12 participants from a public corporation in Puerto Rico was selected to participate in a back school program. The modified and translated version of the American Back School Posttest and the modified version of the Body Mechanics Evaluation Checklist were used to evaluate the theoretical and practical component of the back school program. The test-retest reliability of the BMEC was obtained through the intraclass correlation coefficient (ICC [3,1]). For pre/post assessment, a single factor repeated measures MANOVA was conducted to asses the effect of the intervention.**

***Results*: The test-retest reliability of the modified version of the BMEC was 0.84. The single factor repeated measures MANOVA revealed significant differences between pre-test and post-test ($p < .0001$) scores.**

***Conclusions*: This study demonstrated that the modified version of the BMEC is a reliable instrument to evaluate a lifting activity. It was also demonstrated that the back school program served as an effective educational intervention that promotes short-term changes in the body mechanics of back-injured working adults in Puerto Rico.**

Key words: Back pain, Patient education, Intraclass correlation coefficient

Low back pain is one of the most frequent work related injuries involving all occupations in which workers are exposed to inadequate postures, lifting activities, heavy weight loads (objects), and repetitive activities (1-8). It has been estimated that 60-80% of the adult population in the United States will experience one episode of low back pain at least once in their lifetime (8-10). In Puerto Rico, during fiscal year 2005-2006, the Workers Compensation Corporation of Puerto Rico ("Corporación del Fondo del Seguro del Estado de Puerto Rico"), informed that the total number of working related low back and neck injuries approximated 20% and 14%, respectively (11).

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The National Institute of Neurological Disorders and Stroke suggests that a combination of low or moderate exercise, maintenance of a correct posture, and use of adequate techniques during lifting activities can contribute towards prevention of low back injuries and/or reduction of their complications (12). Back school programs are therapeutic interventions mainly offered by physical therapists, and directed towards treatment, prevention and rehabilitation of backaches (1, 4-5, 13-14). These programs are focused on secondary prevention and/or recurrence of low back and neck injuries in order to help the injured worker create a level of responsibility regarding the health of their own spine (11). Patient education in areas such as body mechanics and lifting techniques has proven to reduce the recurrence of low back injuries in the work place (1, 3-4, 15-17).

The evaluation of the practical component of back school programs offered by public corporations is a necessary mechanism to evaluate the effect these programs have on their participants. The objective of this study were to: 1) evaluate the test-retest reliability of the modified version of the Body Mechanics Evaluation Checklist (BMEC) and 2) examine the effect of the back school program

in terms of application of body mechanic principles explained and demonstrated by a physical therapist in a public corporation. The hypotheses of this study were: 1) that the test-retest reliability of the modified version of the BMEC would be greater than 0.75 (18) and 2) that injured workers participating in a back school program would exhibit improvements in general back health awareness and body mechanics during a lifting task.

Methods

The Spanish version of the American Back School Posttest (ABSPT) was used to measure the theoretical component learned from the back school program (5, 15-16, 19). This test consists of nine multiple-choice items, and three true or false questions (5, 15-16, 19). Content and construct validity of the original instrument has been previously established and reported elsewhere (19). This instrument was refined during a pilot study. A panel of experts assessed face and content validity for the Spanish language version. The panel of experts was integrated by two physical therapists with more than 20 years of experience in the development and administration of back school programs and a linguist with 26 years of experience. After face and content validity were established, the investigators evaluated the instrument's language clarity by inviting ten individuals similar to possible study participants. This group of participants did not participate in the intervention phase. Patients participating in the pilot phase reviewed the test individually, and searched for vocabulary words that created doubts or confusions. A total of nine out of ten (90%) interviewed patients agreed on substituting the word trunk for back. No other modifications were suggested, and a final version was established for testing.

The modified version of the BMEC was selected to assess the practical component of body mechanics (3). This instrument allows for the evaluation of 16 criteria related to body mechanics. The evaluated areas are lifting (6 items), transferring (4 items), and lowering of an object (6 items) criteria. Bending of hips and knees simultaneously, maintaining the object close to the body, and no bending or rotating the trunk were among the most relevant criteria for each of the three areas evaluated. The evaluation of the lifting activity was performed by assigning a score of one point if the criterion was successfully met, and a score of zero points if it was not met (3). To determine the day-to-day test-retest reliability of the modified version of the BMEC, a second pilot study was conducted. During this second pilot phase, 14 individuals with characteristics similar to possible study participants were randomly selected. During this phase, participants completed a lifting activity in two different occasions, two days apart. The activity consisted of lifting a card box from the floor; transferring the box to a table, and lowering the empty cardboard box back to the floor. This pilot phase also provided a practice opportunity for the physical therapist serving as evaluator. The participants of this second pilot (n = 14) did not take part on subsequent study phases.

During the final phase of the study, 12 participants (5 men and 7 women; age: 25-55 years) were conveniently selected from the back-injured worker's compensation patient population of the public corporation in Puerto Rico to assess the effectiveness of the back school program. Participants had different medical diagnosis, and diverse occupations such as: secretaries, office workers, messengers, engineers, distributors, janitors and housekeepers. At the moment of the study, all participants were simultaneously receiving physical rehabilitation services at the department of physical therapy under the public workers' compensation system. Just one of the 12 participants was actively working during the investigation. The inclusion criterion for participation was being older than 18 years of age. Participants were excluded if: 1) were younger than 18 years of age, and 2) had previously participated in a back school program.

Each participant read and signed an informed consent document prior to participation in the back school program. Participants of the back school program completed the Spanish version of the ABSPT and the physical therapist evaluated the lifting activity using the BMEC at baseline. The participants completed the ABSP during the first 15 minutes. Study personnel supervised completion of the self-administered questionnaire. After completion of the ABSPT, each participant was directed to an annexed hall. At this location, a physical therapist evaluated each participant's lifting activities using the BMEC. During this activity, the participant had to follow these verbal commands: "Lift the cardboard box that is placed on the floor in front of you with your arms, and place it on the table that is to your right side. Make a pause. Then, place the box in the same place where you lifted it from initially." The measures of the cardboard box were: 44.45 cm in width and length and 26.67 cm in height. The office desk measured 76.2 cm in height, and was located at a distance of 60.96 cm to the right of the participant. The back school program began once both pretest tasks were completed. The back school class was carried out on a two-hour period, in which the instructor integrated strategies such as conference and demonstration.

The class included topics on: anatomy and biomechanics, positioning, ergonomics, body mechanics, activities of daily living, and sexuality. The physical therapist used

diverse visual materials and aids in order to facilitate the discussion and explanation of these topics. The instructor clarified doubts and maintained active participation during the conference. Once the conference finalized, the participants completed the posttest similar to the pretest. Additionally, the physical therapist offered feedback to participants during performance of the lifting activity, and after scoring on the BMEC of the posttest as required by the back school program. The feedback was given verbally, emphasizing individual difficulties and reinforced during a final demonstration by the evaluator. As a last component, participants were given written educational material discussed during the program conference.

Data analysis

Data analyses were divided into two phases. First, a within session repeated measures analysis of variance (rmANOVA) was used to obtain the intraclass correlation coefficient (ICC [3,1]) and establish the test-retest reliability of the modified version of the BMEC. The Standard Error of Measurement (SEM) for the BMEC was determined by using the following formula: standard deviation ($\sqrt{}$1.0-ICC). Criteria established by Portney and Watkins was used to evaluate and interpret the reliability results (18). This criterion considers an ICC greater than 0.75 as good, between 0.74 and 0.50 as moderate and lower than 0.49 as poor. Screening procedures, including histograms and homoscedasticity and normality assumptions were considered and carried out to verify for ANOVA's assumptions for all variables. To evaluate the effectiveness of the intervention in terms of knowledge and practice, a one factor repeated measures multivariate analysis of variance (rmMANOVA) was conducted, using time as the repeated measures factor with *a priori* alpha level of .05. Follow-up univariate analyses of variance with corrected alpha level at .025 were considered appropriate. Power (1 -β) and effects size (ES) were also calculated for statistically significant variables.

Results

The test-retest reliability for the modified version of the BMEC yielded an ICC of 0.84, and a SEM of 0.93 points. The screening analysis showed that all variables met ANOVA assumptions. The rmMANOVA revealed a significant pre/post difference in scores ($F_{2,10}$=40.01; p<0.0001, ES: 0.89, 1-β: 1.0), with significantly higher scores after the intervention (Figure 1). Follow-up ANOVAs revealed improved performance for both, the American Back School Posttest ($F_{1,11}$=81.27; p<0.0001, ES: .88, 1-β: 1.0) and the BMEC ($F_{1,11}$=20.70; p=0.001, ES: .65, 1-β: 0.99) after the back school program.

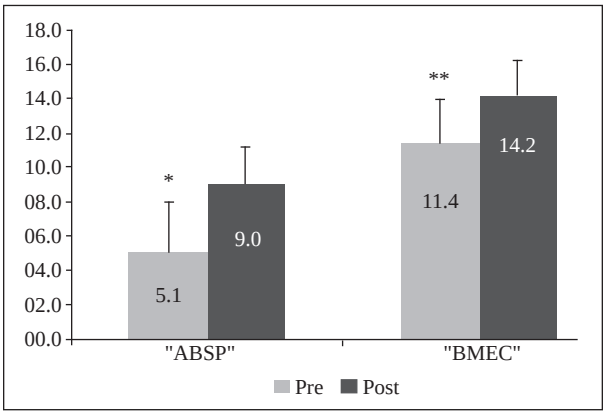

Figure 1. Pretest and posttest ANOVA results for the ABSP (American Back School Posttest) and BMEC (Body Mechanics Evaluation Checklist); *ABSP=($F_{1,11}$=81.27; p<0.0001, ES:0.88, β:1.0); **BMEC=($F_{1,11}$=20.70; p=0.001, ES:.65, β:0.99).

Discussion

The findings from this investigation supported both alternate hypotheses. First, the BMEC instrument exhibited good day-to-day stability as an assessment tool for evaluating the application of appropriate body mechanics during a lifting activity. Based on the procedures followed in this investigation, and in order to maintain the reliability of this instrument, it is highly recommended that it be administered by a physical therapist, trained and familiarized with the instrument. For this reason, the reliability results of the BMEC cannot be generalized to the population of all physical therapists, unless trained in such instrument. Secondly, the back school program produced significant changes in the cognitive and motor behavior in injured adult workers (3, 5). However, later consideration of learned techniques regarding body mechanics during daily and labor activities may or may not be considered by patients (20). Therefore, long-term follow-up and treatment effectiveness could not be pursued by the present study.

An increase in body mechanics knowledge not only can diminish the possibility of recurrence of injuries, but can also contribute to decreasing labor absenteeism, which can result in a cost-effective practice for industries and organizations (2, 4, 5, 21-22). Unlike other studies (15-16), this investigation demonstrated the importance of evaluating the application of body mechanics techniques taught during the program through practice strategies. This study considered a practical component by allowing participants to perform a lifting activity requiring the application of body mechanics principles learned during the back school (2-4, 17). The results

of the Body Mechanics Evaluation Checklist indicated that participants, in addition to obtaining and retaining the information acquired through conferences and demonstrations, correctly applied appropriate body mechanics when performing a lifting activity. The results obtained in this study showed that an increase in body mechanics knowledge and the capacity of the participants to incorporate safe movement patterns when lifting objects is possible. Consequently, it was demonstrated that humans may retain information about body mechanics and may adopt alternating movements, which through practice could be expected to become automatic during the performance of physical activities (23-24).

The results of this investigation not only revealed statistically significant differences, but also reflected a clinically significant difference. The difference resulting from the intervention and after completion of the lifting activity reflected a change in scores that exceeded the Standard Error of Measurement (SEM) for this instrument (.93 points). During this study, changes in the average scores were greater than the pre-established SEM (pretest: 11, posttest: 14). This implies that scores obtained by participants' were outside the deviations of scores established by the range of error (18, 25). Consequently, these changes are considered to be clinically significant and can be interpreted as true change of behavior in the participants performance (18, 25). Therefore, this change can be ascribed to the back school program intervention and not to the error of the instrument or the evaluator.

This study suggests that the combination of several education methods is effective in increasing knowledge and application of body mechanic principles. In addition, the incorporation of a lifting activity to the back school program within this study acted upon enrichment and enhancement of knowledge about body mechanics in injured adults. Healthcare professionals working with injured workers can use educational strategies similar to those considered in this investigation to assist in clinical decision-making, and to design programs with interventions for injured workers that require education and practice in areas such as materials' handling and lifting techniques. Providing patients with an integrated program that may include conferences, demonstrations and written educational material during the educational process or during the education of new techniques can prove to be more efficient (1, 5-6). Taking these educational strategies into consideration can also prove to be useful to physical therapists during the education of patients in areas such as anatomy and correct use of the body through body mechanics. Notwithstanding, the additional time needed to conduct this type of comprehensive education is beneficial in terms of reduction of future sessions of treatment and prevention of recurrence of these types of injuries, outweighing the costs. This type of intervention can in the long run become more cost-effective than simply offering educational material that the patient may not read and/or study at all. It is known that education is an indispensable part of a patient's rehabilitation given that it promotes healthful behavior and supports the return of the patient to an efficient operation (24, 26). Hence, education and training in body mechanic techniques allows the patient to become proactive in regards to their rehabilitation and to take responsibility for their own care, two points of great clinical implication, especially during physical therapy practice.

The results from this study should be evaluated in light of its limitations. It is important to mention that participants were not randomly selected; thus, results cannot be generalized to the population of back-injured adults in Puerto Rico. It is highly recommended to evaluate the clinical relevance and impact of back school programs in larger clinical trials. Also, participants did not have a period to practice the lifting activity due to time restrictions. In addition, the participants were not allowed to repeat the activity even if errors were perceived. Another limitation that should be mentioned is the fact that the physical therapist who offered the back school program conference was also the therapist that later evaluated the participants during the lifting activity, leaving space for a possible bias effect. The model (3,1) used to estimate the ICC for the modified version of the BMEC does not allow generalization to a population of physical therapists different from the one in this study. Therefore, it would be necessary to re-evaluate the instrument's intertester reliability to be able to generalize to multiple evaluators. Lastly, the use of an empty cardboard box as a load object could have influenced the patients' performance during the lifting activity. The use of an empty box was considered a protection strategy to avoid symptoms exacerbation. As part of the recommendations for future investigations, we suggest a long-term re-evaluation in view of the fact that this will allow the clinicians to determinate if participants continued applying the knowledge acquired during the back school program. In addition, adaptation of practice activities to the specific areas of participants' occupations could allow for integration and application of knowledge specific to the area of work. These recommendations can greatly influence the reduction of injury recurrence, labor absenteeism, and the transmission of knowledge to colleagues and relatives as well. It can also be valuable to include variation of weight of the box used during the lifting activity as a comparison criterion of performance in future studies. Weight variation can prove to be a good indicator of the application of body mechanics techniques

during changeable environments (6). Likewise, it would be advantageous to consider healthy non-injured adults with similar occupations to the injured participants in order to determine if an association between suffering a back injury and faulty body mechanics exists. This type of study may suggest that educational interventions such as this can be offered as a primary prevention alternative, and to evaluate its cost effectiveness. It can be of great benefit for large and small companies to implement programs of primary prevention as recruitment requirements, so that employees are educated and oriented about risk factors and injury prevention through body mechanic techniques.

Conclusion

This study demonstrated that the modified version of the Body Mechanics Evaluation Checklist is a reliable instrument for the evaluation of knowledge and application of body mechanic techniques during activities that require lifting, transferring, and lowering an object using pre-established criteria. At the same time, it evidenced that the back school program serves as an effective educational intervention in the production of behavioral changes in terms of application of body mechanics principles, recognition of risk factors, and prevention techniques in adults. However, to make possible generalizations to the worker's compensation with low back injuries population, the effectiveness of back school programs on body mechanics should be evaluated in larger clinical trials.

Resumen

El dolor de espalda baja es una de las lesiones más frecuentes en los trabajadores. Los programas de escuelas de espalda son intervenciones terapéuticas dirigidas a la prevención y rehabilitación de estas lesiones. El propósito de este estudio fue: 1) evaluar la confiabilidad de la hoja de cotejo para la evaluación de mecánica corporal y 2) examinar la efectividad del programa de escuela de espalda en la aplicación de mecánica corporal durante una tarea de levantamiento. Una muestra de 12 participantes lesionados de la espalda baja fueron seleccionados de una corporación pública. La versión en español de la prueba norteamericana de la escuela de espalda y la hoja de cotejo de evaluación de mecánica corporal fueron utilizadas para evaluar los componentes prácticos y teóricos aprendidos en el programa. La confiabilidad prueba-reprueba entre días fue obtenida a través del coeficiente de correlación entreclases [3,1]. Para la evalución antes y después del tratamiento se efectuó un análisis multivariado de varianza (MANOVA) de medidas repetidas con un factor. La confiabilidad de la hoja de cotejo de evaluación de mecánica corporal fue de 0.84. La prueba de MANOVA reveló diferencias significativas desde el punto de vista estadístico entre las medidas antes y después de la intervención ($p < .0001$). Este estudio demostró que la hoja de cotejo de mecánica corporal es un instrumento confiable para evaluar la mecánica corporal durante una actividad de levantamiento. Además, se demostró que el programa de escuela de espalda promovió cambios significativos en la mecánica corporal de trabajadores con dolor de espalda baja en Puerto Rico.

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