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Minimizing Musculoskeletal Injury Risk in Health Care Professionals with Education on Safe Patient Handling

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Introduction

Musculoskeletal injuries can range in severity and location, with low back pain being one of the most prevalent conditions.[1] According to the Global Burden of Disease report, there is a global prevalence rate of 9.4%.[1] Approximately 50-85% of the united states population suffers from low back pain at one point in their lifetime.[2-9] Health care workers, including nurses, are at a higher risk for low back pain and other musculoskeletal injuries due to the strenuous and higher loads of their occupational tasks.[4,6,10,11] For this reason, it is essential to examine these occupational tasks and determine ways that would best benefit the health care workers and prevent injuries. The primary aim of this study was to assess if teaching proper body mechanics and the dangers of improper patient handling could decrease the risk of musculoskeletal symptoms. To begin, I will discuss the musculoskeletal structures associated with the spine, spinal pathologies common with patient handling occupational tasks, and spinal loading considerations will be examined. An overview of the prevalence of low back pain, outcomes of low back pain, interventions for decreasing the risk of spine injuries, and interprofessional relationships that are key to reduce work-related injuries of the spine in health care workers will be provided.

Spinal structure and function

The vertebral column is composed of seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae, five fused sacral vertebrae, and five coccygeal vertebrae. This structure supports the body's peripheral limbs, protects the spinal cord, and provides attachment sites for major muscle groups.[12]

The spine is the central axis of the body and supports the head, along with transferring the upper body's weight to the lower body.[12] The unique joints of the spine allow for rotation of the trunk, flexion and extension, and lateral flexion.[12,13] Between each of the cervical, thoracic and lumbar vertebrae, there are fibrocartilaginous structures called intervertebral discs composed of an inner nucleus pulposus and outer annulus fibrosus. The intervertebral discs provide cushioning between the vertebrae. The spine also exhibits with natural curvatures that include a lordotic, anterior convex, curve for the cervical spine, a kyphotic, posterior convex, curve for the thoracic spine, and then another lordotic curve for the lumbar spine (Figure 1).[12]

The intervertebral discs and natural curvatures of the spine function to absorb shock and distribute forces. The closer the spine is to its neutral position, or the position in which all of the curves are present, the less stiffness the spine exhibits.[14] Stiffening of the spine in this sense is not pathological but to provide spinal stability. The spine also allows for a place for muscle attachments, as well as an articulation point in the thoracic region for the ribs.[12-13]

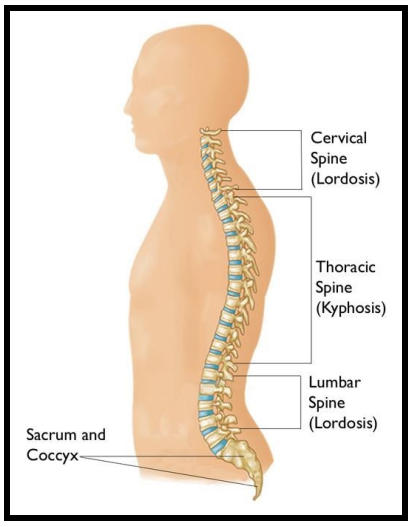

Figure 1. Natural curvatures of the spine.[15]

Muscles

The muscles of the spine are separated into two layers: the intrinsic and extrinsic muscles.[12,13] The intrinsic back muscles are further divided into superficial and deep.[13] The superficial layer of the intrinsic back muscles includes the erector spinae muscles: iliocostalis, longissimus, and spinalis.[12,13] These muscles span the entire length of the spine from the occiput to the sacrum and are essential in extending the trunk and maintaining the spine's natural curvatures.[12,13] Deep to the erector spinae muscle are the transversospinalis muscles including the multifidus, rotatores, and semispinalis.[12,13] The transversospinalis muscles run longitudinally and obliquely across the back and and contribute to the movement of the spine.[12,13] These muscles are essential for providing dynamic stability of the spine.[13] Finally, the extrinsic muscles of the back include the trapezius, latissimus dorsi, serratus posterior superior, serratus posterior inferior, and more. These superficial muscles aid in the movement of the upper limbs, scapula, humerus, and the ribs.[12] The following section provides more information about additional musculature that is vital to maintaining the health of the lower back.

Core musculature

Key core musculature essential for providing trunk stabilization includes the transversus abdominus, multifidus of the aforementioned transversospinalis group, and muscles of the pelvic floor (Figure 2). The transverse abdominis (TA), the deepest of the abdominal muscles, is a broad sheet-like muscle that expands across the abdominal wall with attachments to the lumbar vertebrae via the thoracolumbar fascia, the pelvis, and the rib cage (Figure 2).[14] Due to the horizontal pattern of the muscle fibers, the

muscle is not significantly involved in the movement of the spine, but the TA does modulate the intra-abdominal pressure and assist with spinal stability through the tensing of the thoracolumbar fascia.[14] There is also a positive correlation between intra-abdominal pressure and spinal stiffness, meaning that the TA could impact spinal stiffness through its effect on intra-abdominal pressure.[14] The TA is activated voluntarily by the abdominal draw-in method, in which the abdomen is pulled in toward the spine. The abdominal draw-in method provides spinal segmental stability and assists with maintaining the spine within its neutral zone.[16]

The multifidus, another essential muscle that provides trunk stability, has five fascicles that come from the spinous process and lamina of each lumbar vertebrae and descend in a postero-lateral direction (Figure 2).[14,16] These fibers will either attach to the ilia and sacrum or the mamillary process and facet joint capsule.[14] The multifidus controls intervertebral motion by generating intervertebral compression through activation of the deeper muscle fibers.[14] Due to a large number of fibers in such a small area, the multifidus can create forces, ideal for a stabilizing muscle.[8]

The pelvic floor muscles are the only transverse load-bearing muscles in the body and connect the pubis to the tailbone and the ischial tuberosities (Figure 2).[9] These muscles support the abdomino-pelvic organs and thus function in creating, maintaining, and increasing intra-abdominal pressure while performing functional tasks, such as lifting, laughing, coughing, and the Valsalva maneuver.[7,9] The pelvic floor muscles, the deep fibers of the multifidus, and the TA are typically activated as part of an anticipatory response to trunk perturbation to prepare the lower back and core for an expected amount of compression and trunk loading.[7,14,16]

Altogether, when these core muscles function normally, they can provide spinal stability, protect the spine, and decrease the amount of stress that impacts the lumbar vertebrae and intervertebral discs.[7,8,14,16] Without these muscles, the lumbar spine is capable of buckling failure with compression loads of as little as 90N.[14] Considering most patient handling tasks are near 3000N at least, these muscles are the body's greatest defense against back injuries.

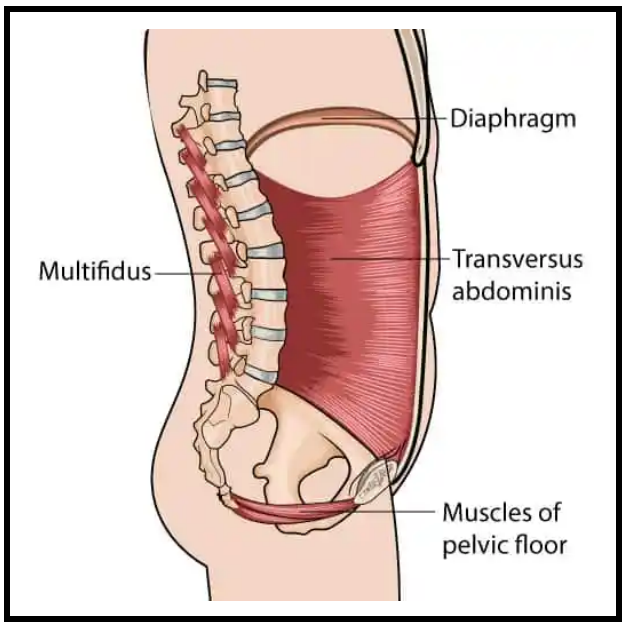

Figure 2. The muscles of the core.[17]

Pathology of spinal musculoskeletal structures

One of the major disorders of the back is low back pain. Low back pain refers to pain on the dorsal side of the trunk that is usually between the costal margin and the gluteal curve.[2] Inflammatory responses, degenerative conditions, trauma, or other disorders can cause low back pain.[4] Additionally, deficits in muscle endurance, insufficient recruitment, or altered motor control of the deep trunk muscles, such as the

transverse abdominis, the multifidus, and the pelvic floor muscles can contribute to pathology of the spine.[7,16] This lack of motor control can lead to decreased function in these muscles resulting in trunk instability, and therefore the inability of the spinal structures to withstand typical occupational loads.[7,9,16] Typically in low back pain, the deep muscles are the ones that become impaired; the activity of these muscles is delayed, more phasic, and are no longer independent of the superficial muscles.[14]

At a musculoskeletal level, evidence suggests hypoactivity of the multifidus and the transverse abdominis is a cofactor of individuals with chronic low back pain.[14] The hypoactivity of these muscles is not completely understood although across a group of studies looking at the activity of different muscles the TA and multifidus were consistently hypoactive in individuals with chronic low back pain.[14] Arab et al[7] reported similar results with the pelvic floor muscle when using a transabdominal ultrasound to measure the amount of pelvic floor function in women with or without low back pain. The women with low back pain had statistically lower pelvic floor function than those women without low back pain.[7] Studies have also reported that in as little as 24 hours after the onset of low back pain, changes in muscle fiber composition, increased fatigability, and a reduced cross-sectional area were observed.[8,14] Atrophy of the multifidus and limited activation can lead to fat deposits within the muscle; this has been strongly associated with low back pain in adults (Figure 3).[8] Freeman et al[8] used a grading system developed by Kader for multifidus atrophy; mild atrophy is less than 10% of the cross-sectional area has fat deposits, moderate is more than 10%, but less than 50%, and severe is more than 50%. Therefore, individuals with low back pain have

characteristically different muscle fibers, and these effects can be seen almost immediately after onset in some cases.

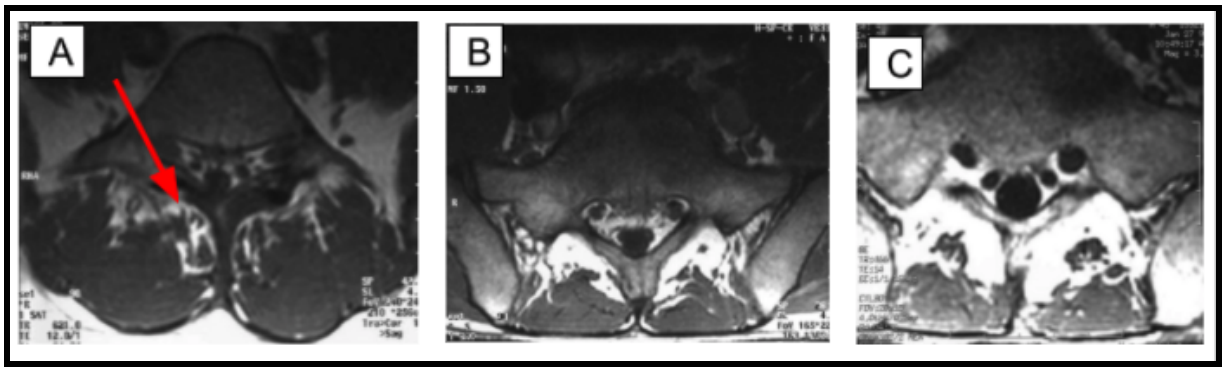

Figure 3. The red arrow is pointing to the white spots within the muscle that are the fat deposits. MRI A shows a mild case of multifidus atrophy. MRI B is a moderate case and MRI C is a severe case of multifidus atrophy.[8]

Factors associated with low back pain

Low back pain is one of the leading causes of work absenteeism and activity limitation worldwide and can cause economic problems for both the individual and the industries.[2,18,19] The National Institute of Occupational Safety and Health (NIOSH) estimated that the cost associated with musculoskeletal injuries in health care workers alone was $7.4 billion annually.[20] In a study conducted by Madani et al[21] the participants stated that the lower back was the most painful part of the body. Many factors can contribute to low back pain: age, sex, arthritis, personnel not trained in or not using good body mechanics, previous back injuries, physical demand at work, and more. In the healthcare setting, improper patient handling and the tasks associated with these skills have been considered as significant risk factors for low back pain.[6,10,11] Anderson et al[11] found that after adjusting for lifestyle and other work-related factors, 1-2 transfers per day can increase the risk for back injury by 66%. Nurses are also frequently lifting

heavier loads, for more extended periods, with awkward postures which creates a harsh demand on the low back.[3-5,10,22]

The American National Institute of Occupational Safety and Health created an recommended safety limit of 3400N for lower back compression or lifting a maximum of 35 pounds, although many of the tasks that the nurses perform exceed these limits.[10,11,23-27] This safety limit of 3400N is the amount of compression the body can handle without permanent stress on the spine. The American National Institute of Occupational Safety and Health also gives a maximum recommendation of 6400N. The individual must also take into consideration the position that their body is in during these tasks because that also has a factor in the amount of stress the low back is receiving.

Spinal loading during awkward postures

The combination of awkward postures, such as extreme flexion, twisting, or lateral flexion, external loads, and the frequency and duration of the high-risk tasks often performed by nurses, can represent some of the most significant loads that the spine receives.[3,10,20,27] In the general and ICU wards, nurses spend 65.6% and 58.7% of their time respectively, flexed (≥45°) in the sagittal plane.[3] Trunk flexion angle ≥45° can generate enough pressure at the level of L4-L5, the compression loads can either meet or exceed the NIOSH recommended limit of 3400N. Even more, if these nurses were at approximately 70° holding 20kg, this could increase their intradiscal pressure at the level of L4-L5 by up to 230%.[3,28] Marras et al[28] found that 52% of the patient transfers performed by one person in their study exceeded the maximum compression limit of 6400N. Compression forces this high can put the nurses at risk for severe back injuries.

Prevalence of low back pain in nurses

Studies have reported that between 30-60% of nurses in the hospital setting will experience low back pain during their career.[2-9] Nursing is considered a high-risk occupation for low back pain and has similar prevalence rates to industrial workers.[2,3,11,20,25,27-30]

According to Marras et al[28] nurses' aids accounted for 3.6 per 100 workers' compensation claims due to back injuries, a rate higher than material handlers and construction workers. In a study conducted by Abolfotouh et al[31], 54.3% of the nurses included in the study reported experiencing low back pain for at least one day in the past 12 months. Aslam et al[20] reported similar prevalence rates in critical care nurses noting that nurses in this setting are lifting three tons per day. The authors conclude that this stress, in terms of frequency and load, is the primary reason that 52% of nurses have low back pain.[20] Nursing assistants have presented with a 12-fold higher risk of work-related musculoskeletal injury compared to other occupations.[19] Researchers have found that low back pain is more prevalent in ICU nurses and nurses' aides, followed by surgical nurses, with the lowest prevalence in outpatient nurses.[4,5,28] This phenomenon is most likely due to patients in the ICU being more dependent than in other wards and the nursing aides doing more of the patient-handling tasks.

Evidence suggests that as the nurses' experience and age increased, there was a decline in the rate of patient handling injuries.[5,19,26] This is most likely due to continuing education on safe body mechanics during patient lifting. Although, even with a decline in

injuries, these nurses are still at risk and the outcomes associated with low back pain can be detrimental to them.

Outcomes of low back pain

Amaro et al[19] stated that lumbar strain injuries were one of the most frequent injuries, 17.5%, and were responsible for a prolonged absence from work. Employees with lumbar strain miss an average of fourteen days per incident for a total combined 4537 lost workdays for healthcare workers performing patient handling tasks.[19] Although if an individual experiences a spinal strain injury, not just of the lumbar region, there is a 5-fold increase of work absenteeism durations of 20 days per incident.[19] These musculoskeletal injuries have caused individuals to lose their job, have overall limited mobility, lower quality of life, and depression.[1,5,] Research has also shown that about 12-18% of nurses will ultimately leave the profession annually because of back injuries.[1,5,20,23,32] These outcomes show why nurses and hospitals need to start providing interventions to prevent low back pain from patient handling.

Interventions

Due to the large prevalence of low back pain in nurses, nurses and hospitals have started to take action to help prevent these injuries from progressing. Nurses can help prevent low back pain by utilizing proper body mechanics during lifts to protect their musculoskeletal system. There are also different types of patient handling interventions in hospitals, but all interventions have the same goal of reducing pain, disability, and absenteeism. These different policies could support the use of mechanical or ceiling

lifts, rather than manual handling, implementing minimal- or no-lift policies, and education.

Interventions: Body mechanics

Using proper body mechanics can significantly minimize the amount of stress that is placed on the body and can allow for more efficient and effective body movements.[27] Body mechanics are the coordinated effort of the musculoskeletal and nervous system to maintain balance, posture, stability, and alignment.[33] Karahan et al[34] stated that 70% of nurses in a study had average to low scores on knowledge and utilization of body mechanics, and those who did know about body mechanics misused them. There are a few essential principles to assist in proper body mechanics.

First, an individual should maintain a natural or neutral spine, in which the spine's natural curvatures are present. Natural curves include a slight lordotic curve in the cervical and lumbar spine and a kyphotic curve in the thoracic spine, and the pelvis in a neutral position. A healthcare worker can achieve a neutral spine while working with patients by engaging the core muscles of the spine and hips to help with stabilization.[16] Also, the individual should flex their hips and knees to maintain their natural curvature and lower their center of gravity. Lowering an individual's center of gravity and increasing the base of support are principles of proper body mechanics, as this can increase an individual's balance and stability.[33] In order to maintain balance and stability, the individual's line of gravity must fall within the base of support. The use of good body mechanics combined with other interventions could reduce spinal stress and thus the risk of injury.[27,34]

Interventions: Policy and procedure

Hospitals have policies and procedures in place that guide decision-making for healthcare providers that perform lifting and patient handling tasks. No lift or minimal lift policies are common and serve to outline expectations of employees to avoid loads that may exceed 35 pounds. One strategy to minimize loads is incorporating the use of ceiling or floor lifts instead of manual patient handling. There have been some contradictory reports about ceiling lifts and their effectiveness in reducing musculoskeletal injuries. In one study, the nurses felt less at risk for injury when using the ceiling lifts, and 75% preferred the ceiling lifts over manual patient handling.[20] At this same hospital, a 1-year post-intervention showed a 70% decrease in claims cost, and the comparison or control hospital had a 241% increase in claims cost during this same time.[20] In another study where the nurses were required to use ceiling lifts, the nurses stated that there was some relief physically but with the increase in time required to use these lifts possibly resulted in increased cumulative spinal loading rather than peak spinal loading seen in manual patient handling.[26]

In one study, the nurses were educated on the minimal-lift policy and provided with the proper equipment and transfer devices, and as a result, there was a reduction in patient handling injuries and absenteeism due to patient handling.[20] As mentioned earlier there is debate about zero-lift policies. Manual patient handling requires a greater peak spinal loading, with a smaller cumulative spinal loading due to how little time it takes to perform manual patient handling. On the contrary, the use of lifting tools often increases the time to perform the lift; therefore, there is a potential increase in cumulative spinal loading.[26] Cumulative spinal loading using a lift accumulates spinal

stresses that exceed the NIOSH safe limit of 3400N. High cumulative spinal loading has been shown in research as an independent risk factor for low back pain.[26]

Interventions: Education

Educating employees on proper lifting techniques, policies in place to guide safe patient handling, and instruction on tools to minimize spinal stress is essential. In hospital-based settings, physical therapists are often part of a team that provides educational programs to teach proper body mechanics and ergonomics designed to reduce the risk of injury. Some researchers believe that to have successful injury prevention; there must also be an ergonomic intervention component.[27] A typical educational intervention is the back school program that educates the individual on relevant spinal anatomy, proper lifting techniques, and body postures. Individuals who have participated in a back school program have experienced decreased disability, pain, and spinal loads. Further, they reported improved overall spinal functions and were able to incorporate these techniques in their everyday lives and at work.[29,35] Aslam et al[20] reported that after educational interventions of body mechanics and proper use of lifting tools for day-to-day occupational tasks, the nurses made fewer biomechanical errors.[20] Further a reduced number of nurses with low back pain was reported.[20] In a study conducted by O'Donnell et al[30] nurses completed a simulation lab and a test to examine their knowledge in injury prevention and patient transfers. There was a significant improvement in patient transfer skills after the simulation lab, and their knowledge on injury prevention and patient transfers also increased.[30] This is just one way that physical therapists and nurses work together.

Interprofessional relationships

Nurses and physical therapists often work together to assist with the early mobilization of patients. The programs for these professions have started to incorporate interprofessional learning, to assist with identifying what each profession's role is in safe patient handling. Lancken et al[32] recognize that health care profession students should not be educated in isolation and expected to work in a team after completion of school, but instead should begin working together while in school to build communication between the two professions. Over 90% of the participants of the study believed that the course was outstanding and they were confident in performing the skills taught.[32] Fogstad et al[36] reported similar findings that practicing patient transfers with nursing and physiotherapy students was advantageous with the physiotherapy students teaching the nursing students. All participants filled out open-ended questions and there was a common theme with the physiotherapy students that they realized that they knew more than they thought they did and were able to help the nursing students.[36] The nursing students believed it was challenging but that it was more enjoyable than just a typical class session.[36] These show that interprofessional collaboration is beneficial for the the educational component of safe patient handling for a variety of reasons.

Methods

Murray State University's Institutional Review Board (IRB) determination form was submitted to determine if a formal review was needed for the study. The IRB reviewed the study and determined that the study did not need official oversight.

Participants

Forty-one students enrolled in an undergraduate class NUR 202: Nursing Assessment and Basic Interventions for the fall semester of 2021 agreed to participate in the study. One participant dropped the class, and three other participants were excluded due to human error; therefore, a total of 37 participants were included in the study. Of the 37 participants, 78.4% were female. The average age of the participants in the study was 19.65±1.06 years old. The participants were in their first year of nursing school and were learning the basics of patient handling skills.

Protocol

Consent was obtained and participants were informed this study would have no impact on their course grade. Baseline knowledge was assessed by the participants completing a pretest one week prior to the educational intervention. The pretest included demographic information (age, sex, and last four digits of student identification number) and ten multiple-choice questions to assess their knowledge on basic spinal anatomy, prevalence of low back injuries in healthcare settings, interprofessional relationships in healthcare, body mechanics, and patient transfers (Table 1).

On October 4, 2021 in the Nursing Lab of Mason Hall, a presentation on low back injury prevalence rates, spinal anatomy, interprofessional relationships in the healthcare setting, and body mechanics was delivered. See the appendix for the presentation. After the presentation, the participants were split into three groups: bed-to-wheelchair transfers, ambulation aids, and patient bed mobility. While in these groups, participants practiced using techniques incorporating good mechanics to reduce

stress to the body as they performed the basic patient handling skills. Supervision and feedback were provided at each station by two undergraduate exercise science pre-health professional students, a licensed physical therapist and exercise science faculty, and a nursing faculty member.

For the bed-to-wheelchair transfers, the participants were taught to maintain a wide base of support and flex at the hips and knees to keep the spine's natural curvature. In order to achieve this, the participants needed to activate the core muscles and keep the patient close to the participant’s center of gravity. By keeping the patient close to the participant’s center of gravity this allows them to have more control over the patient and less strain on the lower back. When gait training with ambulation aids, they were taught to keep a wide base of support when walking alongside patients and were instructed in the proper use of a gait belt. Participants were instructed to avoid crossing their feet while walking with patients, as crossing their feet will not allow them to react quick enough and possibly cause injury to themselves or the patient. Finally, for bed mobility, the individuals were also taught to maintain a neutral spine and a wide base of support to shift weight efficiently while avoiding twisting with a load. Team lifting while performing patient bed mobility tasks was practiced while body mechanics and coordination among team members was emphasized. To reinforce skill development, each participant was given a checklist (appendix B) of procedures and reminders to ensure the skills were performed correctly and the devices were used properly.

At the end of the class, the participants took the posttest to assess their knowledge. The posttest included the demographic questions, the same ten multiple-choice questions, and a comments section. The open-ended comments section

was for the participants to provide any feedback or suggestions on what could be improved, what went well, etc.

Data analysis

Descriptive data was collected and presented as mean± standard deviation, as well as percentages. The dependent sample *t*-test was used to compare the participants' results on the pre- and posttest. Another dependent *t*-test was used to compare the scores for each question. The significance level for this study was set at $p<0.05$, and IBM SPSS ver. 25.0 was used for statistical analysis.

Results

During the study, four participants were excluded from the analysis. One participant dropped the class and therefore did not complete the study, and three other participants were excluded because of incorrectly typing their student codes, and thus we were unable to identify which pre and post scores belonged to them. Of the 37 participants included in the study, results indicated that their knowledge about patient transfers, body mechanics, and interprofessional relationships significantly improved from an average score on the pretest of 49±13% to the posttest 75±17%, $p<0.001$ (Figure 4).

Question	Average Pretest Score	Average Posttest Score
1. What is the role of a rehab health care professional (physical therapy or occupational therapy) within a health care team in a hospital setting?	0.78	0.95*
2. Prior to lifting, you should engage specific muscles to assist in maintaining spine alignment and stability. These key muscles include:	0.24	0.92*
3. To help reduce the stress on the health care worker, proper body mechanics must be used, all of the following are considered basics for good body mechanics **EXCEPT**:	0.76	0.95*
4. When assisting with ambulation with a gait belt, if a patient starts to fall you should:	0.78	1.00*
5. What is the median number of days missed per incident due to lumbar spinal injuries as a result of patient handling tasks?	0.51	0.86*
6. When using lifting equipment instead of manual handling, how much does this reduce the risk of injuries?	0.16	0.62*
7. To ensure proper body mechanics, when fitting a patient for a cane it should be at which following body landmark and at what angle should the elbow be at?	0.14	0.51*
8. When assisting with moving a patient in bed, the bed should be:	0.76	0.84
9. Which of the following statements about moving a patient in bed is **INCORRECT**?	0.19	0.30
10. A 58-year-old male is transferred to the rehabilitation center after falling from the stairs. He suffered a compound fracture of the right tibia and underwent an open reduction and internal fixation to repair the fracture. The orthopedic surgeon asked the patient not to bear weight on his right leg and use a wheelchair instead of walking during the first two weeks. What is the first step in safely transferring the patient from a wheelchair back to his bed after he finishes the morning therapy?	0.57	0.54

Table 1. The questions used for the knowledge assessment. * signifies that there was a significant difference between the values with a p-value<0.05. See appendix for the full assessment.

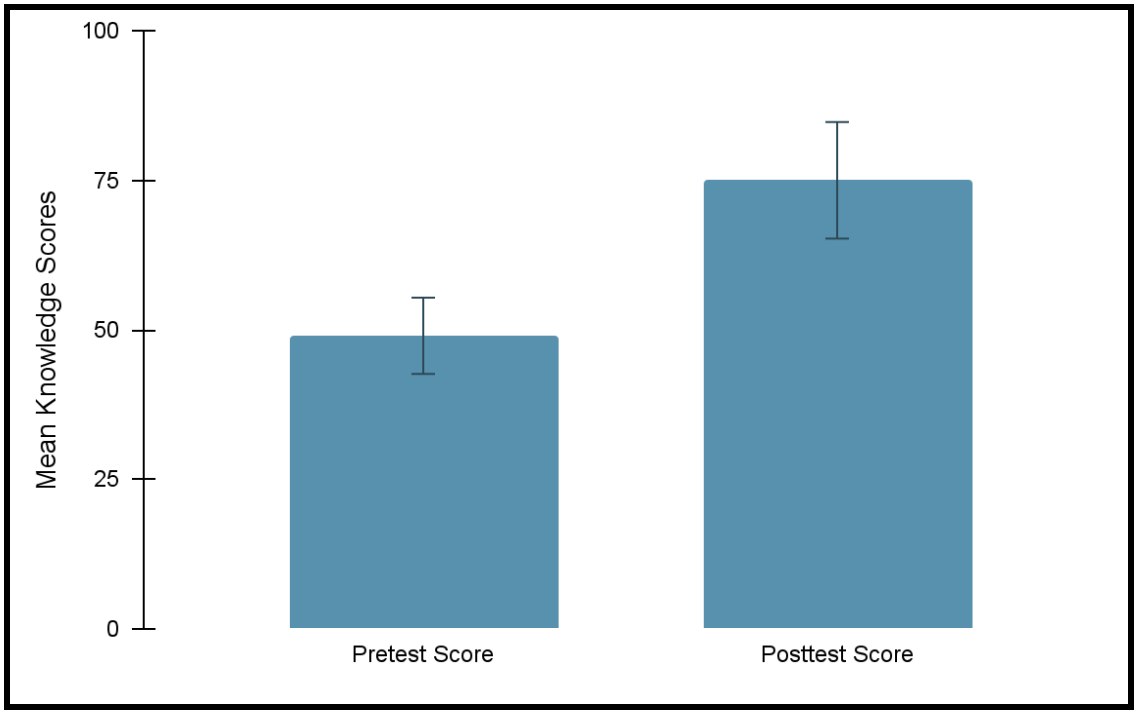

Figure 4. Comparison of the average scores on the pretest and posttest.

For the pretest, there were five frequently missed questions: questions two, five, six, seven, and nine (Table 2). On the posttest, the most frequently missed question was number nine followed by number 7. (Table 2). Six participants, or 16.2% correctly answered question nine on the pretest, and eleven participants (29.7%) answered this question correctly on the posttest. For question 7, correct answers increased from 16.2% on the pretest compared to 51% on the posttest. For question two the number of participants that got this correct after the presentation on body mechanics increased by approximately 400%. For question six on the pretest, only 13.5% of the participants correctly answered how much of a difference lifting equipment can impact the number of musculoskeletal injuries; after the presentation, 62.2% were able to identify the risk reduction correctly.

Frequently Missed Questions	Correct on Pretest (n)	Correct on Posttest (n)
2. Prior to lifting, you should engage specific muscles to assist in maintaining spine alignment and stability. These key muscles include:	8	34
5. What is the median number of days missed per incident due to lumbar spinal injuries as a result of patient handling tasks?	18	32
6. When using lifting equipment instead of manual handling, how much does this reduce the risk of injuries?	5	23
7. To ensure proper body mechanics, when fitting a patient for a cane it should be at which following body landmark and at what angle should the elbow be at?	6	19
9. Which of the following statements about moving a patient in bed is INCORRECT?	6	11

Table 2. The frequently missed questions on the pre- and posttest and the number of participants that answered them correctly.

Qualitative data

Qualitative data in the form of comments was collected on the posttest Google Form. The feedback from the participants about the study are presented in figure 5. The results indicated the participants benefited from the hands-on format and gained knowledge.

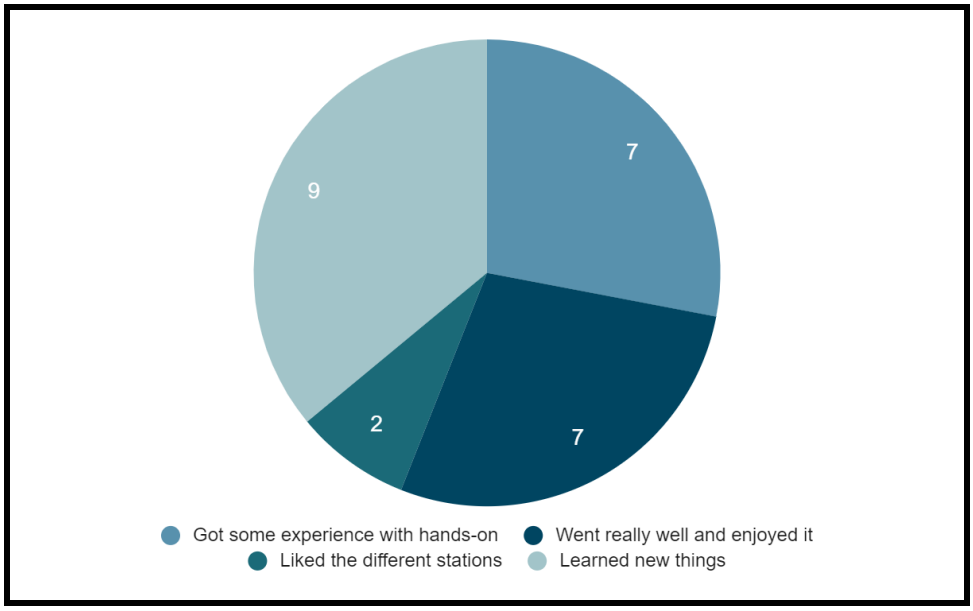

Figure 5. The comments that the participants had about the study

Discussion

This study analyzed whether an educational intervention successfully increased the participants' knowledge about proper patient handling. These results showed that the participants' knowledge significantly improved related to body mechanics and patient handling. There was also a positive response from the participants about the study (Figure 5). These positive results show an understanding that poor body mechanics used during patient handling could lead to an increased risk of musculoskeletal injuries, especially low back pain.

Several different themes emerged during the study. These comments recognized the importance of the stations that provided an opportunity to apply knowledge with hands-on practice of patient handling skills. (Figure 5). The participants stated that they "enjoyed the hands-on learning experience and breaking it down into different groups

helped me learn more" and "I learned many things I did not know about patient handling techniques. I liked the different stations."

Delivery mode

For this study, there was a presentation of information and a skills portion for the participants to practice various transfers and get feedback. In addition, supplemental class readings, videos, and a skills checklist were provided. There have been previous studies that have also used this delivery method with similar success. O'Donnell et al[30] used a simulation lab to evaluate patient transfer skills, and the participants were then debriefed and given a rating for their transfer with evidence-based statements explaining why. Scores on a pre- and post-intervention knowledge assessment improved from 65% to 90%.[30]

In another study using a back school program, the researchers believed that ergonomics and education would decrease pain and improve posture.[29] The subjects participating in the intervention group received education on body mechanics, anatomy, ergonomic theory, body posture, and spinal positioning.[29] Nurses in the program were also taught to apply the knowledge and techniques during their everyday work activities.[29] The results showed that the participant's body posture improved, pain and disability were significantly decreased post-intervention and long term.[29] These two studies show how this delivery method could be an effective method for teaching these skills.

Frequently missed questions

For the posttest, the highest incorrect responses were on question nine followed by question seven(Table 2). The participants may have had difficulty with question nine if they did not perform the required readings before class. Question 7 was related to proper fit of an assistive device to be used during gait. Details related to adjusting assistive devices for patients was presented in pre-class reading assignments, during the presentation, and was practiced during one of the skill stations. Although the number of correct responses increased from pre to posttesting, posttest responses indicated that this information should be further reinforced. Compared to the pretest, there were fewer questions that the majority missed after the educational intervention.

For the pretest, there were five frequently missed questions: questions two, five, six, seven, and nine (Table 2) Question 2 has to do with the core musculature involved in maintaining spinal alignment and stability. These muscles were brought up during the presentation and the skills portion when the participants were practicing. This could explain the increase in correct responses due to the repeated reminder of the muscles and their importance. Question six has to do with the difference between lifting equipment and manual patient handling and how this affects the risk of injury. This was mainly brought up during the presentation. These changes in the frequently missed questions provide examples of how much education on these topics can lead to safer patient handling.

Limitations

There are a few limitations to this study. The first limitation is the number of participants; since this was presented in a class, we only had as many participants as students enrolled in the class. For future research, if this study was replicated every semester, there would be an increase in the total number of participants in the study. We have also considered making this project a longitudinal study to see how well the students retained this information over the years. Another limitation was the lack of a control group. Lastly, the posttest was given at the end of the class time; therefore, if the participants were under the impression that they did not have enough time, they may answer randomly.

Conclusion

In conclusion, the central finding of this study was that an educational intervention with a skills component can significantly increase the knowledge of the participant on patient handling techniques and body mechanics. These results add to the body of evidence that supports the use of educational interventions with hands-on practice of techniques to effectively educate health care workers on the risks of their occupational tasks and how best to prevent musculoskeletal injuries.

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Appendix A. Posttest Knowledge Assessment

You have been invited to be a part of a research study looking at the effects that safe patient handling education can have on the incidence rate of musculoskeletal injuries in health care professionals. This particular research study is necessary because of the incidence rate of musculoskeletal injuries that health care professionals undergo due to improper body mechanics during patient handling tasks is 31% of total injuries.[1]

Instructions: Please complete the short, 10-question survey (post-test) to the best of your ability with no additional assistance. This will assess knowledge of concepts that will be covered in an upcoming class session. This is part of an interprofessional project designed to teach skills that promote the use of strategies to minimize the risk of musculoskeletal injuries in the health care setting while performing patient handling tasks. Scores on the quiz WILL NOT impact your course grade.

1.Pompeii LA, Lipscomb HJ, Schoenfisch AL, et al. Musculoskeletal injuries resulting from patient handling tasks among hospital workers. Amer J Indus Med. 2008;52:571-578. doi:10.1002/ajim.20704.

1. Age?
2. Sex assigned at birth?
    a. Female
    b. Male
    c. Prefer not to say
3. Last four digits of M#?

Post-Test Questions

4. What is the role of a rehab health care professional (physical therapy or occupational therapy) within a health care team in a hospital setting?
    a. Directing care of patients for the diagnosis and treatment of movement system disorders and dysfunction
    b. Providing intervention through education, exercise, activity, and movement for the prevention of disease
    c. Providing employee education on techniques to prevent or minimize the risk of musculoskeletal injuries while performing work duties
    d. All of the above are correct
    e. None of the above are correct
5. Prior to lifting, you should engage specific muscles to assist in maintaining spine alignment and stability. These key muscles include:
    a. Gluteus medius, hamstrings, gastrocnemius
    b. Transversus abdominus, pelvic floor musculature, multifidi
    c. Pectoralis major, rectus abdominus, hamstrings
    d. Pelvic floor muscles, deltoid, external oblique muscles

6. To help reduce the stress on the health care worker, proper body mechanics must be used, all of the following are considered basics for good body mechanics **EXCEPT**:
    a. Keep back, neck, pelvis, and feet aligned during the movement.
    b. Tighten the stomach muscles and tuck your pelvis.
    c. Bend at the knees and hips to lower your center of gravity.
    d. Exaggerate the lumbar curvature to enhance the ability of the spine to absorb shock
7. When assisting with ambulation with a gait belt, if a patient starts to fall you should:
    a. Drop to the ground and get under them to prevent them from hitting the ground.
    b. Catch them before they hit the ground and stand them back up.
    c. Keep a firm hold of the gait belt and lower them to the ground.
    d. None of the above are correct.
8. What is the median number of days missed per incident due to lumbar spinal injuries as a result of patient handling tasks?
    a. 12
    b. 14
    c. 9
    d. 17
9. When using lifting equipment instead of manual handling, how much does this reduce the risk of injuries?
    a. 50%
    b. 70%
    c. 65%
    d. 95%
10. To ensure proper body mechanics, when fitting a patient for a cane it should be at which following body landmark and at what angle should the elbow be at?
    a. Greater trochanter; 30-45°
    b. Iliac crest; 15-30°
    c. Iliac crest, 30-45°
    d. Greater trochanter, 15-30°

11. When assisting with moving a patient in bed, the bed should be
    a. At the lowest level of the bed so that if the patient slips, the distance to fall is shorter
    b. At a proper working height for the healthcare worker (approximately waist level)

c. At the highest level to improve the ability of healthcare workers to use the arms to move the patient
d. Pulled away from the wall and unlocked

12. Which of the following statements about moving a patient in bed is **INCORRECT**?
    a. When using the log roll method, you must have three nurses.
    b. The head of the bed should be laid out flat.
    c. When moving a patient with a draw sheet, it should expand from the shoulder to the lumbar region
    d. When moving a patient up the bed your feet should be shoulder-width apart and knees and hips flexed.
13. A 58-year-old male is transferred to the rehabilitation center after falling from the stairs. He suffered a compound fracture of the right tibia and underwent an open reduction and internal fixation to repair the fracture. The orthopedic surgeon asked the patient not to bear weight on his right leg and use a wheelchair instead of walking during the first two weeks. What is the first step in safely transferring the patient from a wheelchair back to his bed after he finishes the morning therapy?
    a. Raise the footplates
    b. Rotate the leg rests outward
    c. Lock the brakes
    d. Position the wheelchair

Comments

14. Please add any feedback about what you learned in lab today? (What went well, what didn't, what could be improved, etc.)

Appendix B. Participant Skills Checklist

Assisting with Positioning a Patient in Bed
Verified the health care provider's orders, performed hand hygiene, introduced self to the patient and family, and Identified the patient using two identifiers.
Explained the procedure to the patient and ensured that he or she agreed to treatment
Positioned the patient in one of the appropriate positions, using correct body alignment. Protected pressure areas. Began with the patient lying supine. *Placed the bed in a good working height.*
Placed toiletries, personal items, call light within reach and made sure the patient knew how to use it to summon assistance.
Raised the appropriate number of side rails and lowered the bed to the lowest position
Followed up with all body position changes to check for body alignment and patient comfort level.
Disposed of used supplies and equipment. Left the patient's room tidy.
Performed hand hygiene, and documented and reported the patient's response and expected or unexpected outcomes.
Assisting with Ambulation Using a Gait Belt
Verified health care provider's orders, gathered necessary equipment and supplies, performed hand hygiene, provided for the patient's privacy, introduced self to patient and family, and identified patient using two identifiers.
Explained procedure to patient.
Lowered bed as much as possible, lowered side rail, helped patient into appropriate position.
Stood on appropriate side of bed.
Had patient sit on side of bed for a few minutes, had patient take deep breaths until balance is obtained, helped patient into robe, asked patient to move legs and feet in circles, applied nonskid slippers.
Assessed for dizziness.
Applied gait belt, secured and ensured fit was snug
Assisted ambulation with one nurse:
Assisted ambulation with two nurses:
Helped patient into comfortable position, placed personal items and call light within reach and ensured patient knew how to use it.
Raised side rails and lowered bed to ensure patient safety.
Disposed of used equipment and supplies, left patient's room tidy.
Removed and disposed of gloves, performed hand hygiene, and documented and reported patient's response.
Assisting with Moving a Patient in Bed
Verified health care provider's orders, gathered necessary equipment and supplies, performed hand hygiene, ensured patient privacy, introduced self to patient and family, identified patient using two identifiers, and compared these with ID bracelet.
Explained the procedure to the patient and ensured that he or she agreed to treatment.
Assessed amount of weight to be lifted, and assessed for assistance needed to ensure safety of all involved.
Moved patient with a drawsheet:
Moved patient with friction-reducing device:
Logrolled patient:
Helped patient into comfortable position, placed personal items and call light within reach and ensured patient knew how to use it.

Raised side rails and lowered bed to ensure patient safety.
Disposed of used supplies and equipment properly, left patient's room tidy.
Removed and disposed of gloves, performed hand hygiene, and documented and reported patient's response and outcomes.
Assisting with the Use of Canes, Walkers, and Crutches
Reviewed the patient's medical record for orders and restrictions. Gathered the necessary equipment and supplies and ensured the ambulation device is in good working order. Introduced self to the patient and family if present. Identify patient using at least two identifers and verify infromation with patient's ID bracelet.
Explained the procedure and its purpose to the patient and demonstrated the gait technique the patient would use.
Collaborated with the patient and set a goal for how far the patient would ambulate.
Helped the patient to a sitting position, when necessary. Applied a gait belt to the patient.
Helped the patient to stand and assessed the patient's strength and balance. Asked if the patient was experiencing any dizziness. If the patient was too weak to proceed, or if the patient began to feel dizzy, assisted the patient in sitting down.
Checked the fit on the ambulation device and adjusted as needed.
Assisted the patient with ambulation.
If the patient felt weak or dizzy, immediately helped patient to a bed or chair.
Provided patient teaching using Teach Back.
After completing the exercise, returned the patient to a position of comfort. Placed personal items within reach and ensured that the nurse call system was in place.
Discarded used supplies and disposed of used equipment appropriately.
Performed hand hygiene, documented patient teaching, patient's response, and expected or unexpected outcomes.
Transferring From a Bed to a Stretcher
Performed hand hygiene, donned gloves as needed, ensured patient privacy, and introduced self to patient. Identify patient usign two identifiers. Compare these identifiers with the information on the patient's identification bracelet.
Explained the procedure to the patient and ensured that he or she agreed to treatment. Determined number of staff required to safely transfer patient.
Raised bed to comfortable working height. Made sure bed brakes were locked, and lowered head of bed appropriately.
Supported patient's head as pillow was removed.
Lowered the side rails of the bed.
Crossed patient's arms over chest.
On the count of three, turned the patient onto his or her side toward the two nurses. Turned the patient as a single unit, with a smooth, continuous motion.
Fanfolded draw sheet on both sides.
Placed slide board under the waterproof pad and draw sheet.
Gently rolled patient back onto slide board. Adjusted position of patient to center weight on slide board.
Lined up stretcher with bed, set the stretcher one half inch lower than the bed, locked brakes on stretcher.
Ensured nurses were positioned correctly.
Grasped fanfolded draw sheet, and pulled patient appropriately onto the stretcher
Positioned patient in center of stretcher, and moved slide board from under patient.
Raised the side rails on the stretcher, raised the head of the stretcher if doing so was not contraindicated, covered the patient with a blanket
Performed hand hygiene, documented the procedure, and informed the next shift or other caregivers of any assistance that might be needed.

Transferring From a Bed to a Wheelchair Using a Transfer
Verified the health care provider's orders, gathered the necessary equipment and supplies, provided for the patient's privacy, and introduced self to the patient and family. Identified the patient using two identifiers. Compared these identifiers with the information on the patient's identification bracelet.
Explained the procedure to the patient. Performed hand hygiene and applied gloves if indicated.
Locked the bed brakes.
Adjusted the height of the bed to the level of the wheelchair seat.
Placed and positioned the wheelchair. Secured the wheels.
Raised the footrests and swung the leg rests outward on the wheelchair.
Sat the patient up on the side of the bed:
Helped the patient move to the edge of the mattress.
Allowed the patient to sit on the side of the bed for a few minutes before transferring him/her to a wheelchair. Asked if the patient felt dizzy.
Helped the patient apply stable, nonskid shoes. Placed the patient's weight-bearing leg forward, with the weaker foot to the back.
Correctly placed the gait belt on the waist of the patient
Spread feet. Flexed hips and knees, and aligned knees with those of the patient.
Grasped the transfer belt along the patient's sides. Positioned self slightly in front of the patient.
On the count of three, rocked the patient up to a standing position. While rocking the patient in a back-and-forth motion, made sure body weight was moving in the same direction as the patient's body weight. Asked the patient to push up off the mattress.
Maintained the stability of the patient's weak or paralyzed leg with knee.
Instructed the patient to feel for the edge of the wheelchair seat against the legs and to use the armrests for support.
Flex hips and knees while lowering the patient into the wheelchair.
Ensured the patient was positioned well back in the seat. Provided support to the extremities if needed. Ensured proper alignment in a sitting position.
Lowered the footrests after transferring the patient, and placed the patient's feet on them.
Provided comfort measures for the patient and ensured that the call light was within reach.
Placed a blanket over the patient's legs, if needed.
Monitored the patient's vital signs as needed. Asked if the patient felt dizzy or fatigued. Noted the patient's behavior during the transfer. Remained in front of the patient until he or she regains balance. Continued to provide physical support to a weak or cognitively impaired patient.
Documented how long the patient was in the chair and the care provided in the EMR.

Appendix C. Presentation

Minimizing Musculoskeletal Injury Risk in Health Care Professionals

Safe Patient Handling

Interprofessional relationships: Physical Therapist

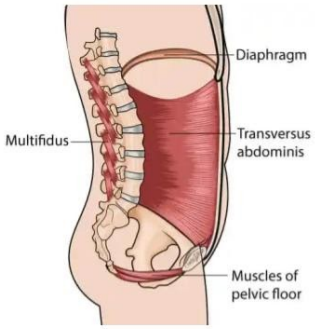
- Provide interventions through exercise, activity, and movement to assist with movement dysfunction and prevention of disease.
- Provide employee education on ways to help prevent or reduce the risk of musculoskeletal injuries while working.
- Diagnosis and treatment of movement system disorders and dysfunction.

Incidence rates among health care workers during patient handling

- A survey reported an annual incidence rate of 16.5 injuries per 100 full-time workers among OTs and 16.9 injuries per 100 full-time workers among PTs—a rate similar to workers employed in heavy manufacturing. (Waters TR)
- Inpatient nurses account for 50% of the patient handling injury claims. (pompeii)
- 32% of injuries from patient handling in the Pompeii et al. study resulted from repositioning a patient in bed, pulling up patients in bed, or catching a falling patient.
- The average number of days missed from a lumbar injury from patient handling per incident is 14 days. (Amaro J)
- Lifting equipment can reduce up to 95% of manual lifting injuries.

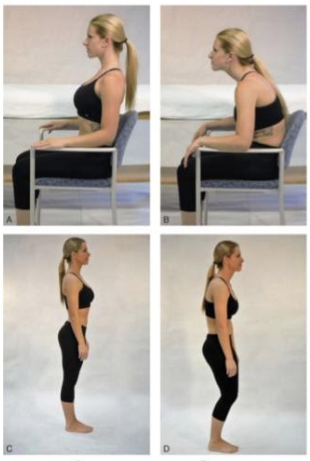
Spinal anatomy and stabilization

- The muscles of the back are divided into extrinsic and intrinsic groups. These are to assist in maintaining the spinal curvature and distributing the body's forces.
- There are also muscles that assist with keeping spinal alignment and stability:
  - Transverse abdominis
  - Multifidus
  - Pelvic floor muscles



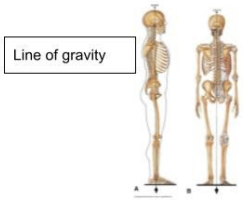
Body Mechanics

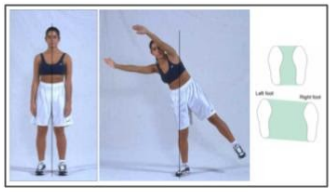
- The position of the body during activity.
- Proper body mechanics is fundamental to proper posture.
  - Good mechanics minimize stresses to body segments and allows more efficient and effective body movements.
  - Poor mechanics increases stresses to body segments, decreases the body's efficiency, and may cause injury.
- Important principles:
  - Neutral spine: maintain natural curvatures and neutral pelvis
  - Stability maintained by a low center of gravity, a broad base of support, and a stance in the direction of force application



Body Mechanics

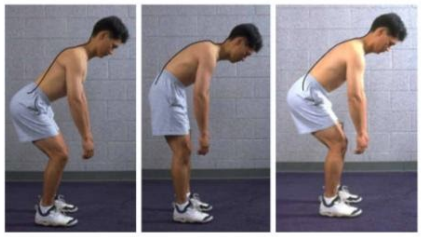
- Basic principles for the healthcare professional
  - Engage core muscles of the spine and hips
  - Bend at the hips and knees to maintain natural curvatures and lower center of gravity.
  - Avoid twisting with a load
    - Weight shift between LEs with a broad base of support and feet in the direction of force application
  - With team patient handling, the person with the heaviest load coordinates the effort



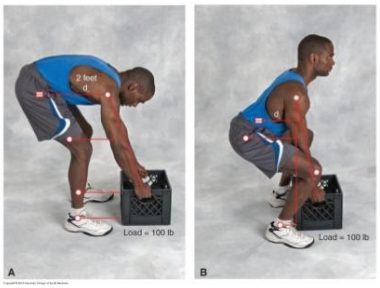


The line of gravity must fall within the BOS for balance and stability.

Neutral spine with bending and lifting objects



Houglum, Peggy A. (2016) Therapeutic Exercise for Musculoskeletal Injuries. 4th ed., Human Kinetics.



Improper **(A)** and proper **(B)** biomechanical lifting technique for lifting an object from a standing position. Improper technique **(A)** produces a large rotational moment at the low back due to the large moment arm ($d_{\perp}$) from the low back to the loading point at the arms. Proper technique **(B)** aligns the hips, knees and ankles as close to the line of force as possible to minimize any rotational moment on the low back.

Assistive devices

- Purpose of assistive devices
  - Increase stability by increasing the BOS
  - Decrease or eliminate weight bearing through the LE
- Fitting
  - Axillary crutches: w/ crutch tips 6 inch anterior and lateral to the 5th toe
    - Axillary pad should be 2-3 finger widths below the axilla
    - Handgrip positioned to allow 20-30 degree elbow bend
  - Canes and walkers: w/ the cane just lateral to the leg and arm resting at the side or standing inside the walker w/ arms resting at sides
    - Adjusted so the handgrip is at the height of the greater trochanter or wrist level

- Getting up and down from a chair
  - Place both crx in one hand holding to the handgrips
  - Place the other hand on the armrest or chair seat
  - Push up from both UE's then place crx in place
  - Sit using the reverse actions

Safety with assistive devices

- Inspect equipment for wear and damage
- Environmental factors
  - Remove environmental hazards
- Keep assistive devices close to body for efficiency, safety and to avoid tripping others