Investigating the effect of caregiver height when completing a pivot transfer

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Abstract

This study investigated the forces required when transferring a patient, using different caregiver physical heights combined with two different “patient” heights. Hand forces and compression and shear forces of the lumbar region were calculated for the caregivers when performing a pivot transferring on the “patient.” With an R^2 of 0.15, the statistically significant regression line indicated that transferring patients taller than 179cm required more than 35 pounds and increased as the patients height increased. Therefore, using alternative lifting equipment when transferring a patient who is taller than 179cm could potentially reduce musculoskeletal injuries. The height ratio between the caregiver and patient was not a significant factor in the hand forces required to pivot transfer a patient. Significant differences were not found for the forces required to transfer a patient based on height ratio or height for compression and shear forces exerted on the caregiver. Future research is needed to contribute to the findings of research in safe patient handling practices.

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Introduction

Work-related musculoskeletal disorders (WRMDs) have been an increasing problem among healthcare workers who handle and move patients (Waters, 2010). Direct and indirect costs for back injuries alone in the healthcare industry were estimated to be $20 billion annually (Leigh, 2011). Handling and transferring patients presents increased difficulty compared to manually handling inanimate objects. In addition to the manual lifting of patients, health care professionals are required to consider the patient's position, the time constraints they have to abide, and the high level of stress linked to direct patient care (Waters, 2010).

Although the level of difficultly in handling and transferring patients has not changed, in 2012, WRMDs accounted for 388,060 cases, with a median of 12 days away from work, compared with 9 days for all types of cases (Bureau of Labor Statistics, 2013). In totality, WRMDs accounted for 34 percent of all workplace injuries and illnesses requiring days away from work (Bureau of Labor Statistics, 2013). Nursing assistants and registered nurses were two of the six occupations that together reported over 25 percent of these WRMD cases (Bureau of Labor Statistics, 2013). "Overexertion and bodily reaction" accounted for 55 percent of the 44,100 WRMD cases reported by nursing assistants (Bureau of Labor Statistics, 2013).

The high incidence rate of musculoskeletal injuries has prompted research specific to patient handling tasks. Pompeii, Lipscomb, Schoenfisch, and Dement (2009) investigated the risk of musculoskeletal injuries resulting from patient handling tasks at Duke University Medical Center. Records were obtained from the Duke Health and Safety Surveillance System over a 7-year period (1997-2003), which included workers' compensation and human resource data (Pompeii et al., 2009). The incidence density rates were articulated as the number of injuries per full time equivalent (FTE), defined as a worker employed 40 hours per week and employed the entire year (Pompeii et al., 2009). They found that one-third of all musculoskeletal injuries resulted from patient handling activities. Specifically, there were 876 patient handling injuries out of 2,849 musculoskeletal injuries reported over the 7-year period (Pompeii et al., 2009). Among all occupational groups, inpatient nurses and nurses' aides accounted for 73.1% of all patient handling injuries (Pompeii et al., 2009). Sixty five percent of these injuries resulted in back pain (Pompeii et al., 2009). These authors suggested that forty percent of these injuries may have been prevented by using mechanical lift equipment (Pompeii et al., 2009).

Registered nurses and nurses' aides have been heavily researched to substantiate their exposure to injury in practice, but there also exists musculoskeletal injuries among occupational and physical therapists. Darragh, Huddleston, and King (2009) found that occupational and physical therapists (OT and PT) are also at risk for musculoskeletal injuries during patient handling. Their study defined a person having a "musculoskeletal injury" if he or she rated pain of at least 4 of 10 on a visual scale (0-10), that lasted more than 1 week or was present at least once a month (Darragh et al., 2009). Fifty percent of the total licensed occupational and physical therapists in Wisconsin were recruited (Darragh et al., 2009). They were selected through a random number table to participate, totaling 3,297 surveys mailed; the response rate was 36% (Darragh et al., 2009). Their research indicated that the 2006 annual injury incidence rate of OTs was 16.5 injuries, and PTs 16.9 injuries per 100 full-time workers (Darragh et al., 2009). These injury incidence rates were calculated using a specific formula: the total number of therapists injured per year multiplied by 200,000 (represents the equivalent of 100 employees working 40 hours per week, 50 weeks per year), divided by the total number of hours worked per year (Darragh et al., 2009).

Rice, Dusseau, and Kopp Miller (2011) conducted a survey study within the state of Ohio for musculoskeletal injuries associated with manual patient lifting in occupational therapy practitioners. Members of the Ohio Occupational Therapy Association (OOTA) were invited to participate in the study (Rice et al., 2011). E-mail addresses from OOTA's membership directory were obtained, and the overall response rate was 26% (Rice et al., 2011). Results revealed that 5% of the responders obtained a musculoskeletal injury associated with manually transferring a patient (Rice et al., 2011). Respondents who indicated they were required to perform manual patient transfers, 8.3% reported they had sustained an injury and 11% missed days from work due to an injury (Rice et al., 2011). "Musculoskeletal injury" was not defined in the study, rather respondents were simply asked whether or not they had a musculoskeletal injury (Rice et al., 2011). The lower back was the most common site of injury (Rice et al., 2011). Additionally, 81% of the respondents indicated that occupational therapists facilitate and provide in-service training for the safety of lifting patients at their facility (Rice et al., 2011). Forty six percent of the responders designated that they learned safe patient handling on the job, while 25% had training at an OT/OTA school (Rice et al., 2011).

Regardless of how health professionals learn safe patient handling, it needs to be implemented into practice. In 2013, the American Nurses Association (ANA) addressed the need for universal safe patient handling (SPH) and mobility standards, to protect healthcare workers from injuries and WRMDs, by publishing eight interprofessional standards of SPH (American Nurses Association, 2013). Although this literature refers to SPH as "SPHM," for the purposes of this paper, SPH will be used. The eight standards include: culture of safety, sustainable SPH program, ergonomic design principles, SPH technology, education, training, and maintaining competence, patient-centered assessment, reasonable accommodation and post-injury return to work, and a comprehensive evaluation system (American Nurses Association, 2013). These standards are voluntary, however, they can be used as a framework for healthcare professionals and applied to all healthcare settings (American Nurses Association, 2013). If properly implemented, it is believed that SPH programs could reduce healthcare injuries (American Nurses Association, 2013).

Occupational therapists have a role as health care professionals to incorporate safe patient handling into their practice. Safe patient handling and mobility programs provide a safe and effective way to move patients. They combine mechanical lift equipment, proper body mechanics, and a series of tasks with strategies to move, position, and transfer a patient successfully (Frost & Barkley, 2012). This makes SPH a critical component to be added to all occupational therapy curricula.

Frost and Barkley (2012) investigated the use of traditional manual patient handling (TMPH) and safe patient handling (SPH) methods taught in occupational therapy curricula through survey research. Two hundred thirty eight schools were selected from the American Occupational Therapy Association (AOTA) website to be invited to participate; the overall response rate was 49.6% (Frost & Barkley, 2012). Of the educators, 94% reported teaching TMPH experimentally, 67% didactically, and 2.5% did not teach them (Frost & Barkley, 2012). Fifty three percent taught SPH experimentally, 62.8% didactically, and 22.3% did not teach them (Frost & Barkley, 2012). Research within health professions has indicated that the practice of TMPH skills puts practitioners at a high risk of injury (Frost & Barkley, 2012). Although this has been repeatedly indicated, Frost and Barkley (2012) deduced that only 22% teach safe patient handling and mobility as a standard of practice.

Slusser, Rice, and Kopp Miller (2012) also examined the use of safe patient handling taught in occupational therapy and occupational therapy assistant programs in the United States of America through survey of educators. Of the 285 surveys e-mailed, 111 were returned for a response rate of 39% (Slusser et al., 2012). More than ninety percent indicated that SPH was addressed in their curriculum and that it was primarily taught during lab-based experiences (Slusser et al., 2012). Fifty five percent of responders indicated that SPH tasks were taught during fieldwork experiences, while 34% used traditional classroom lectures (Slusser et al., 2012). Curricular content was lacking in transferring bariatric patients and using information about The National Institute for Occupational Safety and Health (NIOSH) algorithms (Slusser et al., 2012). The several variations in the SPH content of curriculum show that awareness of SPH needs to increase in occupational therapy curricula.

With continued evidence-based research, SPH could transition to being the sole method in teaching students how to transfer a patient. NIOSH developed an equation to access lifting conditions and generate a recommended weight limit for a task in 1981 called the NIOSH Lifting Equation (Health & Services, 1981). This original equation was developed for general industrial workers in lifting objects (Health & Services, 1981). The NIOSH Lifting Equation was later revised in 1991, limiting the load constant from 90 pounds to 51 pounds (Waters et al., 1993). There was then a modification to the Revised NIOSH Lifting Equation for the unique task of lifting people, and it included a recommended 35-lb maximum weight limit for use in patient handling tasks (Waters, 2007). Due to a patient’s unpredictability (muscle spasms, weighing more than expected, resistive, combative, slipping, falling), this weight limit should only be observed while in ideal conditions (Waters, 2007). Assistive lifting equipment is recommended if a patient exceeds the 35-lb weight limit (Waters, 2007).

Marras, Davis, Kirking, and Bertsche (1999) researched variations in patient handling tasks and techniques commonly used in patient care facilities, to determine the range of low back spinal forces and risk of low back disorders among caregivers. Specifically, they investigated the manual transferring of patients, with one or two caregivers, from bed to wheelchair, commode chair to hospital room chair, and repositioning in bed (Marras et al., 1999). They calculated three-dimensional spinal loads including compression, anterior-posterior shear, and lateral shear forces, using a Lumbar Motion Monitor (LMM) (Marras et al., 1999). None of the transfer methods were found to be anything less than a high-risk job (Marras et al., 1999). NIOSH guidelines consider safe spinal compression to be under 3400N, with the maximum limit at 6400N (Health & Services, 1981). Fifty two percent of the one-person transfers and 17% of the two-person transfers exceeded the maximum 6400N tolerance limit, where spinal disc strain increases greatly (Marras et al., 1999). All of the lifting techniques were found to have a 76% high probability of being a high risk group for injury (Marras et al., 1999). Authors suggested that these methods would not be considered safe for use in a hospital setting (Marras et al., 1999). Rather, 20 percent of one's body weight is recommended as a limit in lifting patients (Knapik & Marras, 2009).

Three unique studies examined repositioning patients in bed (Bartnik & Rice, 2013); (Fragala, 2011) and repositioning patients in a chair (Fragala & Fragala, 2013). Fragala's (2011) laboratory study simulated the task of pulling a 200-pound patient up in bed with the assistance of a gravity feature in the bed system. Results indicated the gravity assist feature, combined with the use of a slide sheet, decreased work demands from 35% to 64%, depending on the bed angle used (Fragala, 2011). The results from this study show clinical significance in using the gravity assist feature in a bed system, along with a slide sheet, to decrease the work demands required by the caregiver when pulling larger residents up in bed.

The second study of repositioning patients in a chair found additional significant evidence to contribute to safe patient handling practices. Patients who are immobilized sit for extended periods of time, requiring repositioning in their chair for correct posture (Fragala & Fragala, 2013). A proper upright-seated position reduces the risk of pressure ulcers and maintains a comfortable position for the patient (Fragala & Fragala, 2013). Some patients are unable to reposition themselves in their chair, requiring a caregiver's assistance (Fragala & Fragala, 2013). Due to the awkward positioning a caregiver needs to be in to do this, and the physical demands required, caregivers are at risk for musculoskeletal injuries (Fragala & Fragala, 2013). This study implemented an ergonomically designed seated positioning system (SPS), examining the effects of the SPS when repositioning a slouching patient in a chair to proper posture (Fragala & Fragala, 2013). A Borg Scale was used to evaluate perceived exertion from the caregiver (Fragala & Fragala, 2013). Results revealed that method 1(two caregivers repositioning a patient with past procedures) required 246% greater exertion than method 2 (two caregivers repositioning a patient using the SPS) (Fragala & Fragala, 2013). Additionally, method 1 required 127% greater exertion than method 3 (one caregiver repositioning a patient using the SPS) (Fragala & Fragala, 2013). This study indicates that use of the SPS when repositioning a patient, regardless of the amount of caregivers, requires less physical exertion, lowering the risk of caregiver injury (Fragala & Fragala, 2013).

Bartnik and Rice (2013) investigated the caregiver forces required when sliding patients up in bed using a traditional cotton sheet versus friction-reducing slide sheets. Results indicated that the friction-reducing slide sheets produced less caregiver force compared to the traditional cotton sheet that is frequently used in the hospital setting (Bartnik & Rice, 2013). This study introduced friction-reducing slide sheets as a beneficial tool in reducing musculoskeletal injuries when pulling a patient up in bed (Bartnik & Rice, 2013).

Ergonomics has contributed to safe patient handling practices. Snook and Ciriello published revised tables of maximum acceptable weights and forces for manual handling tasks (1991). These guidelines were designed to represent worker capabilities and limitations, assisting industry in controlling injuries associated with lifting (Snook & Ciriello, 1991). Results revealed that as task frequency increased, maximum acceptable weights and forces decreased (Snook & Ciriello, 1991). For example, 90% of males were able to lift a 14kg, 75cm width box with a vertical distance of 76cm from floor level to knuckle height, every 5 minutes (Snook & Ciriello, 1991). However, when that task frequency increased to every minute, males were only able to lift 11kg (Snook & Ciriello, 1991). It was also found that females maximum acceptable weights and forces were somewhat lower than males (Snook & Ciriello, 1991). At the same conditions previously stated for males, females were only able to lift 9kg every 5 minutes, and 7kg every minute (Snook & Ciriello, 1991).

“Results confirmed that object size (specifically width), and task distance and height are significant variables to consider when establishing guidelines for maximum acceptable lift” (Snook & Ciriello, 1991, p. 1200). Maximum acceptable weights increased when distance and/or width decreased (Snook & Ciriello, 1991). Results indicated maximum acceptable weight of lift are the highest when lifting knuckle height to shoulder height, rather than floor level to knuckle height or shoulder height to arm reach (Snook & Ciriello, 1991). At shoulder height to arm reach, with the same dimensions previously stated, a male could lift 10kg every minute, and

11kg every 5 minutes; at knuckle height to shoulder height, a male could lift 13kg every minute and 14kg every 5 minutes (Snook & Ciriello, 1991).

The results from Snook and Cireillo's study contributed to the idea that people can lift more weight when it is close to their center of mass. Nielsen, Andersen, and Jorgensen's (1998) study investigated a similar theory. Their study aimed to find the muscular load exerted on the lower back and shoulders by employees at a post office during repetitive lifting of mail transport boxes (Nielsen et al., 1998). Results revealed that the maximum loads on the lower back muscles were the largest when lifting from the lowest lifting height, whereas maximum loads on the shoulders were largest when lifting from the highest lifting height (Nielsen et al., 1998). Hence, it is preferable to lift from medium heights, between 72.5-126.8 cm above floor level (Nielsen et al., 1998). Lifting at this medium height reduces the peak load in the lower back and shoulder muscle groups by approximately 50 percent (Nielsen et al., 1998). Since these biomechanical principles have been shown to be more effective with inanimate objects, it is likely that the same principles would apply to manual patient transfer situations.

Caregiver height could be a contributing factor to consider when transferring a patient. Specifically, caregiver height compared to the height of the patient being transferred should be considered. The purpose of this study is to investigate the forces required when transferring a patient, using different caregiver physical heights combined with different "patient" heights. It is hypothesized that there will be a significant difference in the forces required to transfer a "patient" depending on the disparity in physical height between the caregiver and the "patient." This study is aimed to contribute and identify safer strategies when transferring a patient based on the relative height of the patient and caregiver.

Method

Participants

Five male and 17 female adults aged 20 to 63 years were recruited and participated in this study. Participants were recruited through university email, flyers, and “word of mouth.” In an attempt at controlling variation in assistance levels, the subjects were given some practice at requiring max or total assist using the feedback from their own force plate and wall monitor. The consistent caregivers performing the transfers throughout data collection were a woman who was 5-feet 4.5-inches tall, approximately 125-pounds, and 23 years old and a man who was 5-feet 11.75-inches tall, approximately 198-pounds, and 51 years old. The caregivers also had no history of previous back or shoulder injury and were trained and competent in performing proper transferring techniques.

Apparatus

A three-dimensional motion capture system, using seven Owl motion capture cameras and one Rapture motion capture camera, and Cortex software (version 6403.3.1.1301) collected data for analysis. The system was used alongside two force plates (Amti Model # OR6-5-1, 176 Waltham Street, Watertown, MA 02472 and Bertec Model # 2060A, 6171 Huntley Road, Suite J, Columbus, OH 43229), capturing the ground reaction forces exerted by both the “caregiver” and “patient” during the pivot transfer. Hand force gauges using Futek MTA 400 tri-axial load cell (Tri Axial Load Cell Model, 10 Thomas, Irvine CA 92618) were used along with the 3D Static Strength Prediction Program (University of Michigan, Ann Arbor, MI) to measure and calculate compression and shear forces exerted by the “caregiver’s” hands when transferring the “patient.” The hand force gauges were attached to a padded gait belt that the participant donned to be transferred. Two wooden chairs were used for the pivot transfer. The chairs measured 18-inches from the ground to the seat, 31-inches from the ground to the top of the chair back, and the seats were 15.5-inches by 15.5 inches. A 16-bit analog to digital board was used to collect the analog data and all data were collected using a 120 Hz sample rate. Data were smoothed using a dual pass, low pass filter using a 6Hz cut-off frequency.

Dependent Variables and Statistical Analysis

Hand forces and compression and shear forces of the lumbar region were calculated for the caregivers when pivot transferring the “patient.” The heights of the participants were regressed with the associated forces during the transfer. Additionally, repeated measures ANOVAs were used to analyze the difference between heights upon the associated forces.

Procedure

This research was approved by the sponsoring institution’s Biomedical Institutional Review Board (IRB#200215) before study implementation. The researchers obtained consent from every participant prior to date collection, which occurred from July 2014 through November 2014. Height and mass was collected prior to starting the study using a Detecto (Webb City, MO) scale. Reflective markers were placed on the “caregiver’s” body including: head, shoulders, elbows, wrists, back, torso, pelvis, legs, ankles, and feet. Initially, the participant stood on both force plates in anatomical position for the software to record the participant’s ground reaction force as well as the reflective marker positioning on the participant to facilitate marker accuracy.

Two chairs were positioned and oriented at approximately 45º from each other so that the front right corner of the left most chair was close to the front left corner of the right most chair. This is a typical orientation for a pivot transfer to be performed. For each condition, the caregivers pivot transferred the patient/participant from the left most chair to the right most chair. Prior to data collection, the participant was given several practice trials to ensure he or she was able to adjust the amount of effort he or she provided so that the transfer required either a maximum or total assistance rating, by reducing the amount of weight he or she bore through his or her own lower extremities. This was determined when the participant was able to demonstrate the ability to generate less than 50% of his or her body weight during the transfer. The participant was also able to gauge the amount of weight that he or she was bearing through the force plate by watching a display monitor that displayed the amount of weight he or she was bearing. Once the participant was successful at gauging how much weight he or she bore through his or her lower extremities, data collection began and involved transferring the participant two times from one chair to the other going from the participant's (patient's) right to his or her left. Participants were given a 30 second rest in between each pivot transfer.

Results

Data from 22 participants were included in the hand force gauges analysis; data from 17 participants were included in the low back compression and shear force analyses. Due to insufficient marker identification, data from 5 participants were discarded from the low back compression and shear force analyses.

Hand Force

Height ratios were analyzed with hand force when completing the pivot transfer. Ratios were defined as the caregiver's height divided by the patient's height. A regression model yielded a *p*-value of 0.54 for height ratio (See Table 1 and Figure 1). The R^2 value of 0.00916 indicates that the caregiver/patient height ratio does not contribute to explaining the variance in the regression model for the factor of hand forces exerted by the caregiver (See Figure 1). This suggests that height ratio, defined as the difference between the caregiver and patient's physical height, may not be a significant factor in the hand forces required to pivot transfer a patient.

A regression for height was also completed. This regression model revealed a *p*-value of 0.01 for height (See Table 1 and Figure 2). The R^2 value of 0.14727 indicates that the height of the patient does contribute, albeit minimally, to explaining the variance in the regression model for the dependent variable of hand forces exerted by the caregiver (See Figure 2). This result suggests that as a patient increases in height, more hand force will be required from the caregiver to transfer. In Figure 2, the regression line increases in hand force as height increases. Less hand force was required when patients were under 165 cm (See Figure 2).

Back Forces

Completing data analyses for back forces was critical in revealing if an increased height or height ratio required more force from the caregiver to complete a pivot transfer.

Height ratios were analyzed with L4/L5 compression forces (See Table 3). This regression model revealed a *p*-value of 0.28 for height ratio (See Table 3). The R^2 value of 0.0374 indicates that the caregiver/patient height ratio contributes minimally to explaining the variance in the regression model for the factor of L4/L5 compression forces exerted by the caregiver (See Figure 5). Height ratios were also analyzed with L4/L5 forward shear forces (See Table 3). This regression model revealed a *p*-value of 0.98 for height ratio (See Table 3). The R^2 value of 1.9E-05 indicates that the caregiver/patient height ratio does not contribute to explaining the variance in the regression model for the factor of L4/L5 forward shear forces exerted by the caregiver (See Figure 6).

Height regressions were completed with L4/L5 compression forces (See Table 3). This regression model revealed a *p*-value of 0.80 for height (See Table 3). The R^2 value of .00207 indicates that the height of the patient contributed minimally to explaining the variance in the regression model for the factor of L4/L5 compression forces (Figure 3). Height regressions were also completed with L4/L5 forward shear forces (See Table 2). This regression model revealed a *p*-value of 0.32 for height (See Table 3). The R^2 value of .03073 indicates that the height of the patient also contributes minimally to explaining the variance in the regression model for the factor of L4/L5 forward shear forces (See Figure 4).

Discussion

As suggested by Bartnik and Rice (2013), further evidence is needed to support that health care practitioners are exceeding their bodies' physical capabilities and placing themselves at risk for work-related musculoskeletal injuries. The purpose of this study was to investigate the forces required when transferring a patient, using different caregiver physical heights combined with different "patient" heights. Results of this study suggest that a caregiver needs to exert more force in pounds to pivot transfer a patient as a patient increases in height. Therefore, those responsible for manually transferring other people should be aware that as the height of the person needing to be transferred increases, so too does the required hand forces.

The modification to the Revised NIOSH Lifting equation recommended that the maximum weight limit to transfer patients be no more than 35 pounds hand force when in the most ideal conditions (Waters, 2007). In the current study, hand forces exceeded this recommended limit (See Figure 1 and Figure 2). In Figure 2, the regression line illustrates that the height of people who are transferred does contribute to the hand forces required to pivot transfer a patient. Patients with a height of 160 cm or less tend to stay closer to the recommended 35 pound limit recommended by (Waters, 2007). Therefore, the results of this study suggest that the use of alternative lifting equipment be considered during a total assist transfer when patients exceed the height of 160 cm, which could reduce the possibility of a musculoskeletal injury for the caregiver.

Marras et al., (1999) investigated the manual transferring of patients with one of the conditions being a one-person transfer. NIOSH guidelines consider under 3400N to be safe spinal compression, with the maximum limit at 6400N (Health & Services, 1981). In their study, 52% of the one-person transfers exceeded the maximum limit (Marras et al., 1999). Our current study, which involved one-person total assist pivot transfers, had 0% exceed the 6400N limit (See Figure 3, 4, 5, and 6). Furthermore, none of the transfers exceeded the recommended 3400N limit (See Figure 3, 4, 5, and 6). In the Marras study, a one-person hug method was used when transferring the patient (Marras et al., 1999). During the transfer, the patient sat upright in short sitting on the edge of the bed (Marras et al., 1999). The caregiver leaned over toward the patient with the lower extremities staying vertical, bending at the waist with the torso flexing at the hips (Marras et al., 1999). Furthermore, the patient wrapped her arms around the caregiver’s neck, while the caregiver wrapped his arms around the patient’s waist (Marras et al., 1999). It is inferred that this type of transfer involved greater spinal loads compared to the spinal loads experienced by the caregivers in the current study. In the current study, patients were bearing some of his or her own weight because the caregiver used a knee blocking method when pulling on the gait belt to lift the patient (See Figure 7). The key component of this style of pivot transfer obliges the patient to bare his or her own weight because of his or her torso being leaned forward over his or her knees during the initiation of the transfer. Additionally, there is counter pressure provided by the caregiver at the patient’s knees and through the gait belt. It is inferred that this type of pivot transfer involved less spinal loads, reducing the amount of impact on back forces and thus staying under the recommended 3400N limit.

Knapik & Marras (2009) concluded that 20% of the caregiver's body weight be recommended for safe patient handling in a hospital setting. For the two caregiver's in the current study, 20% of his or her body weight would equal 25-lbs for the woman and 39.6-lbs for the man. Data reported indicates these limits were exceeded more often than not during data collection. As seen in Figure 2, as patients increased in height, the hand forces required to transfer the patient increased. All pivot transfers exceeded the recommended limits for these caregivers when patients were at a height of 177 cm or more (See Figure 2). Currently, there are no guidelines that consider the height of a patient for safe patient handling. This research may be the first step in establishing preliminary information that could lead to such guidelines.

Several studies have discovered methods that decrease the amount of work demands on the caregiver while transferring or repositioning a patient. Many of these studies have a similar condition: including an assistive device to use during the transfer to decrease caregiver force required.

Fragala (2011) implemented the use of a gravity assist feature in a bed system to pull up a patient in bed. This repositioning task is required for patients to limit the possibility of pressure ulcers, and put patients in a more proper, comfortable position (Fragala, 2011). When using the gravity assist feature and a sliding sheet, workloads for the caregiver were decreased from 35% to 64%, depending on the bed angle used during the transfer (Fragala, 2011). By combining the use of these assistive devices, the force required by the caregiver was reduced up to 64% (Fragala, 2011).

Fragala and Fragala (2013) employed an ergonomically designed seating positioning system to reposition patients in his or her chair to proper posture. Employing proper posture would reduce the risk of falling out of the chair (Fragala & Fragala, 2013). The need for caregiver assistance to reposition patients have put caregivers at risk for musculoskeletal injuries (Fragala & Fragala, 2013). The utilization of this assistive device limited past procedures to reposition a patient, which required 246% greater exertion than the new method (Fragala & Fragala, 2013).

Barnik and Rice (2013) discovered that friction-reducing slide sheets could be utilized to pull a patient up in bed, requiring less caregiver force than using a traditional cotton sheet typically found in the hospital setting. Although the friction-reducing slide sheets require less caregiver force, every sheet used in the study exceeded the recommended hand force of 35 pounds, with the traditional cotton sheet creating the greatest amount of force at the hands (Bartnik & Rice, 2013). The utilization of a friction-reducing slide sheet could potentially decrease the risk of caregiver musculoskeletal injury.

In the current study involving height and height ratio, it was discovered that height may be a factor in the hand forces required to transfer a patient. As seen in Figure 2, as the heights of the patient increases, more hand force was required by the caregiver to pivot transfer the patient.

Six patients at least 179cm tall were transferred during data collection (See Figure 2). Caregivers used an average of 56.7 pounds of hand force to transfer patients 179cm or taller. When a patient was 180 cm or taller, at least 54 pounds of hand force was required by the caregiver (Figure 2). Seven patients with a height of 157cm or shorter were transferred during data collection (See Figure 2). Caregivers used an average of 38.5 pounds of hand force to transfer patients at a height of 157cm. These findings suggest that for every additional centimeter of height on a patient 157cm or taller, the caregiver will exert, on average, 0.72 more pounds of hand force to pivot transfer the patient. These numbers should be taken into consideration when deciding whether to pivot transfer a patient or alternatively choosing to use an assistive device.

Work-related musculoskeletal injuries affect health professionals and can have deleterious consequences upon the health professional and his or her career.. Rice et al. (2011) found in their survey study of occupational therapy practitioners in Ohio that 12% of the professionals considered leaving the profession early due to patient handling concerns. As the American population ages, there is an increased demand for occupational therapists to help people recover from injuries. In January 2014, TIME reported occupational therapy as one of the top 5 most in-demand jobs (Matthews, 2014). Also in January 2014, the Bureau of Labor Statistics reported that employment of occupational therapists is projected to grow 29 percent from 2012 to 2022, which is much faster than the average for all occupations (Bureau of Labor Statistics, 2014). In 2012, there were 113,200 occupational therapy jobs, while projected employment in 2022 is 146,100 (Bureau of Labor Statistics, 2014). It is imperative that our current and future occupational therapists remain in the profession to keep up with the demand of occupational therapy in the future. If changing the way to transfer patients could decrease the risk of incurring a musculoskeletal injury, SPH methods should be considered to increase the safety of all health professionals.

The height of a patient should be taken into consideration when choosing a transferring method. An appropriate choice can be made based on height of the patient, choosing alternative lifting equipment if the patient’s height dictates that more than 35 pounds of hand force be required. Choosing an appropriate transferring method could further reduce musculoskeletal injuries. It is important to keep in mind, however, that these strategies may not always be available in real-life situations. Recommendations for safe patient handling practices will depend on the facility, the staff availability and preferences, and the physical characteristics of the patients.

Limitations and Future Research

Several limitations in the current study need to be addressed. The pivot transfers were completed in a motion capture lab with rather healthy subjects. It is inferred that caregiver forces may be different in a more natural environment with actual patients. In order to accommodate for the data needed from the hand force gauges, participants were transferred using a padded gait belt with hand force gauges attached. It is possible that while performing the pivot transfer, caregivers used unnatural body mechanics due to holding hand force gauges, rather than being closer to the actual participant to perform a typical transfer. Only one type of transfer was used, with 2 different caregivers. The force at the hands and lower back may be different if a different type of transfer was performed, or if the same technique was implemented by different caregivers. Finally, the full complement of participants was not recruited due to an investigator incurring a musculoskeletal injury to the lower back during data collection. It is recommended that this study be repeated with a larger sample size so results could be generalized to the population while limiting the transfers to the minimal and moderate assistance level.

Conclusion

This study aimed to contribute and identify safer strategies with regard to height when transferring a patient. It was found that the shorter the patient, the less hand force that was required from the caregiver to perform the transfer. Further, it was determined that patients who were taller than 179cm required hand forces in excess of the 35 pound limit established by Waters (2007). As such, it is safer to transfer a taller patient at a height of 179cm or taller using alternative lifting equipment, due to the force needed to physically transfer the patient. The high incidence rate of musculoskeletal injuries could be decreased if the height of the patient were taken into consideration when choosing the method of transfer.

Future research should focus on the efficacy of alternative lifting equipment for transferring patients, as well as alternative methods if lifting equipment is not available. Safe patient handling needs to be implemented in studies to show how these practices can reduce the risk of musculoskeletal injuries.

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Table 1.

Regression ANOVAs for height ratio and total hand force, and height and total hand force

	df	SS	MS	*F*	*p*-value
Height Ratio and Total Hand Force					
Regression	1	83.97	83.97	0.39	0.54
Residual	42	9087.77	216.38		
Total	43	9171.74			
Height and Total Hand Force					
Regression	1	1350.70	1350.70	7.25	0.01
Residual	42	7821.04	186.22		
Total	43	9171.74			

Table 2.

Descriptive Statistics for L4/L5 Compression Forces, Forward Shear Forces, Height Ratio, and Height

	Mean	SD
L4/L5 Compression (N)	1648	576.17
L4/L5 Forward Shear (N)	434.90	79.40
Height Ratio	0.96	0.061
Height (cm)	166.18	8.47

Table 3.

Regression ANOVAs for height ratio and L4/L5 compression forces, for height and L4/L5 compression forces, for height ratio and L4/L5 forward shear, and for height and L4/L5 forward shear

	df	SS	MS	*F*	*p*-value
Height Ratio and Total L4/L5 Compression Force					
Regression	1	20510.91	20510.91	1.23	0.28
Residual	32	533172.84	16661.65		
Total	33	553683.75			
Height and Total L4/L5 Compression Force					
Regression	1	1088.21	1088.21	.063	0.80
Residual	32	552595.54	17268.61		
Total	33	553683.75			
Height Ratio and Total L4/L5 Forward Shear Force					
Regression	1	0.20	.20	0.001	0.98
Residual	32	10514.99	328.60		
Total	33	10515.18			
Height and Total L4/L5 Forward Shear Force					
Regression	1	323.11	323.11	1.01	0.32
Residual	32	10192.07	318.50		
Total	33	10515.18			

Figure 1.

Height Ratio and Hand Force required by Caregiver

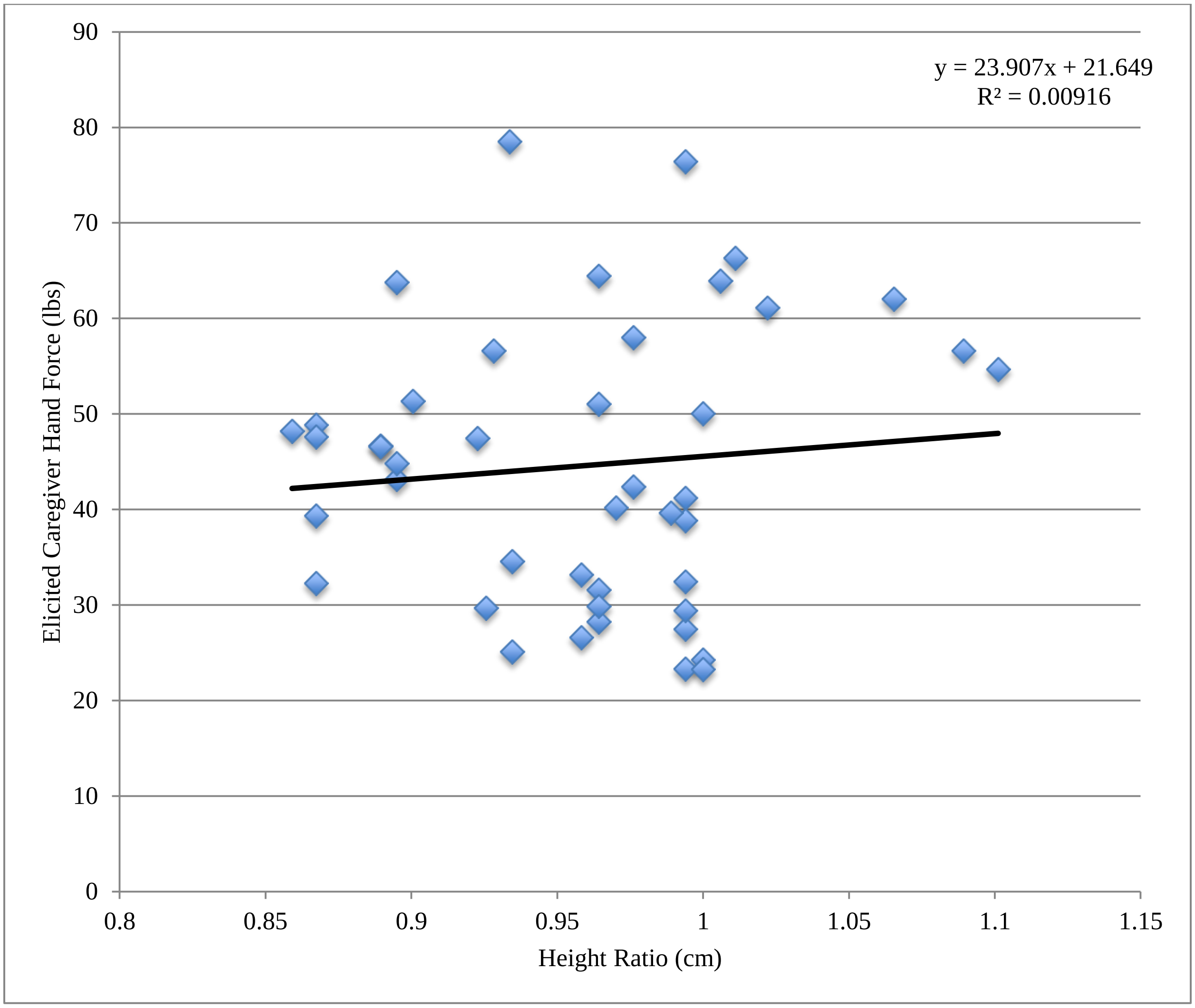

Figure 2.

Height of the Patient and Hand Force required by Caregiver

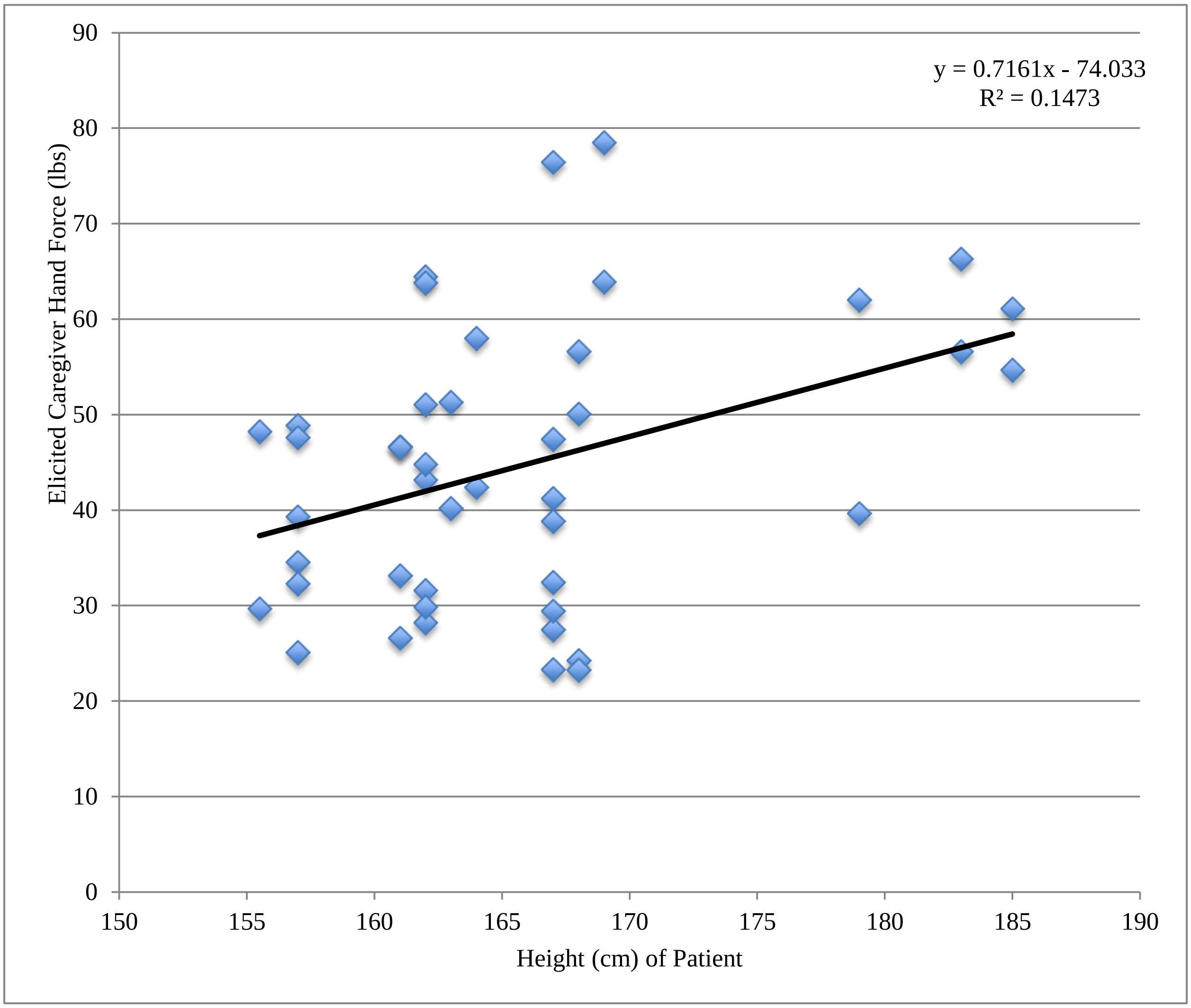

Figure 3.

Height of patient and L4/L5 Compression Forces exerted on Caregiver

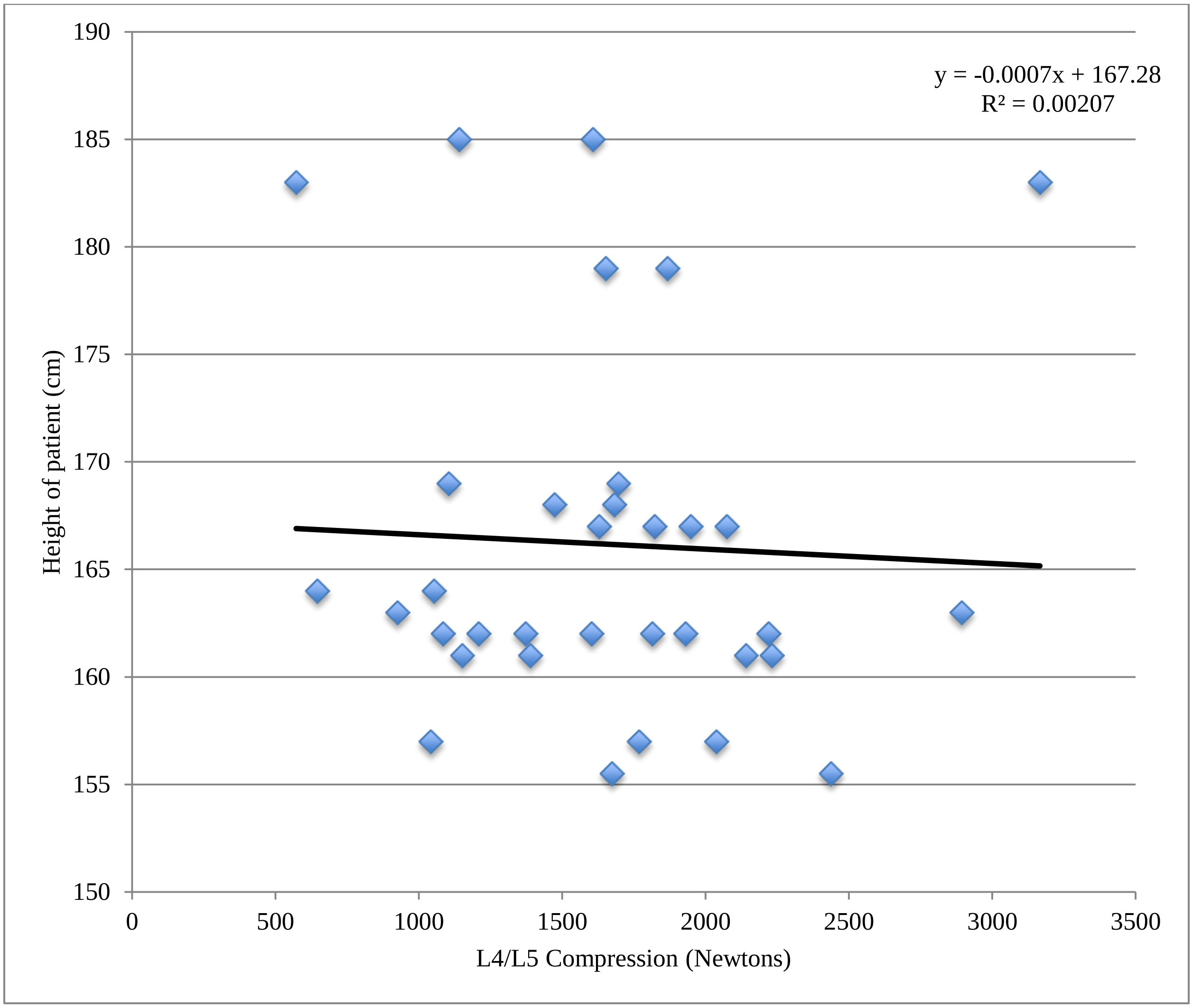

Figure 4.

Height of patient and L4/L5 Forward Shear Forces exerted on Caregiver

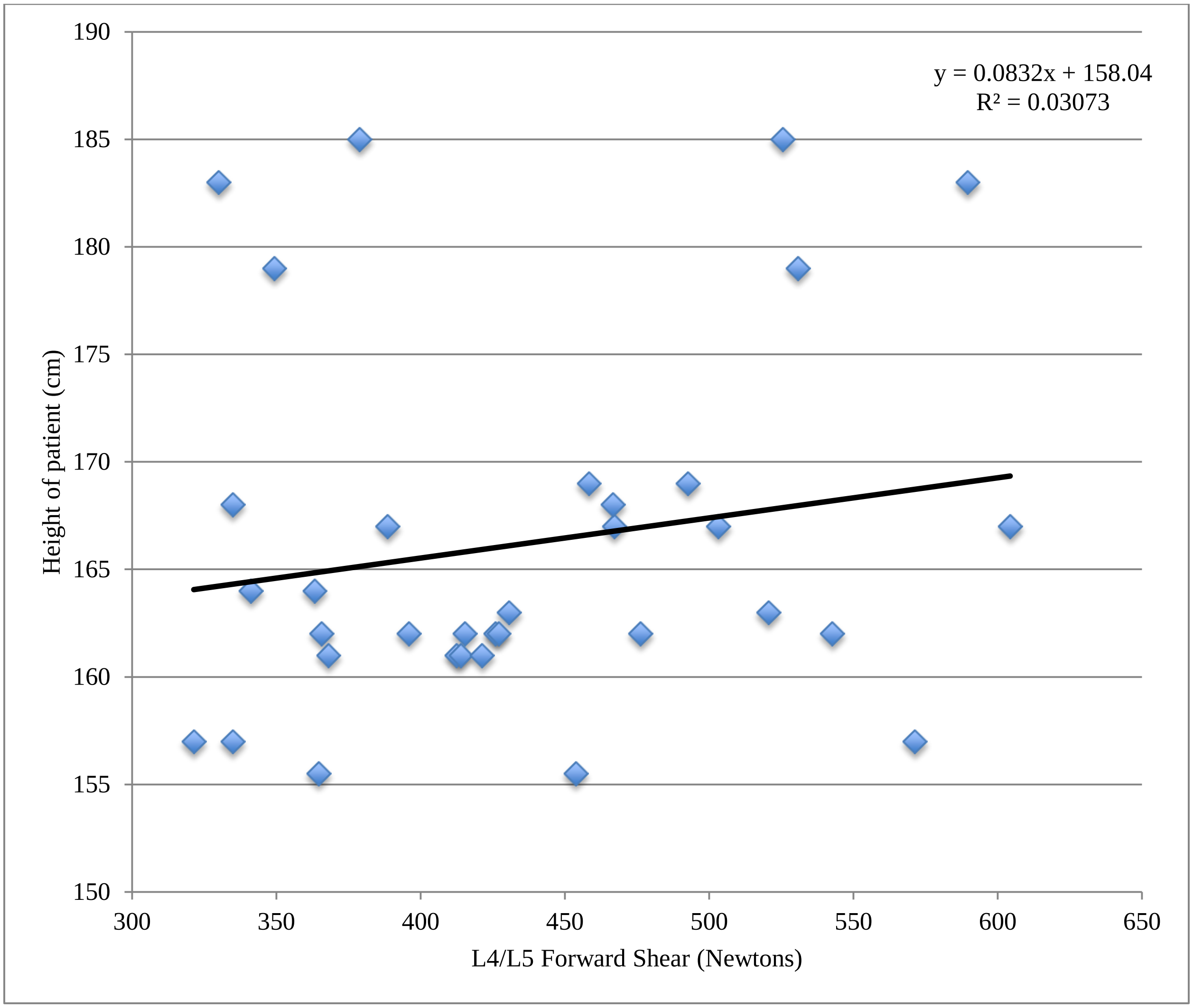

Figure 5.

Height Ratio and L4/L5 Compression Forces exerted on caregiver

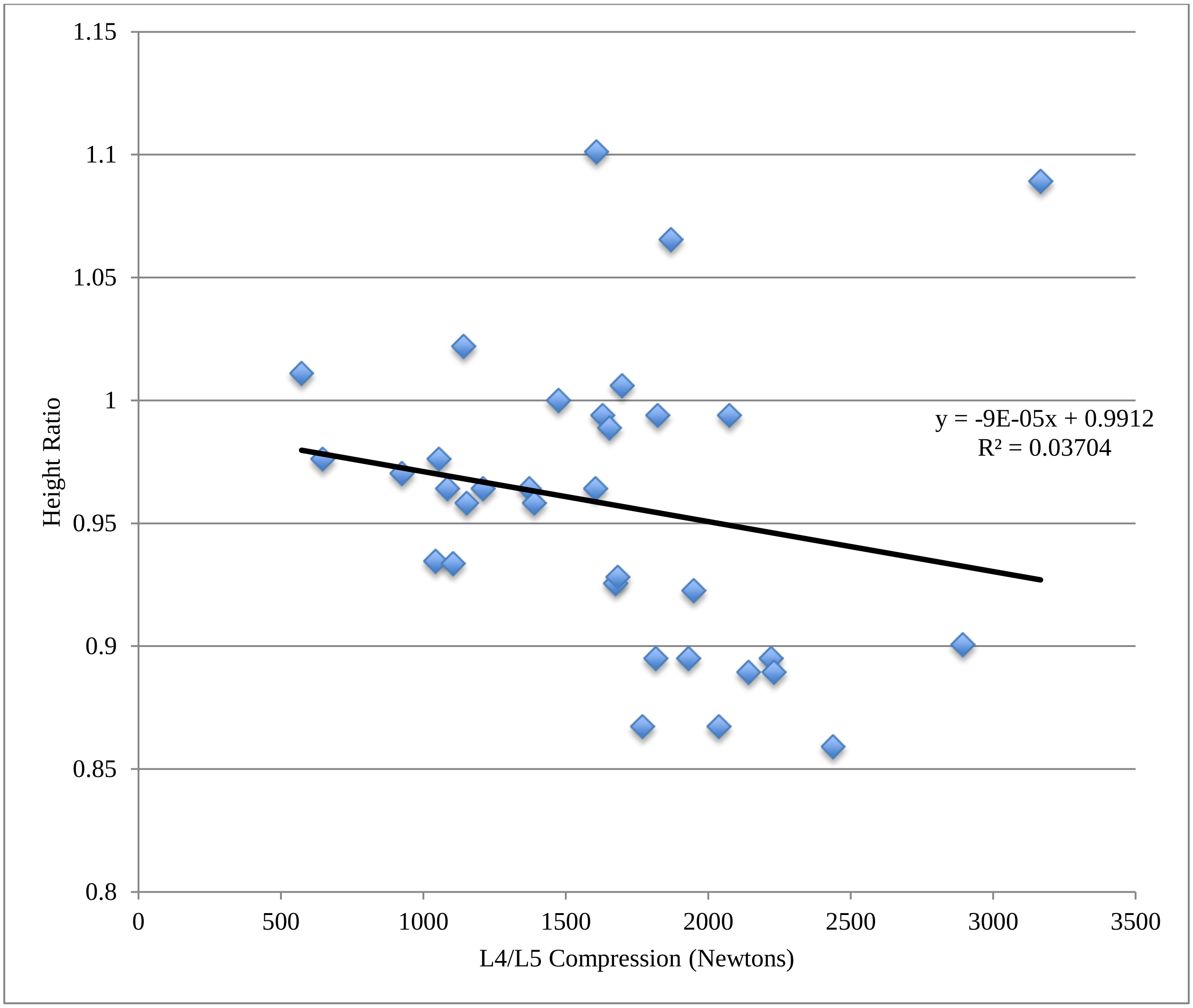

Figure 6.

Height Ratio and L4/L5 Forward Shear Forces exerted on Caregiver

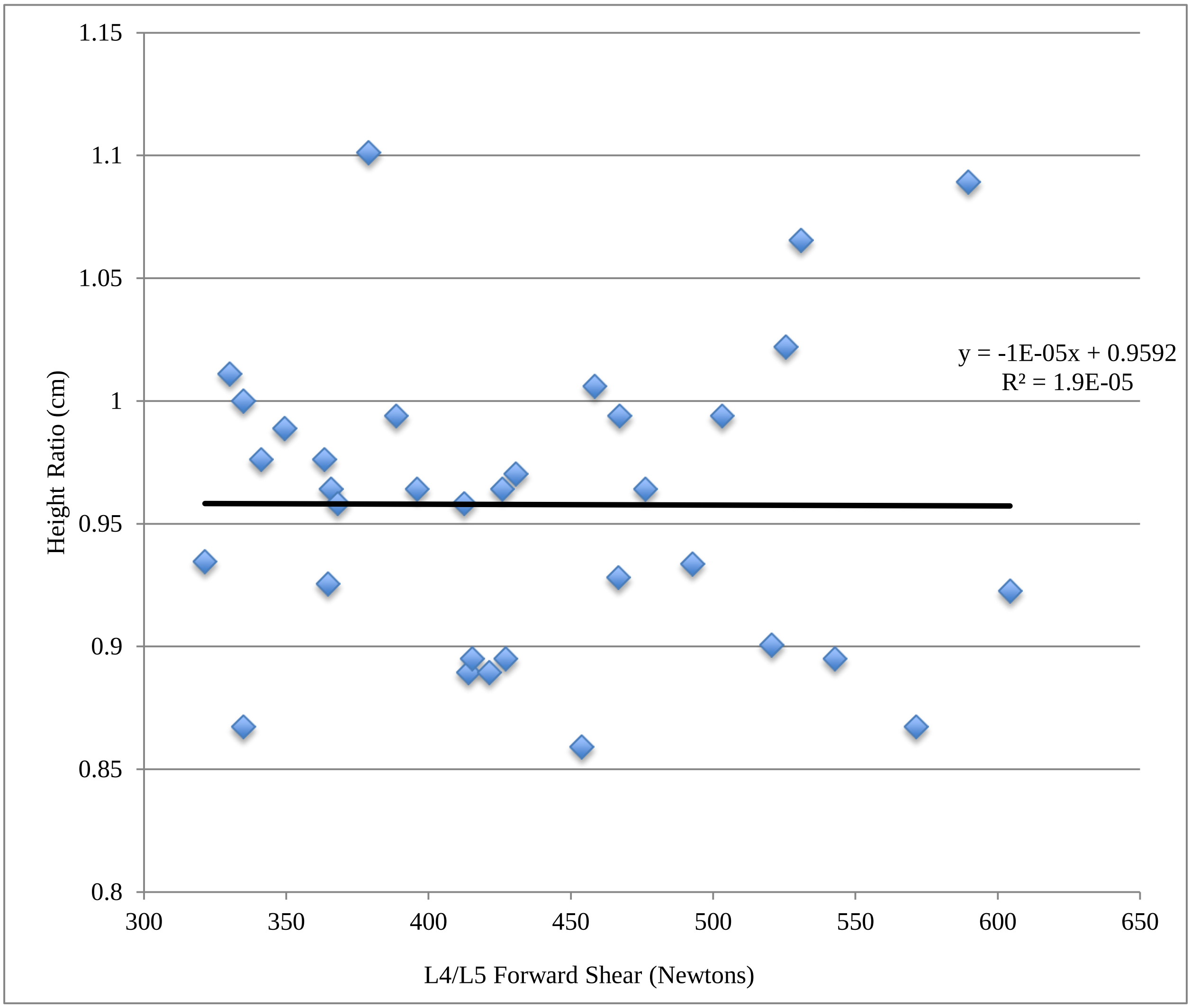

Figure 7.

Current study's pivot transfer method