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The differences between normal and obese patient handling: re- structural analysis of two questionnaires

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Abstract

Background Precise causes of musculoskeletal complaints among nurses are not known well, but many studies have pointed to manual patient handling tasks. Subjective judgment and decision-making process for patient lifting is crucial for gathering data regards patient handling. The aim of this study was to consider reliability and validity and re-structure of two special tools for patient handling's tasks.

Methods In this cross- sectional study 249 nurses were fully participated. As recommended by literature for cultural adaptation of instruments, forward/backward translation method was applied. Reliability of the translated version was assessed by Cronbach's alpha coefficient. Validity testing for the two scales was based on content validity index/ratio analysis and also Exploratory Factor Analysis was run to extract latent factors.

Results Reliability estimated by internal consistency reached a Cronbach's Alpha of above 0.7 for all subscales of two questionnaires. After testing the validity, the final version of questionnaires was remained by 14 and 15 questions respectively.

Conclusions These instruments evaluated for manual handling of normal and obese patients had acceptable validity and reliability in Iranian Nursing context. So, these tools can be used in further studies with the same cultures.

Keywords Patient transfer, Musculoskeletal diseases, Moving and lifting patients, Patient safety, Validation study

Background

Musculoskeletal disorders (MSDs) are known as a crucial problem that nurses must endure it because of their duties [1, 2]. This fact also was pointed out in recent original [3, 4] and literature review [5] studies. The precise causes of musculoskeletal complaints among nurses are not known well [6] but many studies have pointed to manual patient handling tasks [1, 7]. Maybe that is why the safe transferring and handling patients have remained as an ergonomic concern in healthcare systems worldwide [8, 9].

It is true that complete avoidance of manual patient handling was a crucial health recommendation for nurses [1], but manually ambulating and repositioning

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patients occurs frequently in daily work activities of nurses and caregivers [2, 3]. Nowadays it is well-believed that manual patient-handling is a physically demanding task [1, 2] and that is accounted for up to 72% of MSDs cases among hospital workers [7, 10]. When nurses manually handle patients, the recommended maximum compression force which was advised by The National Institute for Occupational Safety and Health (NIOSH) of the United State of America can easily reach (3400 Newtons). But when appropriate patient-handling equipment is used the physical burden might be reduced to a safe level [11, 12]. Elnitsky has showed that with positioning, lifting and transferring patients, nurses experience high prevalence of MSDs [13]. Also results of a large prospective cohort study demonstrated that nurses with daily patient-handling tasks had the more risk of MSDs problems in comparison to nurses without daily patient-handling [14].

Indeed, it is true that accessing to a variety of patient-handling instruments, good ergonomic intervention and training may decrease the chance of nurses' physical health problems [15–17], but studying manual patient handling is still a challenging topic [18]. So it can be claimed that in addition to objective studies, the study of manual handling of patients according to the subjective data can also have an effective role in improving nurses' working conditions [19, 20]. In patient handling duties based on the patient body mass, awkwardness and unpredictable nature of the task and environment, subjective judgment of nurses and health professionals about patient handling task must be considered [21, 22]. For this reason in some studies nurses' subjective judgment and decision making process for patient lifting is discussed [23–25].

One of the most important parameters in the subjective judgment of the healthcare staffs when performing a manual patient handling task is the body mass of prospective patient. Recent studies have shown that as the body mass of the patient increases, the risk of musculoskeletal disorders enhances in the carrier [18, 26, 27]. Having information about the reliability and validity of subjective tools on the topic of patient handling in different countries and cultures can be a great help in assessing nurses' work situations [20]. These tools are more valuable when they include information such as patient body mass in data collection [19, 28].

The validity and reliability of the two tools (one is especially for super heavy obese patients) for assessing nurses' perception regards to manual patient handling were addressed and second aim of the current study was to test the following hypothesis:

- H_0 : Nurses' perception of carrying super heavy and obese patients differs from their perception of carrying normal patients.

Methods

Study design, setting, and participants

This cross-sectional study was done between August and December 2019 in the in the educational hospitals of two cities in Iran. In coordination with the nursing team, participants were enrolled from the nurses and other patient handlers. The current study assessed a sample size of 350 participants who performed patient handling in the hospitals. A sample of 350 patient handlers was participated from these hospitals. Patient handlers whom they didn't accept defined procedures were excluded from the study. The inclusion criterion included all patient handlers who have done patient handling for minimum 1 year. From all, 249 participants were remaining to the end of the research.

The original instruments

Nurses' attitudes regarding the safe handling of patients who are morbidly obese

This questionnaire includes 26 questions with 5-point Likert (strongly agree to strongly disagree). In addition, a set of demographic questions were asked. At the beginning of the questionnaire, the definitions of super heavy and obese patients were explained and six of 26 items, were asked about obesity (e.g., I believe obesity is due to lack of self-control). The content validity index and test-retest reliability scores were reported as satisfactory by authors. All of 26 items were classified into nine subscales including: Nurses' perception of stress/ demands of patients' handling who are morbidly obese, Nurses' perception of controllable factors of obesity, Nurses' motivation to use safe handling equipment with patients who are morbidly obese, Nurses' perception of time/workload involved in SPH of patients who are morbidly obese, Nurses' perception of nursing peers' responses to patients who are morbidly obese, Nurses' perceived confidence in assessing safe handling needs of patients who are morbidly obese, Nurses' perception of safety as a priority, Nurses' perception of uncontrollable factors of obesity, Nurse's own response to patients who are morbidly obese [19].

Safe patient handling perception scale

This tool was introduced by some researchers affiliated to U.S.A. The aim of this 17-item questionnaire was to assess perceptual risk of musculoskeletal disorders in the healthcare context. Seventeen items were grouped into 3 themes according to factor structure analysis: knowledge

(11 item), practice (3 item), and resource accessibility (3 item). Alpha score was reported for each subscale which was 0.886, 0.901 and 0.855 for knowledge, practice and accessibility subscales, respectively. The authors stated that this measure can be used to assess employee perceptions of safe patient handling policies and practices. The 5-point Likert scoring was used to gather the data [20].

Translation procedure

As recommended by literature, linguistic validation technique was used. Translation of the questionnaire from English to Persian was done by two bilingual qualified translators. They had a long experience in occupational health and Ergonomics. Main researcher of the current study prepared the final Persian version of two mentioned translated questionnaires due to the agreement between their similarities. Afterwards, a great specialist of occupational health and Ergonomics, who was blinded about the original version of the questionnaire, translated the Persian version back into English. Finally, this English version was sent to the corresponding author of the main paper that allowed us to utilize their questionnaire and she confirmed the translation [19, 20]. The aim of this step was to ensure that the content is identical to the original one. The original and back-translated versions were checked by the research team of current study completely, and final version of the questionnaire in Persian was prepared.

Reliability assessment

Reliability of the translated version was assessed by Cronbach’s alpha coefficient which estimates the internal consistency of tools [29]. This procedure was calculated based on item-total correlation and estimate of alpha on which an item was removed from the scale. If 70% of the variance of the observed score was systematic, and the left 30% was due to random errors, the alpha was reported as 70% and considered acceptable.

Validity assessment

Validity testing for the two scales was based on content validity index/ratio analysis. An expert panel consisting of nurses and other caregivers that doing patient handling tasks [5] and Occupational Ergonomists [5] were participated in this stage. The Lawshe’s method for analysis of Content Validity Ratio (CVR) was used in the present study [30]. Responses of experts for each item were divided into three categories, including: "necessary", "useful, but unnecessary" and "Unnecessary". The CVR calculated according to completed questionnaires as depicted below:

Table 1 Description of qualitative parameters of patient handlers

Variable	N	Percentage
Gender		
Woman	130	52.6
Man	117	47.4
Position		
Nurse	86	36.3
First Aider	41	17.3
Assistance	77	32.5
Service Personnel	33	13.9
Education		
Diploma and lesser	47	20.3
Upper diploma	70	30.2
Bachelor	108	46.6
Upper bachelor	7	3
Marital Status		
Single	97	41.5
Married	131	56
Divorced	6	2.6
Chronic OR acute MSDs		
Yes	102	41.1
No	146	58.9
Course Ergonomics		
Yes	159	64.4
No	88	35.6
Regular Exercise		
Yes	127	51
No	122	49
Physical Health Status		
Good	79	31.7
Mean	137	55
Bad	33	13.3

$$CVR = \frac{ne - \frac{N}{2}}{\frac{N}{2}}$$

ne: number of persons responding to requested questions

N: total number of experts.

Table 2 Description of quantitative demographic parameters of participants

Variables	N	Min	Max	Mean	Std. Dev
Age	235	17	72	35.38	11.858
Experience	192	1	22	7.02	5.257
Stature	166	147	192	163.64	22.454
Body Mass	170	61	115	67.85	13.376

Simplicity, relevancy and clarity were considered by experts separately to be scored in evaluating the CVI in a Likert scale. Simplicity, relevancy and clarity were considered by experts separately to be scored in evaluating the CVI in a Likert scale.

Data analysis

Descriptive analyses were carried out to describe the patient handlers’ characteristics. Kolmogorov–Smirnov was used to assess normal distribution of data. After checking the CVR and CVI, for testing the validity of instruments, an Exploratory Factor Analysis was run to extract latent factors [31, 32]. The standard Eigenvalue greater than one and scree plot was used to specify the number of extracted factors. For testing reliability of instruments, Cronbach’s alpha, a measure of internal consistency, was calculated for each sub-component. Kruskal-Wallis Test or Mann–Whitney U was used. Analyses were conducted by SPSS. A significance level of 0.05 was utilized for testing the hypothesis.

Ethical approval

This study was approved by the ethical committee of Hamadan University of Medical Sciences (Reference: 980210777). The nursing management of each ward was also approved the procedure. Written consent was obtained from all of 249 patient handlers.

Results

Totally 247 nurses and other patient handlers were participated. Each nurse answered two mentioned questionnaires which one of them was designed for handling of super heavy and obese patients. In this section, descriptive characteristics of participants and the reliability and validity of two questionnaires have presented respectively.

Description of participants

One hundred seventeen participants were male. Only 36% of participants were nurses and most of them had bachelor’s degree in nursing field. More than 40% of them declared that they had previous musculoskeletal pain. As results have shown in Table 1, more than 85% of them reported their health status as good or moderate and 63% of them had heard about Ergonomics or previously passed a related course. Other descriptive results present in Table 2.

Reliability and validity of two questionnaires

Nurses’ attitudes regarding the safe handling of patients who are morbidly obese

This questionnaire assess was about super heavy and obese patients’ handling. The initial version of this instrument had 26 questions in nine subscales. Calculating content validity index and content validity ratio

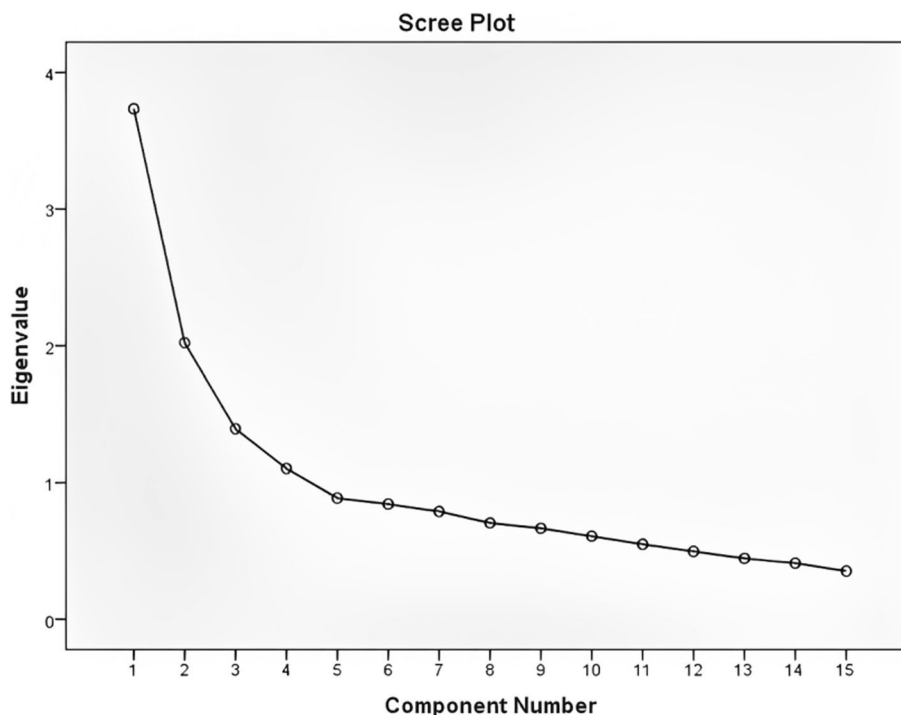


Fig. 1 Score plot of remained item in questionnaire

Table 3 Results of rotated component matrix

Questions	Components			
	1: Experience	2: Perception	3: Attitude	4: Judgment
Q10: It is important to use lifting equipment for moving a patient with morbid obesity in order to protect myself from injury	0.759			
Q13: Workers' injuries while handling patients can be predicted by using lifting equipment	0.644			
Q11: I am confident in assessing the level of assistance needed for patients who are morbidly obese	0.679			
Q07: It is time consuming to transfer a patient with morbid obesity from bed to chair by using patient-handling equipment	0.613			
Q09: It is time consuming to move or position the patients with morbid obesity by using patient relocation device	0.499			
Q06: It is important to use lifting equipment to move patients with morbid obesity	0.695			
Q04: If I am given the choice, I would prefer not to take care of patients with morbid obesity		0.768		
Q02: Taking care of patients who are obese is stressful for me		0.659		
Q03: Taking care of patients with morbid obesity is physically high demanding		0.582		
Q05: Many nurses I work with have negative reactions toward patients who are morbidly obese		0.719		
Q14: It is often so easier to apply manual handling techniques than using lifting equipment in the case of patients with morbid obesity			0.785	
Q08: I often use lifting equipment when working with patients who are morbidly obese			0.571	
Q16: In general, staff safety is considered as a priority by the nurses and the managers in my work unit			0.510	
Q15: In general, patient safety is considered as a priority by the nurses and the managers in my work unit				0.798
Q17: My workload interferes with my ability to use lifting equipment in order to handling patients				0.592
Reliability of Subscales based on Cronbach's alpha coefficient	0.766	0.780	0.781	0.736

based on opinion of 4 lay and 5 academic experts, caused 11 items' deletion (CVR < 0.78). Analyzing factor structure revealed new structure with 4 new components and 15 questions. Due to the acceptable level of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (0.777) and Bartlett's Test of Sphericity (*p*-value < 0.001) 15 remained questions were categorized in four subscales. Score plot of these items depicted in Fig. 1.

The questions, their subscale, and reliability score of the questionnaire were presented in Table 3.

Safe patient handling perception scale

This instrument initially introduced with 17 items which were categorized in three subscales including: knowledge, Practice and Resource accessibility. In

Table 4 Results of KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		0.830
Bartlett's Test of Sphericity	Approx. Chi-Square	1131.314
	df	91
	Sig	< 0.001

current study 3 items (8, 9 and 13) were excluded based on expert panel team's opinion (CVR < 0.62). Table 3 illustrates the results of sample adequacy and Sphericity based on KMO and Bartlett's Tests.

Results of total variances explained in Table 4. Based on the results, a new questionnaire with two subscale and 14 items were introduced for further studies. The reliability score of each subscale was presented in Table 5.

Also, Table 6 illustrates the results of principal Component Analysis with Kaiser Normalization Varimax which proposed new subscales and their related items.

Relationship between demographic variables and the questionnaires

Only stature and body mass from quantitative variables and educational level, official position and passed Ergonomics courses from qualitative variables had significantly correlated by mean score of two questionnaires (Table 7). As the results in Table 8, mean score of the questionnaires are increasing with passing Ergonomics courses, reporting good subjective health status and increasing in education level of participants.

Table 5 Total variance explained for new questionnaire

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.792	34.232	34.232	4.088	29.197	29.197
2	2.133	15.233	49.464	2.837	20.267	49.464

Differences between perception of patient handlers in regards to handling of normal and super heavy patients
 Because of abnormality of the data, Wilcoxon Signed Ranks Test used to assess the differences of perception. The 2-tailed assumption was used to investigate this difference. Results showed that patient handlers differentiate between various handling situations of normal and obese patients (Table 9).

Discussion

The aim of the present study was to shed light on the applicability of two well-psychometrically instruments for patient handling and surveying differences between patient handlers’ perception of handling normal and obese patients. Also, the results of re-structural analysis and Persian adopted version are included. According to the results, there was a significant difference between the perception of carrying obese and normal body mass patients.

There is a same point in the literature review that occupational complaints increase whenever nurses and nursing assistants involve in handling of overweight or obese patients [27]. This issue has also stated in ‘Best Practices

for Safe Handling of the Morbidly Obese Patient’ [33]. Moreover a recent study by Ugras et al. has demonstrated nurses’ reluctance to move obese patients [34]. Patients’ body mass is considered as a crucial parameter in a newly introduced Risk Index for patient handling [9]. In addition the differences between handling of heavy and normal patients has been considered as a hot topic in other emergency workers [18].

Others results showed that the reliability and validity of Persian adopted version of Safe Patient Handling Perception Scale and Nurses’ Attitudes Regarding the Safe Handling of Patients Who Are Morbidly Obese, were satisfactory. In line with this cross-cultural study, subjective judgment of patient handlers in analysis of their work considered in other studies [28, 35, 36], and cross-cultural studies are common in examining the nurses’ work environment [37]. Acceptable level of validity and reliability scores were similar to other studies [38, 39]. It was possible to remove questions due to low reliability in cross cultural assessment of patient handling and patient transfer studies [40, 41].

Alongside all other relevant studies, reliability of Persian version of Safe Patient Handling Perception Scale

Table 6 Results of rotated component matrix

Questions	Component	
	1: Work Awareness	2: Work Culture
Q2: I am able to identify the high-risk patient-handling tasks prior to moving a patient	0.774	
Q3: Safe patient-handling training prepares me to do patient-handling tasks in my workplace	0.748	
Q1: Patient assessments including handling tasks, equipment, space, time and safety concerns	0.714	
Q4: Compared to the last year, my job has become more demanding in terms of physical tasks this year	0.684	
Q8: I feel comfortable asking my colleagues to help me move a patient	0.659	
Q9: I report all patient-handling-related injuries to my supervisors when an injury occurs	0.591	
Q6: I understood the policy of the safe patient handling in my work setting	0.588	
Q5: I can perform safe patient-handling tasks without hurting myself or patients	0.550	
Q10: The content of safe patient-handling training is satisfactory	0.526	
Q13: The proper patient handling equipment is accessible		0.803
Q14: The patient handling equipment is regularly maintained		0.742
Q12: The quality of the patient lifting equipment is satisfactory		0.726
Q11: The frequency of safe patient-handling training is satisfactory		0.686
Q7: The safe patient handling policy in my complex is accessible to me		0.455
Reliability of Subscales based on Cronbach’s alpha coefficient	0.836	0.748

Table 7 Correlation between quantitative variables and mean score of questionnaires

Variable	Questionnaire 1		Questionnaire 2	
	Spearman correlation	P-value	Spearman correlation	P-value
Age	-0.252	0.212	-0.216	0.106
Work Experience	0.033	0.645	0.124	0.087
Stature	0.303	<0.001	0.234	0.002
Body Mass	0.268	<0.001	0.17	0.027

Table 8 Correlation between qualitative variables and mean score of questionnaires

Variable	Questionnaire 1		Questionnaire 2	
	Z-Score or Chi-Square	P-value	Z-Score or Chi-Square	P-value
Gender	-0.611	0.541	-0.858	0.391
Chronic OR Acute MSDs	-1.629	0.103	-0.165	0.869
Course Ergonomics	2.295	0.022	3.082	0.002
Doing Regular Exercise	-0.926	0.354	-3.942	<0.001
Official Position	20.875	<0.001	15.463	0.001
Education level	19.527	<0.001	11.201	0.011
Marital Status	1.226	0.542	0.799	0.671
Subjective Health status	19.329	<0.001	4.563	0.102

was remained acceptable such as its original version [20]. To the best of our knowledge, other translated versions of mentioned questionnaire in current study were not introduced yet. Also the Persian version of Nurses' Attitudes Regarding the Safe Handling of Patients Who Are Morbidly Obese also had a good reliability score like its Original version [19].

The limitation of the current study was the sample size, which may have influenced the power of the study. It's recommended to increase the acceptability of these questionnaires in future studies for other cultures.

Table 9 Wilcoxon signed ranks test for analysis of differences between perceptions of patient handlers

Ranks		N	Mean rank	Sum of ranks
Ques1-Ques2	Negative Ranks	25 ^a	41.92	1048.00
	Positive Ranks	221 ^b	132.73	29,333.00
	Ties	1 ^c		
	Total	247		
Sig. (2-tailed)	P < 0.001			

^a Ques1 < Ques2

^b Ques1 > Ques2

^c Ques1 = Ques2

Conclusions

These two instruments evaluated for manual handling of normal and obese patients had acceptable validity and reliability among Iranian Nursing. So they can be used in further studies with the same cultures to assess patient handling task from patient handlers' point of view.

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Authors' contributions

RH and AM designed the study. SM and HS collected the data. KHG and PkR analyzed the data. Initial draft of manuscript is prepared by all authors. And the final version of the manuscript is approved by all of them.

Availability of data and materials

All data generated or analyzed during this study are included in this published article. Also, more information can be asked on the reasonable request from corresponding author.

Declarations

Ethics approval and consent to participate

This study was approved (Reference: 980210777) by the ethical committee of Hamadan University of Medical Sciences. all methods were performed in accordance with the relevant guidelines and regulations by our national guidelines and also Helsinki recommendations. Written Informed consent was obtained from all participants.

Consent for publication

Not applicable

Competing interests

The authors declare no competing interests.

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References

- Risør BW, Casper SD, Andersen LL, Sørensen J. A multi-component patient-handling intervention improves attitudes and behaviors for safe patient handling and reduces aggression experienced by nursing staff: a controlled before-after study. *Appl Ergon.* 2017;60:74–82.
- Lee S-J, Lee JH. Safe patient handling behaviors and lift use among hospital nurses: a cross-sectional study. *Int J Nurs Stud.* 2017;74:53–60.
- Kayser SA, Wiggermann NE, Kumpar D. Factors associated with safe patient handling practice in acute care and its relationship with patient mobilization: a cross-sectional study. *Int J Nurs Stud.* 2019;104:103508.
- Cheung K, Dai J, Cheung CL, Cho HK, Chow YL, Fung KY, et al. The biomechanical evaluation of patient transfer tasks by female nursing students: with and without a transfer belt. *Appl Ergon.* 2020;82:102940.
- Davis KG, Kotowski SE. Prevalence of musculoskeletal disorders for nurses in hospitals, long-term care facilities, and home health care: a comprehensive review. *Hum Factors.* 2015;57(5):754–92.
- Garg A, Kapellusch JM. Long-term efficacy of an ergonomics program that includes patient-handling devices on reducing musculoskeletal injuries to nursing personnel. *Hum Factors.* 2012;54(4):608–25.
- Kim H, Dropkin J, Spaeth K, Smith F, Moline J. Patient handling and musculoskeletal disorders among hospital workers: analysis of 7 years of institutional workers' compensation claims data. *Am J Ind Med.* 2012;55(8):683–90.
- Hurtado DA, Dumet LM, Greenspan SA, Rodriguez YI. Social Network Analysis of peer-specific safety support and ergonomic behaviors: An application to safe patient handling. *Appl Ergon.* 2018;68:132–7.

9. Larouche D, Bellemare M, Prairie J, Hegg-Deloye S, Corbeil P. Overall risk index for patient transfers in total assistance mode executed by emergency medical technician-paramedics in real work situations. *Appl Ergon*. 2019;74:177–85.
10. Lipscomb HJ, Schoenfish AL, Myers DJ, Pompeii LA, Dement JM. Evaluation of direct workers' compensation costs for musculoskeletal injuries surrounding interventions to reduce patient lifting. *Occup Environ Med*. 2012;69(5):367.
11. Daynard D, Yassi A, Cooper JE, Tate R, Norman R, Wells R. Biomechanical analysis of peak and cumulative spinal loads during simulated patient-handling activities: a substudy of a randomized controlled trial to prevent lift and transfer injury of health care workers. *Appl Ergon*. 2001;32(3):199–214.
12. Essendrop M, Andersen TB, Schibye B. Increase in spinal stability obtained at levels of intra-abdominal pressure and back muscle activity realistic to work situations. *Appl Ergon*. 2002;33(5):471–6.
13. Elnitsky CA, Lind JD, Rugs D, Powell-Cope G. Implications for patient safety in the use of safe patient handling equipment: a national survey. *Int J Nurs Stud*. 2014;51(12):1624–33.
14. Andersen LL, Burdorf A, Fallentin N, Persson R, Jakobsen MD, Mortensen OS, et al. Patient transfers and assistive devices: prospective cohort study on the risk for occupational back injury among healthcare workers. *Scand J Work Environ Health*. 2014;1:74–81.
15. Tullar JM, Brewer S, Amick BC, Irvin E, Mahood Q, Pompeii LA, et al. Occupational safety and health interventions to reduce musculoskeletal symptoms in the health care sector. *J Occup Rehabil*. 2010;20(2):199–219.
16. Thomas DR, Thomas YLN. Interventions to reduce injuries when transferring patients: a critical appraisal of reviews and a realist synthesis. *Int J Nurs Stud*. 2014;51(10):1381–94.
17. Carayon P, Kianfar S, Li Y, Xie A, Alyousef B, Wooldridge A. A systematic review of mixed methods research on human factors and ergonomics in health care. *Appl Ergon*. 2015;51:291–321.
18. Lavender SA, Sommerich CM, Bigelow S, Weston EB, Seagren K, Pay NA, et al. A biomechanical evaluation of potential ergonomic solutions for use by fire-fighter and EMS providers when lifting heavy patients in their homes. *Appl Ergon*. 2020;82:102910.
19. Bejciy-Spring S, Vermillion B, Morgan S, Newton C, Chucta S, Gatens C, et al. Nurses' attitudes regarding the safe handling of patients who are morbidly obese: instrument development and psychometric analysis. *J Nurs Meas*. 2016;24(3):340–55.
20. White-Heisel R, Canfield JP, Young-Hughes S. Examining the factor structure and reliability of the safe patient handling perception scale: an initial validation study. *Rehabil Nurs*. 2017;42(3):164–71. <https://doi.org/10.1002/rmj.262>.
21. Ngo M, Schneider-Kolsky M, Baird M. The attitudes of Australian radiography students towards the use of assistive transfer devices to reduce biomechanical stress in the clinical setting. *Radiography*. 2013;19(2):125–9.
22. Nelson A, Matz M, Chen F, Siddharthan K, Lloyd J, Fragala G. Development and evaluation of a multifaceted ergonomics program to prevent injuries associated with patient handling tasks. *Int J Nurs Stud*. 2006;43(6):717–33.
23. Kanaskie ML, Snyder C. Nurses and nursing assistants decision-making regarding use of safe patient handling and mobility technology: a qualitative study. *Appl Nurs Res*. 2018;39:141–7.
24. Holman GT, Ellison KJ, Maghsoodloo S, Thomas RE. Nurses' perceptions of how job environment and culture influence patient handling. *Int J Orthopaedic Trauma Nurs*. 2010;14(1):18–29.
25. Lafleur B, Weaver TB, Tondat A, Boscart V, Laing AC. Manual patient transfers: factors that influence decisions and kinematic strategies employed by nursing aides. *Ergonomics*. 2019;62(4):565–74.
26. Réminiac F, Jouan Y, Cazals X, Bodin J-F, Dequin P-F, Guillon A. Risks associated with obese patient handling in emergency prehospital care. *Prehosp Emerg Care*. 2014;18(4):555–7.
27. Choi SD, Brings K. Work-related musculoskeletal risks associated with nurses and nursing assistants handling overweight and obese patients: a literature review. *Work*. 2016;53(2):439–48.
28. Kindblom-Rising K, Wahlström R, Nilsson-Wikmar L, Buer N. Nursing staff's movement awareness, attitudes and reported behaviour in patient transfer before and after an educational intervention. *Appl Ergon*. 2011;42(3):455–63.
29. Gliem JA, Gliem RR. Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Midwest research-to-Practice Conference in Adult, Continuing, and community*;2003.
30. Gilbert GE, Prion S. Making sense of methods and measurement: Lawshe's content validity index. *Clin Simul Nurs*. 2016;12(12):530–1.
31. Harerimana A, Mtshali NG. Using exploratory and confirmatory factor analysis to understand the role of technology in nursing education. *Nurse Educ Today*. 2020;92:104490.
32. Gorsuch RL. Exploratory factor analysis. *Handbook Multivariate Exp Psychol*. 1988:231–58. https://link.springer.com/chapter/10.1007/978-1-4613-0893-5_6.
33. McGinley LD, Bunke J. Best practices for safe handling of the morbidly obese patient. *Bariatric Nurs Surg Patient Care*. 2008;3(4):255–60.
34. AltunUğraş G, Yüksel S, Erer MTI, Kettaş E, Randa S. are nurses willing to provide care to obese surgical patients? *Bariatric Surg Pract Patient Care*. 2017;12(3):116–22.
35. Chen B-A, Chien H-H, Chen C-C, Chen H-T, Jeng C. Patient transfer decision difficulty scale: development and psychometric testing of emergency department visits by long-term care residents. *PLoS One*. 2019;14(2):e0210946.
36. Villarroya A, Arezes P, Díaz-Freijo S, Fraga F. Comparison between five risk assessment methods of patient handling. *Int J Ind Ergon*. 2016;52:100–8.
37. Kim H-J, Abraham I. Measurement of fatigue: comparison of the reliability and validity of single-item and short measures to a comprehensive measure. *Int J Nurs Stud*. 2017;65:35–43.
38. Radovanovic CAT, Alexandre NMC. Validation of an instrument for patient handling assessment. *Appl Ergon*. 2004;35(4):321–8.
39. Villarroya A, Arezes P, Díaz de Freijo S, Fraga F. Validity and reliability of the HEMPA method for patient handling assessment. *Applied Ergonomics*. 2017;65:209–22.
40. Warming S, Juul-Kristensen B, Ebbenhøj NE, Schibye B. An observation instrument for the description and evaluation of patient transfer technique. *Appl Ergon*. 2004;35(6):603–14.
41. Park J-K, Boyer J, Tessler J, Casey J, Schemm L, Gore R, et al. Inter-rater reliability of PATH observations for assessment of ergonomic risk factors in hospital work. *Ergonomics*. 2009;52(7):820–9.

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