Evaluation of the Risk Assessment Pressure Ulcer Score Scale Used Among Residents in Norwegian Nursing Homes

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Abstract

Objective. The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the Risk Assessment Pressure Score scale.

Background. Risk assessment scales for pressure ulcer prevention have become an aspect of quality improvement in healthcare, but their effectiveness depends on the reliability and validity of the scale.

Methods. A convenience sample of 481 residents in 15 nursing homes in rural Norway was included between January and June 2007. The English-language version of the Risk Assessment Pressure Score scale was translated into Norwegian, and this scale was used to collect the data, including a skin examination. The number of pressure ulcers and grades were documented. Homogeneity and equivalence, as measures of reliability, and construct validity were assessed. Sensitivity and specificity were assessed to determine a cut-off point for being at risk for developing pressure sores.

Results. A Cronbach's alpha coefficient of 0.75 and ten significant item-to-total correlations were obtained as measures of homogeneity. Agreement between two assessments of 26 residents varied between very good and moderately good for nine of ten items, reflecting equivalence. Construct validity was supported. The Risk Assessment Pressure Score scale could define groups with expected low and high scores.

Conclusion. The Norwegian version of the Risk Assessment Pressure Score scale has shown sufficient psychometric properties to be considered a reliable and valid scale for identifying risk of pressure ulcers among nursing home residents.

Keywords: aged, geriatric nursing, instrument development, reliability, validity

Article summary

Article focus

- In the Norwegian nursing home setting, there is a lack of reliable and valid assessment scales for identifying the risk for pressure ulcers.
- This paper focuses the translation and psychometric testing of the Norwegian-language version of the Risk Assessment Pressure Score scale.

Key messages

- Acceptable testing results for homogeneity, equivalence and construct validity were obtained for the Norwegian-language version of the Risk Assessment Pressure Score scale.
- According to the values for sensitivity and specificity, a suitable cut-off point for the Risk Assessment Pressure Score scale was found.

Strengths and limitations of this study

- The study describes a translated and tested pressure ulcer risk assessment scale with an adequate number of items for use in clinical practice.
- The sample of residents was a convenience sample from nursing homes and the most preferable study group would have been a more mixed group.
- The study did not assess the concurrent validity that would have been strengthened.

INTRODUCTION

Risk assessment scales for pressure ulcer (PU) prevention have been used for several years, and different scales have been developed [1]. Their effectiveness depends on the reliability and validity of the scale [1], and when translated, it must undergo proper testing [2,3].

No national Norwegian PUs guidelines have been implemented in Norwegian nursing homes [4]. Research conducted in Norwegian nursing home settings may enrich our knowledge of the factors that can predict PUs. However, to conduct such studies, it is of considerable importance to use a risk assessment scale that has been tested for reliability and validity.

Background

PUs are of significant concern in nursing home settings throughout the world, and they increase length of stay, the amount of treatment needed and financial costs [5]. In nursing homes, the PU prevalence varies between 4.3 % and 43.3 % [6-8]. A high-quality risk assessment scale should have high sensitivity and specificity and should be reliable and easy to use in clinical practice [9].

The Risk Assessment Pressure Score (RAPS) scale, used in this study, was developed and tested in Sweden and includes items from the Norton scale, the modified Norton scale and the Braden scale [10]. The items in the RAPS are known to predict the risk for PUs [10,11]. However, because it is of crucial importance to use a reliable and valid scale, the RAPS must be translated and tested before it can be used in a Norwegian context in clinical practice and research.

THE STUDY

Aim

The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the Risk Assessment Pressure Score (RAPS) scale.

Translating procedure

The English version of the RAPS was translated into Norwegian according to the recommended procedure presented by Swaine-Verdier *et al*. [2] and then back to English. The two English RAPS versions were compared. A panel with representatives from nursing homes and a hospital discussed the translation until consensus was reached; this process resulted in a few linguistic changes.

Design and sample

The study had a cross-sectional design. Between January and June 2007, a convenience sample of 481 residents, 121 (25.2 %) men and 360 (74.8 %) women from 46 units in 15 nursing homes in rural areas in southern Norway, was included in the study. Mean age was 84.5 years (SD 8.4), ranging between 55 and 102 years. The exclusion criteria used were terminal illness, having resided less than 24 hours in the nursing home, having lower extremity amputation or receiving enteral and/or parenteral nutrition. Residents from special units for rehabilitation were also excluded.

Risk Assessment Pressure Score Scale

The RAPS is a summative, ordinal scale with ten questions, and the total sum scores ranges from 10 to 39 points. A lower score indicates greater risk for PU development. Nine questions are rated from 1 to 4: general physical condition, physical activity, mobility, moisture, food intake, fluid intake, sensory perception, body temperature, and serum albumin level. One

question about friction and shear is rated from 1 to 3. Skin inspection, with PU classification from stage 1 to stage 4 is also incorporated as a part of the scale but not included in the total score [10,11]. An optimal cut-off point of ≤31 for determining when a resident is at risk for PU was found for the Swedish version of the RAPS [10]. Registered nurses (RNs) and nursing aides (NAs), in the nursing homes were trained to use the RAPS, that was used for data collection and they also conducted the skin examination.

Ethics

The Regional Committee for Medical Research Ethics in southern Norway (REK Sør, reference number S-07212b) and the Norwegian Social Science Data Services (project number 16822) approved the study.

Data analysis

The most analyses were carried out using the PASW Statistics 18. A p-value <0.05 was considered statistically significant. Descriptive statistics were used to describe the study sample. Nominal data are presented with numbers (n) and percentages (%), and ordinal and interval data are presented with mean values (M) and standard deviations (SD).

Reliability

The reliability of the RAPS (10 items) was assessed in terms of homogeneity and equivalence. Cronbach's alpha coefficient [12] and item-to-total Pearson correlations between each item and the scale total were calculated as measures of homogeneity. Item-to-total correlations were performed when the particular item was omitted from the total scale [13].

Equivalence was assessed in a smaller group of 26 residents drawn from the study sample, 20 women and six men. They were from two nursing homes and were assessed by five pairs of RNs. The mean age was 86.2 years (SD=7.3). Two RNs, independent of each other, completed the RAPS on the same residents on the same day. Pearson correlations were calculated between the total scores of the two assessments as a measure of association. In order to assess the agreement between the two clinicians' ratings, a weighted kappa (κ_w) [14] with a 95 % confidence interval (CI) was calculated [15]. κ_w is a recommended analysis for ordinal scales [14,15], and the formula used was provided by Fleiss and Cohen [16] and Fleiss *et al*. [17]. To interpret the obtained κ_w coefficients, the categorisation according to Altman [14] was used: 0.81-1.00, very good agreement; 0.61-0.80, good agreement; 0.41-0.60, moderate agreement; 0.21-0.40, fair agreement; and <0.21, poor agreement.

Validity

The validity of the RAPS (10 items), assessed as construct validity, was investigated by the so-called "known groups technique" [13,18] and factor analysis [19]. The used "known groups" with expected high and low the RAPS scores were those residents who had BMI ≥23 kg/m^2 and BMI <23 kg/m^2, respectively, and calf circumferences (CC) ≥31 cm and CC <31 cm, respectively, according to the cut-off points used in the Mini Nutritional Assessment instrument [20]. Another used "known group" was those residents who had PUs (stage 1-4) and those who had no PUs, according to the performed skin inspection. The differences between the RAPS mean scores of these "known groups" were tested with Student's *t*-test for independent samples.

The factor analysis implemented was a principal component analysis with Varimax rotation with Kaiser normalisation. The RAPS is formally an ordinal scale, but it was treated as an

instrument on interval level, because this fact do not have much influence on the correlations between items, which are the basic inputs to the factor analysis [19,21]. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.80, and the Bartlett's test showed p<0.001, indicating that there was an adequate sample and a sufficient minimum sample size for performing a factor analysis [19].

Sensitivity and specificity

Sensitivity, specificity and positive and negative predictive values were estimated [13,18,22] in order to determine a suitable cut-off point of the RAPS for being at risk for developing pressure sores. To find this cut-off point, the standard used was whether or not the patient had PUs (stage 1-4). Sensitivity, specificity and positive and negative predictive values were calculated for each cut-off point of the RAPS. A receiver operating characteristic (ROC) curve was constructed. The optimal point is found near "a shoulder" of the ROC curve, in the upper left corner [13,18,22]. The area under the optimal point was calculated.

RESULTS

Reliability

Homogeneity in the study sample (n=481) was demonstrated by a Cronbach's alpha coefficient of 0.75 and by significant item-to-total correlations that varied between 0.74 and 0.11 (Table 1).

Table 1. Item-to-total correlations of the RAPS scale (n=481)

Item number	*Item content*	*r*	*p*
A	General physical condition	0.33	<0.001
B	Physical activity	0.68	<0.001

C	Mobility	0.74	<0.001
D	Moisture	0.26	<0.001
E	Food intake	0.33	<0.001
F	Fluid intake	0.24	<0.001
G	Sensory perception	0.46	<0.001
H	Friction and shear	0.69	<0.001
I	Body temperature	0.11	0.013
K	Serum albumin level	0.19	<0.001

RAPS, Risk Assessment Pressure Score; r, Pearson correlation coefficient

Equivalence, was reflected by a correlation coefficient of 0.91 (p<0.001, n=26) between the two obtained total scores of the RAPS. The agreement between the two assessments with the RAPS was found to be very good for three of the items, good for two of the items and moderate for four of the items (Table 2).

Table 2. Agreements between the two assessments with the RAPS scale (n=26)

Item	*Item content*	κ_w	*95% CI*
A	General physical condition	0.63	0.34-0.92
B	Physical activity	0.86	0.73-0.99
C	Mobility	0.63	0.41-0.85
D	Moisture	0.57	0.20-0.94
E	Food intake	0.44	0.17-0.71
F	Fluid intake	0.51	0.25-0.76
G	Sensory perception	0.50	0.24-0.75
H	Friction and shear	0.85	0.69-1.01

I	Body temperature	---	---
K	Serum albumin level	0.84	0.53-1.14

CI, confidence interval; κ_w, weighted kappa coefficients; RAPS, Risk Assessment Pressure Score

Validity

Construct validity of the RAPS was supported by significant differences between the mean scores for groups with expected high and low RAPS scores (Table 3).

Table 3. RAPS scale scores for groups with expected high and low scores, respectively

Groups with expected high scores	*n*	*Mean (SD)*	*Groups with expected low scores*	*n*	*Mean (SD)*	*p*
BMI ≥23 kg/m^2	235	34.3 (3.6)	BMI <23 kg/m^2	245	32.8 (4.2)	<0.001
CC ≥31 cm	243	34.3 (3.7)	CC <31 cm	180	31.9 (3.9)	<0.001
No pressure sores	424	34.0 (3.7)	Pressure sores	57	30.0 (4.2)	<0.001

BMI, body mass index; CC, calf circumference; RAPS, Risk Assessment Pressure Score

Construct validity reflected in the factor analysis is displayed in Table 4. A logical three-factor solution explained 56.9% of the total variances.

Table 4. The factor analysis for the RAPS scale (n=481)

Item number and content	*Factor 1*	*Factor 2*	*Factor 3*	*Communalities*
	Major risk factors for	*Nutritional status*	*Physical condition*	*h2*

	pressure sores			
A General physical condition	0.282	0.164	**0.476**	0.333
B Physical activity	**0.887**	0.123	0.056	0.805
C Mobility	**0.904**	0.135	0.118	0.850
D Moisture	**0.422**	-0.033	0.017	0.179
E Food intake	0.149	**0.783**	0.078	0.642
F Fluid intake	0.016	**0.839**	0.056	0.707
G Sensory perception	**0.496**	0.193	0.344	0.402
H Friction and shear	**0.885**	0.079	0.108	0.802
I Body temperature	-0.058	-0.093	**0.803**	0.656
K Serum albumin level	0.078	0.086	**0.550**	0.316
Eigenvalues	3.315	1.266	1.111	
Cumulative variance	33.151	45.813	56.919	
Cronbach's alpha	0.81	0.53	0.23	

Factor loadings with a value >0.400 are printed in bold.

Sensitivity and specificity

The cut-off point ≤31 for the RAPS was shown to be a possible cut-off point, based on the sensitivity, specificity and positive and negative predictive values (Table 5) and the ROC curve. The area under the ROC curve for the cut-off point ≤31 was 0.69 (95% CI: 0.62–0.77).

Table 5. Sensitivity, specificity and positive and negative predictive values for some scores on the RAPS scale with having pressure sores or not as standard (n=481)

Cut off points	*Sensitivity %*	*Specificity %*	*Positive predictive value %*	*Negative predictive value %*
38	100	10	13	100
37	98	22	15	99
36	93	31	15	97
35	88	41	17	96
34	81	49	18	95
33	75	59	20	95
32	72	66	22	95
31	65	74	25	94
30	54	80	27	93
29	46	87	33	92
28	39	91	36	92

RAPS, Risk Assessment Pressure Score

DISCUSSION

Discussion of results

The Cronbach's alpha coefficient obtained was 0.75. This finding would be considered to be a sufficient value [13]. However, it was lower than the obtained value of 0.83 in the Swedish testing study [10]. All item-to-total correlation coefficients were statistically significant. There are various suggestions in the literature of recommended standards, but a coefficients between 0.30 and 0.70, according to Ferketich [23], and between 0.20 and 0.80, according to Streiner and Norman [13], have been described as good. In this study, physical activity, mobility and friction and shear were the items with the highest correlation coefficients. This result was in line with the results from Lindgren's and co-workers' testing in Sweden,

although that testing was conducted in hospital patients [10,11]. The items moisture, fluid intake, serum albumin and body temperature had coefficients less than 0.30. The coefficient of 0.19 for serum albumin would be seen to be acceptable, according to Streiner and Norman [13]. Only one item had a very low value, i.e., body temperature, with a coefficient of 0.11. This low value can be explained by the fact that the body temperatures among the participants were, to a great extent, the same, and therefore not all of the response alternatives for the item were used. Such a low correlation coefficient may also have contributed to the Cronbach's alpha coefficient being lower. Moreover, the number of items in the scale could have affected the Cronbach's alpha coefficient. A higher value is often found in scales with many items [24].

The agreement between the two assessments with the RAPS, assessed by κ_w, was found to vary between very good agreement and moderately good agreement. These results can be seen to be satisfactory. However, the studied group consisted of only 26 residents, and five pairs of RNs conducted the assessments. Rating the items based on the concepts 'moisture', 'sensory perception' and 'nutrition' may have caused measurement errors because of the difficulties in providing operational definitions of these concepts. At the same, 'activity' seemed to yield fewer measurement errors [6]. This finding may provide some explanation to why the assessments of the items on the RAPS yield measurement errors. It was not possible to obtain a κ_w value for body temperature due to the fact that the RNs performed an identical assessment in all residents and only used one response alternative. This outcome can be seen as a stable result, but the formula used for κ_w was constructed in such a way that the all response alternatives have to be used.

The construct validity of the RAPS was supported because significant differences were obtained when comparing groups with expected high and low scores. The RAPS, could distinguish the group with PUs from the group with no PUs, as well as the groups with low BMIs and low CCs, respectively. It is well known that there is a connection between the development of PUs and bad nutritional status [25-27].

The factor analysis yielded a logical factor solution, with three separate factors: major risk factors for PUs, nutritional status and physical condition. In the Swedish testing study by Lindgren *et al*. [10], a factor analysis, i.e., a principal component analysis with oblique rotation, explained 65.1% of the total variance, with the three factors termed mobility, physical condition and nutrition. These three factors included exactly the same items as the factors did in our study. The difference was the ranking of the second and third factors. The first factor in our factor analysis demonstrated an alpha coefficient of 0.81, which was a higher value than the obtained coefficient for the total scale. This factor could, therefore, possibly be used as a risk assessment scale. However, the items in the other factors added important information and were, therefore, not deleted from the scale. The items in the RAPS can be seen as causal indicators that define the risk for PUs. According to Streiner and Norman [13], the demand for high homogeneity is not as great for a scale with such items.

The obtained cut-off point of ≤31 was supported by the results of similar tests of the RAPS in Swedish settings [10,11]. The area under the ROC curve in the present study was 0.69. According to Terwee *et al*. [24], the area under the curve should be at least 0.70 to be adequate. We believe, therefore, that the Norwegian version of the RAPS, with a value of 0.69, has shown sufficient ability to distinguish between older nursing home residents who are at risk for developing PUs and those residents who are not at risk.

Study limitations

The sample of residents from 15 nursing homes was a convenience sample, and this fact might lead to a possible selection bias [18], because not all residents in all nursing homes were able to be included. However, our results were similar to the results from the Swedish studies [11].

Our study sample, consisting of residents in nursing homes can be assessed as fairly heterogeneous. The most preferable study group would have been a more mixed group, for example, one that included healthy, home-dwelling people and residents from different care settings of different ages and with different medical diagnoses.

The study would have been strengthened if concurrent validity had been assessed. However, it was not possible to investigate this, due to a lack of a suitable risk assessment scale to compare with the RAPS. Despite these limitations, this study offers the first test of the Norwegian translation of the RAPS in a sample of nursing home residents.

CONCLUSION

The Norwegian version of the RAPS scale has shown sufficient psychometrical properties to be considered as a reliable and valid risk assessment scale for identifying the risk for PUs among nursing home residents. However, further testing is needed.

REFERENCES

1. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006;**54**(1):94-110.

2. Swaine-Verdier A, Doward LC, Hagell P, Thorsen H, McKenna SP. Adapting quality of life instruments. *Value Health* 2004;**7 Suppl 1**:S27-30.

3. Maneesriwongul W, Dixon JK. Instrument translation process: a methods review. *J Adv Nurs* 2004;**48**(2):175-86.

4. Skøien R, Braathen Hellum S. Metode for å redusere forekomst av trykksår ved norske sykehjem. (Method to reduce the incidence of pressure ulcers in Norwegian nursing homes). Oslo: SINTEF, 2007.

5. Schuurman J, Schoonhoven L, Defloor T, van Engelshoven I, van Ramshorst B, Buskens E. Economic evaluation of pressure ulcer care: a cost minimization analysis of preventive strategies. *Nurs Econ* 2009;**27**(6):390-415.

6. Kottner J, Halfens R, Dassen T. An interrater reliability study of the assessment of pressure ulcer risk using the Braden scale and the classification of pressure ulcers in a home care setting. *Int J Nurs Stud* 2009;**46**(10):1307-12.

7. Tannen A, Dassen T, Halfens R. Differences in prevalence of pressure ulcers between the Netherlands and Germany associations between risk, prevention and occurrence of pressure ulcers in hospitals and nursing homes. *J Clin Nurs* 2008;**17**(9):1237-44.

8. Capon A, Pavoni N, Mastromattei A, Di Lallo D. Pressure ulcer risk in long-term units: prevalence and associated factors. *J Adv Nurs* 2007;**58**(3):263-72.

9. Moore Zena EH, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2008; (3). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD006471/frame.html.

10. Lindgren M, Unosson M, Krantz AM, Ek AC. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002;**38**(2):190-9.

11. Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784, 2003.

12. Cronbach L. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951;**16**(3):297-334.

13. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. Oxford: Oxford University Press, 2003.

14. Altman DG. Practical statistics for medical research. London: Chapman and Hall/CRC, 1991.

15. Jakobsson U, Westergren A. Statistical methods for assessing agreement for ordinal data. *Scand J Caring Sci* 2005;**19**(4):427-31.

16. Fleiss. The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educ Psychol Meas* 1973;**33**(3):613-19.

17. Fleiss JL, Levin B, Paik MC. The measurements of interrater agreement. In: Fleiss JL, Levin B, Paik MC, eds. Statistical methods for rates and proportions. Hoboken, New Jersey: John Wiley & Sons, 2003:598-626.

18. Polit DF, Beck CT. Nursing research principles and methods. Philadelphia: Lippincott Williams & Wilkins, 2004.

19. Pett MA, Lackey NR, Sullivan JJ. Making sense of factor analysis: the use of factor analysis for instrument development in health care research. Thousand Oaks, Calif.: Sage, 2003.

20. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;**54**(1 part 2):S59-65.

21. Kim J-O, Mueller CW. Factor analysis: statistical methods and practical issues. Thousand Oaks, Calif.: Sage, 1978.

22. Fletcher RH, Fletcher SW. Clinical epidemiology: the essentials. Baltimore: Lippincott Williams & Wilkins, 2005.

23. Ferketich S. Focus on psychometrics. Aspects of item analysis. *Res Nurs Health* 1991;**14**(2):165-68.

24. Terwee CB, Bot SDM, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007;**60**(1):34-42.

25. Kwong EW-y, Pang SM-c, Aboo GH, Law SS-m. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs* 2009;**65**(12):2608-20.

26. Shahin ESM, Meijers JMM, Schols JMG, Tannen A, Halfens RJG, Dassen T. The relationship between malnutrition parameters and pressure ulcers in hospitals and nursing homes. *Nutrition* 2010;**26**(9):886-89.

27. Ek AC, Unosson M, Larsson J, Von Schenck H, Bjurulf P. The development and healing of pressure sores related to the nutritional state. *Clin Nutr* 1991;**10**(5):245-50.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Background. Risk assessment scales for pressure ulcer prevention have become an aspect of quality improvement in healthcare, but their effectiveness depends on the reliability and validity of the scale.

Methods. A convenience sample of 481 residents in 15 nursing homes in rural Norway was included between January and June 2007. The English-language version of the Risk Assessment Pressure Sore scale was translated into Norwegian, and this scale was used to collect the data, including a skin examination. The number of pressure ulcers and grades were documented. Homogeneity as a measure of reliability, and construct validity were assessed. Interrater reliability was assessed in a small group of 26 residents.

Results. A Cronbach's alpha coefficient of 0.75 was obtained. The agreement between the two assessments regarding total scores of the Risk Assessment Pressure Sore scale was reflected in an intraclass correlation coefficient of 0.95. Construct validity was supported. The Risk Assessment Pressure Sore scale could define groups with expected low and high scores.

Conclusion. The Norwegian version of the Risk Assessment Pressure Sore scale has shown sufficient psychometric properties to be considered a reliable and valid scale for identifying risk of pressure ulcers among nursing home residents. However, further testing is needed.

Keywords: aged, geriatric nursing, instrument development, reliability, validity

Article summary

Article focus

- In the Norwegian nursing home setting, there is a lack of reliable and valid assessment scales for identifying risk for pressure ulcers.
- This paper focuses the translation and psychometric testing of the Norwegian-language version of the Risk Assessment Pressure Sore scale.

Key messages

- Acceptable testing results for homogeneity, equivalence and construct validity were obtained for the Norwegian-language version of the Risk Assessment Pressure Sore scale.
- The Risk Assessment Pressure Sore scale could define groups with expected low and high scores.

Strengths and limitations of this study

- The study describes a translated and tested pressure ulcer risk assessment scale with an adequate number of items for use in clinical practice.
- The sample of residents was a convenience sample from nursing homes, and the most preferable study group would have been a more mixed group.
- The study did not assess the concurrent validity that would have been strengthened.

INTRODUCTION

Risk assessment scales for pressure ulcer (PU) prevention have been used for several years, and different scales have been developed [1]. Their effectiveness depends on the reliability and validity of the scale [1], and when translated, it must undergo proper testing [2,3].

No national Norwegian PUs guidelines have been implemented in Norwegian nursing homes [4]. Research conducted in Norwegian nursing home settings may enrich our knowledge of the factors that can predict PUs. However, to conduct such studies, it is of considerable importance to use a risk assessment scale that has been tested for reliability and validity.

Background

PUs are of significant concern in nursing home settings throughout the world, and they increase length of stay, the amount of treatment needed and financial costs [5]. In nursing homes, the PU prevalence varies between 4.3 % and 43.3 % [6-8]. A high-quality risk assessment scale should have high sensitivity and specificity and should be reliable and easy to use in clinical practice [9].

The Risk Assessment Pressure Sore (RAPS) scale, used in this study, was developed and tested in Sweden and includes items from the Norton scale, the modified Norton scale and the Braden scale [10,11]. The RAPS scale is used to promote prevention of PUs by clinicians to identify residents at risk. The items in the RAPS scale are known to predict the risk for PUs [10,11]. However, because it is of crucial importance to use a reliable and valid scale, the RAPS scale must be translated and tested before it can be used in a Norwegian context in clinical practice and research.

THE STUDY

Aim

The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the RAPS scale.

Translating procedure

The English version of the RAPS scale was translated into Norwegian according to the recommended procedure presented by Swaine-Verdier *et al*. [2] and then back to English. The two English RAPS versions were compared. A panel with representatives from nursing homes and a hospital discussed the translation until consensus was reached; this process resulted in a few linguistic changes. They were discussed with a bilingual (Norwegian-English) expert in nursing. He suggested a few linguistic changes of verb tenses for improved clarity and understanding.

Design and sample

The study had a cross-sectional design and was conducted in 15 nursing homes in rural areas in southern Norway. The residents in Norwegian nursing homes are mainly in need of long-term care and are provided with care 24 hours a day including assistance to all their activities of daily living and medical care. Mainly registered nurses (RNs), nursing aides (NAs) and nursing assistants (nurses without formal education) are working shift in the nursing homes. Between January and June 2007, a convenience sample of 481 residents, 121 (25.2 %) men and 360 (74.8 %) women from 46 units was included. Mean age was 84.5 years (SD 8.4), ranging between 55 and 102 years. The exclusion criteria used were terminal illness, having resided less than 24 hours in the nursing home, having lower extremity amputation or receiving enteral and/or parenteral nutrition, based on the difficulties to measure weight and

height for Body Mass Index (BMI) calculation. Residents from special units for rehabilitation were also excluded.

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Data were collected with the RAPS scale and skin examination was performed in all the nursing homes included. Clinicians, RNs and NAs, in the nursing homes were trained to use the scale and conduct a skin examination (as a part of the RAPS scale), as well as to measure weight, height and calf circumference once on all residents included. BMI was also calculated. A smaller group of 26 residents (mean age 86.2 years (SD 7.3)) from two nursing homes drawn from the study sample, 20 women and six men, were assessed with the RAPS scale two times by five pairs of RNs. Two RNs, independent of each other, completed the RAPS scale on the same residents on the same day.

Risk Assessment Pressure Sore Scale

The RAPS scale is a summative, ordinal scale with ten questions, and the total sum scores ranges from 10 to 39 points. A lower score indicates greater risk for PU development. Nine questions are rated from 1 to 4: general physical condition, physical activity, mobility, moisture, food intake, fluid intake, sensory perception, body temperature, and serum albumin level. One question about friction and shear is rated from 1 to 3. Skin inspection, with PU classification from stage 1 to stage 4 is also incorporated as a part of the scale but not included in the total score [10,11]. An optimal cut-off point of ≤31 for determining when a resident is at risk for PU was found for the Swedish version of the RAPS scale [10].

Ethics

The Regional Committee for Medical Research Ethics in southern Norway (REK Sør, reference number S-07212b) and the Norwegian Social Science Data Services (project number 16822) approved the study.

Data analysis

Most analyses were carried out using the PASW Statistics 18. A p-value <0.05 was considered statistically significant. Descriptive statistics were used to describe the study sample. Nominal data are presented with numbers (n) and percentages (%), and ordinal and interval data are presented with mean values (M) and standard deviations (SD).

Reliability

The reliability of the RAPS scale was assessed in terms of homogeneity and equivalence. Cronbach's alpha coefficient [12] was calculated as measure of homogeneity. Equivalence was assessed by means of intraclass correlation coefficient (ICC) [13] as interrater reliability in a smaller group of 26 residents drawn from the study sample. ICC with a 95% confidence interval (Cl) was calculated between the two assessments regarding total score of RAPS and for each item.

Validity

The validity of the RAPS scale, assessed as construct validity, was investigated by the so-called "known groups technique" [14,15] and factor analysis [16]. The used "known groups" with expected high and low RAPS scores were those residents who had BMI ≥23 kg/m^2 and BMI <23 kg/m^2, respectively, and calf circumferences (CC) ≥31 cm and CC <31 cm, respectively, according to the cut-off points used in the Mini Nutritional Assessment instrument [17] which is developed for older people. The cut-off points are used because the

sample consists of older people. Another used "known group" was those residents who had PUs (stage 1-4) and those who had no PUs, according to the performed skin inspection. The differences between the RAPS mean scores of these "known groups" were tested with Student's *t*-test for independent samples.

The factor analysis implemented was a principal component analysis with Varimax rotation with Kaiser normalisation. The RAPS scale is formally an ordinal scale, but it was treated as an instrument on interval level, because this fact do not have much influence on the correlations between items, which are the basic inputs to the factor analysis [16,18]. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.80, and the Bartlett's test showed $p<0.001$, indicating that there was an adequate sample and a sufficient minimum sample size for performing a factor analysis [16].

RESULTS

Reliability

Homogeneity in the study sample (n=481) was demonstrated by a Cronbach's alpha coefficient of 0.75. Equivalence, was reflected by an ICC of 0.95 (CI 0.89-098, $p<0.001$, n=26) between the two obtained total scores of the RAPS scale. The agreements regarding the item level are displayed in Table 1.

Table 1. Agreements between the two assessments for the items in the RAPS scale (n=26)

Item	*Item content*	*ICC*	*95% CI*
A	General physical condition	0.68	0.41-0.84
B	Physical activity	0.92	0.82-0.96
C	Mobility	0.77	0.56-0.89

D	Moisture	0.58	0.26-0.79
E	Food intake	0.60	0.29-0.80
F	Fluid intake	0.70	0.43-0.85
G	Sensory perception	0.64	0.34-0.82
H	Friction and shear	0.89	0.77-0.95
I	Body temperature	---	---
K	Serum albumin level	0.84	0.68-0.93

CI, confidence interval; ICC, intraclass correlation coefficient; RAPS, Risk Assessment Pressure Sore

Validity

Construct validity of the RAPS scale was supported by significant differences between the mean scores for groups with expected high and low RAPS scores (Table 2).

Table 2. RAPS scale scores for groups with expected high and low scores, respectively

Groups with expected high scores	*n*	*Mean (SD)*	*Groups with expected low scores*	*n*	*Mean (SD)*	*p*
BMI ≥23 kg/m^2	235	34.3 (3.6)	BMI <23 kg/m^2	245	32.8 (4.2)	<0.001
CC ≥31 cm	243	34.3 (3.7)	CC <31 cm	180	31.9 (3.9)	<0.001
No pressure sores	424	34.0 (3.7)	Pressure sores	57	30.0 (4.2)	<0.001

BMI, Body Mass Index; CC, calf circumference; RAPS, Risk Assessment Pressure Sore

Construct validity reflected in the factor analysis is displayed in Table 3. A logical three-factor solution explained 56.9% of the total variances.

Table 3. The factor analysis for the RAPS scale (n=481)

Item number and content	*Factor 1* *Risk factors*	*Factor 2* *Nutritional status*	*Factor 3* *Physical condition*	*Communalities* *h2*
A General physical condition	0.282	0.164	**0.476**	0.333
B Physical activity	**0.887**	0.123	0.056	0.805
C Mobility	**0.904**	0.135	0.118	0.850
D Moisture	**0.422**	-0.033	0.017	0.179
E Food intake	0.149	**0.783**	0.078	0.642
F Fluid intake	0.016	**0.839**	0.056	0.707
G Sensory perception	**0.496**	0.193	0.344	0.402
H Friction and shear	**0.885**	0.079	0.108	0.802
I Body temperature	-0.058	-0.093	**0.803**	0.656
K Serum albumin level	0.078	0.086	**0.550**	0.316
Eigenvalues	3.315	1.266	1.111	
Cumulative variance	33.151	45.813	56.919	
Cronbach's alpha	0.81	0.53	0.23	

Factor loadings with a value >0.400 are printed in bold.

DISCUSSION

Discussion of results

The Cronbach's alpha coefficient obtained was 0.75. It was lower than the obtained value of 0.83 in the Swedish testing study [10]. Cronbach's alpha coefficient has been widely used for testing homogeneity. However, in recent literature it is argued that calculation of homogeneity is not appropriate for instruments with items that can be seen as causal indicators. Interrater reliability assessed by ICC is the recommended analysis for estimating reliability for such instruments [13,19]. In our study the ICC was calculated for assessing agreement between the two RAPS measurements for 26 residents. Interrater reliability was not been possible to calculate in the total study group. The obtained Cronbach's alpha coefficient would be considered to be a sufficient value because a recommended interval is 0.70 to 0.90 [19]. However, the Cronbach's alpha coefficient has to be interpreted very cautiously due to the lack of effect variables in the RAPS scale.

The obtained ICCs for each item in the RAPS scale were found to vary between 0.58-0.92 and showed thereby sufficient values for the assessed agreements between the two RN's ratings. ICCs are considered almost perfect when greater than 0.81, substantial between 0.61 and 0.80 and moderate between 0.41 and 0.60 [20]. However, the studied group consisted of only 26 residents, and five pairs of RNs conducted the assessments. Rating the items based on the concepts 'moisture', 'sensory perception' and 'nutrition' may have caused measurement errors because of the difficulties in providing operational definitions of these concepts. At the same, 'activity' seemed to yield fewer measurement errors [6]. This finding may provide some explanation to why the assessments of the items on the RAPS scale yield measurement errors. It was not possible to obtain an ICC value for body temperature due to the fact that the RNs performed an identical assessment in all residents and only used one response alternative.

The construct validity of the RAPS scale was supported because significant differences were obtained when comparing groups with expected high and low scores. The RAPS scale, could distinguish the group with PUs from the group with no PUs, as well as the groups with low BMIs and low CCs, respectively. It is well known that there is a connection between the development of PUs and bad nutritional status [21-23].

The factor analysis yielded a logical factor solution, with three separate factors: risk factor, nutritional status and physical condition. In the Swedish testing study by Lindgren *et al*. [10], a factor analysis, i.e., a principal component analysis with oblique rotation, explained 65.1% of the total variance, with the three factors termed mobility, physical condition and nutrition. These three factors included exactly the same items as the factors did in our study. The difference was the ranking of the second and third factors. The first factor in our factor analysis demonstrated an alpha coefficient of 0.81, which was a higher value than the obtained coefficient for the total scale. This factor could, therefore, possibly be used as a risk assessment scale. However, the items in the other factors added important information and were, therefore, not deleted from the scale. The items in the RAPS scale can be seen as causal indicators that define the risk for PUs.

Based on the fact that this is the first testing study of the Norwegian RAPS scale we have chosen to perform a factor analysis for comparison with the original Swedish version [10]. In further testing of the RAPS scale should confirmatory analysis be performed to confirm obtained factors from the present study and the study conducted by Lindgren *et al*. [10]. According to Streiner and Norman [13], confirmatory analysis is very useful when comparing two versions of a scale.

Study limitations

An important limitation of this study is the cross-sectional design, which does not allow us to estimate the predictive validity for the total study group. The sample of residents from 15 nursing homes was a convenience sample, and this fact might lead to a possible selection bias [15], because not all residents in all nursing homes were able to be included. However, our results were similar to the results from the Swedish studies [11]. Our study sample, consisting of residents in nursing homes can be assessed as fairly heterogeneous. The most preferable study group would have been a more mixed group, for example, one that included healthy, home-dwelling people and residents from different care settings of different ages and with different medical diagnoses.

The study would have been strengthened if concurrent validity had been assessed by using a well validated scale. This had also could give us an opportunity to use the well validated scale as a gold standard in order to estimate sensitivity and specificity values. However, it was not possible to investigate this, due to a lack of a suitable risk assessment scale to compare with the RAPS scale. Despite these limitations, this study offers the first test of the Norwegian translation of the RAPS scale in a sample of nursing home residents.

CONCLUSION

The Norwegian version of the RAPS scale has shown sufficient psychometrical properties to be considered as a reliable and valid risk assessment scale for identifying the risk for PUs among nursing home residents. However, further testing is needed.

REFERENCES

1. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006;**54**(1):94-110.

2. Swaine-Verdier A, Doward LC, Hagell P, Thorsen H, McKenna SP. Adapting quality of life instruments. *Value Health* 2004;**7 Suppl 1**:S27-30.

3. Maneesriwongul W, Dixon JK. Instrument translation process: a methods review. *J Adv Nurs* 2004;**48**(2):175-86.

4. Skøien R, Braathen Hellum S. Metode for å redusere forekomst av trykksår ved norske sykehjem. (Method to reduce the incidence of pressure ulcers in Norwegian nursing homes). Oslo: SINTEF, 2007.

5. Schuurman J, Schoonhoven L, Defloor T, van Engelshoven I, van Ramshorst B, Buskens E. Economic evaluation of pressure ulcer care: a cost minimization analysis of preventive strategies. *Nurs Econ* 2009;**27**(6):390-415.

6. Kottner J, Halfens R, Dassen T. An interrater reliability study of the assessment of pressure ulcer risk using the Braden scale and the classification of pressure ulcers in a home care setting. *Int J Nurs Stud* 2009;**46**(10):1307-12.

7. Tannen A, Dassen T, Halfens R. Differences in prevalence of pressure ulcers between the Netherlands and Germany associations between risk, prevention and occurrence of pressure ulcers in hospitals and nursing homes. *J Clin Nurs* 2008;**17**(9):1237-44.

8. Capon A, Pavoni N, Mastromattei A, Di Lallo D. Pressure ulcer risk in long-term units: prevalence and associated factors. *J Adv Nurs* 2007;**58**(3):263-72.

9. Moore Zena EH, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2008; (3). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD006471/frame.html.

10. Lindgren M, Unosson M, Krantz AM, Ek AC. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002;**38**(2):190-9.

11. Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784, 2003.

12. Cronbach L. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951;**16**(3):297-334.

13. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 4th ed. Oxford: Oxford University Press, 2008.

14. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 3rd ed. Oxford: Oxford University Press, 2003.

15. Polit DF, Beck CT. Nursing research principles and methods. Philadelphia: Lippincott Williams & Wilkins, 2004.

16. Pett MA, Lackey NR, Sullivan JJ. Making sense of factor analysis: the use of factor analysis for instrument development in health care research. Thousand Oaks, Calif.: Sage, 2003.

17. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;**54**(1 part 2):S59-65.

18. Kim J-O, Mueller CW. Factor analysis: statistical methods and practical issues. Thousand Oaks, Calif.: Sage, 1978.

19. Kottner J, Streiner DL. Internal consistency and Cronbach's α: A comment on Beeckman et al. (2010). *Int J Nurs Stud* 2010;**47**(7):926-28.

20. Zou GY. Sample size formulas for estimating intraclass correlation coefficients with precision and assurance. *Stat. Med.* 2012;**doi: 10.1002/sim.5466**.

21. Kwong EW-y, Pang SM-c, Aboo GH, Law SS-m. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs* 2009;**65**(12):2608-20.

22. Shahin ESM, Meijers JMM, Schols JMG, Tannen A, Halfens RJG, Dassen T. The relationship between malnutrition parameters and pressure ulcers in hospitals and nursing homes. *Nutrition* 2010;**26**(9):886-89.

23. Ek AC, Unosson M, Larsson J, Von Schenck H, Bjurulf P. The development and healing of pressure sores related to the nutritional state. *Clin Nutr* 1991;**10**(5):245-50.

Abstract

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E Food intake	0.149	**0.783**	0.078	0.642
F Fluid intake	0.016	**0.839**	0.056	0.707
G Sensory perception	**0.496**	0.193	0.344	0.402
H Friction and shear	**0.885**	0.079	0.108	0.802
I Body temperature	-0.058	-0.093	**0.803**	0.656
K Serum albumin level	0.078	0.086	**0.550**	0.316
Eigenvalues	3.315	1.266	1.111	
Cumulative variance	33.151	45.813	56.919	
Cronbach's alpha	0.81	0.53	0.23	

Factor loadings with a value >0.400 are printed in bold.

DISCUSSION

Discussion of results

The Cronbach's alpha coefficient obtained was 0.75. It was lower than the obtained value of 0.83 in the Swedish testing study [10]. Cronbach's alpha coefficient has been widely used for testing homogeneity. However, in recent literature it is argued that calculation of homogeneity is not appropriate for instruments with items that can be seen as causal indicators. Interrater reliability assessed by ICC is the recommended analysis for estimating reliability for such instruments [13,19]. In our study the ICC was calculated for assessing agreement between the two RAPS measurements for 26 residents. Interrater reliability was not been possible to calculate in the total study group. The obtained Cronbach's alpha coefficient would be considered to be a sufficient value because a recommended interval is 0.70 to 0.90 [19]. However, the Cronbach's alpha coefficient has to be interpreted very cautiously due to the lack of effect variables in the RAPS scale.

The obtained ICCs for each item in the RAPS scale were found to vary between 0.58-0.92 and showed thereby sufficient values for the assessed agreements between the two RN's ratings. ICCs are considered almost perfect when greater than 0.81, substantial between 0.61 and 0.80 and moderate between 0.41 and 0.60 [20]. However, the studied group consisted of only 26 residents, and five pairs of RNs conducted the assessments. Rating the items based on the concepts 'moisture', 'sensory perception' and 'nutrition' may have caused measurement errors because of the difficulties in providing operational definitions of these concepts. At the same, 'activity' seemed to yield fewer measurement errors [6]. This finding may provide some explanation to why the assessments of the items on the RAPS scale yield measurement errors. It was not possible to obtain an ICC value for body temperature due to the fact that the RNs performed an identical assessment in all residents and only used one response alternative.

The construct validity of the RAPS scale was supported because significant differences were obtained when comparing groups with expected high and low scores. The RAPS scale, could distinguish the group with PUs from the group with no PUs, as well as the groups with low BMIs and low CCs, respectively. It is well known that there is a connection between the development of PUs and bad nutritional status [21-23].

The factor analysis yielded a logical factor solution, with three separate factors: risk factor, nutritional status and physical condition. In the Swedish testing study by Lindgren *et al*. [10], a factor analysis, i.e., a principal component analysis with oblique rotation, explained 65.1% of the total variance, with the three factors termed mobility, physical condition and nutrition. These three factors included exactly the same items as the factors did in our study. The difference was the ranking of the second and third factors. The first factor in our factor analysis demonstrated an alpha coefficient of 0.81, which was a higher value than the obtained coefficient for the total scale. This factor could, therefore, possibly be used as a risk assessment scale. However, the items in the other factors added important information and were, therefore, not deleted from the scale. The items in the RAPS scale can be seen as causal indicators that define the risk for PUs.

Based on the fact that this is the first testing study of the Norwegian RAPS scale we have chosen to perform a factor analysis for comparison with the original Swedish version [10]. In further testing of the RAPS scale should confirmatory analysis be performed to confirm obtained factors from the present study and the study conducted by Lindgren *et al*. [10]. According to Streiner and Norman [13], confirmatory analysis is very useful when comparing two versions of a scale.

Study limitations

An important limitation of this study is the cross-sectional design, which does not allow us to estimate the predictive validity for the total study group. The sample of residents from 15 nursing homes was a convenience sample, and this fact might lead to a possible selection bias [15], because not all residents in all nursing homes were able to be included. However, our results were similar to the results from the Swedish studies [11]. Our study sample, consisting of residents in nursing homes can be assessed as fairly heterogeneous. The most preferable study group would have been a more mixed group, for example, one that included healthy, home-dwelling people and residents from different care settings of different ages and with different medical diagnoses.

The study would have been strengthened if concurrent validity had been assessed by using a well validated scale. This had also could give us an opportunity to use the well validated scale as a gold standard in order to estimate sensitivity and specificity values. However, it was not possible to investigate this, due to a lack of a suitable risk assessment scale to compare with the RAPS scale. Despite these limitations, this study offers the first test of the Norwegian translation of the RAPS scale in a sample of nursing home residents.

CONCLUSION

The Norwegian version of the RAPS scale has shown sufficient psychometrical properties to be considered as a reliable and valid risk assessment scale for identifying the risk for PUs among nursing home residents. However, further testing is needed.

REFERENCES

1. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006;**54**(1):94-110.

2. Swaine-Verdier A, Doward LC, Hagell P, Thorsen H, McKenna SP. Adapting quality of life instruments. *Value Health* 2004;**7 Suppl 1**:S27-30.

3. Maneesriwongul W, Dixon JK. Instrument translation process: a methods review. *J Adv Nurs* 2004;**48**(2):175-86.

4. Skøien R, Braathen Hellum S. Metode for å redusere forekomst av trykksår ved norske sykehjem. (Method to reduce the incidence of pressure ulcers in Norwegian nursing homes). Oslo: SINTEF, 2007.

5. Schuurman J, Schoonhoven L, Defloor T, van Engelshoven I, van Ramshorst B, Buskens E. Economic evaluation of pressure ulcer care: a cost minimization analysis of preventive strategies. *Nurs Econ* 2009;**27**(6):390-415.

6. Kottner J, Halfens R, Dassen T. An interrater reliability study of the assessment of pressure ulcer risk using the Braden scale and the classification of pressure ulcers in a home care setting. *Int J Nurs Stud* 2009;**46**(10):1307-12.

7. Tannen A, Dassen T, Halfens R. Differences in prevalence of pressure ulcers between the Netherlands and Germany associations between risk, prevention and occurrence of pressure ulcers in hospitals and nursing homes. *J Clin Nurs* 2008;**17**(9):1237-44.

8. Capon A, Pavoni N, Mastromattei A, Di Lallo D. Pressure ulcer risk in long-term units: prevalence and associated factors. *J Adv Nurs* 2007;**58**(3):263-72.

9. Moore Zena EH, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2008; (3). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD006471/frame.html.

10. Lindgren M, Unosson M, Krantz AM, Ek AC. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002;**38**(2):190-9.

11. Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784, 2003.

12. Cronbach L. Coefficient alpha and the internal structure of tests. *Psychometrika* 1951;**16**(3):297-334.

13. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 4th ed. Oxford: Oxford University Press, 2008.

14. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 3rd ed. Oxford: Oxford University Press, 2003.

15. Polit DF, Beck CT. Nursing research principles and methods. Philadelphia: Lippincott Williams & Wilkins, 2004.

16. Pett MA, Lackey NR, Sullivan JJ. Making sense of factor analysis: the use of factor analysis for instrument development in health care research. Thousand Oaks, Calif.: Sage, 2003.

17. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;**54**(1 part 2):S59-65.

18. Kim J-O, Mueller CW. Factor analysis: statistical methods and practical issues. Thousand Oaks, Calif.: Sage, 1978.

19. Kottner J, Streiner DL. Internal consistency and Cronbach's α: A comment on Beeckman et al. (2010). *Int J Nurs Stud* 2010;**47**(7):926-28.

20. Zou GY. Sample size formulas for estimating intraclass correlation coefficients with precision and assurance. *Stat. Med.* 2012;**doi: 10.1002/sim.5466**.

21. Kwong EW-y, Pang SM-c, Aboo GH, Law SS-m. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs* 2009;**65**(12):2608-20.

22. Shahin ESM, Meijers JMM, Schols JMG, Tannen A, Halfens RJG, Dassen T. The relationship between malnutrition parameters and pressure ulcers in hospitals and nursing homes. *Nutrition* 2010;**26**(9):886-89.

23. Ek AC, Unosson M, Larsson J, Von Schenck H, Bjurulf P. The development and healing of pressure sores related to the nutritional state. *Clin Nutr* 1991;**10**(5):245-50.

STARD checklist for reporting of studies of diagnostic accuracy

(version January 2003)

Section and Topic	Item #		On page #
TITLE/ABSTRACT/ KEYWORDS	1	Identify the article as a study of diagnostic accuracy (recommend MeSH heading 'sensitivity and specificity').	1
INTRODUCTION	2	State the research questions or study aims, such as estimating diagnostic accuracy or comparing accuracy between tests or across participant groups.	3 and 4
METHODS			
Participants	3	The study population: The inclusion and exclusion criteria, setting and locations where data were collected.	4
	4	Participant recruitment: Was recruitment based on presenting symptoms, results from previous tests, or the fact that the participants had received the index tests or the reference standard?	4
	5	Participant sampling: Was the study population a consecutive series of participants defined by the selection criteria in item 3 and 4? If not, specify how participants were further selected.	4
	6	Data collection: Was data collection planned before the index test and reference standard were performed (prospective study) or after (retrospective study)?	5
Test methods	7	The reference standard and its rationale.	
	8	Technical specifications of material and methods involved including how and when measurements were taken, and/or cite references for index tests and reference standard.	6
	9	Definition of and rationale for the units, cut-offs and/or categories of the results of the index tests and the reference standard.	-
	10	The number, training and expertise of the persons executing and reading the index tests and the reference standard.	-
	11	Whether or not the readers of the index tests and reference standard were blind (masked) to the results of the other test and describe any other clinical information available to the readers.	-
Statistical methods	12	Methods for calculating or comparing measures of diagnostic accuracy, and the statistical methods used to quantify uncertainty (e.g. 95% confidence intervals).	6
	13	Methods for calculating test reproducibility, if done.	
RESULTS			
Participants	14	When study was performed, including beginning and end dates of recruitment.	4
	15	Clinical and demographic characteristics of the study population (at least information on age, gender, spectrum of presenting symptoms).	4
	16	The number of participants satisfying the criteria for inclusion who did or did not undergo the index tests and/or the reference standard; describe why participants failed to undergo either test (a flow diagram is strongly recommended).	4
Test results	17	Time-interval between the index tests and the reference standard, and any treatment administered in between.	4
	18	Distribution of severity of disease (define criteria) in those with the target condition; other diagnoses in participants without the target condition.	-
	19	A cross tabulation of the results of the index tests (including indeterminate and missing results) by the results of the reference standard; for continuous results, the distribution of the test results by the results of the reference standard.	-
	20	Any adverse events from performing the index tests or the reference standard.	-
Estimates	21	Estimates of diagnostic accuracy and measures of statistical uncertainty (e.g. 95% confidence intervals).	7
	22	How indeterminate results, missing data and outliers of the index tests were handled.	-
	23	Estimates of variability of diagnostic accuracy between subgroups of participants, readers or centers, if done.	
	24	Estimates of test reproducibility, if done.	
DISCUSSION	25	Discuss the clinical applicability of the study findings.	9, 10, 11 and 12

Translation and Testing of the Risk Assessment Pressure Ulcer Score Scale Used Among Residents in Norwegian Nursing Homes

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Translation and Testing of the Risk Assessment Pressure Ulcer Score Scale Used Among Residents in Norwegian Nursing Homes

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Conflict of interest

No conflicts of interest have been declared by the authors.

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Data Sharing Statement

No additional data are available

Contributors

MF, OS and US were responsible for the study conception and design.

MF administered the data collection.

MF, OS, CC and US performed the data analyses.

MF, OS and US were responsible for the drafting of the manuscript.

MF, OS, CC and US made critical revisions to the paper for important intellectual content.

OS, CC and US provided statistical expertise.

OS and US supervised the study

Word: 2161

Abstract

Objective. The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the Risk Assessment Pressure Sore scale.

Background. Risk assessment scales for pressure ulcer prevention have become an aspect of quality improvement in healthcare, but their effectiveness depends on the reliability and validity of the scale.

Methods. A convenience sample of 481 residents in 15 nursing homes in rural Norway was included between January and June 2007. The English-language version of the Risk Assessment Pressure Sore scale was translated into Norwegian, and this scale was used to collect the data, including a skin examination. The number of pressure ulcers and grades were documented. Reliability was assessed in a small group of 26 residents and construct validity in the total study group.

Results. Equivalence between two assessments regarding total scores of the Risk Assessment Pressure Sore scale was reflected in an intraclass correlation coefficient of 0.95. Construct validity was supported, and the Risk Assessment Pressure Sore scale could define groups with expected low and high scores. Further evidence of construct validity was shown in a confirmatory factor analysis.

Conclusion. The Norwegian version of the Risk Assessment Pressure Sore scale has shown sufficient psychometric properties to be considered a reliable and valid scale for identifying risk of pressure ulcers among nursing home residents. However, further testing is needed.

Keywords: aged, geriatric nursing, instrument development, reliability, validity

Article summary

Article focus

- In the Norwegian nursing home setting, there is a lack of reliable and valid assessment scales for identifying risk for pressure ulcers.
- This paper focuses the translation and psychometric testing of the Norwegian-language version of the Risk Assessment Pressure Sore scale.

Key messages

- Acceptable testing results for equivalence and construct validity were obtained for the Norwegian-language version of the Risk Assessment Pressure Sore scale.
- The Risk Assessment Pressure Sore scale could define groups with expected low and high scores.

Strengths and limitations of this study

- The study describes a translated and tested pressure ulcer risk assessment scale with an adequate number of items for use in clinical practice.
- The sample of residents was a convenience sample from nursing homes, and the most preferable study group would have been a more mixed group.
- The study did not assess concurrent validity.

INTRODUCTION

Risk assessment scales for pressure ulcer (PU) prevention have been used for several years, and different scales have been developed [1]. Their effectiveness depends on the reliability and validity of the scale [1], and when translated, it must undergo proper testing [2,3].

No national Norwegian PUs guidelines have been implemented in Norwegian nursing homes [4]. Research conducted in Norwegian nursing home settings may enrich our knowledge of the factors that can predict PUs. However, to conduct such studies, it is of considerable importance to use a risk assessment scale that has been tested for reliability and validity.

Background

PUs are of significant concern in nursing home settings throughout the world, and they increase length of stay, the amount of treatment needed and financial costs [5]. In nursing homes, the PU prevalence varies between 4.3 % and 43.3 % [6-8]. A high-quality risk assessment scale should be, among other things, reliable and easy to use in clinical practice [9].

The Risk Assessment Pressure Sore (RAPS) scale, used in this study, was developed and tested in Sweden and includes items from the Norton scale, the modified Norton scale and the Braden scale [10,11]. The RAPS scale is used to promote prevention of PUs by clinicians to identify residents at risk. The items in the RAPS scale are known to predict the risk for PUs [10,11]. However, because it is of crucial importance to use a reliable and valid scale, the RAPS scale must be translated and tested before it can be used in a Norwegian context in clinical practice and research.

THE STUDY

Aim

The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the RAPS scale.

Translating procedure

The English version of the RAPS scale was translated into Norwegian according to the recommended procedure presented by Swaine-Verdier *et al*. [2] and then back to English. The two English RAPS versions were compared. A panel with representatives from nursing homes and a hospital discussed the translation until consensus was reached; this process resulted in a few linguistic changes. They were discussed with a bilingual (Norwegian-English) expert in nursing. He suggested a few linguistic changes of verb tenses for improved clarity and understanding.

Design and sample

The study had a cross-sectional design and was conducted in 15 nursing homes in rural areas in southern Norway. The residents in Norwegian nursing homes are mainly in need of long-term care and are provided with care 24 hours a day including assistance to all their activities of daily living and medical care. Mainly registered nurses (RNs), nursing aides (NAs) and nursing assistants (nurses without formal education) are working shift in the nursing homes. Between January and June 2007, a convenience sample of 481 residents, 121 (25.2 %) men and 360 (74.8 %) women from 46 units was included. Mean age was 84.5 years (SD 8.4), ranging between 55 and 102 years.

The exclusion criteria used were terminal illness, having resided less than 24 hours in the nursing home, having lower extremity amputation or receiving enteral and/or parenteral

nutrition, based on the difficulties to measure weight and height for Body Mass Index (BMI) calculation. Residents from special units for rehabilitation were also excluded.

Data Collection

Data were collected with the RAPS scale and skin examination was performed in all the nursing homes included. Clinicians, RNs and NAs, in the nursing homes were trained to use the scale and conduct a skin examination (as a part of the RAPS scale), as well as to measure weight, height and calf circumference once on all residents included. BMI was also calculated.

A smaller group of 26 residents with a mean age of 86.2 years (SD 7.3) from two nursing homes was drawn from the study sample. Twenty women and six men were assessed with the RAPS scale two times by five pairs of RNs. Two RNs, independent of each other, completed the RAPS scale on the same residents on the same day.

Risk Assessment Pressure Sore Scale

The RAPS scale is a summative, ordinal scale with ten questions, and the total sum scores ranges from 10 to 39 points. A lower score indicates greater risk for PU development. Nine questions are rated from 1 to 4: general physical condition, physical activity, mobility, moisture, food intake, fluid intake, sensory perception, body temperature, and serum albumin level. One question about friction and shear is rated from 1 to 3. Skin inspection, with PU classification from stage 1 to stage 4 is also incorporated as a part of the scale but not included in the total score [10,11]. An optimal cut-off point of ≤31 for determining when a resident is at risk for PU was found for the Swedish version of the RAPS scale [10].

Ethics

The Regional Committee for Medical Research Ethics in southern Norway (REK Sør, reference number S-07212b) and the Norwegian Social Science Data Services (project number 16822) approved the study.

Data analyses

Most analyses were carried out using the PASW Statistics 18. A p-value <0.05 was considered statistically significant. Descriptive statistics were used to describe the study sample. Nominal data are presented with numbers (n) and percentages (%), and ordinal and interval data are presented with mean values (M) and standard deviations (SD).

Reliability

The reliability of the RAPS scale was assessed as equivalence by means of a two-way mixed intraclass correlation coefficient (ICC) with a 95% confidence interval (Cl) [12] between the two assessments regarding total scores of RAPS in the group of 26 residents. ICCs were also calculated between each item of the two RAPS assessments.

Validity

The validity of the RAPS scale, assessed as construct validity, was investigated by the so-called “known groups technique” [13,14] and confirmatory factor analysis [15]. Confirmatory factor analysis was carried out using Mplus, version 5 [15,16] under the STREAMS [17] environment.

The used "known groups" with expected high and low RAPS scores were those residents who had BMI ≥23 kg/m^2 and BMI <23 kg/m^2, respectively, and calf circumferences (CC) ≥31 cm and CC <31 cm, respectively, according to the cut-off points used in the Mini Nutritional Assessment instrument [18], which is developed for older people. The cut-off points are used because the sample consists of older people. Another used "known group" was those residents who had PUs (stage 1-4) and those who had no PUs, according to the performed skin inspection. The differences between the RAPS mean scores of these "known groups" were tested with Student's *t*-test for independent samples.

The factors found by Lindgren et al. [10] were used in the confirmatory factor analysis. The total amount of internal missing data was 43 scores distributed across the items. Although the amount of missing variables was very small, in order to include all of the collected information, the missing data modeling procedure implemented in the Mplus program was used [19]. This procedure yields unbiased estimates under relatively moderate assumptions [20].

To measure model fit, the χ^2 goodness-of-fit test, the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) assessments were used. The RMSEA is strongly recommended as a tool when evaluating model fit since it takes both the number of observations and the number of free parameters into account. An acceptable model fit is indicated by values less than 0.08, while values of less than 0.05 imply a good model fit. SRMR can range from 0–1, [20], where 0 is indicative of perfect model fit and values 0.08 or smaller indicate an acceptable model fit [15].

RESULTS

Reliability

Reliability of the RAPS, reflected as equivalence reached an ICC of 0.95 (CI 0.89-098, p<0.001, n=26) between the two obtained total scores of the RAPS scale. The ICC values regarding the item level are displayed in Table 1.

Table 1. Intraclass correlations between the two assessments for the items in the RAPS scale (n=26)

Item	*Item content*	*ICC*	*95% CI*
A	General physical condition	0.68	0.41-0.84
B	Physical activity	0.92	0.82-0.96
C	Mobility	0.77	0.56-0.89
D	Moisture	0.58	0.26-0.79
E	Food intake	0.60	0.29-0.80
F	Fluid intake	0.70	0.43-0.85
G	Sensory perception	0.64	0.34-0.82
H	Friction and shear	0.89	0.77-0.95
I	Body temperature	---	---
K	Serum albumin level	0.84	0.68-0.93

CI, confidence interval; ICC, intraclass correlation coefficient; RAPS, Risk Assessment Pressure Sore

Validity

Construct validity of the RAPS scale was supported by significant differences between the mean scores for groups with expected high and low RAPS scores (Table 2).

Table 2. RAPS scale scores for groups with expected high and low scores, respectively

Groups with expected high scores	*n*	*Mean (SD)*	*Groups with expected low scores*	*n*	*Mean (SD)*	*p*
BMI ≥23 kg/m^2	235	34.3 (3.6)	BMI <23 kg/m^2	245	32.8 (4.2)	<0.001
CC ≥31 cm	243	34.3 (3.7)	CC <31 cm	180	31.9 (3.9)	<0.001
No pressure sores	424	34.0 (3.7)	Pressure sores	57	30.0 (4.2)	<0.001

BMI, Body Mass Index; CC, calf circumference; RAPS, Risk Assessment Pressure Sore

Construct validity reflected in the confirmatory factor analysis is displayed in Figure 1.

The fit indices were good (χ^2(32, N=490)=47.45; RMSEA=0.031; SRMR=0.036; and CFI=0.98) indicating satisfactory fit with the original instrument and, thus, evidence for construct validity of this version.

DISCUSSION

Discussion of results

Reliability assessed as equivalence by ICC is the recommended analysis for estimating reliability for such instruments [12,21]. In our study the ICC was calculated between the two RAPS measurements for 26 residents. This interrater reliability was not been possible to calculate in the total study group.

The obtained ICCs for each item in the RAPS scale were found to vary between 0.58-0.92 and showed thereby sufficient values between the two RN's ratings. ICCs are considered almost perfect when greater than 0.81, substantial between 0.61 and 0.80 and moderate between 0.41 and 0.60 [22]. However, the studied group consisted of only 26 residents, and five pairs of RNs conducted the assessments. Rating the items based on the concepts 'moisture', 'sensory perception' and 'nutrition' may have caused measurement errors because of the difficulties in providing operational definitions of these concepts. At the same, 'activity' seemed to yield fewer measurement errors [6]. This finding may provide some explanation to why the assessments of the items on the RAPS scale yield measurement errors. It was not possible to obtain an ICC value for body temperature due to the fact that the RNs performed an identical assessment in all residents and only used one response alternative.

The construct validity of the RAPS scale was supported because significant differences were obtained when comparing groups with expected high and low scores. The RAPS scale, could distinguish the group with PUs from the group with no PUs, as well as the groups with low BMIs and low CCs, respectively. It is well known that there is a connection between the development of PUs and bad nutritional status [23-25].

The confirmatory factor analysis yielded a factor solution, with three separate factors: mobility, nutritional status and physical condition. In the Swedish testing study by Lindgren *et al*. [10], a factor analysis, i.e., a principal component analysis with oblique rotation, explained 65.1% of the total variance, with the same three factors. According to Streiner and Norman [12], confirmatory analysis is very useful when comparing two versions of a scale, and in this study the construct validity of the RAPS was confirmed.

Study limitations

An important limitation of this study is the cross-sectional design, which does not allow us to estimate the predictive validity for the total study group. The sample of residents from 15 nursing homes was a convenience sample, and this fact might lead to a possible selection bias [14], because not all residents in all nursing homes were able to be included. However, our results were similar to the results from the Swedish studies [11]. Our study sample, consisting of residents in nursing homes can be assessed as fairly heterogeneous. The most preferable study group would have been a more mixed group, for example, one that included healthy, home-dwelling people and residents from different care settings of different ages and with different medical diagnoses.

The study would have been strengthened if concurrent validity had been assessed by using a well validated scale. However, since every tool is related to context, risk profiles among the residents and knowledge level of the users, it is difficult to find a gold standard. Despite these limitations, this study offers the first test of the Norwegian translation of the RAPS scale in a sample of nursing home residents that confirms both its reliability and construct validity.

CONCLUSION

The Norwegian version of the RAPS scale has shown sufficient psychometrical properties to be considered as a reliable and valid risk assessment scale for identifying the risk for PUs among nursing home residents. However, further testing is needed.

Figure 1. The three-factor model with covariances among the three factors, Nutritional status, Mobility and Physical condition.

REFERENCES

1. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, et al. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006;**54**(1):94-110.

2. Swaine-Verdier A, Doward LC, Hagell P, et al. Adapting quality of life instruments. *Value Health* 2004;**7 Suppl 1**:S27-30.

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6. Kottner J, Halfens R, Dassen T. An interrater reliability study of the assessment of pressure ulcer risk using the Braden scale and the classification of pressure ulcers in a home care setting. *Int J Nurs Stud* 2009;**46**(10):1307-12.

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8. Capon A, Pavoni N, Mastromattei A, et al. Pressure ulcer risk in long-term units: prevalence and associated factors. *J Adv Nurs* 2007;**58**(3):263-72.

9. Moore Zena EH, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2008; (3). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD006471/frame.html.

10. Lindgren M, Unosson M, Krantz AM, et al. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002;**38**(2):190-9.

11. Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784, 2003.

12. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 4th ed. Oxford: Oxford University Press, 2008.

13. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 3rd ed. Oxford: Oxford University Press, 2003.

14. Polit DF, Beck CT. Nursing research principles and methods. Philadelphia: Lippincott Williams & Wilkins, 2004.

15. Brown T, A. Confirmatory factor analysis for applied research. New York: The Guilford Press 2006.

16. Muthén LK, Muthén BO. Mplus User's Guide. 5th ed. Los Angeles: CA: Muthén & Muthén, 2009.

17. Gustafsson J-E, Stahl P-A. STREAMS 3.0 User's Guide. Mölndal, Sweden: Multivaraiteware, 2005.

18. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;**54**(1 part 2):S59-65.

19. Muthén B, Kaplan D, Hollis M. On structural equation modelling with data that are not missing completely at random. *Psychometrica* 1987;**52**(3):431-62.

20. Allison PD. Missing data techniques for structural equation modeling. *J. Abnorm. Psychol.* 2003;**112**(4):545-57.

21. Kottner J, Streiner DL. Internal consistency and Cronbach's α: A comment on Beeckman et al. (2010). *Int J Nurs Stud* 2010;**47**(7):926-28.

22. Zou GY. Sample size formulas for estimating intraclass correlation coefficients with precision and assurance. *Stat. Med.* 2012;**doi: 10.1002/sim.5466**.

23. Kwong EW-y, Pang SM-c, Aboo GH, et al. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs* 2009;**65**(12):2608-20.

24. Shahin ESM, Meijers JMM, Schols JMG, et al. The relationship between malnutrition parameters and pressure ulcers in hospitals and nursing homes. *Nutrition* 2010;**26**(9):886-89.

25. Ek AC, Unosson M, Larsson J, et al. The development and healing of pressure sores related to the nutritional state. *Clin Nutr* 1991;**10**(5):245-50.

Abstract

Objective. The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the Risk Assessment Pressure Sore scale.

Background. Risk assessment scales for pressure ulcer prevention have become an aspect of quality improvement in healthcare, but their effectiveness depends on the reliability and validity of the scale.

Methods. A convenience sample of 481 residents in 15 nursing homes in rural Norway was included between January and June 2007. The English-language version of the Risk Assessment Pressure Sore scale was translated into Norwegian, and this scale was used to collect the data, including a skin examination. The number of pressure ulcers and grades were documented. Reliability was assessed in a small group of 26 residents and construct validity in the total study group.

Results. Equivalence between two assessments regarding total scores of the Risk Assessment Pressure Sore scale was reflected in an intraclass correlation coefficient of 0.95. Construct validity was supported, and the Risk Assessment Pressure Sore scale could define groups with expected low and high scores. Further evidence of construct validity was shown in a confirmatory factor analysis.

Conclusion. The Norwegian version of the Risk Assessment Pressure Sore scale has shown sufficient psychometric properties to be considered a reliable and valid scale for identifying risk of pressure ulcers among nursing home residents. However, further testing is needed.

Keywords: aged, geriatric nursing, instrument development, reliability, validity

Article summary

Article focus

- In the Norwegian nursing home setting, there is a lack of reliable and valid assessment scales for identifying risk for pressure ulcers.
- This paper focuses the translation and psychometric testing of the Norwegian-language version of the Risk Assessment Pressure Sore scale.

Key messages

- Acceptable testing results for equivalence and construct validity were obtained for the Norwegian-language version of the Risk Assessment Pressure Sore scale.
- The Risk Assessment Pressure Sore scale could define groups with expected low and high scores.

Strengths and limitations of this study

- The study describes a translated and tested pressure ulcer risk assessment scale with an adequate number of items for use in clinical practice.
- The sample of residents was a convenience sample from nursing homes, and the most preferable study group would have been a more mixed group.
- The study did not assess concurrent validity.

INTRODUCTION

Risk assessment scales for pressure ulcer (PU) prevention have been used for several years, and different scales have been developed [1]. Their effectiveness depends on the reliability and validity of the scale [1], and when translated, it must undergo proper testing [2,3].

No national Norwegian PUs guidelines have been implemented in Norwegian nursing homes [4]. Research conducted in Norwegian nursing home settings may enrich our knowledge of the factors that can predict PUs. However, to conduct such studies, it is of considerable importance to use a risk assessment scale that has been tested for reliability and validity.

Background

PUs are of significant concern in nursing home settings throughout the world, and they increase length of stay, the amount of treatment needed and financial costs [5]. In nursing homes, the PU prevalence varies between 4.3 % and 43.3 % [6-8]. A high-quality risk assessment scale should be, among other things, reliable and easy to use in clinical practice [9].

The Risk Assessment Pressure Sore (RAPS) scale, used in this study, was developed and tested in Sweden and includes items from the Norton scale, the modified Norton scale and the Braden scale [10,11]. The RAPS scale is used to promote prevention of PUs by clinicians to identify residents at risk. The items in the RAPS scale are known to predict the risk for PUs [10,11]. However, because it is of crucial importance to use a reliable and valid scale, the RAPS scale must be translated and tested before it can be used in a Norwegian context in clinical practice and research.

THE STUDY

Aim

The purpose of this study was to translate and test the psychometric properties of the Norwegian-language version of the RAPS scale.

Translating procedure

The English version of the RAPS scale was translated into Norwegian according to the recommended procedure presented by Swaine-Verdier *et al*. [2] and then back to English. The two English RAPS versions were compared. A panel with representatives from nursing homes and a hospital discussed the translation until consensus was reached; this process resulted in a few linguistic changes. They were discussed with a bilingual (Norwegian-English) expert in nursing. He suggested a few linguistic changes of verb tenses for improved clarity and understanding.

Design and sample

The study had a cross-sectional design and was conducted in 15 nursing homes in rural areas in southern Norway. The residents in Norwegian nursing homes are mainly in need of long-term care and are provided with care 24 hours a day including assistance to all their activities of daily living and medical care. Mainly registered nurses (RNs), nursing aides (NAs) and nursing assistants (nurses without formal education) are working shift in the nursing homes. Between January and June 2007, a convenience sample of 481 residents, 121 (25.2 %) men and 360 (74.8 %) women from 46 units was included. Mean age was 84.5 years (SD 8.4), ranging between 55 and 102 years.

The exclusion criteria used were terminal illness, having resided less than 24 hours in the nursing home, having lower extremity amputation or receiving enteral and/or parenteral

nutrition, based on the difficulties to measure weight and height for Body Mass Index (BMI) calculation. Residents from special units for rehabilitation were also excluded.

Data Collection

Data were collected with the RAPS scale and skin examination was performed in all the nursing homes included. Clinicians, RNs and NAs, in the nursing homes were trained to use the scale and conduct a skin examination (as a part of the RAPS scale), as well as to measure weight, height and calf circumference once on all residents included. BMI was also calculated.

A smaller group of 26 residents with a mean age of 86.2 years (SD 7.3) from two nursing homes was drawn from the study sample. Twenty women and six men were assessed with the RAPS scale two times by five pairs of RNs. Two RNs, independent of each other, completed the RAPS scale on the same residents on the same day.

Risk Assessment Pressure Sore Scale

The RAPS scale is a summative, ordinal scale with ten questions, and the total sum scores ranges from 10 to 39 points. A lower score indicates greater risk for PU development. Nine questions are rated from 1 to 4: general physical condition, physical activity, mobility, moisture, food intake, fluid intake, sensory perception, body temperature, and serum albumin level. One question about friction and shear is rated from 1 to 3. Skin inspection, with PU classification from stage 1 to stage 4 is also incorporated as a part of the scale but not included in the total score [10,11]. An optimal cut-off point of ≤31 for determining when a resident is at risk for PU was found for the Swedish version of the RAPS scale [10].

Ethics

The Regional Committee for Medical Research Ethics in southern Norway (REK Sør, reference number S-07212b) and the Norwegian Social Science Data Services (project number 16822) approved the study.

Data analyses

Most analyses were carried out using the PASW Statistics 18. A p-value <0.05 was considered statistically significant. Descriptive statistics were used to describe the study sample. Nominal data are presented with numbers (n) and percentages (%), and ordinal and interval data are presented with mean values (M) and standard deviations (SD).

Reliability

The reliability of the RAPS scale was assessed as equivalence by means of a two-way mixed intraclass correlation coefficient (ICC) with a 95% confidence interval (Cl) [12] between the two assessments regarding total scores of RAPS in the group of 26 residents. ICCs were also calculated between each item of the two RAPS assessments.

Validity

The validity of the RAPS scale, assessed as construct validity, was investigated by the so-called "known groups technique" [13,14] and confirmatory factor analysis [15]. Confirmatory factor analysis was carried out using Mplus, version 5 [15,16] under the STREAMS [17] environment.

The used "known groups" with expected high and low RAPS scores were those residents who had BMI ≥23 kg/m^2 and BMI <23 kg/m^2, respectively, and calf circumferences (CC) ≥31 cm and CC <31 cm, respectively, according to the cut-off points used in the Mini Nutritional Assessment instrument [18], which is developed for older people. The cut-off points are used because the sample consists of older people. Another used "known group" was those residents who had PUs (stage 1-4) and those who had no PUs, according to the performed skin inspection. The differences between the RAPS mean scores of these "known groups" were tested with Student's *t*-test for independent samples.

The factors found by Lindgren et al. [10] were used in the confirmatory factor analysis. The total amount of internal missing data was 43 scores distributed across the items. Although the amount of missing variables was very small, in order to include all of the collected information, the missing data modeling procedure implemented in the Mplus program was used [19]. This procedure yields unbiased estimates under relatively moderate assumptions [20].

To measure model fit, the χ^2 goodness-of-fit test, the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) assessments were used. The RMSEA is strongly recommended as a tool when evaluating model fit since it takes both the number of observations and the number of free parameters into account. An acceptable model fit is indicated by values less than 0.08, while values of less than 0.05 imply a good model fit. SRMR can range from 0–1, [20], where 0 is indicative of perfect model fit and values 0.08 or smaller indicate an acceptable model fit [15].

RESULTS

Reliability

Reliability of the RAPS, reflected as equivalence reached an ICC of 0.95 (CI 0.89-098, p<0.001, n=26) between the two obtained total scores of the RAPS scale. The ICC values regarding the item level are displayed in Table 1.

Table 1. Intraclass correlations between the two assessments for the items in the RAPS scale (n=26)

Item	*Item content*	*ICC*	*95% CI*
A	General physical condition	0.68	0.41-0.84
B	Physical activity	0.92	0.82-0.96
C	Mobility	0.77	0.56-0.89
D	Moisture	0.58	0.26-0.79
E	Food intake	0.60	0.29-0.80
F	Fluid intake	0.70	0.43-0.85
G	Sensory perception	0.64	0.34-0.82
H	Friction and shear	0.89	0.77-0.95
I	Body temperature	---	---
K	Serum albumin level	0.84	0.68-0.93

CI, confidence interval; ICC, intraclass correlation coefficient; RAPS, Risk Assessment Pressure Sore

Validity

Construct validity of the RAPS scale was supported by significant differences between the mean scores for groups with expected high and low RAPS scores (Table 2).

Table 2. RAPS scale scores for groups with expected high and low scores, respectively

Groups with expected high scores	*n*	*Mean (SD)*	*Groups with expected low scores*	*n*	*Mean (SD)*	*p*
BMI ≥23 kg/m^2	235	34.3 (3.6)	BMI <23 kg/m^2	245	32.8 (4.2)	<0.001
CC ≥31 cm	243	34.3 (3.7)	CC <31 cm	180	31.9 (3.9)	<0.001
No pressure sores	424	34.0 (3.7)	Pressure sores	57	30.0 (4.2)	<0.001

BMI, Body Mass Index; CC, calf circumference; RAPS, Risk Assessment Pressure Sore

Construct validity reflected in the confirmatory factor analysis is displayed in Figure 1.

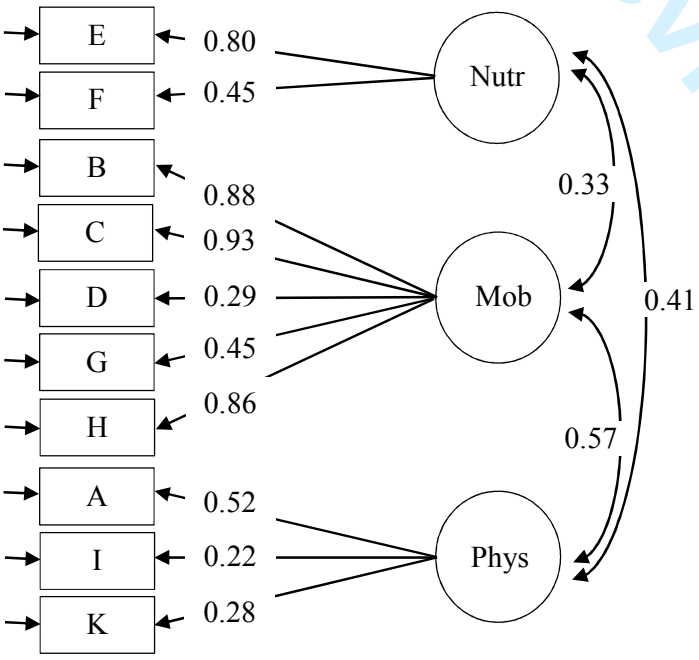


Figure 1. The three-factor model with covariances among the three factors, Nutritional status, Mobility and Physical condition.

The fit indices were good ($\chi^2(32, N=490)=47.45$; RMSEA=0.031; SRMR=0.036; and CFI=0.98) indicating satisfactory fit with the original instrument and, thus, evidence for construct validity of this version.

DISCUSSION

Discussion of results

Reliability assessed as equivalence by ICC is the recommended analysis for estimating reliability for such instruments [12,21]. In our study the ICC was calculated between the two RAPS measurements for 26 residents. This interrater reliability was not been possible to calculate in the total study group.

The obtained ICCs for each item in the RAPS scale were found to vary between 0.58-0.92 and showed thereby sufficient values between the two RN's ratings. ICCs are considered almost perfect when greater than 0.81, substantial between 0.61 and 0.80 and moderate between 0.41 and 0.60 [22]. However, the studied group consisted of only 26 residents, and five pairs of RNs conducted the assessments. Rating the items based on the concepts 'moisture', 'sensory perception' and 'nutrition' may have caused measurement errors because of the difficulties in providing operational definitions of these concepts. At the same, 'activity' seemed to yield fewer measurement errors [6]. This finding may provide some explanation to why the assessments of the items on the RAPS scale yield measurement errors. It was not possible to obtain an ICC value for body temperature due to the fact that the RNs performed an identical assessment in all residents and only used one response alternative.

The construct validity of the RAPS scale was supported because significant differences were obtained when comparing groups with expected high and low scores. The RAPS scale, could

distinguish the group with PUs from the group with no PUs, as well as the groups with low BMIs and low CCs, respectively. It is well known that there is a connection between the development of PUs and bad nutritional status [23-25].

The confirmatory factor analysis yielded a factor solution, with three separate factors: mobility, nutritional status and physical condition. In the Swedish testing study by Lindgren *et al*. [10], a factor analysis, i.e., a principal component analysis with oblique rotation, explained 65.1% of the total variance, with the same three factors. According to Streiner and Norman [12], confirmatory analysis is very useful when comparing two versions of a scale, and in this study the construct validity of the RAPS was confirmed.

Study limitations

An important limitation of this study is the cross-sectional design, which does not allow us to estimate the predictive validity for the total study group. The sample of residents from 15 nursing homes was a convenience sample, and this fact might lead to a possible selection bias [14], because not all residents in all nursing homes were able to be included. However, our results were similar to the results from the Swedish studies [11]. Our study sample, consisting of residents in nursing homes can be assessed as fairly heterogeneous. The most preferable study group would have been a more mixed group, for example, one that included healthy, home-dwelling people and residents from different care settings of different ages and with different medical diagnoses.

The study would have been strengthened if concurrent validity had been assessed by using a well validated scale. However, since every tool is related to context, risk profiles among the residents and knowledge level of the users, it is difficult to find a gold standard. Despite these

limitations, this study offers the first test of the Norwegian translation of the RAPS scale in a sample of nursing home residents that confirms both its reliability and construct validity.

CONCLUSION

The Norwegian version of the RAPS scale has shown sufficient psychometrical properties to be considered as a reliable and valid risk assessment scale for identifying the risk for PUs among nursing home residents. However, further testing is needed.

REFERENCES

1. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006;**54**(1):94-110.

2. Swaine-Verdier A, Doward LC, Hagell P, Thorsen H, McKenna SP. Adapting quality of life instruments. *Value Health* 2004;**7 Suppl 1**:S27-30.

3. Maneesriwongul W, Dixon JK. Instrument translation process: a methods review. *J Adv Nurs* 2004;**48**(2):175-86.

4. Skøien R, Braathen Hellum S. Metode for å redusere forekomst av trykksår ved norske sykehjem. (Method to reduce the incidence of pressure ulcers in Norwegian nursing homes). Oslo: SINTEF, 2007.

5. Schuurman J, Schoonhoven L, Defloor T, van Engelshoven I, van Ramshorst B, Buskens E. Economic evaluation of pressure ulcer care: a cost minimization analysis of preventive strategies. *Nurs Econ* 2009;**27**(6):390-415.

6. Kottner J, Halfens R, Dassen T. An interrater reliability study of the assessment of pressure ulcer risk using the Braden scale and the classification of pressure ulcers in a home care setting. *Int J Nurs Stud* 2009;**46**(10):1307-12.

7. Tannen A, Dassen T, Halfens R. Differences in prevalence of pressure ulcers between the Netherlands and Germany associations between risk, prevention and occurrence of pressure ulcers in hospitals and nursing homes. *J Clin Nurs* 2008;**17**(9):1237-44.

8. Capon A, Pavoni N, Mastromattei A, Di Lallo D. Pressure ulcer risk in long-term units: prevalence and associated factors. *J Adv Nurs* 2007;**58**(3):263-72.

9. Moore Zena EH, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2008; (3). http://www.mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD006471/frame.html.

10. Lindgren M, Unosson M, Krantz AM, Ek AC. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002;**38**(2):190-9.

11. Lindgren M. Pressure sores risk assessment and prevention Linköping, Sweden: Linköping University Medical Dissertations No 784, 2003.

12. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 4th ed. Oxford: Oxford University Press, 2008.

13. Streiner DL, Norman GR. Health measurement scales: a practical guide to their development and use. 3rd ed. Oxford: Oxford University Press, 2003.

14. Polit DF, Beck CT. Nursing research principles and methods. Philadelphia: Lippincott Williams & Wilkins, 2004.

15. Brown T, A. Confirmatory factor analysis for applied research. New York: The Guilford Press 2006.

16. Muthén LK, Muthén BO. Mplus User's Guide. 5th ed. Los Angeles: CA: Muthén & Muthén, 2009.

17. Gustafsson J-E, Stahl P-A. STREAMS 3.0 User's Guide. Mölndal, Sweden: Multivaraiteware, 2005.

18. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;**54**(1 part 2):S59-65.

19. Muthén B, Kaplan D, Hollis M. On structural equation modelling with data that are not missing completely at random. *Psychometrica* 1987;**52**(3):431-62.

20. Allison PD. Missing data techniques for structural equation modeling. *J. Abnorm. Psychol.* 2003;**112**(4):545-57.

21. Kottner J, Streiner DL. Internal consistency and Cronbach's α: A comment on Beeckman et al. (2010). *Int J Nurs Stud* 2010;**47**(7):926-28.

22. Zou GY. Sample size formulas for estimating intraclass correlation coefficients with precision and assurance. *Stat. Med.* 2012;**doi: 10.1002/sim.5466**.

23. Kwong EW-y, Pang SM-c, Aboo GH, Law SS-m. Pressure ulcer development in older residents in nursing homes: influencing factors. *J Adv Nurs* 2009;**65**(12):2608-20.

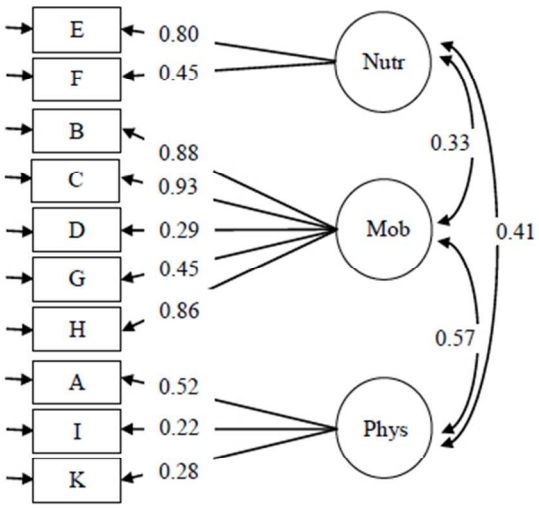
24. Shahin ESM, Meijers JMM, Schols JMG, Tannen A, Halfens RJG, Dassen T. The relationship between malnutrition parameters and pressure ulcers in hospitals and nursing homes. *Nutrition* 2010;**26**(9):886-89.

25. Ek AC, Unosson M, Larsson J, Von Schenck H, Bjurulf P. The development and healing of pressure sores related to the nutritional state. *Clin Nutr* 1991;**10**(5):245-50.

Guidelines for Reporting Reliability and Agreement Studies (GRRAS)

Kottner J, Audigé L, Brorson S, et al. Guidelines for Reporting Reliability and Agreement Studies (GRRAS) were proposed. *J Clin Epidemiol* 2011;64(1):96-106.

		On page #
TITLE AND ABSTRACT	1. Identify in title or abstract that interrater/intrarater reliability or agreement was investigated.	1
INTRODUCTION	2. Name and describe the diagnostic or measurement device of interest explicitly.	3
	3. Specify the subject population of interest.	3
	4. Specify the rater population of interest (if applicable).	3
	5. Describe what is already known about reliability and agreement and provide a rationale for the study (if applicable).	3
METHODS	6. Explain how the sample size was chosen. State the determined number of raters, subjects/objects, and replicate observations.	4
	7. Describe the sampling method.	4
	8. Describe the measurement/rating process (e.g. time interval between repeated measurements, availability of clinical information, blinding).	5
	9. State whether measurements/ratings were conducted independently.	5
	10. Describe the statistical analysis.	6
RESULTS	11. State the actual number of raters and subjects/objects which were included and the number of replicate observations which were conducted.	4 and 5
	12. Describe the sample characteristics of raters and subjects (e.g. training, experience).	4 and 5
	13. Report estimates of reliability and agreement including measures of statistical uncertainty.	8 and 9
DISCUSSION	14. Discuss the practical relevance of results.	10 and11
AUXILIARY MATERIAL	15. Provide detailed results if possible (e.g. online).	-



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