ORIGINAL ARTICLE

Factors related to falls, weight-loss and pressure ulcers – more insight in risk assessment among nursing home residents

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Aims and objectives. To describe how the included items in three different scales, Downton Fall Risk Index, the short form of Mini Nutritional Assessment and the Modified Norton Scale are associated to severe outcomes as falls, weight loss and pressure ulcers.

Background. Falls, malnutrition and pressure ulcers are common adverse events among nursing home residents and risk scoring are common preventive activities, mainly focusing on single risks. In Sweden the three scales are routinely used together with the purpose to improve the quality of prevention.

Design. Longitudinal quantitative study.

Methods. Descriptive analyses and Cox regression analyses.

Results. Only 4% scored no risk for any of these serious events. Longitudinal risk scoring showed significant impaired mean scores indicating increased risks. This confirms the complexity of this population's status of general condition. There were no statistical significant differences between residents categorised at risk or not regarding events. Physical activity increased falls, but decreased pressure ulcers. For weight loss, cognitive decline and the status of general health were most important.

Conclusions. Risk tendencies for falls, malnutrition and pressure ulcers are high in nursing homes, and when measure them at the same time the majority will have several of these risks. Items assessing mobility or items affecting mobility were of most importance. Care processes can always be improved and this study can add to the topic.

Relevance to clinical practice. A more comprehensive view is needed and prevention can not only be based on total scores. Mobility is an important factor for falls and pressure ulcers, both as a risk factor and a protective factor. This involves a challenge for care – to keep the inmates physical active and at the same time prevent falls.

What does this paper contribute to the wider global clinical community?

- *The complexity to risk group categorise frail older persons.* Risk tendencies for falls, malnutrition and pressure ulcers are high among older people living in nursing homes and the majority will have several risks. The total scores, which constitute basis for risk grouping, are not always sufficient information for the preventive work as a more comprehensive view is needed.

- *Care processes can always be improved.* The results from this study can contribute to the knowledge on how to assess older frail persons. Maybe there are other ways than using several assessing scales. Mobility remains an important factor, both as a risk factor and a protective factor and that is challenge for care to manage.

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A study aimed to provide more insight in how different scale items interact with each other and how they are associated to severe outcomes. It is not a prediction study or a study of diagnostic accuracy, but a study that can contribute to the field of knowledge of assessments in older persons.

Introduction

In Sweden, like in the rest of Western societies the numbers of older people are increasing, and also the number of older people needing care and services (WHO 2012). The municipality has the responsibility to offer care in nursing home facilities when the older person can no longer manage at home. According to national statistics Sweden had approximately 87,600 persons at the age 65 and over permanently staying in nursing home facilities. From these, 80% were aged above 80 years and 69% were women (Board of National Health and Welfare 2012). Old age care in Sweden requires a need assessment performed by a special trained social worker. The need assessment is based on the amount of functional problems performing activities in daily life (ADL). As a 'stay-in-place' policy is applied, home care service is offered as long as possible. Moreover, the number of beds in nursing homes has decreased by 20% during the last 10 years in Sweden (Board of National Health and Welfare 2012). These circumstances indicates that individuals moving in to nursing homes today are frailer and in more extended need of care than previously.

To provide optimal care and foremost preventive actions it is essential to know risk status, and helpful tools to establish action policies can be assessing scales. Accordingly, scoring risk for falls, malnutrition and pressure ulcers are common preventive activities in the care of older people and numerous scales and assessments are used for this purpose. In Sweden the most common tools are Downton Fall Risk Index (DFRI) to assess fall risk (Downton 1993), the short form of Mini Nutritional Assessment (MNA-SF) (Rubenstein *et al.* 2001) to assess risk for malnutrition and the Modified Norton Scale (MNS) (Ek 1987) to assess risk for developing pressure ulcers.

Background

Falls by older people in nursing home facilities are common events. The prevalence of falls in institutionalised older people is reported at 53–62% of the inmates (Rosendahl *et al.* 2003, Meyer *et al.* 2009). Risk factors have been described as gait and balance instability, cognitive and functional impairment, sedating and psychoactive medications (Rubenstein *et al.* 1994) and number of diseases (Damian *et al.* 2013). Some falls may be caused by a single factor, but the majority of falls are caused by a combination of factors (Cameron *et al.* 2010).

Older persons are also considered to be at high risk of malnutrition. Several studies in nursing homes populations have shown both high risk and high prevalence of malnutri-

tion; a recent review showed that approximately 14% were classified as malnourished and more than half were at risk of malnutrition (Kaiser *et al.* 2011). A follow-up study in Swedish nursing homes showed that nutritional status was improved, but still 63% were assessed at risk, and 30% of those were malnourished (Torma *et al.* 2013).

A third major and serious event that is common among older persons in nursing homes is pressure ulcers. A recent systematic review of pressure ulcers risk factor studies identified three primary risk domains; mobility/activity, perfusion and general skin status. However, no single factor can predict pressure ulcer risk, which is caused by a complex interplay of factors (Coleman *et al.* 2013). A Swedish nursing home study showed a prevalence of pressure ulcers at 14% and according to risk assessment, a risk between 26–30% (Gunningberg *et al.* 2013) which is similar to other European studies (Meesterberends *et al.* 2013).

One must also consider ageing as a risk factor for these outcomes, knowing that biological ageing increases the vulnerability and decreases the reserve capacity (Fried *et al.* 2001, Rockwood & Mitnitski 2007).

In Sweden, DFRI, MNS and MNA-SF are routinely used together to assess risks in older persons living in nursing homes. The scales are included in the quality registry Senior Alert which is a national investment aimed to increase the quality of the preventive work. The widely used MNA was developed and validated for the assessment of older, frail persons. MNA has a long history (Secher *et al.* 2007) and seems to be well suited for nursing home residents (Diekmann *et al.* 2013). Further validation has shown that the short-form can be used as a stand-alone unit (Bauer *et al.* 2008, Salvi *et al.* 2008, Dent *et al.* 2012). DFRI was validated in a Swedish study (Rosendahl *et al.* 2003) and appeared to be a useful tool for predicting falls among older people in residential care facilities. However, a comparison with DFRI and nurses judgement alone showed no clinical benefit for DFRI (Meyer *et al.* 2009). MNS is tested, recommended and well known in Sweden (Gunningberg *et al.* 2013) and it is validated to its actual content (Ek & Bjurulf 1987).

It is reasonable to believe that frail older persons have several risks and that general decline increases serious events, but using several different instruments can be time consuming and increase the workload as results must be documented and interventions should be planned and followed. Therefore, it is important to put knowledge to this topic so that nurses can reflect upon the usefulness. One problem when using the three scales together is that several functions are assessed repeatedly as they exist in more than one scale. Mobility and cognition are, for exam-

ple, assessed in all three scales but in different ways and with different grading. The ambition with the present study is to gain knowledge about the relations among the outcomes and the included scale items.

Aim

This study aims to find patterns of associations among scale risk items in MNA-SF, DFRI and MNS, with the outcomes falls, pressure ulcers and weight-loss.

Method

Study population

Data from this study were collected from a longitudinal cohort study of older people living in nursing homes in Sweden; The Study on Health and Drugs in Elderly (SHADES). The SHADES study was launched in 2008 and completed in 2011 and the overall aims were to describe and analyse morbidity, health-conditions and drug-use among older people in nursing home facilities. A convenience sample of 12 nursing homes including 443 beds was included in the SHADES study. The nursing homes were located in three different regions in southern Sweden and were all in the public sector. As participants were included during the whole study period, the participants had different durations which consequently led to varying number of follow-up assessments. When the study nurse returned for a follow-up visit, all new inmates were asked to participate, not just those who moved in where a deceased participant had lived. Figure 1 describes the inclusion flow. Exclusion criteria were palliative care or language problems. All together 664 were asked to participate and 429 were included.

As 98 individuals participated only once, 331 of 429 participants were available for prospective analysis. For some of the statistical analyses sub-samples were used, which are described under the heading of 'Statistical analyses'.

The study, which complied with the Declaration of Helsinki, was approved by the Regional Ethical Review Board, Linköping, Sweden (M150-07). Written informed consent was obtained from all participants. If the patient could not understand the information and give informed consent, it was obtained from a proxy. For those who declined to participate, information of age, gender, diagnoses and reason for not participating was recorded. There were no differences between the participants and those who declined to participate according to age, gender and diagnoses.
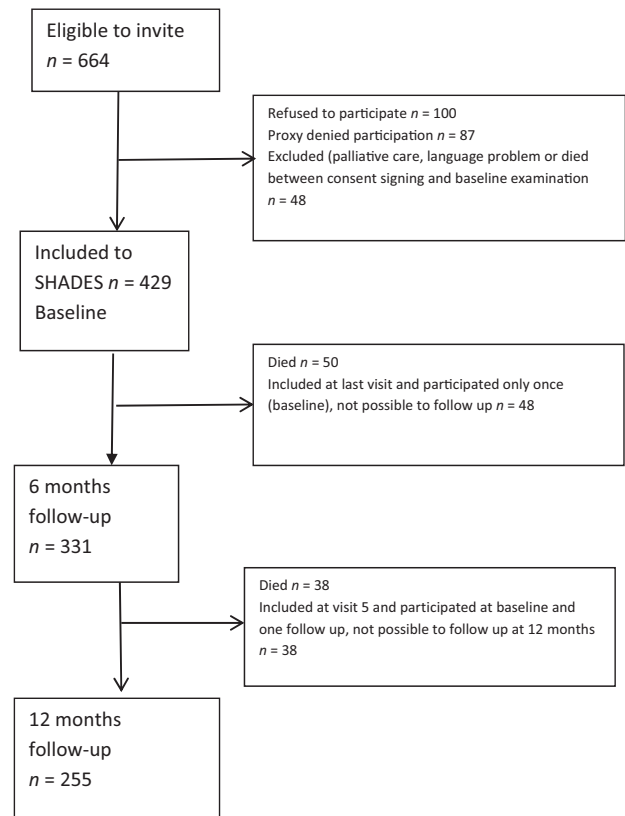

Figure 1 Inclusion to the SHADES study.

Data collection

A total of six visits at every sixth month were performed by specially trained nurses. The same nurse visited the same nursing homes at each follow-up visit for examinations, data collecting and to include new residents. Risk-assessment tools were performed with support from the staff, that is, each individual's contact person. Fall risk was assessed with DFRI, which includes 11 risk items concerning previous falls in the last six months, use of drugs (tranquillisers/ sedatives, diuretics, antihypertensives, antidepressants and antiparkinsonian drugs), sensory deficits (visual- and hearing impairment), limb abnormalities (hemiparesis), cognitive dysfunction and walking ability (Downton 1993). Each item is scored 1 point and added to give a total score range of maximum 11. A score of 3 and more indicates an increased risk to fall. Falls were defined as 'an event which causes the patient to come unintentionally to the ground or some lower level, regardless of the cause' (Lamb *et al.* 2005).The number of individual falls was not taken into account, but only if they had fallen or not.

Risk for malnutrition was assessed by using MNA-SF, which is a six-question short-form of MNA (Rubenstein *et al.* 2001). MNA-SF covers the past three months and

addresses decreased food intake (0–2 points), estimated weight loss (0–3 points), mobility (0–2 points), acute diseases or psychological stress (0 or 2 points), neuropsychological impairment (0–2 points) and BMI (0–3 points). The higher the value the lower the risk. The maximum MNA-SF score is 14 points. A score of 7 points or less indicates malnutrition, 8–11 indicates risk of malnutrition and 12–14 points indicates no risk for malnutrition.

Risk for pressure ulcers was assessed with MNS. In addition to the more internationally known Norton Scale, MNS also includes two items assessing nutrition status. MNS consists of seven items; mental condition, activity, mobility, food intake, fluid intake, incontinence and general physical condition. Each item is assessed with a range from 1 (lack of function) to 4 (normal function). The maximum score is 28 and a score at 20 or lower indicates an increased risk for pressure ulcers (Ek 1987).

The scales internal consistency in this study, measured by Cronbach's alpha showed −0·5 for DFRI, 0·66 for MNS and 0·45 for MNA-SF.

In the SHADES study the nurses examined the participants in many ways regarding different assessment scales, blood testing, use of drugs, different measurements etc. For this present study we used data from DFRI, MNA-SF, MNS, data of weight and data of eventual presence of pressure ulcers. Pressure ulcers were graded as: (1) persistent discoloration, with intact skin surface; (2) epithelial damage; (3) damage to the full thickness of the skin without a deep cavity and (4) damage to the full thickness of the skin with deep cavity. In this study, all kinds of pressure ulcers were taken into account, but not gradated, only counted as existing or not. Description of the study population concerning prevalence and risks are presented in Table 1.

Statistical analyses

Descriptive statistics were used for baseline characteristics and to describe outcomes at 6 and 12 months. For analysing outcomes in relation to risks at six and 12 months a subsample of 255 was used, that is, participants with at least three occasions of measure (baseline and at least two follow-ups). The proportions of being at risk or not were compared using a two-sided Chi square test. To analyse the longitudinal changes of the total scores in the three assessments scales, General Linear Model (GLM with repeated measures) was used. For the GLM analyses a subsample of 116 was used, that is, those who participated during the whole study period (30 months). Cox regressions were performed to analyse factors related to the outcomes falls, weight loss and pressure ulcers. Three outcome variables

Table 1 Description of study population at baseline

	n = 331
Age (mean)	84
Mean DFRI (SD)	4·8 (1·6)
DFRI risk %	93
Falls % (≥1 fall last six months)	62
Mean MNA SF (SD)	10·3 (2·5)
Mna-SF risk %	58
MNA-SF item Weight loss > 3 kg last three months %	3
MNA-SF item BMI < 19 (%)	6
BMI 19–20 (%)	13
BMI 21–23 (%)	18
BMI > 23 (%)	63
Mean BMI (SD)	25 (4·76)
Mean MNS (SD)	23 (3·45)
MNS risk %	27
Presence of pressure ulcers %	10
Mean number of medication (SD)	6·85 (3·04)
Mean Number of diseases (SD)	2·9 (1·33)
Mobility	
Wheelchair bound (%)	30
Walking with assistance (%)	15
Walking with or without aid (%)	55
Bedridden (%)	0
Mean MMSE (SD)*	17 (6·3)
MMSE<24 points (%)	68
Hospital care last six months %	24
Emergency care last six months %	6

*MMSE was not performed on all participants. Due to cognitive dysfunction, blindness or impaired hearing, questions could not be understood for all, which made 83% eligible to assess.

were created 'Falls last six months' (coded as 1), 'Weight loss with at least 10% or at least 6 kg' (coded as 1) and 'Presence of pressure ulcers' (coded as 1). Those who eventually already had suffered from any of these events at baseline were included in the analyses with the purpose to increase the size of the population. Exclusion of these individuals would have decreased the population and made it less representative for a nursing home population. However, the time variable for those who already suffered from some kind of pressure ulcer at baseline was time coded with 0. For the other two outcomes the time variable was determined as time from baseline to the follow-up visit date when the outcome variable first was detected. If no occurrence of the outcome variables during the two follow-ups was detected, the time variable was determined to be approximately one year, or, if the participant was deceased, time to death was calculated. Three Cox regression analyses in two steps were performed for each outcome. Baseline data on age, gender, number of drugs and number of diagnoses were included as covariates in the first step to control

for sociodemographics and health. In the second step, the scale items for one scale were included as covariates. This procedure was then repeated for each scale, respectively, which made a total of nine regression models. Finally, three two-step Cox regression analyses were performed with the sociodemographics described above as covariates in the first step and the total scores of each scale as covariates in the next step.

Analyses were performed using the SPSS statistical software (IBM SPSS version 20, IBM Corp, Armonk, NY). *p*-values ≤0·05 were considered statistically significant.

Results

Description of study population

A sample of total 331 residents had consecutive and complete data from baseline to at least one follow-up. Of those, mean age was 84 years (SD 7) and 71% were female. The subjects had been staying at the nursing homes for in median 10 months. At baseline (Table 1), the study population demonstrated a considerable risk for fall n = 307 (93%), malnutrition n = 192 (58%) and pressure ulcers n = 89 (27%). Combination of risks were more common than single risk as 25% had risk for both fall, malnutrition and pressure ulcers and 32% had risk for two of these conditions. Single risk was demonstrated at 39%, but only 4% of the sample scored no risk at any of the three assessing scales at baseline.

To see how the total score values for DFRI, MNS and MNA-SF varied over time, repeated measures were analysed in several GLMs. The result showed statistically significant impaired mean scores; MNS decreased from 23·09 to 20·94 ($p < 0.001$), MNA-SF decreased from 10·76 to 9·34 ($p < 0.001$) and DRFI increased from 4·58 to 4·88 ($p < 0.05$).

Events related to risk

Table 2 shows outcomes for fall, weight loss and pressure ulcers at six and 12 months, in relation to risk group categories at baseline. To give a broader view of weight loss, both weigh loss with at least 5% and weight loss with at least 10% or 6 kg were shown in the table. Weight loss of at least 5% was shown separately although those individuals might be included in the higher level of weight loss if that limit also was reached. The results in Table 2 shows that individuals considered to low/no risk at baseline assessment also experienced events to a great extent, with no statistical significant differences between being at risk or not.

Events related to items

The Cox regression analyses (Table 3) demonstrated the outcome *Falls last six months* significantly related to the items *Mobility* (MNA-SF) HR 1·53 (95% CI 1·26–1·86), and *Activity* (MNS) HR 1·72 (95% CI 1·21–2·44), indicat-

Table 2 Events of falls, pressure ulcers and two levels of weight loss at six and 12 months in relation to risk category

Fall risk assessment at baseline (DFRI) *n* = 255	Risk (≥3 p DFRI) *n* = 236	No risk (<3 p DFRI) *n* = 19	χ^2/*p*-values
Falls at six months (*n*)	101	4	3·43/*p* = 0·064
Falls at 12 months (cum *n*)	128	7	2·14/*p* = 0·144
Pressure ulcer risk assessment at baseline (MNS) *n* = 255	Risk (≤20 p MNS) *n* = 64	No risk (>20 p MNS) *n* = 191	χ^2/*p*-values
Pressure ulcer at six months (*n*)	10	16	2·75/*p* = 0·097
Pressure ulcer at 12 months (cum *n*)	15	25	3·43/*p* = 0·064
Malnutrition assessment at baseline (MNA-SF) *n* = 255	Risk (≤11 p MNA-SF) *n* = 145	No risk (>11 p MNA-SF) *n* = 110	χ^2/*p*-values
Weight loss at least 5% at six months (*n*)	26	12	2·43/*p* = 0·119
Weight loss at least 5% at 12 months (cum *n*)	47	27	1·88/*p* = 0·170
Weight loss at least 10% or at least 6 kg at six months (*n*)	10	5	0·63/*p* = 0·429
Weight loss at least 10% or at least 6 kg at 12 months (cum *n*)	27	18	0·22/*p* = 0·640

ing that physical activity increased falls. *Unsafe gait* (DFRI) was also related to falls, HR 1·64 (95% CI 1·19–2·27) as well as *Known previous fall* (DFRI) HR 2·5 (95% CI 1·74–3·57). *Number of diagnoses* was significantly related to falls together with the items from DFRI, HR 0·82 (95% CI 0·71–0·94), as well as, MNA-SF HR 0·86 (95% CI 0·75–0·99) indicating that fewer diagnoses increased falls. *Sedatives/neuroleptics* (DFRI) HR 0·66 (95% CI 0·46–0·94) and *Limb impairment/hemiparesis* (DFRI) HR 0·52 (95% CI 0·34–0·79) were also negatively associated, which implies that less physical activity decreases falls.

The outcome variable *Presence of pressure ulcer* was significantly related to *Number of drugs* where all three scales showed significant relations; DFRI HR 1·16 (95% CI 1·01–1·34), MNA-SF HR 1·14 (1·03–1·27), MNS HR 1·14 (1·02–1·26) respectively. *Presence of pressure ulcer* was also related to the mobility items *Limb impairment/hemiparesis* (DFRI) HR 1·96 (95% CI 1·04–3·70), *Mobility* (MNA-SF) HR 0·46 (95% CI 0·32–0·64), *Activity* (MNS) HR 0·56 (95% CI 0·33–0·93) respectively, indicating that less physical activity increased presence of pressure ulcers. *Age* was also significantly related together with MNA-SF HR 1·05 (CI 1·00–1·10), MNS HR 1·06 (CI 1·01–1·11) respectively. *Number of diagnoses* was positively related together with DFRI HR 1·32 (CI 1·00–1·73). Other related items were *Food intake* (MNS) HR 1·54 (95% CI 1·06–2·23) and *Hearing impairment* (DFRI) HR 2·06 (1·10–3·83).

Weight loss at least 10% or 6 kg as outcome demonstrated significant relations to two items indicating impaired cognition; *Cognitive dysfunction* (DFRI) HR 2·07 (95% CI 1·06–4·03) and *Neuropsychological impairment* (MNA-SF) HR 0·57 (95% CI 0·38–0·86). The third item related to weight loss was *General condition* MNS HR 0·44 (95% CI 0·27–0·72).

Table 4 shows the total scores of DFRI, MNA-SF and MNS analysed together with the sociodemographics as covariates in a two-step Cox regression model. *Falls last six months* showed significant relations to *Number of diagnoses* HR 0·81(95% CI 0·703–0·925) DFRI HR 1·18 (95% CI 1·054–1·324) and MNS HR 1·14 (95% CI 1·076–1·206). *Presence of pressure ulcers* was related to *Age* HR 1·05 (95% CI 1·00–1·10), *Number of drugs* HR 1·15 (95% CI 1·03–1·30) and MNS HR 0·86 (95% CI 0·78–0·94). *Weight loss at least 10% or 6 kg* was only related to MNS HR 0·90 (95% CI 0·820–0·997).

Discussion

This study population was characterised by cognitive impairment and high risk for falls, malnutrition and pressure ulcers.

According to the results from the GLM analyses, all three scales reflected increased risk scores over time. Furthermore, combinations of risks (57%) were more common than single risks. This confirms the complexity of this population's status of general condition and does also illustrate that it is questionable to focus only on single risks. Further, there were no statistically significant differences regarding events between those categorised at risk or not. This confirms the complexity of the preventive work and implies that the total scores of scales should be interpreted with caution and a more comprehensive view is needed before any preventive actions.

Cox regression was used with the ambition to use the longitudinal time points and at the same time make it possible to use a larger sample. It was thereby possible to analyse those with baseline measures and just one follow-up mixed with those with two follow-ups, which made the total of 331 persons. The time variable for the outcome *Presence of pressure ulcer* was set to 0 for individuals with pressure ulcers already at baseline, depending of the constancy of pressure ulcers. Falls are not so constant so the time variable was not set to 0 for earlier fallers, and besides, *Known earlier falls* (DFRI) contributed as an independent variable. Any eventual weight loss with at least 10% or 6 kg was unknown before inclusion, so time adjustment to 0 for this outcome was not possible. However, the item *Weight-loss last three months* (MNA-SF) contributed as an independent variable.

For the outcome variable *Falls last six months*, the item *Known previous falls* was important, which is consistent with other findings (Barker *et al.* 2009, da Costa *et al.* 2012). In contrast to other findings (Damian *et al.* 2013), *Number of diagnoses* was associated so fewer diagnoses related to more falls. This might appear as a paradox, but it is possible that those with fewer diseases are more physically active which makes them more fall prone. Other surprising findings were that use of *sedative/neuroleptics* and *limb impairment/hemiparesis* decreased falls. Both these items are risk factors in DFRI but this result seem to show the opposite. A possible explanation can be less physical activity among those and consequently these persons are less fall prone.

The total score of DFRI showed a significant association with falls, but a problem with DFRI is that almost all residents will be assessed as having risk to fall. A great amount of older persons in nursing homes uses many drugs and also suffers from sensory, mobility, and cognitive problems. These characteristics are not confined only to fallers (Barker *et al.* 2009), which also complicates the preventive work. Moreover, other studies in similar settings, have reported that assessing fall risk with DFRI did not result in better clinical outcome than reliance on nurse's clinical judgement (Meyer *et al.* 2009) (da Costa *et al.* 2012).

Table 3 Cox regressions with three outcome variables in relation to the included items in DFRI, MNA-SF and MNS. The regressions were performed in two steps with the purpose to control for sociodemographics factors like age, gender, number of drugs and number of diagnoses. Varying n is depending on internal missing

DFRI	Falls last 6 months		Presence of pressure ulcers		Weight loss 10% or 6 kg	
	Step 1 – 2LL: 1790·14 Hazard ratio	Step 2 – 2LL: 1737·50 $\chi^2_{(15)} = 64.2^{***}$ Hazard ratio	Step 1 – 2LL: 498·44 $\chi^2_{(4)} = 15.56^{**}$ Hazard ratio	Step 2 – 2LL: 477·59 $\chi^2_{(15)} = 34.95^{**}$ Hazard ratio	Step 1 – 2LL: 476·95 Hazard ratio	Step 2 – 2LL: 466·94 Hazard ratio
	$n = 323$		$n = 323$		$n = 321$	
Age	1·02	1·01	1·05**	1·04	0·99	1·00
Gender	1·04	1·01	1·58	1·64	1·15	1·11
No. of drugs	1·04	1·03	1·12*	1·16*	1·05	1·02
No. of diagnoses	0·85**	0·82**	1·28	1·32*	1·00	0·96
Known earlier falls		2·50***		0·98		1·49
Sedative/neurolept		0·66**		1·37		0·92
Diuretics		1·03		1·03		1·29
Antihypertensive		1·41		0·58		1·13
Anti parkinsonian		1·59		0·00		1·57
Antidepressants		0·95		0·88		1·00
Visual impairment		1·33		0·86		1·47
Hearing impairment		0·97		2·06*		0·87
Hemipharesis/Limb imp		0·52**		1·96*		1·39
Cognitive dysfunction		1·09		1·32		2·07*
Unsafe gait		1·64**		0·72		0·79
MNA-SF	– 2LL: 1805·36 $\chi^2_{(4)} = 10.41^{*}$	– 2LL: 1792·97 $\chi^2_{(15)} = 30.9^{**}$	– 2LL: 520·94 $\chi^2_{(4)} = 16.12^{**}$	– 2LL: 499·29 $\chi^2_{(15)} = 39.26^{***}$	– 2LL: 478·06	– 2LL: 465·5
	$n = 328$		$n = 328$		$n = 326$	
Age	1·02	1·02	1·05*	1·05*	0·99	1·00
Gender	1·02	0·97	1·43	1·51	1·14	1·30
No. of drugs	1·04	1·05	1·14**	1·14*	1·05	1·05
No. of diagnoses	0·84**	0·86*	1·23	1·16	1·00	1·00
Reduced food intake		0·84		1·22		0·87
Loss of weight		0·99		1·23		1·27
Mobility		1·53***		0·46***		0·73
Psychological stress		0·86		0·99		0·89
Neuropsych impairment		0·90		1·13		0·57**
BMI		1·01		0·87		1·04
MNS	– 2LL: 1817·48 $\chi^2_{(4)} = 10.16^{*}$	– 2LL: 1773·28 $\chi^2_{(15)} = 50.22^{***}$	– 2LL: 532·96 $\chi^2_{(4)} = 15.66^{**}$	– 2LL:509·61 $\chi^2_{(15)} = 38.8^{***}$	– 2LL: 488·96 $\chi^2_{(4)} = 1.76^{**}$	– 2LL:468·63 $\chi^2_{(15)} = 25.55^{**}$
	$n = 330$		$n = 330$		$n = 326$	
Age	1·02	1·02	1·04	1·06*	0·99	0·97
Gender	1·03	1·09	1·45	1·28	1·07	1·21
No. of drugs	1·04	1·06	1·13*	1·14*	1·06	1·04
No. of diagnoses	0·84**	0·90	1·25	1·22	0·97	1·01
Mental condition		0·82		0·87		0·80
Mobility		1·72**		0·56*		1·21
Activity		1·21		1·14		0·85
Food intake		1·00		1·54*		0·83
Fluid intake		0·98		0·77		1·16
Incontinence		0·91		0·87		0·90
General condition		0·83		0·66		0·44**

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 4 Cox regressions with three outcome variables in relation to the total scores of DFRI, MNA-SF and MNS. The regressions were performed in two steps with the purpose to control for sociodemographics factors like age, gender, number of drugs and number of diagnoses

	Falls last six months		Presence of pressure ulcers		Weight loss at least 10% or at least 6 kg	
	Step 1 $-2LL$: 1703·06 $\chi^2_{(4)} = 11.07^*$ HR	Step 2 $-2LL$: 509·49 $\chi^2_{(7)} = 27.58^{***}$ HR	Step 1 $-2LL$: 520·79 $\chi^2_{(4)} = 15.49^{**}$ HR	Step 2 $-2LL$: 509·49 $\chi^2_{(7)} = 27.58^{***}$ HR	Step 1 $-2LL$: 488·10 HR	Step 2 $-2LL$: 478·77 HR
Age	1·02	1·02	1·05*	1·05*	0·99	0·98
Gender	1·04	0·93	1·39	1·51	1·07	0·96
No. of drugs	1·04	1·02	1·14*	1·15*	1·06	1·01
No. of diagnoses	0·84**	0·81**	1·23	1·23	0·98	0·98
DFRI		1·18**		0·93		1·20
MNA-SF		0·94		1·06		0·98
MNS		1·14***		0·86**		0·90*

$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Increased risk for malnutrition at baseline was found among 58% of the residents, which is consistent with other studies (Kaiser *et al.* 2009, 2011, Torma *et al.* 2013). It was not clear which was the most relevant outcome variable for MNA-SF to be used in the analysis. A reason for choosing 10% or at least 6 kg was that unintentional weight loss around 10% in six months is a mark for malnutrition (Blackburn *et al.* 1977, Faxén Irving *et al.* 2010). However, in Table 3 two levels of weight loss were shown to reflect both slower/lower (5%) and rapid (10%) weight loss. Although the concept 'malnutrition' comprises more than weight loss, it is still surprising that the total score of MNA-SF was not associated with such a serious event as weight loss with at least 10% or 6 kg in six months. Moreover, rather few items were associated with weight loss, but items assessing cognitive impairment seems to be important risk factors as such items from both DFRI and MNA-SF were associated. Several other studies confirmed this association (Lee *et al.* 2009, Verbrugghe *et al.* 2013).

The outcome *Presence of pressure ulcer* also showed substantial associations with items assessing mobility and activity, which also other have reported (Lindgren *et al.* 2004). According to MNS, approximately 25% was considered to have risk, which was consistent with others (Gunningberg *et al.* 2013, Meesterberends *et al.* 2013). Other important factors were increased values of *Age* and *Number of drugs,* which seems rather logical. Why *Hearing impairment* (DFRI) was associated with the presence of pressure ulcers is unclear, but it might reflect the influence of sensory functional decline. Poor nutrition status has been demonstrated as a risk factor for pressure ulcers (Casimiro *et al.* 2002), but in this present study *Intake of food* (MNS) was related in a way that larger intake increased the presence of pressure ulcers. A conceiv-

able explanation might be the difficulty to estimate food intake. An attempt to compare how nurses estimated food intake with the actual intake (measured with accurate registration) showed no correlation, but there was a tendency to overestimate food intake (Ernsth 2001). MNS has four options to estimate meal size; normal, three quarters, half and smaller than half. What is a normal portion for the individual resident? It could be the same as half the size for another. Another explanation might be that those who developed pressure ulcers were taken care of with special attention on food intake.

Important factors for falls and pressure ulcers were items concerning mobility and activity. This indicates that these are factors always require attention, but it is probably not the variables *per se* that identify the older persons at risk, but rather the underlying condition. This also confirms the importance of exercise including strength-, balance- and gait training, which of course must be performed in a safe way. Further, it is shown that common care problems in long-term care facilities in general, including falls, pressure ulcers and malnutrition are associated with immobility, which emphasises its importance in nursing care (Lahmann *et al.* 2015).

The analyses of the total scores showed that MNS significantly related with all three outcomes. This is an interesting finding implicating that MNS cover many important items. One explanation can be that many of the items from MNS measures general health and that several of them are known risk factors for frailty (Ernsth Bravell *et al.* 2011). Nevertheless, the total scores, which constitute basis for risk grouping, are not the whole truth. Besides categorising into risk/no risk, each assessed item should be considered separately as a reminder of shortage in abilities or functions, and should be done irrespective of used scale. In this process, the factors

highlighted in this study should be considered with special attention. Accordingly, a comprehensive view and individual judgment is necessary, irrespective of being at risk or not, as persons without risk also will suffer from events. Nurses should also consider what is actually measured when using assessment scales; a special risk or general decline, which in turn may increase both risk tendency and lead to events.

The results presented in this study and the fact that the used scales had low internal consistency, make them questionable for this population with high care need. However, using assessment scales routinely might bring attention to the phenomenon of preventive care, and thereby serve as pedagogical tools.

Normally, the reason for using risk assessments tools is to address prevention actions to the subjects that are most in need of these actions. In this study, no special interventions were performed, but we have no information about treatment and level of prevention of the routine care given at the nursing homes. This is important to keep in mind, especially regarding interpretations of the results from Table 2. As we do not know what, or if any special treatment or intervention was given to those being at risk, it is possible that the lack of statistical difference can be influenced of the fact that the risk groups event rate, depending on intervention, was decreased to a level more equal to those being without risk. On the other hand, even those without risk could possibly have received intervention in accordance to nurse's judgement and/or the routines of care, instead of a score point. However, this study was not aimed to evaluate interventions or to be predictive. According to Balzer *et al.* (2013) an assessment scale cannot solely be judged from the amount of events or outcome due to serious risk of bias. Thus, is not possible to control for every care process in daily clinical practice. Instead, the study aimed to give insight in how scale items are associated to severe outcomes under the existing circumstances.

Limitations

The exact date for the outcome variables *Falls last six months* was not recorded for the SHADES study but only if there had been a fall or not. Occurrences of fall were collected from the routine care documentation. If there had been any fall during the last six months, the date for the actual scoring became the fall date. This shortage in accuracy may have affected the time variable in the Cox regressions. For pressure ulcers, if there were any at the follow-up, the actual date for scoring became the date. It is possible, but not likely, that a pressure ulcer had risen and reached to be healed between the follow-up visits, and therefore not detected.

These shortages of accuracy can be explained by the fact of using data from a study where these issues were not of primary interest.

Conclusions

In this study 93% had fall risk, 58% risk for malnutrition and 27% risk for pressure ulcers. Only 4% scored no risk for any of these serious events. Longitudinal risk scoring showed significant impaired mean scores indicating increased risks. This confirms the complexity of this population's status of general condition. Further, there was no statistical significant difference between those being at risk or not regarding falls, weight loss or pressure ulcers which implies that the total scores of scales should be interpreted with caution. Regression analyses with falls, pressure ulcers and weight loss as dependent variables showed that mobility, activity and factors that may affect mobility were associated with falls. Age, number of drugs, mobility and activity revealed shared associations to pressure ulcers. For weight loss with at least 10% or 6 kg cognitive decline was of most importance. Regression analyses with the same outcome variables in relation to the total scores showed that MNS was associated with all three outcomes. This implies that MNS covers many important items to assess general decline and frailty which in turn increase both risk tendency and lead to events.

Relevance to clinical practice

Mobility and activity from the three different scales showed shared associations with falls and pressure ulcers but in two different ways – physical activity increases falls but decreases pressure ulcers. This involves a challenge for care – to improve and maintain physical activity and at the same time prevent falls. For weight loss the most important associations were cognitive decline. Further, when planning the preventive interventions, a comprehensive view and individual judgment is needed and not only to focus on the total scores.

Contributions

Study Design: CL, MEB; Data collection and analysis: CL, MEB; Manuscript preparation: CL, MEB, PM, CJÖ, SM.

Conflict of interest

The authors have no conflicts of interest to declare.

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