BMJ Open

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument in Norwegian homecare services

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052293
Article Type:	Original research
Date Submitted by the Author:	13-Apr-2021
Complete List of Authors:	Viksveen, Petter; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Røhne, Mette; SINTEF, SINTEF Digital, Health Grut, Lisbet; SINTEF, SINTEF Digital, Health Cappelen, Kathrine; University of South-Eastern Norway Faculty of Health and Social Sciences, Center for Caring Research South Wiig, Siri; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Ree, Eline ; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, STATISTICS & RESEARCH METHODS

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Title page

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument in Norwegian homecare services

Petter Viksveen, Mette Røhne, Lisbet Grut, Kathrine Cappelen, Siri Wiig, Eline Ree

Corresponding author:
Dr. Petter Viksveen, PhD, Associate Professor
SHARE - Centre for Resilience in Healthcare
Department for Quality and Health Technology
Faculty of Health Sciences
University of Stavanger
Postboks 8600 Forus
4036 Stavanger, Norway
Tel + 47 51 83 27 37
Email petter.viksveen@uis.no
Website University of Stavanger
Website SHARE - Centre for Resilience in Healthcare

Names, institutions, city and country for co-authors:
Dr. Mette Røhne, Department of Smart Sensor Systems, SINTEF Digital, Oslo, Norway.
Mrs. Lisbet Grut, Department of Health Research, SINTEF Digital, Oslo, Norway.
Dr. Kathrine Cappelen, Center for Caring Research South, Faculty of Health and Social Services, University of South- Eastern Norway, Porsgrunn, Norway.
Professor Siri Wiig, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.
Dr. Eline Ree, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.

Keywords: patient safety, safety culture, health services research, healthcare quality improvement, evaluation methodology

Word count: 3966

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument in Norwegian homecare services

Abstract

Introduction: A growing proportion of the aging population stay in their homes and require homecare services for healthcare conditions. This is associated with increased risks of adverse events within the context of citizens' homes. Assessment of patient safety culture is important for improving patient safety. The *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* is a commonly used safety culture assessment instrument, but has hardly been tested in homecare services. Assessment instruments must be valid, reliable and of minimal burden to personnel for day-to-day practice and research.

Aims: Measure patient safety culture in homecare services; test the psychometric properties of the *NHSOPSC* instrument; and propose a short version instrument for use in homecare services.

Method: Cross-sectional survey with 540 participants in 27 publicly funded homecare units in eight municipalities (six counties) in Norway. Psychometric testing of the *NHSOPSC* instrument using factor analysis and optimal test assembly (OTA) with generalized partial credit (GPCM) to develop a short version instrument proposal.

Results: Most healthcare personnel rated patient safety culture in homecare services positively. A 19-item short version instrument for assessing patient safety culture had high internal consistency, and was considered to have sufficient concurrent and convergent validity. It explained a greater proportion of variance (59%) than the full version (50%). Short version factors included *safety improvement actions*, *teamwork*, *information flow*, and *management support*.

Conclusion: This study provides a first proposal for a short version *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument to assess patient safety culture within homecare services. It provides a starting point for developing an improved valid and reliable short version instrument as part of assessment of patient safety and quality improvement processes.

Strengths and limitations of this study

- The first proposal for a short version instrument to assess patient safety culture in homecare services
- Factor analysis, generalized partial credit model (CPCM) and optimal test assembly OTA approach to assess internal consistency, concurrent and convergent validity
- The largest study assessing patient safety culture in Norwegian homecare services, possibly worldwide
- A limitation was lack of random selection of participants, although variation in contextual settings contributes to strengthen generalizability of results
- Transferability to other countries or other healthcare settings must be tested through further research

Introduction

In this study we report on patient safety culture and assess the psychometric properties of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument within the context of homecare services in Norway, and propose and test a short version instrument.

A recent systematic review with a meta-analysis including over 70 studies worldwide with 330,000 patients, found that one in twenty experienced preventable health service inflicted harm (1). Harm could take place in any clinical context, including primary, secondary and tertiary care, involving e.g. infections; diagnostic procedures; and the use of drugs, surgical or other therapeutic interventions. In 12% of patients, harm was severe or fatal. Estimates suggest that in primary and ambulatory care almost four in ten patients experience safety issues, resulting in increased need for

hospitalization (2). Patient harm is a major global health burden costing trillions of dollars annually (3).

Considerable efforts have been made to improve patient safety over the last decades, resulting in some reduction in the prevalence of harm. For example, the mortality rate due to adverse effects of medical treatment decreased by 21% in the US from 1990 to 2016 (4). However, a significant proportion of patients are still exposed to risk and experience adverse events, some of which are fatal. In Norway, a recent review found that 4.2% of deaths in hospitals could probably have been avoided (5).

Improving patient safety measures within healthcare services is particularly important for older patients (70 years+) who have 20 times higher mortality rates due to adverse medical effects, compared to younger age groups (15-49 years) (4). Improved patient safety is crucial from a societal perspective as the number of older citizens will increase from 700 million to 1.5 billion worldwide over the next three decades (6). Most citizens wish to "age in place," which can be understood as living safely in their own home, regardless of age and ability (7). A high proportion of older citizens living at home can have significant societal benefits, by reducing the increasing burden to healthcare services and by limiting the need for nursing homes. However, healthcare services must adapt to the demographic shift and attend to the needs of a much larger proportion of older citizens, many of whom have chronic health conditions and will require homecare services (8).

To advance patient safety, the *National Patient Safety Foundation (NPSF)* recommended a total systems approach in 2015, where leaders should establish and sustain a safety culture at all levels of patient care, including homecare services (9). Although the understanding of *patient safety culture* varies among researchers (10), it is most commonly defined as: "*The product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety programmes. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures.*" (11) *NPSF's* recommendations are supported by a systematic review which found that improvements in healthcare services' organizational culture were associated with positive patient outcomes (12). Although results were similar across clinical settings, most studies took place within the context of hospitals and none within homecare services. A scoping review assessing patient safety culture in care homes for older people found that most studies were carried out in the United States and within nursing homes rather than residential home settings (13). Since then, three studies have assessed patient safety culture in Norwegian homecare services (14-16). Two studies found better safety culture scores for homecare nursing compared to other healthcare settings, albeit there was room for improvement (14,16). The third identified transformational leadership as important in improving patient safety culture and work engagement in homecare services (15). These studies contribute to the evidence-base to support the *World Health Organization's* global patient safety action plan 2021–2030 policy to improve patient safety culture in order to eliminate avoidable harm in healthcare (17).

To assess patient safety culture, validated outcome measures are needed. A commonly used instrument is the *Hospital Survey on Patient Safety Culture (HSOPSC)* (18). It is completed by healthcare personnel and addresses core components of safety culture, including sharing attitudes, values, perceptions, competencies and behaviours. The *HSOPSC* was developed in 2004 for hospital contexts and it has been found to be an efficient measure of patient safety culture (19). It has since then been modified and become the most commonly used instrument to assess patient safety culture in primary care (20), such as the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)*, developed by *The Agency of Healthcare Research and Quality (AHRQ)* (21).

The *NHSOPSC* has been translated into Norwegian and was found to be a valid and reliable measure of patient safety culture within the context of nursing homes (22-23). A slightly modified version has been used in homecare services (24). There is a need to test the psychometric properties of the instrument in homecare services. Moreover, results of surveys in other fields of research suggests that questionnaire length is negatively associated with response rates (25,26). It is not

unreasonable to assume that the length of the *NHSOPSC* instrument (41 items) poses increased burden on participants, thereby limiting its usefulness as a measure in clinical practice. A short version instrument could reduce participant burden and be introduced in routine practice.

The aims of this study were:

1) to measure patient safety culture in Norwegian homecare services;
2) to test the psychometric properties of the *NHSOPSC*; and
3) to propose a short version of the *NHSOPSC* for use in homecare services and test its psychometric properties.

Methods

A cross-sectional survey was used to assess patient safety culture in homecare services in Norway using the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument. An optimal test assembly (OTA) approach with psychometric testing was used to develop a proposal for a short version *NHSOPSC* instrument.

Clinical context

In Norway, healthcare provision is the responsibility of the government. It provides over 95% of all homecare services, with equal access for citizens regardless of socio-economic status, ethnicity or area of residence (27). The aim is for care recipients to stay at home as long as possible, and nursing homes are only used when citizens can no longer live in their home (28). Although there is variation between homecare services, they primarily consist of nursing at home, and to a smaller extent practical assistance to support a physically and socially active life. Public homecare services are adapted to individuals' care needs, based on assessments of a broad range of areas, including e.g. daily help required for treatment (e.g. medication administration), personal hygiene, rehabilitation, wound/palliative care, physical activity, housework, mental health management and social activities (29). Services may be time-limited or permanent, but must meet acceptable minimum care and safety standards. Management of homecare services is delegated to the 356 municipalities and services are provided by different categories of health personnel (e.g. nurses, general practitioners, physiotherapists, untrained healthcare workers).

Recruitment and inclusion criteria

This survey took place in 27 publicly funded homecare units in eight municipalities in six counties in Norway. Purposeful sampling was used to increase generalizability of results, through inclusion of homecare services in different municipalities over a wide geographical area, due to the country's variation in contextual settings, such as municipality type (urban/rural), municipality size (median 26,000, range 4,600–79,000) and distance to hospitals.

Recruitment of homecare services took place through two projects: *Digital Solutions for Increased Quality, Improved Patient Safety and Efficient Use of Resources in Municipal Healthcare (DigiPAS)* by *SINTEF*, an independent private multidisciplinary research organization, in collaboration with *the University of South-Eastern Norway*; and *Improving Quality and Safety in Primary Care – Implementing a Leadership Intervention in Nursing Homes and Homecare (SAFE-LEAD)*, (30) run by *SHARE–Centre for Resilience in Healthcare*, at the *University of Stavanger*. Recruitment was facilitated by researchers, managers in homecare services, and nurse co-researchers from the *Centre for Development of Institutional and Homecare services (USHT)*. Invitations for participation and a link to the online questionnaire were sent by email to employees. The response rate was 57% (table 1).

Table 1. Response rates according to municipality size

	Invited (n)	Responders (n,%)	Municipality size (n)
Municipality 1	295	160 (54.2)	50–55,000
Municipality 2	230	140 (60.9)	25–30,000
Municipality 3	93	71 (76.3)	60–65,000
Municipality 4	75	65 (86.7)	15–20,000
Municipality 5	116	30 (25.9)	25–30,000
Municipality 6	46	27 (58.7)	< 5,000
Municipality 7	47	25 (53.2)	5–10,000
Municipality 8	39	22 (56.4)	70–75,000
Total	**941**	**540 (57.4)**	

Cumulative percent for 540 participants, missing values not included (n=28)

Data collection

The questionnaire included the validated Norwegian version of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* (22-24), overall perception of service safety, and participant characteristics (age, position/education, years in current workplace, work hours per week) (appendix A).

NHSOPSC originally consisted of 42 items (12 dimensions) (US version) (21), whereas the Norwegian validated version consisted of 41 items (10 dimensions) (23): teamwork staffing, compliance with procedures, training and skills, non-punitive responses to mistakes, handoffs, feedback and communication about incidents, communication openness, supervisor expectations and actions promoting patient safety, and management and organizational learning. Wording was slightly modified to fit the homecare setting, by replacing "nursing homes" with "unit" and "patient" with "user" (15,16) (appendix A). Items were rated on five-point Likert scales, from 1 (never or totally disagree) to 5 (always or totally agree).

Data analyses

Data were analysed to report on patient safety culture in homecare services, to test the psychometric properties of the *NHSOPSC*, and to develop a proposal for a short version of the *NHSOPSC* for use in homecare services. *NHSOPSC* instrument assessment was carried out by testing internal consistency, factor analysis and a generalized partial credit model (GPCM) approach. Patient safety culture was reported using the best version of the *NHSOPSC* instrument identified through an optimal test assembly (OTA) approach, and reporting mean item scores and proportion of participants positively scoring instrument items and three single item outcomes. Data were normally distributed. Alpha was set to 0.05. Statistical analyses were carried out using SPSS (version 25.0) and GPCM analyses using STATA (version 16.1).

Factor analysis

Factor analysis was used to test the full version 41-item *NHSOPSC* instrument with data from 540 participants. Only factors with initial eigenvalue of min. 1 were included. For development of two candidate short version instruments, two of the 41 *NHSOPSC* instrument items were first removed, as they were outcomes rather than instrument items (*"The homecare services are safe for service users"* and *"Service users are well cared for"*). In the factor analyses, items with factor loadings (Λ) below 0.4 were excluded, as suggested by Stevens (31).

Based on previous publications, we expected factors to be correlated with each other. Nevertheless, we carried out initial testing of correlations using oblique rotation (direct oblimin) as suggested by Tabachnick and Fidell (32). For the full version instrument, eight out of 21 factor correlations were above 0.32 (max.0.647), suggesting min. 10% overlap in variance among some factors (appendix B). Similarly, significant overlap was found for candidate short version instruments (short version 1: 6 of 15 factor correlations; and short version 2: 6 of 6 factor correlations). We did therefore not apply orthogonal rotation, but used oblique rotation.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy test was ideal for the full version instrument (0.952) and candidate short version 1 (0.936) and 2 (0.938). Bartlett's test of sphericity for the full version instrument indicated that 21 correlations significantly differed from zero ($\chi^2(820)=11886$, $p<0.001$), and 15 correlations for candidate short version 1 ($\chi^2(351)=7884$, $p<0.001$) and for six for short version 2 ($\chi^2(190)=6758$, $p<0.001$).

Generalized partial credit model (GPCM)

For development of the second candidate short version instrument, a generalized partial credit model (GPCM) was carried out prior to factor analysis (33). The partial credit helps to evaluate items that may be scored on a scale, instead of dichotomous outcomes. The generalized approach was used to determine measurement quality of items, rather than assuming that items were of equal discrimination. Items with high discrimination parameters are likely to contribute better at obtaining estimates of the latent trait of interest. GPCM was therefore used to assess each individual item's discrimination (precision) and the total instrument's function (TIF) consists of the sum of the individual polytomous items. Individual item information function (IIF) was assessed by boundary and category characteristic curves. Items with low discrimination parameters (coefficients < 1) were removed.

Optimal test assembly (OTA)

To determine whether we could recommend either of the short version instruments to replace the full version instrument, we applied an optimal test assembly (OTA) approach, partially based on recommendations by Harel and Baron (33). Our approach differed slightly from their suggestions, as our dataset did not include a second validated instrument for assessment of convergent validity. Instead, we compared correlation between instrument sum scores and three outcomes. Our OTA approach included a four-stage process to determine whether:

1) candidate short version instruments maintain 95% of Cronbach's alpha of the full-length instrument (internal consistency);
2) the correlation of short version instrument summed scores was at least 0.95 of the full-length instrument (concurrent validity);
3) the correlation of candidate short version instrument factor scores was at least 0.95 of the full-length instrument (concurrent validity);
4) the correlation of candidate short version instrument summed scores with three outcomes, were at least 0.95 of the full-length instrument (convergent validity).

The first of the three outcomes was a single item question (*"Overall, how do you consider users' safety when using these homecare services"*), used as an outcome in previous patient safety culture studies within the context of nursing homes (21,23) and homecare services (24). The other two outcomes were the two single items removed from the full version instrument as the first step in developing candidate short version instruments.

The OTA results, together with results of a factor analysis, were used to consider if any of the *NHSOPSC* instrument versions could be recommended for assessing patient safety culture within the context of homecare services.

Analysis of patient safety culture

Patient safety culture was assessed using the best version of the *NHSOPSC* instrument identified through the optimal test assembly (OTA) approach. Results included mean overall and factor scores and proportion of items indicating participants' perception of a positive patient safety culture (scored as "agree" or "entirely agree", or "often" or "always"). Multiple regression analysis was used to determine influence of participants' age, education/background, number of years in current practice, number of hours worked per week, or municipality, on the instrument total score. There

were no violations of linearity/undue influence of single cases on the model (Cook's distance=0.002) and no evidence of multicollinearity (tolerance >0.2). The plotted residuals did not suggest homoscedasticity. Standardized residuals were normally distributed, the normal probability plot was sufficiently linear, and the scatterplot did not show any specific pattern for standardized residuals. Pearson correlation was calculated to determine the association between the overall *NHSOPSC* score and each of the three individual outcomes.

Patient and public involvement

Stakeholder involvement was used in all phases of the SAFE-LEAD project, including representatives of patients/users and next-of-kin, a patient and user ombudsman, and managers in nursing homes and home care services. Co-researchers from the Centre for Development of Institutional and Homecare Services (USHT) were involved in planning and recruitment of participants in this survey.

Results

A total of 540 health personnel working in homecare services participated (response rate 57%, table 1). Most were healthcare workers with upper secondary school education (45%) or healthcare personnel (min. Bachelor's degree) (36%) (table 2). The remaining were untrained care assistants (13%), managers (3%), administrative (1%) or other personnel (3%). The majority (93%) worked directly with service users most of the time. Most health personnel were from 30 to 59 years (73%), one in five was under 30 and one in ten above 60. Almost two out of three had practiced for min. six years, 30% had less than one year's experience.

Table 2. Participants' characteristics

	N (%)
Age group	
20–29 years	103 (19.1)
30–39 years	123 (22.8)
40–49 years	127 (23.5)
50–59 years	138 (25.6)
60+ years	49 (9.1)
Position/education	
Managers (incl. leaders at first-line level)	17 (3.1)
Healthcare personnel (min. bachelor's degree)	194 (35.9)
Healthcare workers (upper secondary school)	242 (44.8)
Care assistants (untrained)	68 (12.6)
Administrative personnel	5 (0.9)
Other	14 (2.6)
Number of years in current workplace	
< 1 year	163 (30.2)
1–5 years	38 (7.0)
6–10 years	122 (22.6)
11–15 years	84 (15.6)
16–20 years	81 (15.0)
21+ years	52 (9.6)
Amount of work per week	
< 15 hours	28 (5.2)
16–24 hours	103 (19.1)
25–35.5 hours	298 (55.2)
> 35.5 hours	111 (20.6)

Cumulative percent for 540 participants, missing values not included (n=28)

We will now present the process of developing a short version *NHSOPSC* proposal for use within homecare services. It involves development of two candidate short version instruments and comparison to the full version. The version fulfilling most criteria is selected as the final short version. We also present the psychometric properties of the full and short versions. Finally, we use the instrument to assess patient safety culture within the context of Norwegian homecare services.

Factors of full and candidate short version instruments

Analysis of the full version *NHSOPSC* instrument resulted in seven factors explaining 50.3% of the variance (Λ range 0.316–0.875). The analysis did not confirm the former 10-factor solution used in nursing homes (22) and homecare services (16) (appendix C). Candidate short version 1 resulted in six factors explaining 54.7% of the variance (Λ range 0.416–0.936). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (5 items); 4) management support (4 items); 5) compliance with procedures (4 items); and 6) managing workload (2 items) (appendix D). Candidate short version 2 resulted in four factors explaining 59.2% of the variance (Λ range 0.428–0.957). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (3 items); and 4) management support (4 items) (appendix E).

Internal consistency

All versions had high internal consistency (Cronbach's alpha 0.929–0.949) (table 3). Short versions were both within the boundary of the first OTA criterion by maintaining over 95% of Cronbach's alpha compared to the full version (short version 1: 97.9%, 2: 98.4%) (31).

Table 3. Patient safety culture measured using full and candidate *NHSOPSC* short version instruments

	Full version		Short version 1		Short version 2	
	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]
Items (n)	41		27		19	
Factors (n)	7		6		4	
Complete	3.8 (0.5)	0.949	3.7 (0.5)	0.929	3.8 (0.6)	0.934
% of full version				97.9%		98.4%
Factor 1: Safety improvement actions	3.8 (0.6)	0.917	3.7 (0.6)	0.910	3.7 (0.6)	0.910
Factor 2: Teamwork	3.9 (0.6)	0.850	4.1 (0.6)	0.837	4.1 (0.6)	0.837
Factor 3: Information flow	3.7 (0.6)	0.837	3.7 (0.6)	0.803	3.7 (0.7)	0.786
Factor 4: Management support	3.9 (0.7)	0.872	4.0 (0.7)	0.870	4.0 (0.7)	0.870
Factor 5: Compliance with procedures	3.8 (0.6)	0.618	3.7 (0.6)	0.635		
Factor 6: Managing workload	3.3 (0.6)	0.465	2.8 (0.8)	0.610		
Factor 7: Reporting mistakes	3.7 (0.8)	0.669				

a. Mean scores and standard deviation for complete instrument and instrument factors
b. α: instrument's internal consistency measured using Cronbach's alpha

Concurrent validity

Comparison of summed scores for short and full version instruments were above the minimum threshold of 0.95 (table 4). Results therefore fulfilled the criterion of the second OTA rule (33). Correlation coefficients for factor scores comparing short version 1 with the full version instrument ranged from 0.747 to 0.989, with four out of seven below the threshold of 0.95 (table 4). For short version 2, two out of four factor correlations were below the minimum, although not as low as for short version 1.

Table 4. Comparison of summed and factor scores for full and candidate *NHSOPSC* short version instruments

Full version	Short version 1		Short version 2	
	r[a]	sig.	r[a]	sig.
Sum[b]	0.986	0.000	0.960	0.000
Factor 1: Safety improvement actions	0.989	0.000	0.989	0.000
Factor 2: Teamwork	0.915	0.000	0.915	0.000
Factor 3: Information flow	0.961	0.000	0.905	0.000
Factor 4: Management support	0.960	0.000	0.960	0.000
Factor 5: Compliance with procedures	0.747	0.000		
Factor 6: Managing workload	0.927	0.000		
Factor 7: Reporting mistakes				

a. Pearson correlation b. Sum: total score of the scale

Convergent validity

Correlation coefficients for summed scores and short version 1 outcomes were from 89% to 104% of the full version instrument (table 5). Similarly, results for short version 2 were from 89% to 102% of the full version. Hence, results were within the 95% threshold level for OTA criterion for two of the comparisons, and below for one comparison.

Table 5. Correlation between instruments' summed scores and outcomes

Outcomes	Full version	Short version 1		Short version 2	
	r[a]	r[a]	% of full version	r[a]	% of full version
Overall safety of service users	0.613	0.585	95	0.581	95
The homecare services are safe for service users	0.668	0.593	89	0.596	89
Service users are well cared for	0.625	0.647	104	0.639	102

a. Pearson correlation

Instruments to assess patient safety culture in homecare services

The two candidate short version instruments fulfilled some, but not all, of the OTA criteria. Both short versions fulfilled the first two criteria (internal consistency, concurrent validity). For the third criterion (second part of concurrent validity), some factors were within the minimum threshold for concurrent validity, others were not. Short version 2 was however close to the minimum threshold. For the fourth criterion (convergent validity), both short versions were within the minimum threshold for two out of three outcomes, and slightly below for one. Factor analyses suggested short version 2 explained more of the variance (59.2%) than short version 1 (54.7%), and both did better than the full version (50.3%).

In summary, we are unable to draw firm conclusions to determine which of the three versions should be preferred. We suggest the results favour short version 2 as it scored well on most tests, explained more of the variance, and the individual items fit well with the four factors which include: A) safety improvement actions; B) teamwork; C) information flow; and D) management support.

Patient safety culture in Norwegian homecare services

Employees' overall perception of a positive patient safety culture was suggested by the mean score of 3.8 (SD 0.6) and 69% of items scored positively in the 19-item short version 2 *NHSOPSC* instrument (table 6). Positive results were found for all four factors: "teamwork" (4.1, SD 0.7, 78%), "management support" (4.0, SD 0.7, 78%), "safety improvement actions" (3.7, SD 0.6, 63%) and "information flow" (3.7, SD 0.7, 64%). A linear regression did not suggest significant influence of age, education/background, years in current practice, hours worked per week, or municipality (data not shown).

The three single item outcomes indicated perception of positive patient safety culture: overall perception of service users' safety (4.0, SD 0.7, 75%), service safety (4.1, SD 0.7, 84%), and overall care (4.2, SD 0.7, 86%). Scores positively correlated with short version 2 *NHSOPSC* sum scores ($p<0.001$).

Table 6. Patient safety culture in Norwegian homecare services (n=540)[a]

	Mean (SD)	Positive responses (n, %)[b]
Overall score	**3.8 (0.6)**	**(69.4)**
Factor 1: Safety improvement actions	**3.7 (0.6)**	**(62.8)**
Item 1: Management asks staff how the services can improve patient safety (U2)	3.7 (0.9)	341 (61.3)
Item 2: It is easy to make changes to improve service users' safety (U3)	3.6 (0.8)	321 (57.7)
Item 3: The service is always doing something to improve service users' safety (U4)	3.7 (0.7)	366 (65.8)
Item 4: A good job is done to keep service users safe (U5)	3.9 (0.7)	422 (75.9)
Item 5: Management listens to staff ideas and suggestions to improve safety (U6)	3.9 (0.8)	423 (76.1)
Item 6: Management regularly stays in touch with service users in order to assess the care (U8)	3.2 (1.0)	214 (38.5)
Item 7: Changes to improve service users' safety are evaluated (U9)	3.5 (0.8)	293 (52.7)
Item 8: Within this unit, we discuss ways to keep service users safe from harm (C8)	3.9 (0.8)	424 (74.6)
Factor 2: Teamwork	**4.1 (0.7)**	**(78.0)**
Item 1: Staff in our unit treat each other with respect (W1)	4.2 (0.8)	449 (79.0)
Item 2: Staff within our unit support each other (W2)	4.2 (0.8)	459 (80.8)
Item 3: Staff feel like they are part of a team (W5)	4.0 (0.8)	444 (78.1)
Item 4: When someone gets really busy, other staff help out (W9)	4.0 (0.8)	421 (74.1)
Factor 3: Information flow	**3.7 (0.7)**	**(63.8)**
Item 1: Staff are told what they need to know before taking care of a service user for the first time (C1)	3.8 (0.8)	377 (66.4)
Item 2: Staff are told right away when there is a change in a service user's care plan (C2)	3.4 (0.9)	268 (47.2)
Item 3: Staff are given all the information they need to care for service users (C10)	3.9 (0.7)	442 (77.8)
Factor 4: Management support	**4.0 (0.7)**	**(77.8)**
Item 1: My supervisor listens to staff ideas and suggestions concerning service users' safety (M1)	4.1 (0.8)	447 (79.3)
Item 2: My supervisor says a good word to staff who follow the right procedures (M2)	4.0 (0.9)	428 (75.9)

Item 3: My supervisor pays attention to service users' safety (M3)	4.3 (0.7)	497 (88.1)
Item 4: Staff ideas and suggestions are valued (C7)	3.8 (0.8)	387 (68.1)

a. Based on the proposed short version 19-item *NHSOPSC* scale. b. "Positive responses" were defined as responding "agree" or "entirely agree", or "often" or "always" to individual items. Valid percent, missing data for factor 1 (n=12) and factor 4 (n=4), no missing data for factors 2 and 3.

Discussion

Results of this study suggest the majority of healthcare personnel rated patient safety culture positively in Norwegian homecare. This includes positive ratings for information flow, teamwork, management support, and patient safety actions. Results indicate that the *NHSOPSC* instrument could potentially be reduced to half the number of items. Psychometric testing suggested the short version instrument was comparable to the full version. An arising question is how the instrument compares to previous studies (e.g. 22,23). Three dimensions – *teamwork*, *information flow,* and *management* – were comparable to previous studies. The *Safety improvement actions* dimension encompassed several items from dimensions included in the original full version (*incident feedback/communication*; *communication openness*; *supervisor expectations and safety actions*; and *management/organizational learning*). However, the short version did not include *staffing*; *compliance with procedures*; *training and skills*; and *non-punitive responses to mistakes*.

Differences found raise the question of which dimensions are needed to assess patient safety culture. The commonly used patient safety culture definition (11), emphasizes shared perceptions of safety importance, and communication within the context of trusting relationships. This is captured by both the full and short version instrument. However, the definition provides a very general and overarching description of patient safety culture. Moreover, there is disagreement as to how patient safety culture should be defined (10). Lack of clarity in definitions and discrepancies between dimensions in the full version *NHSOPSC* instrument and previous research, raises questions about the instrument's validity and reliability, at least in Norwegian homecare services setting. Lack of consistency warrants further studies to develop agreement on the definition of patient safety culture and instruments to assess clinical practice and research.

Among original *NHSOPSC* dimensions not included in the short version, we suggest items should cover *staffing* and *non-punitive responses to mistakes*. In previous research these had the highest need for improvement (34). *Staffing* has been found to have strong predictive value on health personnel's perception of patient safety (34-36) and patient safety outcomes (37-39) in different settings and countries. We consider *non-punitive responses to mistakes* important due to considerable variation between countries and clinical settings in blame-culture (16), which may significantly influence patient safety culture (34,35,40). Healthcare personnel in Norwegian studies score higher on *non-punitive responses to mistakes* compared to international studies (16), which might be explained by the non-hierarchical structure in Norway (41). However, items covering these two dimensions in the original *NHSOPSC* are not valid, at least not within the context of Norwegian homecare services. We suggest new items should be developed to cover these dimensions and be tested with the other dimensions in a revised short version. Healthcare personnel with different backgrounds (e.g. nurses, general practitioners, physiotherapists, occupational therapists) should be involved in the development process to ensure relevance and face validity. Finally, we also recommend the instrument title reflects the contextual setting of homecare services.

Strengths and limitations of this study

This was the second and largest study assessing patient safety culture in homecare services in Norway. To our best knowledge, it was the largest study assessing patient safety culture in homecare worldwide. Overall response rate was not ideal, but not far off from our previous survey (22), and comparable to research involving nurses (42). Although participants were not randomly selected,

variation in contextual settings (e.g. geographical, distance to hospitals, urban/rural areas) was used to increase generalizability of results, and should be representative for Norwegian homecare services. Caution should be made when generalizing findings to other countries with different structures and organization of services, and to other healthcare settings.

This was the first study developing a proposal for a short version instrument to assess patient safety culture within homecare services. The factor analysis and OTA approach was a strength of this study. It provides assessment of internal consistency, concurrent and convergent validity. In lack of a "gold standard" instrument to assess convergent validity, we used single-item outcomes previously used (16,22,23,43,44). The GPCM approach helped to determine whether items were discriminable.

Conclusion

The aging population worldwide, with increased risk of adverse events within the context of citizens' homes, requires strengthened focus on patient safety within homecare services. The results of this study showed that the majority of home healthcare personnel rated patient safety culture positively. Patient safety culture is central for assessing and improving patient safety. Valid and reliable instruments are needed. The *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* is the most commonly used instrument, but its length carries significant burden on personnel who struggle to carry out daily tasks. This article proposes the first short version of the *NHSOPSC* instrument which could serve as a starting point for an improved short version instrument for assessing patient safety culture within homecare services. Psychometric tests indicated that the short version instrument was comparable to the full version, and both had high internal consistency. Nevertheless, there is a need to further develop a validated short-version instrument to ensure relevance and validity. A short version instrument would be less time-consuming and reduce burden on personnel. It is more likely to be used in routine practice, and to give higher response rates in research projects. Results could potentially be transferred to other clinical contexts.

Ethical considerations

The Regional Committees for Research Ethics in Norway found that the research was not governed by the Health Research Act. Both projects were assessed by the Norwegian Centre for Research Data (NSD) and were in line with legislation (SAFE-LEAD ID 52324; DigiPAS ID 561903). All participants gave written informed consent, and projects followed the Helsinki declaration. All study information was provided at the beginning of the questionnaire.

Competing interests statement

We have no competing interests

Data sharing statement

Data can be accessed by reasonable request to the lead author.

Funding

Data collection carried out as part of the: 'Improving Quality and Safety in Primary Care—Implementing a Leadership Intervention in Nursing Homes and Homecare' (SAFE-LEAD) was supported by The Research Council of Norway (RCN) grant number 256681/H10 and the University of Stavanger, Norway. Data collection carried out as part of the "*Digital Solutions for Increased Quality and Improved Patient Safety*" (DigiPAS) project was funded by The Norwegian Regional Research Funds (RFF)/Oslofjord Fund grant number 285538 (project owner: Skien municipality).

Acknowledgment

Firstly, we thank homecare services and all individual participants agreeing to participate in the study. Thank you also to the following members of the SAFE-LEAD team: Co-researchers from the

Centre for Development of Institutional and Homecare Services (USHT): Elisabeth Holen-Rabbersvik, Marta Strandos, Line Hurup Thomsen, Berit Ullebust for help with recruitment of units to the project.

Contributorship statement

MR, LG, KC, SW and ER contributed to project design, recruitment and data collection. ALL authors participated in planning of analyses. PV and ER performed statistical analyses. PV drafted the manuscript, and all authors contributed to and approved the final submitted manuscript.

References

1. Panagioti M, Khan K, Keers RN, Abuzour A, Phipps D, Kontopantelis E, Bower P, Campbell S, Haneef R, Avery AJ, Ashcroft DM. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. *BMJ.* 2019; 366:l4185. doi: https://doi.org/10.1136/bmj.l4185
2. Auraaen A, Slawomirski L, Klazinga N. *The economics of patient safety in primary and ambulatory care: Flying blind.* OECD Health Working Paper No. 106. DELSA/HEA/WD/HWP(2018)3. Available at URL https://www.oecd-ilibrary.org/content/paper/baf425ad-en
3. Slawomirski L, Auraaen A, Klazinga N. *The economics of patient safety. Strengthening a value-based approach to reducing patient harm at national level.* OECD Health Working Paper No. 96. DELSA/HEA/WD/HWP(2017)6. Available at URL https://www.oecd-ilibrary.org/docserver/5a9858cd-en.pdf?expires=1587099735&id=id&accname=guest&checksum=F933FA2A81C7352C5151517F558B8DA5
4. Sunshine JE, Meo N, Kassebaum NJ, Collison ML, Mokdad AH, Naghavi M. Association of Adverse Effects of Medical Treatment With Mortality in the United States: A Secondary Analysis of the Global Burden of Diseases, Injuries, and Risk Factors Study. *JAMA Netw Open*. 2019 Jan 4;2(1):e187041. doi: 10.1001/jamanetworkopen.2018.7041.
5. Rogne T, Nordseth T, Marhaug G, Berg EM, Tromsdal A, Sæther O, Gisvold S, Hatlen P, Hogan H, Solligård E. Rate of avoidable deaths in a Norwegian hospital trust as judged by retrospective chart review. *BMJ Qual Saf*. 2019 Jan;28(1):49-55. doi: 10.1136/bmjqs-2018-008053.
6. United Nations, Department of Economic and Social Affairs, Population Division (2019). *World Population Ageing 2019: Highlights* (ST/ESA/SER.A/430).
7. Centers for Disease Control and Prevention. *Healthy Places Terminology*, 2009. Available at URL https://www.cdc.gov/healthyplaces/terminology.htm
8. Thiem U, Hinrichs T, Muller CA, Holt-Noreiks S, Nagl A, Bucchi C, et al. Prerequisites for a new health care model for elderly people with multiple morbidities: Results and conclusions from 3 years of research in the PRISCUS consortium. *Z Gerontol Geriatr.* 2011; 44(Suppl 2):101–112. https://doi.org/10.1007/s00391-011-0246-6
9. National Patient Safety Foundation. *Free from harm. Accelerating patient safety improvement fifteen years after to err is human.* Boston: National Patient Safety Foundation; 2015.
10. Halligan M, Zecevic A. Safety culture in healthcare: a review of concepts, dimensions, measures and progress. BMJ Quality & Safety 2011;20:338-343. http://dx.doi.org/10.1136/bmjqs.2010.040964
11. Health and Safety Commission. Third Report: Organizing for Safety. ACSNI Study Group on Human Factors. London: HMSO, 1993:23.
12. Braithwaite J, Herkes J, Ludlow K, Testa L, Lamprell G. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ Open.* 2017. https://doi.org/10.1136/bmjopen-2017-017708
13. Gartshore E, Waring J, Timmons S. Patient safety culture in care homes for older people: a scoping review. *BMC Health Serv Res.* 2017; 17(1):752. doi: 10.1186/s12913-017-2713-2

14. Olsen RM, Bjerkan J. Patient safety culture in Norwegian home health nursing: a cross-sectional study of healthcare provider's perceptions of the teamwork and safety climates. *Saf Health.* 2017;3(1):15. doi: 10.1186/s40886-017-0066-5
15. Ree E, Wiig S. Linking transformational leadership, patient safety culture and work engagement in home care services. *Nurs Open.* 2019 Oct 8;7(1):256-264. doi: 10.1002/nop2.386. eCollection 2020 Jan.
16. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res*. 2019; 19: 607. doi: 10.1186/s12913-019-4456-8
17. World Health Organization (WHO). *Towards eliminating avoidable harm in health care. Global patient safety action plan 2021-2030*. Second Draft, November 2020.
18. Sorra JS, Nieva VF. *Hospital Survey on Patient Safety Culture.* Rockville, MD: Agency for Healthcare Research and Quality, 2004. [Accessed 02.03.2020]. Available at URL https://proqualis.net/sites/proqualis.net/files/User%20guide%20HSOPSC.pdf
19. Reis CT, Paiva SG, Sousa P. The patient safety culture: a systematic review by characteristics of Hospital Survey on Patient Safety Culture dimensions. *Int J Qual Health Care.* 2018 Nov 1;30(9):660-677. doi: 10.1093/intqhc/mzy080.
20. Lawati MHA, Dennis S, Short SD, Abdulhadi NN. Patient safety and safety culture in primary health care: a systematic review. *BMC Fam Pract.* 2018;19:104. https://doi.org/10.1186/s12875-018-0793-7
21. Sorra J, Franklin M, Streagle S. *Nursing Home Survey on Patient Safety Culture.* (Prepared by Westat, under Contract No. 233-02-0087). AHRQ Publication No. 08-0060. Rockville: Agency for Healthcare Research and Quality; 2008.
22. Cappelen K, Aase K, Storm M, Hetland J, Harris A. Psychometric properties of the Nursing Home Survey on Patient Safety Culture in Norwegian nursing homes. *BMC Health Serv Res.* 2016 Aug 27;16:446. doi: 10.1186/s12913-016-1706-x.
23. Cappelen K, Harris A, Aase K. Variability in staff perceptions of patient safety culture in Norwegian nursing homes—a longitudinal cross-sectional study. *Saf Health.* 2018. https://doi.org/10.1186/s40886-018-0076-y
24. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res.* 2019 Aug 29;19(1):607. doi: 10.1186/s12913-019-4456-8.
25. Liu M, Wronski L. Examining completion rates in web surveys via over 25,000 real-world surveys. *Soc Sci Comput Rev.* 2018; 36(1):116-124. doi: 10.1177/0894439317695581
26. Rolstad S, Adler J, Rydén A. Response burden and questionnaire length: Is shorter better? A review and meta-analysis. *Value in Health* 2011; 14(8):1101-1108. https://doi.org/10.1016/j.jval.2011.06.003
27. Lindahl AK. The Norwegian Health Care System, 2015. In: Mossialos E, Wenzl M, Osborn R, Sarnak D. (Eds.) *2015 International profiles of health care systems.* The Commonwealth Fund: New York: January 2016.
28. Holm SG, Mathisen TA, Sæterstrand TM, Brinchmann BS. Allocation of home care services by municipalities in Norway: a document analysis. *BMC Health Serv Res.* 2017; 17:673. doi: 10.1186/s12913-017-2623-3
29. Ringard Å, Sagan A, Sperre Saunes I, Lindahl AK. Norway: health system review. *Health Syst Transit.* 2013;15(8):1–162.
30. Wiig S, Ree E, Johannessen T, Strømme T, Storm M, Aase I, Ullebust B, Holen-Rabbersvik E, Hurup Thomsen L, Sandvik Pedersen AT, van de Bovenkamp H, Bal R, Aase K. Improving quality and safety in nursing homes and home care: the study protocol of a mixed-methods research design to implement a leadership intervention. *BMJ Open*. 2018;8:e020933. doi: 10.1136/bmjopen-2017-020933.
31. Stevens JP. *Applied multivariate statistics for the social sciences.* Fifth edition. Routledge, 1992.
32. Tabachnick BG, Fidell LS. *Using multivariate statistics* (5th ed.) Upper Saddle River, NR: Pearson Allyn & Bacon, 2007.

33. Harel D, Baron M, on behalf of the CSRG Investigators. Methods for shortening patient-reported outcome measures. *Stat Methods Med Res*. Oct-Nov 2019;28(10-11):2992-3011. doi: 10.1177/0962280218795187
34. Gurková E, Zeleníková R, Friganovic A, Uchmanowicz I, Jarošová D, Papastavrou E, Žiaková K. Hospital safety climate from nurses' perspective in four European countries. *Int Nurs Rev.* 2020; 67(2):208-217.
35. Alenius LS, Tishelman C, Runesdotter S, Lindqvist. Staffing and resource adequacy strongly related to RNs' assessment of patient safety: a national study of RNs working in acute-care hospitals in Sweden. *BMJ Qual Saf.* 2014; 23(3):242-249.
36. Cho E, Lee, NJ b, Kim EY, Kim S, Lee K, Park, KO, et al. Nurse staffing level and overtime associated with patient safety, quality of care, and care left undone in hospitals: a cross-sectional study. *Int J Nurs Stud.* 2016; 60:263-271.
37. Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, et al. Nurse staffing and education and hospital mortality in nine European countries. A retrospective observational study. *Lancet.* 2014; 383:1824–30.
38. Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Med Care. 2007*; 45(12):1195-1204.
39. McHugh M, Rochman M, Sloane D, Berg R, Mancini M, Nadkarni V, et al. Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Med Care.* 2016; doi:10.1097/MLR.0000000000000456.
40. Aase K, Shibevaag L (Eds.). *Researching patient safety and quality in healthcare.* A Nordic perspective. Boca Raton: Taylor & Francis Group; 2017.
41. Cook JV, Dickinson HO, Eccles MP. Response rates in postal surveys of healthcare professionals between 1996 and 2005: An observational study. *BMC Health Serv Res.* 2009; 9:160–167.
42. Albalawi A, Kidd L, Cowey E. Factors contributing to the patient safety culture in Saudi Arabia: a systematic review. *BMJ Open*. 2020; 10:e0378875. Doi:10.1136/bmjopen-2020-037875
43. Cappelen K, Harris A, Storm M, Aase K. Healthcare staff perceptions on patient safety culture in nursing home settings – A cross sectional study. *Open J Nurs.* 2017; 7:1069-1085. https://doi.org/10.4236/ojn.2017.79078
44. Seljemo C, Viksveen P, Ree E. The role of transformational leadership, job demands and job resources for patient safety culture in Norwegian nursing homes: a cross sectional study. *BMC Health Serv Res* 2020; 20:799. https://doi.org/10.1186/s12913-020-05671-y

Appendix A. Survey questionnaire

1. Age
20 – 29 years
30 – 39 years
40 – 49 years
50 – 59 years
60+ years

2. What is your position/educational background?
Leader position with responsibility for personnel
Healthcare professional with min. three-year education from university or other higher education
Healthcare professional with education from high school or similar
Care assistant (untrained)
Administrative personnel (mercantile/financial/personnel)
Other

3. How long have you been working in this homecare service?
Less than 1 year
1 - 5 years
6 - 10 years
11 - 15 years
16 - 20 years
21 years or more

4. How many hours per week do you normally work?
Less than 15 hours/week
16 - 24 hours/week
25 - 35,5 hours/week
More than 35,5 hours/week

5. When do you most often work?
Daytime only
Two-split shift work
Three-split shift work
Regular evening shift
Regular nightshift
Other

6. Do you work directly with service users most of the time?
Yes
No

<u>About working within your unit</u>
To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree
7. We treat each other with respect within our unit
8. We support each other within our unit
9. We have enough staff to handle the workload
10. Staff follow standard procedures to care for service users
11. Staff feel they are part of a team
12. Staff use shortcuts to get their work done faster

13. Staff get the training they need in our unit
14. Staff have to hurry because they have too much work to do
15. When someone gets really busy in our unit, other staff help out
16. Staff are blamed when a service user is harmed
17. Staff receive enough training to know how to handle difficult service users
18. Staff are afraid to report their mistakes
19. Staff understand the training they get
20. To make work easier, staff often ignore procedures
21. Staff are treated fairly when they make mistakes
22. Service users' needs are met during shift changes
23. It is hard to keep service users safe because so many quit their jobs
24. Staff feel safe reporting their mistakes

Communication

How often does the following happen within your unit? Never, Rarely, Sometimes, Often, Always

25. Staff are told what they need to know before taking care of a service user for the first time
26. Staff are informed soon when there is a change in a service user's care plan
27. We have all the information we need when service users are transferred from the hospital
28. When staff report something that could harm a service user, this is followed up
29. We discuss within our unit how we can prevent unwanted episodes to reoccur
30. Staff report if they see something that might harm a service user (physically or mentally)
31. Staff ideas and suggestions are valued
32. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
33. Staff opinions are ignored
34. Staff are provided all the information they need to take care of service users
35. It is easy for staff to speak up about problems

Your line manager

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

36. My line manager listens to staff ideas and suggestions about service users' safety
37. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
38. My line manager pays attention to service users' safety

Your unit

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

39. Service users are well cared for
40. Management asks staff how the service can improve safety
41. It is easy to implement changes to improve service users' safety
42. Something is always done to improve service users' safety
43. A good job is done in order to maintain service users' safety
44. Management listens to employees' ideas and proposals for how safety can be improved
45. The homecare services are safe for users
46. Management is in regular contact with service users to assess the care
47. Changes with a view to improve service users' safety are assessed

Overall assessment

48. Overall, how do you assess service users' safety in these homecare services?
Very poor
Poor
Satisfactory
Good
Very good

Appendix B. Correlation between factors in the factor analysis

Factor Correlation Matrix

Factor	1	2	3	4	5	6	7
1	1,000	,471	,295	,647	-,060	-,435	-,164
2	,471	1,000	,339	,446	,041	-,341	-,250
3	,295	,339	1,000	,337	-,137	-,244	-,304
4	,647	,446	,337	1,000	-,144	-,344	-,196
5	-,060	,041	-,137	-,144	1,000	,064	-,012
6	-,435	-,341	-,244	-,344	,064	1,000	,169
7	-,164	-,250	-,304	-,196	-,012	,169	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4	5	6
1	1,000	,454	,272	,619	-,591	,198
2	,454	1,000	,306	,394	-,424	,035
3	,272	,306	1,000	,304	-,265	,225
4	,619	,394	,304	1,000	-,450	,316
5	-,591	-,424	-,265	-,450	1,000	-,252
6	,198	,035	,225	,316	-,252	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4
1	1,000	,465	-,604	,642
2	,465	1,000	-,430	,438
3	-,604	-,430	1,000	-,496
4	,642	,438	-,496	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Appendix C. Full version *NHSOPSC* instrument (7 factors, 41 items)

	Items	Factor loadings (Λ)	Cronbach's alpha	Question
C n	**Factor 1**		0.917	**Factor 1: Safety improvement actions**
1	Unit 1	0.463		U1. Service users are well cared for
2	Unit 2	0.691		U2. Management asks staff how the service can improve safety
3	Unit 3	0.629		U3. It is easy to implement changes to improve service users' safety
4	Unit 4	0.815		U4. Something is always done to improve service users' safety
5	Unit 5	0.820		U5. A good job is done in order to maintain service users' safety
6	Unit 6	0.619		U6. Management listens to employees' ideas and proposals for how safety can be improved
7	Unit 7	0.430		U7. The homecare services are safe for users
8	Unit 8	0.537		U8. Management is in regular contact with service users to assess the care
9	Unit 9	0.687		U9. Changes with a view to improve service users' safety are assessed
10	Communication 8	0.464		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.850	**Factor 2: Teamwork**
1	Work 1	0.832		W1. We treat each other with respect within our unit
2	Work 2	0.875		W2. We support each other within our unit
3	Work 4	0.395		W4. Staff follow standard procedures to care for service users
4	Work 5	0.663		W5. Staff feel they are part of a team
5	Work 7	0.347		W7. Staff get the training they need in our unit
6	Work 9	0.562		W9. When someone gets really busy in our unit, other staff help out
7	Work 13	0.339		W13. Staff understand the training they get
8	Work 15	0.316		W15. Staff are treated fairly when they make mistakes
C n	**Factor 3**		0.837	**Factor 3: Information flow**
1	Communication 1	0.721		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.690		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.557		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.509		C4. When staff report something that could harm a service user, this is followed up
5	Communication 5	0.378		C5. We discuss within our unit how we can prevent unwanted episodes to reoccur
6	Communication 10	0.620		C10. Staff are provided all the information they need to take care of service users
7	Work 11	0.394		W11. Staff receive enough training to know how to handle difficult service users
C n	**Factor 4**		0.872	**Factor 4: Management support**
1	Management 1	-0.558		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	-0.595		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	-0.524		M3. My line manager pays attention to service users' safety
4	Communication 7	-0.452		C7. Staff ideas and suggestions are valued
5	Communication 9r	-0.420		C9r. Staff opinions are ignored
6	Communication 11	-0.389		C11. It is easy for staff to speak up about problems
C n	**Factor 5**		0.618	**Factor 5: Compliance with procedures**
1	Work 6r	0.509		W6r. Staff use shortcuts to get their work done faster
2	Work 10r	0.400		W10r. Staff are blamed when a service user is harmed
3	Work 14r	0.465		W14r. To make work easier, staff often ignore procedures
5	Work 17r	0.431		W17r. It is hard to keep service users safe because so many quit their jobs
C n	**Factor 6**		0.465	**Factor 6: Managing workload**
1	Communication 6	0.370		C6. Staff report if they see something that might harm a service user (physically or mentally)
2	Work 3	-0.455		W3. We have enough staff to handle the workload
3	Work 8r	-0.420		W8r. Staff have to hurry because they have too much work to do
C n	**Factor 7**		0.669	**Factor 7: Reporting mistakes**
1	Work 12r	-0.554		W12r. Staff are afraid to report their mistakes
2	Work 18	-0.485		W18. Staff feel safe reporting their mistakes
	Overall (41 items)		0.949	

One item (A16) did not load with any factor. Items numbers marked with "r" were reversed in analyses.

Appendix D. Candidate short version 1 (6 factors, 27 items)

	Items	Factor loadings (Λ)	Cronbach's alpha	Question
C n	**Factor 1**		0.910	**Factor 1: Safety improvement actions**
1	Unit 2	0.636		U2. Management asks staff how the service can improve safety
2	Unit 3	0.657		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.864		U4. Something is always done to improve service users' safety
4	Unit 5	0.765		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.536		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.470		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.675		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.491		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.837	**Factor 2: Teamwork**
1	Work 1	0.847		W1. We treat each other with respect within our unit
2	Work 2	0.936		W2. We support each other within our unit
3	Work 5	0.632		W5. Staff feel they are part of a team
4	Work 9	0.517		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.803	**Factor 3: Information flow**
1	Communication 1	0.726		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.707		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.553		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.453		C4. When staff report something that could harm a service user, this is followed up
5	Communication 10	0.598		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.870	**Factor 4: Management support**
1	Management 1	-0.739		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	-0.730		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	-0.632		M3. My line manager pays attention to service users' safety
4	Communication 7	-0.416		C7. Staff ideas and suggestions are valued
C n	**Factor 5**		0.635	**Factor 5: Compliance with procedures**
1	Work 6r	0.450		W6r. Staff use shortcuts to get their work done faster
2	Work 12r	0.707		W12r. Staff are afraid to report their mistakes
3	Work 14r	0.473		W14r. To make work easier, staff often ignore procedures
4	Work 18	0.432		W18. Staff feel safe reporting their mistakes
C n	**Factor 6**		0.610	**Factor 6: Managing workload**
1	Work 3	0.608		W3. We have enough staff to handle the workload
2	Work 8r	0.598		W8r. Staff have to hurry because they have too much work to do
	Overall (27 items)		0.929	

Analysis carried out using a three-stage factor analysis (principal axis factoring).
NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7.
Not included in any factors (no score): W15, W16. Factor loading < 0.4: W4, W7, W10r, W11, W13, W17r, C5, C6, C9r, C11.
Items numbers marked with "r" were reversed in analyses.

Appendix E. Candidate short version 2 (4 factors, 19 items)

	Items	Factor loadings (Λ)	Cronbach's alpha	Question
C n	**Factor 1**		0.910	**Factor 1: Safety improvement actions**
1	Unit 2	0.635		U2. Management asks staff how the service can improve safety
2	Unit 3	0.673		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.875		U4. Something is always done to improve service users' safety
4	Unit 5	0.791		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.538		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.481		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.689		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.502		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.837	**Factor 2: Teamwork**
1	Work 1	0.859		W1. We treat each other with respect within our unit
2	Work 2	0.957		W2. We support each other within our unit
3	Work 5	0.617		W5. Staff feel they are part of a team
4	Work 9	0.520		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.786	**Factor 3: Information flow**
1	Communication 1	0.767		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.717		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 10	0.660		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.870	**Factor 4: Management support**
1	Management 1	-0.764		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	-0.746		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	-0.614		M3. My line manager pays attention to service users' safety
4	Communication 7	-0.428		C7. Staff ideas and suggestions are valued
	Overall (19 items)		0.934	

Analysis carried out using a generalized partial credit model (GPCM) approach, followed by a two-stage factor analysis process (principal axis factoring). NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7.
GPCM assessment of boundary and category characteristic curves, and low discrimination parameters (coefficients < 1): W3, W6, W8, W10, W11, W12, W14, W17, C3, C9, C11. Factor loading < 0.4: W4, W7, W13, W15, W16, W18, C4, C5, C6.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-6
		(*b*) Describe any methods used to examine subgroups and interactions	4-5
		(*c*) Explain how missing data were addressed	4,7,10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
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	3-4,6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	4,7,10
Outcome data	15*	Report numbers of outcome events or summary measures	7-10
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	6-10

		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	4-5
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	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
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	11

*Give information separately for exposed and unexposed groups.

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.

BMJ Open

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052293.R1
Article Type:	Original research
Date Submitted by the Author:	18-Oct-2021
Complete List of Authors:	Viksveen, Petter; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Røhne, Mette; SINTEF, SINTEF Digital, Health Grut, Lisbet; SINTEF, SINTEF Digital, Health Cappelen, Kathrine; University of South-Eastern Norway Faculty of Health and Social Sciences, Center for Caring Research South Wiig, Siri; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Ree, Eline ; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Public health, Research methods
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, STATISTICS & RESEARCH METHODS

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Title page

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services

Petter Viksveen, Mette Røhne, Lisbet Grut, Kathrine Cappelen, Siri Wiig, Eline Ree

Corresponding author:
Dr. Petter Viksveen, PhD, Associate Professor
SHARE - Centre for Resilience in Healthcare
Department for Quality and Health Technology
Faculty of Health Sciences
University of Stavanger
Postboks 8600 Forus
4036 Stavanger, Norway
Tel + 47 51 83 27 37
Email petter.viksveen@uis.no
Website University of Stavanger https://www.uis.no/nb
Website SHARE - Centre for Resilience in Healthcare https://www.uis.no/en/share-centre-resilience-healthcare

Names, institutions, city and country for co-authors:
Dr. Mette Røhne, Department of Smart Sensor Systems, SINTEF Digital, Oslo, Norway.
Mrs. Lisbet Grut, Department of Health Research, SINTEF Digital, Oslo, Norway.
Dr. Kathrine Cappelen, Center for Caring Research South, Faculty of Health and Social Services, University of South- Eastern Norway, Porsgrunn, Norway.
Professor Siri Wiig, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.
Dr. Eline Ree, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.

Keywords: patient safety, safety culture, health services research, healthcare quality improvement, evaluation methodology

Word count: 4804

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services

Abstract

Objectives: Measure patient safety culture in homecare services; test the psychometric properties of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument; and propose a short version *Homecare Services Survey on Patient Safety Culture* instrument for use in homecare services.
Design: Cross-sectional survey with psychometric testing.
Setting: Twenty-seven publicly funded homecare units in eight municipalities (six counties) in Norway.
Participants: Five-hundred-and-forty health personnel working in homecare services.
Interventions: Not applicable.
Primary and secondary outcome measures: Primary: Patient safety culture assessed using the *NHSOPSC* instrument. Secondary: Overall perception of service users' safety, service safety and overall care.
Methods: Psychometric testing of the *NHSOPSC* instrument using factor analysis and optimal test assembly (OTA) with generalized partial credit model (GPCM) to develop a short version instrument proposal.
Results: Most healthcare personnel rated patient safety culture in homecare services positively. A 19-item short version instrument for assessing patient safety culture had high internal consistency, and was considered to have sufficient concurrent and convergent validity. It explained a greater proportion of variance (59%) than the full version (50%). Short version factors included *safety improvement actions*, *teamwork*, *information flow*, and *management support*.
Conclusion: This study provides a first proposal for a short version *Homecare Services Survey on Patient Safety Culture* instrument to assess patient safety culture within homecare services. It needs further improvement, but provides a starting point for developing an improved valid and reliable short version instrument as part of assessment of patient safety and quality improvement processes.

Strengths and limitations of this study

- A strength of this article was that it provided first proposal for a short version instrument to assess patient safety culture in homecare services, entitled the *Homecare Services Survey on Patient Safety Culture*
- Another strength was the combined use of a factor analysis, generalized partial credit model (GPCM) and optimal test assembly OTA approach to assess internal consistency, concurrent and convergent validity
- A limitation was the lack of comparison to a "gold standard" instrument for assessment of convergent validity, although the use of three single-item outcomes compensated somewhat for this
- The largest study assessing patient safety culture in Norwegian homecare services, possibly worldwide
- A limitation was lack of random selection of participants, although variation in contextual settings contributes to strengthen generalizability of results, and a somewhat low response rate, although it was comparable to previous surveys

Introduction

A recent systematic review with a meta-analysis including over 70 studies worldwide with 330,000 patients, found that one in twenty experienced preventable health service inflicted harm (1). Harm

could take place in any clinical context, including primary, secondary and tertiary care, involving e.g. infections; diagnostic procedures; and the use of drugs, surgical or other therapeutic interventions. In 12% of patients, harm was severe or fatal. Estimates suggest that in primary and ambulatory care almost four in ten patients experience safety issues, resulting in increased need for hospitalization (2). Patient harm is a major global health burden costing trillions of dollars annually (3).

Considerable efforts have been made to improve patient safety over the last decades, resulting in some reduction in the prevalence of harm. For example, the mortality rate due to adverse effects of medical treatment decreased by 21% in the US from 1990 to 2016 (4). However, a significant proportion of patients are still exposed to risk and experience adverse events, some of which are fatal. In Norway, a recent review found that 4.2% of deaths in hospitals could probably have been avoided (5).

Improving patient safety measures within healthcare services is particularly important for older patients (70 years+) who have 20 times higher mortality rates due to adverse medical effects, compared to younger age groups (15-49 years) (4). Improved patient safety is crucial from a societal perspective as the number of older citizens will increase from 700 million to 1.5 billion worldwide over the next three decades (6). Most citizens wish to "age in place," which can be understood as living safely in their own home, regardless of age and ability (7). A high proportion of older citizens living at home can have significant societal benefits, by reducing the increasing burden to healthcare services and by limiting the need for nursing homes. However, healthcare services must adapt to the demographic shift and attend to the needs of a much larger proportion of older citizens, many of whom have chronic health conditions and will require homecare services (8).

To advance patient safety, the *National Patient Safety Foundation (NPSF)* recommended a total systems approach in 2015, where leaders should establish and sustain a safety culture at all levels of patient care, including homecare services (9). Although the understanding of *patient safety culture* varies among researchers, Halligan & Zecevic found in their review (10), that the UK Health and Safety Commission's definition (11) was most commonly used: "*The product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety programmes. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures." NPSF's* recommendations are supported by a systematic review which found that improvements in healthcare services' organizational culture were associated with positive patient outcomes (12). Although results were similar across clinical settings, most studies took place within the context of hospitals and none within homecare services. A scoping review assessing patient safety culture in care homes for older people found that most studies were carried out in the United States and within nursing homes rather than residential home settings (13). Since then, three studies have assessed patient safety culture in Norwegian homecare services (14-16). Two studies found better safety culture scores for homecare nursing compared to other healthcare settings, albeit there was room for improvement (14,16). The third identified transformational leadership as important in improving patient safety culture and work engagement in homecare services (15). These studies contribute to the evidence-base to support the *World Health Organization's* global patient safety action plan 2021–2030 policy to improve patient safety culture in order to eliminate avoidable harm in healthcare (17).

To assess patient safety culture, validated outcome measures are needed. Several instruments exist, out of which three have been recommended for use in EU Member States (18). Two of these instruments have been further tested and validated, the *Safety Attitudes Questionnaire (SAQ)* (19), and the *Hospital Survey on Patient Safety Culture (HSOPSC)* (20). The *HSOPSC* is completed by healthcare personnel and addresses core components of safety culture, including sharing attitudes, values, perceptions, competencies and behaviours. It was developed in 2004 for hospital contexts and has been found to be an efficient measure of patient safety culture (21). It has since then been modified and become the most commonly used instrument to assess patient safety

culture in primary care (22), such as the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)*, developed by *The Agency of Healthcare Research and Quality (AHRQ)* (23).

The *NHSOPSC* has been translated into Norwegian and was found to be a valid and reliable measure of patient safety culture within the context of nursing homes (24,25). A slightly modified version has been used in homecare services (26). There is a need to test the psychometric properties of the instrument in homecare services. Moreover, results of surveys in other fields of research suggests that questionnaire length is negatively associated with response rates (27,28). It is not unreasonable to assume that the length of the *NHSOPSC* instrument (41 items) poses increased burden on participants, thereby limiting its usefulness as a measure in clinical practice. A short version instrument could reduce participant burden and be introduced in routine practice.

The aims of this study were:

1) to measure patient safety culture in Norwegian homecare services;
2) to test the psychometric properties of the *NHSOPSC*; and
3) to propose a short version of the *NHSOPSC* for use in homecare services and test its psychometric properties.

Methods

Design

A cross-sectional and psychometric design was used to assess patient safety culture in homecare services in Norway using the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument. Health personnel working in 27 publicly funded homecare units in eight municipalities in six counties in Norway were recruited through two research projects (further information follows). Data from the two projects was merged and analysed collectively. An optimal test assembly (OTA) approach with psychometric testing was used to develop a proposal for a short version *NHSOPSC* instrument.

Clinical context

In Norway, healthcare provision is the responsibility of the government. It provides over 95% of all homecare services, with equal access for citizens regardless of socio-economic status, ethnicity or area of residence (29). The aim is for care recipients to stay at home as long as possible, and nursing homes are only used when citizens can no longer live in their home (30). Although there is variation between homecare services, they primarily consist of nursing at home, and to a smaller extent practical assistance to support a physically and socially active life. Public homecare services are adapted to individuals' care needs, based on assessments of a broad range of areas, including e.g. daily help required for treatment (e.g. medication administration), personal hygiene, rehabilitation, wound/palliative care, physical activity, housework, mental health management and social activities (31). Services may be time-limited or permanent, but must meet acceptable minimum care and safety standards. Management of homecare services is delegated to the 356 municipalities and services are provided by different categories of health personnel (e.g. nurses, general practitioners, physiotherapists, untrained healthcare workers).

Participants and setting

Purposeful sampling was used to increase generalizability of results, through inclusion of homecare services in different municipalities over a wide geographical area, due to the country's variation in contextual settings, such as municipality type (urban/rural), municipality size (median 26,000, range 4,600–79,000) and distance to hospitals.

Recruitment of homecare services took place through two projects: *Digital Solutions for Increased Quality, Improved Patient Safety and Efficient Use of Resources in Municipal Healthcare (DigiPAS)* by *SINTEF*, an independent private multidisciplinary research organization, in collaboration

with *the University of South-Eastern Norway*; and *Improving Quality and Safety in Primary Care – Implementing a Leadership Intervention in Nursing Homes and Homecare (SAFE-LEAD)*, (32) run by *SHARE–Centre for Resilience in Healthcare*, at the *University of Stavanger*. In the SAFE-LEAD project co-researchers from the *Centre for Development of Institutional and Homecare Services (USHT)* contacted managers in all homecare units with information about the project, followed by researchers meeting each unit. Homecare service managers provided researcher with email contact lists, which were used to send a link to the online questionnaire by email to employees. Five survey reminders were sent. The response rate was 57% (table 1).

Table 1. Response rates according to municipality size

	Invited (n)	Responders (n,%)	Municipality size (n)
Municipality 1	295	160 (54.2)	50–55,000
Municipality 2	230	140 (60.9)	25–30,000
Municipality 3	93	71 (76.3)	60–65,000
Municipality 4	75	65 (86.7)	15–20,000
Municipality 5	116	30 (25.9)	25–30,000
Municipality 6	46	27 (58.7)	< 5,000
Municipality 7	47	25 (53.2)	5–10,000
Municipality 8	39	22 (56.4)	70–75,000
Total	**941**	**540 (57.4)**	

Cumulative percent for 540 participants, missing values not included (n=28)

Data collection

Participants completed the survey digitally. Data collection took place from March 1st to April 8th 2018 in the SAFE-LEAD project, and March 26th to May 9th 2019 in the DigiPAS project. Response time was 20 and 14 minutes, respectively. Responses were automatically transferred to research centres.

Questionnaire and instrument

The questionnaire (appendix A) included the validated Norwegian version of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument (24,26), overall perception of service safety (see *Optimal test assembly* section), and participant characteristics (age, position/education, years in current workplace, shift type, work hours per week, extent of patient contact).

NHSOPSC originally consisted of 42 items (12 dimensions, Cronbach's alpha 0.71-0.86) (US version) (23), whereas the Norwegian validated version consisted of 41 items (10 dimensions, Cronbach's alpha 0.55-0.90) (24,25): teamwork staffing, compliance with procedures, training and skills, non-punitive responses to mistakes, handoffs, feedback and communication about incidents, communication openness, supervisor expectations and actions promoting patient safety, and management and organizational learning. Wording was slightly modified to fit the homecare setting, by replacing "nursing homes" with "unit" and "patient" with "user" (15,16) (appendix A). Items were rated on five-point Likert scales, from 1 (never or totally disagree) to 5 (always or totally agree). The full-scale instrument is presented in appendix B, the developed short versions presented in appendixes C and D. The average percentage of positive scores was calculated for each individual dimension, in line with previous research, and an average of at least 60% positive responses was considered a good score, as this has been shown to indicate lower risk of adverse events (23,25,33).

Data analyses

Data were analysed to report on patient safety culture in homecare services, to test the psychometric properties of the *NHSOPSC* instrument, and to develop a proposal for a short version of *NHSOPSC* for use in homecare services. *NHSOPSC* instrument assessment was carried out by testing

internal consistency, factor analysis and a generalized partial credit model (GPCM) approach. Patient safety culture was reported using the best version of the *NHSOPSC* instrument identified through an optimal test assembly (OTA) approach, and reporting mean item scores and proportion of participants positively scoring instrument items and three single item outcomes. Data were normally distributed. Alpha was set to 0.05. Statistical analyses were carried out using SPSS (version 25.0) and GPCM analyses using STATA (version 16.1).

Factor analysis

Factor analysis was used to test the full version 41-item *NHSOPSC* instrument with data from 540 participants. Only factors with initial eigenvalue of min. 1 were included. For development of two candidate short version instruments, two of the 41 *NHSOPSC* instrument items were first removed, as they were outcomes rather than instrument items (*"The homecare services are safe for service users"* and *"Service users are well cared for"*). In factor analyses for short version 1 and 2, items with factor loadings (Λ) below 0.4 were excluded, as suggested by Stevens (34).

Based on previous publications, we expected factors to be correlated with each other. Nevertheless, we carried out initial testing of correlations using oblique rotation (direct oblimin) as suggested by Tabachnick and Fidell (35). For the full version instrument, eight out of 21 factor correlations were above 0.32 (maximum = 0.65), suggesting min. 10% overlap in variance among some factors (appendix E). Similarly, significant overlap was found for candidate short version instruments (short version 1: 6 of 15 factor correlations; and short version 2: 6 of 6 factor correlations). We did therefore not apply orthogonal rotation, but used oblique rotation.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy test was ideal for the full version instrument (0.95) and candidate short version 1 (0.94) and 2 (0.94). Bartlett's test of sphericity for the full version instrument indicated that 21 correlations significantly differed from zero ($\chi^2(820)=11886$, $p<0.001$), and 15 correlations for candidate short version 1 ($\chi^2(351)=7884$, $p<0.001$) and for six for short version 2 ($\chi^2(190)=6758$, $p<0.001$).

Generalized partial credit model (GPCM)

For development of the second candidate short version instrument, a generalized partial credit model (GPCM) was carried out prior to factor analysis (36). The partial credit helps to evaluate items that may be scored on a scale, instead of dichotomous outcomes. The generalized approach was used to determine measurement quality of items, rather than assuming that items were of equal discrimination. Items with high discrimination parameters are likely to contribute better at obtaining estimates of the latent trait of interest. GPCM was therefore used to assess each individual item's discrimination (precision) and the total instrument's function (TIF) consists of the sum of the individual polytomous items. Although the use of Likert scales implied that individual items contained ordinal data, the sum scores across instruments can be considered to be interval (37). The GPCM approach was therefore used, instead of the graded response model. Individual item information function (IIF) was assessed by boundary and category characteristic curves. Items with low discrimination parameters (coefficients < 1) were removed.

Optimal test assembly (OTA)

To determine whether either of the short version instruments could be recommended to replace the full version instrument, we applied an optimal test assembly (OTA) approach, partially based on recommendations by Harel and Baron (36). Our approach differed slightly from their suggestions, as our dataset did not include a second validated instrument for assessment of convergent validity. Instead, we compared correlation between instrument sum scores and three outcomes. Our OTA approach included a four-stage process to determine whether:

1) candidate short version instruments maintain 95% of Cronbach's alpha of the full-length instrument (internal consistency);
2) the correlation of short version instrument summed scores was at least 0.95 of the full-length instrument (concurrent validity);
3) the correlation of candidate short version instrument factor scores was at least 0.95 of the full-length instrument (concurrent validity);
4) the correlation of candidate short version instrument summed scores with three outcomes, were at least 0.95 of the full-length instrument (convergent validity).

Weaknesses associated with the use of Cronbach's alpha as a measure of internal consistency has been pointed out by others (e.g. 38). Therefore, we also calculated the omega coefficient.

The first of the three outcomes was a single item question (*"Overall, how do you consider users' safety when using these homecare services"*), used as an outcome in previous patient safety culture studies within the context of nursing homes (23,25) and homecare services (26). The other two outcomes were the two single items removed from the full version instrument as the first step in developing candidate short version instruments.

The OTA results, together with results of a factor analysis, were used to consider if any of the *NHSOPSC* instrument versions could be recommended for assessing patient safety culture within the context of homecare services.

Analysis of patient safety culture

Patient safety culture was assessed using the best version of the *NHSOPSC* instrument identified through the optimal test assembly (OTA) approach. Results included mean overall and factor scores, and proportion of items indicating participants' perception of a positive patient safety culture (scored as "agree" or "entirely agree", or "often" or "always"). Multiple regression analysis was used to determine influence of participants' age, education/background, number of years in current practice, number of hours worked per week, or municipality, on the instrument total score. There were no violations of linearity/undue influence of single cases on the model (Cook's distance=0.002) and no evidence of multicollinearity (tolerance >0.2). The plotted residuals did not suggest homoscedasticity. Standardized residuals were normally distributed, the normal probability plot was sufficiently linear, and the scatterplot did not show any specific pattern for standardized residuals. Pearson correlation was calculated to determine the association between the overall *NHSOPSC* score and each of the three individual outcomes.

Patient and public involvement

Stakeholder involvement was used in all phases of the SAFE-LEAD project, including representatives of patients/users and next-of-kin, a patient and user ombudsman, and managers in nursing homes and homecare services. Co-researchers from the Centre for Development of Institutional and Homecare Services (USHT) were involved in planning and recruitment of participants in this survey.

Results

A total of 540 health personnel working in homecare services participated (response rate 57%, table 1). Most were healthcare workers with upper secondary school education (45%) or healthcare personnel (min. Bachelor's degree) (36%) (table 2). The remaining were untrained care assistants (13%), managers (3%), administrative (1%) or other personnel (3%). The majority (93%) worked directly with service users most of the time. Most health personnel were from 30 to 59 years (73%), one in five was under 30 and one in ten above 60. Almost two out of three had practiced for min. six years, 30% had less than one year's experience.

Table 2. Participants' characteristics

	N (%)
Age group	
20–29 years	103 (19.1)
30–39 years	123 (22.8)
40–49 years	127 (23.5)
50–59 years	138 (25.6)
60+ years	49 (9.1)
Position/education	
Managers (incl. leaders at first-line level)	17 (3.1)
Healthcare personnel (min. bachelor's degree)	194 (35.9)
Healthcare workers (upper secondary school)	242 (44.8)
Care assistants (untrained)	68 (12.6)
Administrative personnel	5 (0.9)
Other	14 (2.6)
Number of years in current workplace	
< 1 year	163 (30.2)
1–5 years	38 (7.0)
6–10 years	122 (22.6)
11–15 years	84 (15.6)
16–20 years	81 (15.0)
21+ years	52 (9.6)
Amount of work per week	
< 15 hours	28 (5.2)
16–24 hours	103 (19.1)
25–35.5 hours	298 (55.2)
> 35.5 hours	111 (20.6)

Cumulative percent for 540 participants, missing values not included (n=28)

We will now present the process of developing a short version *NHSOPSC* proposal for use within homecare services. It involves development of two candidate short version instruments and comparison to the full version. The version fulfilling most criteria is selected as the final short version. We also present the psychometric properties of the full and short versions. Finally, we use the instrument to assess patient safety culture within the context of Norwegian homecare services.

Factors of full and candidate short version instruments

Analysis of the full version *NHSOPSC* instrument resulted in seven factors explaining 50.3% of the variance (Λ range 0.32–0.88). The analysis did not confirm the former 10-factor solution used in nursing homes (24) and homecare services (16) (appendix B). Candidate short version 1 resulted in six factors explaining 54.7% of the variance (Λ range 0.42–0.94). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (5 items); 4) management support (4 items); 5) compliance with procedures (4 items); and 6) managing workload (2 items) (appendix C). Candidate short version 2 resulted in four factors explaining 59.2% of the variance (Λ range 0.43–0.96). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (3 items); and 4) management support (4 items) (appendix D).

Internal consistency

All versions had high internal consistency (Cronbach's alpha 0.93–0.95) (table 3). The omega coefficient was found to be identical to Cronbach's alpha for the full version and short version 1 instrument, and marginally higher for short version 2 (0.93 versus 0.94). Short versions were both

within the boundary of the first OTA criterion by maintaining over 95% of Cronbach's alpha compared to the full version (short version 1: 97.9%, 2: 98.4%) (34).

Table 3. Patient safety culture measured using full and candidate *NHSOPSC* short version instruments

	Full version		Short version 1		Short version 2	
	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]
Items (n)	41		27		19	
Factors (n)	7		6		4	
Complete	3.8 (0.5)	0.95	3.7 (0.5)	0.93	3.8 (0.6)	0.93
% of full version				97.9%		98.4%
Factor 1: Safety improvement actions	3.8 (0.6)	0.92	3.7 (0.6)	0.91	3.7 (0.6)	0.91
Factor 2: Teamwork	3.9 (0.6)	0.85	4.1 (0.6)	0.84	4.1 (0.6)	0.84
Factor 3: Information flow	3.7 (0.6)	0.84	3.7 (0.6)	0.80	3.7 (0.7)	0.79
Factor 4: Management support	3.9 (0.7)	0.87	4.0 (0.7)	0.87	4.0 (0.7)	0.87
Factor 5: Compliance with procedures	3.8 (0.6)	0.62	3.7 (0.6)	0.64		
Factor 6: Managing workload	3.3 (0.6)	0.47	2.8 (0.8)	0.61		
Factor 7: Reporting mistakes	3.7 (0.8)	0.67				

a. Mean scores and standard deviation for complete instrument and instrument factors
b. α: instrument's internal consistency measured using Cronbach's alpha

Concurrent validity

Comparison of summed scores for short and full version instruments were above the minimum threshold of 0.95 (table 4). Results therefore fulfilled the criterion of the second OTA rule (36). Correlation coefficients for factor scores comparing short version 1 with the full version instrument ranged from 0.75 to 0.99, with four out of seven below the threshold of 0.95 (table 4). For short version 2, two out of four factor correlations were below the minimum, although not as low as for short version 1.

Table 4. Comparison of summed and factor scores for full and candidate *NHSOPSC* short version instruments

Full version	Short version 1		Short version 2	
	r[a]	sig.	r[a]	sig.
Sum[b]	0.99	0.000	0.96	0.000
Factor 1: Safety improvement actions	0.99	0.000	0.99	0.000
Factor 2: Teamwork	0.92	0.000	0.92	0.000
Factor 3: Information flow	0.96	0.000	0.91	0.000
Factor 4: Management support	0.96	0.000	0.96	0.000
Factor 5: Compliance with procedures	0.75	0.000		
Factor 6: Managing workload	0.93	0.000		
Factor 7: Reporting mistakes				

a. Pearson correlation b. Sum: total score of the scale

Convergent validity

Correlation coefficients for summed scores and short version 1 outcomes were from 89% to 104% of the full version instrument (table 5). Similarly, results for short version 2 were from 89% to 102% of the full version. Hence, results were within the 95% threshold level for OTA criterion for two of the comparisons, and below for one comparison.

Table 5. Correlation between instruments' summed scores and outcomes

Outcomes	Full version	Short version 1		Short version 2	
	r[a]	r[a]	% of full version	r[a]	% of full version
Overall safety of service users	0.61	0.59	95	0.58	95
The homecare services are safe for service users	0.67	0.59	89	0.60	89
Service users are well cared for	0.63	0.65	104	0.64	102

a. Pearson correlation

Instruments to assess patient safety culture in homecare services

The two candidate short version instruments fulfilled some, but not all, of the OTA criteria. Both short versions fulfilled the first two criteria (internal consistency, concurrent validity). For the third criterion (second part of concurrent validity), some factors were within the minimum threshold for concurrent validity, others were not. Short version 2 was however close to the minimum threshold. For the fourth criterion (convergent validity), both short versions were within the minimum threshold for two out of three outcomes, and slightly below for one. Factor analyses suggested short version 2 explained more of the variance (59.2%) than short version 1 (54.7%), and both did better than the full version (50.3%).

In summary, it was not possible to draw firm conclusions to determine which of the three versions should be preferred. However, the results favour short version 2 as it scored well on most tests, explained more of the variance, and the individual items fit well with the four factors which include: A) safety improvement actions; B) teamwork; C) information flow; and D) management support.

Patient safety culture in Norwegian homecare services

Employees' overall perception of a positive patient safety culture was suggested by the mean score of 3.8 (SD 0.6) and 69% of items scored positively in the 19-item short version 2 *NHSOPSC* instrument (table 6). Positive results were found for all four factors: "teamwork" (4.1, SD 0.7, 78%), "management support" (4.0, SD 0.7, 78%), "safety improvement actions" (3.7, SD 0.6, 63%) and "information flow" (3.7, SD 0.7, 64%). A linear regression did not suggest significant influence of age, education/background, years in current practice, hours worked per week, or municipality (data not shown).

The three single item outcomes indicated perception of positive patient safety culture: overall perception of service users' safety (4.0, SD 0.7, 75%), service safety (4.1, SD 0.7, 84%), and overall care (4.2, SD 0.7, 86%). Scores positively correlated with short version 2 *NHSOPSC* sum scores ($p<0.001$).

Table 6. Patient safety culture in Norwegian homecare services (n=540)[a]

	Mean (SD)	Positive responses (n, %)[b]
Overall score	**3.8 (0.6)**	**(69.4)**
Factor 1: Safety improvement actions	**3.7 (0.6)**	**(62.8)**
Item 1: Management asks staff how the services can improve patient safety (U2)	3.7 (0.9)	341 (61.3)
Item 2: It is easy to make changes to improve service users' safety (U3)	3.6 (0.8)	321 (57.7)

Item 3: The service is always doing something to improve service users' safety (U4)	3.7 (0.7)	366 (65.8)
Item 4: A good job is done to keep service users safe (U5)	3.9 (0.7)	422 (75.9)
Item 5: Management listens to staff ideas and suggestions to improve safety (U6)	3.9 (0.8)	423 (76.1)
Item 6: Management regularly stays in touch with service users in order to assess the care (U8)	3.2 (1.0)	214 (38.5)
Item 7: Changes to improve service users' safety are evaluated (U9)	3.5 (0.8)	293 (52.7)
Item 8: Within this unit, we discuss ways to keep service users safe from harm (C8)	3.9 (0.8)	424 (74.6)
Factor 2: Teamwork	**4.1 (0.7)**	**(78.0)**
Item 1: Staff in our unit treat each other with respect (W1)	4.2 (0.8)	449 (79.0)
Item 2: Staff within our unit support each other (W2)	4.2 (0.8)	459 (80.8)
Item 3: Staff feel like they are part of a team (W5)	4.0 (0.8)	444 (78.1)
Item 4: When someone gets really busy, other staff help out (W9)	4.0 (0.8)	421 (74.1)
Factor 3: Information flow	**3.7 (0.7)**	**(63.8)**
Item 1: Staff are told what they need to know before taking care of a service user for the first time (C1)	3.8 (0.8)	377 (66.4)
Item 2: Staff are told right away when there is a change in a service user's care plan (C2)	3.4 (0.9)	268 (47.2)
Item 3: Staff are given all the information they need to care for service users (C10)	3.9 (0.7)	442 (77.8)
Factor 4: Management support	**4.0 (0.7)**	**(77.8)**
Item 1: My supervisor listens to staff ideas and suggestions concerning service users' safety (M1)	4.1 (0.8)	447 (79.3)
Item 2: My supervisor says a good word to staff who follow the right procedures (M2)	4.0 (0.9)	428 (75.9)
Item 3: My supervisor pays attention to service users' safety (M3)	4.3 (0.7)	497 (88.1)
Item 4: Staff ideas and suggestions are valued (C7)	3.8 (0.8)	387 (68.1)

a. Based on the proposed short version 19-item *NHSOPSC* scale. b. "Positive responses" were defined as responding "agree" or "entirely agree", or "often" or "always" to individual items. Valid percent, missing data for factor 1 (n=12) and factor 4 (n=4), no missing data for factors 2 and 3.

Discussion

Results of this study suggest the majority of healthcare personnel rated patient safety culture positively in Norwegian homecare. This includes positive ratings for information flow, teamwork, management support, and patient safety actions. Results indicate that the *NHSOPSC* instrument could potentially be reduced to half the number of items. Psychometric testing suggested the short version instrument was comparable to the full version. An arising question is how the instrument compares to previous studies (e.g. 24,25). Three dimensions – *teamwork*, *information flow,* and *management* – were comparable to previous studies. The *Safety improvement actions* dimension encompassed several items from dimensions included in the original full version (*incident feedback/communication*; *communication openness*; *supervisor expectations and safety actions*; and *management/organizational learning*). However, the short version did not include *staffing*; *compliance with procedures*; *training and skills*; and *non-punitive responses to mistakes*.

Out of the other patient safety culture instruments recommended for use in EU member States (18), the *Safety Attitudes Questionnaire (SAQ)* has been tested and validated, also within the

context of Norwegian homecare services (19). It includes six dimensions, out of which two share considerable resemblance to *NHSOPSC* dimensions focusing on perceptions of *teamwork* and *management support*. *SAQ safety climate* and *working conditions* dimensions share some resemblance to items from different *NHSOPSC* dimensions. For example, items addressing feedback performance and learning from others' mistakes under *SAQ's* safety climate dimension, would fit under two different *NHSOPSC* dimensions (*management support* and *safety improvement action*). Furthermore, *SAQ* dimensions of *job satisfaction* and *stress recognition* are not covered by the *NHSOPSC* instrument. We suggest it might be more appropriate to assess *job satisfaction* as a separate outcome measure that may influence patient safety culture.

A significant advantage of the *NHSOPSC* instrument, in particular the short version, over the *SAQ* instrument, is the reduced burden it poses on health personnel in everyday practice (19 versus 62 items).

Differences between our current findings and previous studies using the *NHSOPSC* or *SAQ* instruments raise the question of which dimensions are needed to assess patient safety culture. The commonly used patient safety culture definition (11), emphasizes shared perceptions of safety importance, and communication within the context of trusting relationships. This is captured by both the full and short version *NHSOPSC* instrument. However, the definition provides a very general and overarching description of patient safety culture. Moreover, there is disagreement as to how patient safety culture should be defined (10). Lack of clarity in definitions and discrepancies between dimensions in the full version *NHSOPSC* instrument and previous research (24-26), raises questions about the instrument's validity and reliability, at least in Norwegian homecare service settings. Lack of consistency warrants further studies to develop agreement on the definition of patient safety culture and instruments to assess clinical practice and research.

Among original *NHSOPSC* dimensions not included in the short version, we suggest items should cover *staffing* and *non-punitive responses to mistakes*. These dimensions seem to be of significant importance to patient safety culture. Firstly, in previous research these had the highest need for improvement (39). Secondly, *staffing* has been found to have strong predictive value on health personnel's perception of patient safety (39-41) and patient safety outcomes (42-44) in different settings and countries. Thirdly, we consider *non-punitive responses to mistakes* important due to considerable variation between countries and clinical settings in blame-culture (16), which may significantly influence patient safety culture (39,40,45). Healthcare personnel in Norwegian studies score higher on *non-punitive responses to mistakes* compared to international studies (16), which might be explained by the non-hierarchical structure in Norway (46). Exclusion of these dimensions may limit the instrument's ability to assess important aspects of patient safety culture. However, items covering these two dimensions in the original *NHSOPSC* are not valid, at least not within the context of Norwegian homecare services. We therefore suggest new items should be developed to cover these dimensions and be tested with the other dimensions in a revised short version. Healthcare personnel with different backgrounds (e.g. nurses, general practitioners, physiotherapists, occupational therapists) should be involved in the development process to ensure relevance and face validity. Finally, we also recommend the instrument title reflects the contextual setting of homecare services, and therefore propose renaming it the *Homecare Services Survey on Patient Safety Culture*.

Strengths and limitations of this study

This was the second and largest study assessing patient safety culture in homecare services in Norway. To our best knowledge, it was the largest study assessing patient safety culture in homecare worldwide. Overall response rate was not ideal, but not far off from our previous survey (24), and comparable to research involving nurses (47). Although participants were not randomly selected, variation in contextual settings (e.g. geographical, distance to hospitals, urban/rural areas) was used to increase generalizability of results, and should be representative for Norwegian homecare services. Another limitation was variability in response rates between municipalities. Caution should

be made when generalizing findings to other countries with different structures and organization of services, and to other healthcare settings.

This was the first study developing a proposal for a short version instrument to assess patient safety culture within homecare services. The factor analysis and OTA approach was a strength of this study. It provides assessment of internal consistency, concurrent and convergent validity. Others found that inclusion of factors with initial eigenvalue of min. 1 may over- or underestimate the number of components (48). However, Velicer's Minimum Average Partial (MAP) test also resulted in a four-factor model for the recommended short version instrument (data not shown).

In lack of a "gold standard" instrument to assess convergent validity, we used single-item outcomes previously used (16,24,25,49,50). The use of single items might not capture variability and the use of an additional instrument such as the *Safety Attitudes Questionnaire (SAQ)* (19) is recommended to assess convergent validity in future studies. In the current study, we did however find comparable results using all three single-item outcomes. The GPCM approach helped to determine whether items were discriminable. In future studies, variance-based structural equation modelling (SEM) could be used as an addition to the OTA approach, to assess discriminant validity (51).

Conclusion

The aging population worldwide, with increased risk of adverse events within the context of citizens' homes, requires strengthened focus on patient safety within homecare services. The results of this study showed that the majority of home healthcare personnel rated patient safety culture positively. Patient safety culture is central for assessing and improving patient safety. Valid and reliable instruments are needed. The *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* is the most commonly used instrument, but its length carries significant burden on personnel who struggle to carry out daily tasks. This article proposes the first short version of the *NHSOPSC* instrument which could serve as a starting point for an improved short version *Homecare Services Survey on Patient Safety Culture* instrument for assessing patient safety culture within homecare services. Psychometric tests indicated that the short version instrument was comparable to the full version, and both had high internal consistency. Nevertheless, there is a need to further develop a validated short-version instrument to ensure relevance and validity. A short version instrument would be less time-consuming and reduce burden on personnel. It is more likely to be used in routine practice, and to give higher response rates in research projects. Results could potentially be transferred to other clinical contexts.

Ethical considerations

The Regional Committees for Research Ethics in Norway found that the research was not governed by the Health Research Act. Both projects were assessed by the Norwegian Centre for Research Data (NSD) and were in line with legislation (SAFE-LEAD ID 52324; DigiPAS ID 561903). All participants gave written informed consent, and projects followed the Helsinki declaration. All study information was provided at the beginning of the questionnaire.

Competing interests statement

We have no competing interests

Data sharing statement

Data can be accessed by reasonable request to the lead author.

Funding

Data collection carried out as part of the: 'Improving Quality and Safety in Primary Care—Implementing a Leadership Intervention in Nursing Homes and Homecare' (SAFE-LEAD) was supported by The Research Council of Norway (RCN) grant number 256681/H10 and the University of

Stavanger, Norway. Data collection carried out as part of the "*Digital Solutions for Increased Quality and Improved Patient Safety*" (DigiPAS) project was funded by The Norwegian Regional Research Funds (RFF)/Oslofjord Fund grant number 285538 (project owner: Skien municipality).

Acknowledgment

Firstly, we thank homecare services and all individual participants agreeing to participate in the study. Thank you also to the following members of the SAFE-LEAD team: Co-researchers from the *Centre for Development of Institutional and Homecare Services (USHT)*: Elisabeth Holen-Rabbersvik, Marta Strandos, Line Hurup Thomsen, Berit Ullebust for help with recruitment of units to the project.

Contributorship statement

MR, LG, KC, SW and ER contributed to project design, recruitment and data collection. ALL authors participated in planning of analyses. PV and ER performed statistical analyses. PV drafted the manuscript, and all authors contributed to and approved the final submitted manuscript.

References

1. Panagioti M, Khan K, Keers RN, Abuzour A, Phipps D, Kontopantelis E, Bower P, Campbell S, Haneef R, Avery AJ, Ashcroft DM. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. *BMJ.* 2019;366:l4185. doi: https://doi.org/10.1136/bmj.l4185
2. Auraaen A, Slawomirski L, Klazinga N. *The economics of patient safety in primary and ambulatory care: Flying blind.* OECD Health Working Paper No. 106. DELSA/HEA/WD/HWP(2018)3. Available at URL https://www.oecd-ilibrary.org/content/paper/baf425ad-en
3. Slawomirski L, Auraaen A, Klazinga N. *The economics of patient safety. Strengthening a value-based approach to reducing patient harm at national level.* OECD Health Working Paper No. 96. DELSA/HEA/WD/HWP(2017)6. Available at URL https://www.oecd-ilibrary.org/docserver/5a9858cd-en.pdf?expires=1587099735&id=id&accname=guest&checksum=F933FA2A81C7352C5151517F558B8DA5
4. Sunshine JE, Meo N, Kassebaum NJ, Collison ML, Mokdad AH, Naghavi M. Association of Adverse Effects of Medical Treatment With Mortality in the United States: A Secondary Analysis of the Global Burden of Diseases, Injuries, and Risk Factors Study. *JAMA Netw Open*. 2019 Jan 4;2(1):e187041. doi: 10.1001/jamanetworkopen.2018.7041.
5. Rogne T, Nordseth T, Marhaug G, Berg EM, Tromsdal A, Sæther O, Gisvold S, Hatlen P, Hogan H, Solligård E. Rate of avoidable deaths in a Norwegian hospital trust as judged by retrospective chart review. *BMJ Qual Saf*. 2019 Jan;28(1):49-55. doi: 10.1136/bmjqs-2018-008053.
6. United Nations, Department of Economic and Social Affairs, Population Division (2019). *World Population Ageing 2019: Highlights* (ST/ESA/SER.A/430).
7. Centers for Disease Control and Prevention. *Healthy Places Terminology*, 2009. Available at URL https://www.cdc.gov/healthyplaces/terminology.htm
8. Thiem U, Hinrichs T, Muller CA, Holt-Noreiks S, Nagl A, Bucchi C, et al. Prerequisites for a new health care model for elderly people with multiple morbidities: Results and conclusions from 3 years of research in the PRISCUS consortium. *Z Gerontol Geriatr.* 2011;44(Suppl 2):101–112. https://doi.org/10.1007/s00391-011-0246-6
9. National Patient Safety Foundation. *Free from harm. Accelerating patient safety improvement fifteen years after to err is human.* Boston: National Patient Safety Foundation; 2015.
10. Halligan M, Zecevic A. Safety culture in healthcare: a review of concepts, dimensions, measures and progress. *BMJ Qual Saf*. 2011;20:338-343. http://dx.doi.org/10.1136/bmjqs.2010.040964
11. Health and Safety Commission. *Third Report: Organizing for Safety*. ACSNI Study Group on Human Factors. London: HMSO, 1993:23.

12. Braithwaite J, Herkes J, Ludlow K, Testa L, Lamprell G. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ Open.* 2017;7:e017708. doi:10.1136/bmjopen-2017-017708
13. Gartshore E, Waring J, Timmons S. Patient safety culture in care homes for older people: a scoping review. *BMC Health Serv Res.* 2017;17(1):752. doi: 10.1186/s12913-017-2713-2
14. Olsen RM, Bjerkan J. Patient safety culture in Norwegian home health nursing: a cross-sectional study of healthcare provider's perceptions of the teamwork and safety climates. *Saf Health.* 2017;3(1):15. doi: 10.1186/s40886-017-0066-5
15. Ree E, Wiig S. Linking transformational leadership, patient safety culture and work engagement in home care services. *Nurs Open.* 2019 Oct 8;7(1):256-264. doi: 10.1002/nop2.386. eCollection 2020 Jan.
16. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res*. 2019;19:607. doi: 10.1186/s12913-019-4456-8
17. World Health Organization (WHO). *Towards eliminating avoidable harm in health care. Global patient safety action plan 2021-2030*. Second Draft, November 2020.
18. European Union Network for Patient Safety (EUNetPaS). *Patient safety culture instruments used in member states.* European Society for Quality in Healthcare – Office for Quality Indicators. Aarhus, Denmark, March 2010. ISBN 978-87-993779-1-6.
19. Bondevik GT, Hofoss D, Husebø BS, Tveter Deilkås EC. Patient safety culture in Norwegian nursing homes. *BMC Health Serv Res*. 2017;17:424. doi: 10.1186/s12913-017-2387-9
20. Sorra JS, Nieva VF. *Hospital Survey on Patient Safety Culture.* Rockville, MD: Agency for Healthcare Research and Quality, 2004. [Accessed 02.03.2020]. Available at URL https://proqualis.net/sites/proqualis.net/files/User%20guide%20HSOPSC.pdf
21. Reis CT, Paiva SG, Sousa P. The patient safety culture: a systematic review by characteristics of Hospital Survey on Patient Safety Culture dimensions. *Int J Qual Health Care.* 2018 Nov 1;30(9):660-677. doi: 10.1093/intqhc/mzy080.
22. Lawati MHA, Dennis S, Short SD, Abdulhadi NN. Patient safety and safety culture in primary health care: a systematic review. *BMC Fam Pract.* 2018;19:104. https://doi.org/10.1186/s12875-018-0793-7
23. Sorra J, Franklin M, Streagle S. *Nursing Home Survey on Patient Safety Culture.* (Prepared by Westat, under Contract No. 233-02-0087). AHRQ Publication No. 08-0060. Rockville: Agency for Healthcare Research and Quality; 2008.
24. Cappelen K, Aase K, Storm M, Hetland J, Harris A. Psychometric properties of the Nursing Home Survey on Patient Safety Culture in Norwegian nursing homes. *BMC Health Serv Res.* 2016 Aug 27;16:446. doi: 10.1186/s12913-016-1706-x.
25. Cappelen K, Harris A, Aase K. Variability in staff perceptions of patient safety culture in Norwegian nursing homes—a longitudinal cross-sectional study. *Saf Health.* 2018;4(9).https://doi.org/10.1186/s40886-018-0076-y
26. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res.* 2019 Aug 29;19(1):607. doi: 10.1186/s12913-019-4456-8.
27. Liu M, Wronski L. Examining completion rates in web surveys via over 25,000 real-world surveys. *Soc Sci Comput Rev.* 2018;36(1):116-124. doi: 10.1177/0894439317695581
28. Rolstad S, Adler J, Rydén A. Response burden and questionnaire length: Is shorter better? A review and meta-analysis. *Value in Health* 2011;14(8):1101-1108. https://doi.org/10.1016/j.jval.2011.06.003
29. Lindahl AK. The Norwegian Health Care System, 2015. In: Mossialos E, Wenzl M, Osborn R, Sarnak D. (Eds.) *2015 International profiles of health care systems.* The Commonwealth Fund: New York: January 2016.
30. Holm SG, Mathisen TA, Sæterstrand TM, Brinchmann BS. Allocation of home care services by municipalities in Norway: a document analysis. *BMC Health Serv Res.* 2017;17:673. doi: 10.1186/s12913-017-2623-3

31. Ringard Å, Sagan A, Sperre Saunes I, Lindahl AK. Norway: health system review. *Health Syst Transit.* 2013;15(8):1–162.
32. Wiig S, Ree E, Johannessen T, Strømme T, Storm M, Aase I, Ullebust B, Holen-Rabbersvik E, Hurup Thomsen L, Sandvik Pedersen AT, van de Bovenkamp H, Bal R, Aase K. Improving quality and safety in nursing homes and home care: the study protocol of a mixed-methods research design to implement a leadership intervention. *BMJ Open*. 2018;8:e020933. doi: 10.1136/bmjopen-2017-020933.
33. Haugen AS, Storm M. *Sikkerhetskultur i sykehus [Patient safety culture in hospitals]* [Norwegian]. In: Aase K, editor. Pasientsikkerhet - Teori og praksis. Oslo: Universitetsforlaget; 2015:77–86.
34. Stevens JP. *Applied multivariate statistics for the social sciences.* Fifth edition. Routledge, 1992.
35. Tabachnick BG, Fidell LS. *Using multivariate statistics* (5th ed.) Upper Saddle River, NR: Pearson Allyn & Bacon, 2007.
36. Harel D, Baron M, on behalf of the CSRG Investigators. Methods for shortening patient-reported outcome measures. *Stat Methods Med Res*. 2019 Oct-Nov;28(10-11):2992-3011. doi: 10.1177/0962280218795187
37. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Adv in Health Sci Educ.* 2010;15:625-632. doi: 10.1007/s10459-010-9222-y
38. Dunn TJ, Bagueley T, Brunsden V. From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. *Br J Psychol.* 2015;105:399-412. DOI:10.1111/bjop.12046
39. Gurková E, Zeleníková R, Friganovic A, Uchmanowicz I, Jarošová D, Papastavrou E, Žiaková K. Hospital safety climate from nurses' perspective in four European countries. *Int Nurs Rev.* 2020;67(2):208-217.
40. Alenius LS, Tishelman C, Runesdotter S, Lindqvist. Staffing and resource adequacy strongly related to RNs' assessment of patient safety: a national study of RNs working in acute-care hospitals in Sweden. *BMJ Qual Saf.* 2014;23(3):242-249.
41. Cho E, Lee, NJ b, Kim EY, Kim S, Lee K, Park, KO, et al. Nurse staffing level and overtime associated with patient safety, quality of care, and care left undone in hospitals: a cross-sectional study. *Int J Nurs Stud.* 2016;60:263-271.
42. Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, et al. Nurse staffing and education and hospital mortality in nine European countries. A retrospective observational study. *Lancet.* 2014;383:1824–30.
43. Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Med Care. 2007*;45(12):1195-1204.
44. McHugh M, Rochman M, Sloane D, Berg R, Mancini M, Nadkarni V, et al. Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Med Care.* 2016. doi:10.1097/MLR.0000000000000456.
45. Aase K, Shibevaag L (Eds.). *Researching patient safety and quality in healthcare.* A Nordic perspective. Boca Raton: Taylor & Francis Group; 2017.
46. Cook JV, Dickinson HO, Eccles MP. Response rates in postal surveys of healthcare professionals between 1996 and 2005: An observational study. *BMC Health Serv Res.* 2009;9(160). doi:10.1186/1472-6963-9-160
47. Albalawi A, Kidd L, Cowey E. Factors contributing to the patient safety culture in Saudi Arabia: a systematic review. *BMJ Open*. 2020;10:e0378875. doi:10.1136/bmjopen-2020-037875
48. Zwick WR, Velicer WF. Comparison of five rules for determining the number of components to retain. *Psychol Bull.* 1986;99(3):432-442.
49. Cappelen K, Harris A, Storm M, Aase K. Healthcare staff perceptions on patient safety culture in nursing home settings – A cross sectional study. *Open J Nurs.* 2017;7:1069-1085. https://doi.org/10.4236/ojn.2017.79078

50. Seljemo C, Viksveen P, Ree E. The role of transformational leadership, job demands and job resources for patient safety culture in Norwegian nursing homes: a cross sectional study. *BMC Health Serv Res* 2020;20:799. https://doi.org/10.1186/s12913-020-05671-y
51. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J of the Acad Mark Sci.* 2015;43:115-135. doi: 10.1007/s11747-014-0403-8

Appendix A. Survey questionnaire

1. Age
20 – 29 years
30 – 39 years
40 – 49 years
50 – 59 years
60+ years

2. What is your position/educational background?
Leader position with responsibility for personnel
Healthcare professional with min. three-year education from university or other higher education
Healthcare professional with education from high school or similar
Care assistant (untrained)
Administrative personnel (mercantile/financial/personnel)
Other

3. How long have you been working in this homecare service?
Less than 1 year
1 - 5 years
6 - 10 years
11 - 15 years
16 - 20 years
21 years or more

4. How many hours per week do you normally work?
Less than 15 hours/week
16 - 24 hours/week
25 - 35,5 hours/week
More than 35,5 hours/week

5. When do you most often work?
Daytime only
Two-split shift work
Three-split shift work
Regular evening shift
Regular nightshift
Other

6. Do you work directly with service users most of the time?
Yes
No

<u>About working within your unit</u>
To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree
7. We treat each other with respect within our unit
8. We support each other within our unit
9. We have enough staff to handle the workload
10. Staff follow standard procedures to care for service users
11. Staff feel they are part of a team
12. Staff use shortcuts to get their work done faster

13. Staff get the training they need in our unit
14. Staff have to hurry because they have too much work to do
15. When someone gets really busy in our unit, other staff help out
16. Staff are blamed when a service user is harmed
17. Staff receive enough training to know how to handle difficult service users
18. Staff are afraid to report their mistakes
19. Staff understand the training they get
20. To make work easier, staff often ignore procedures
21. Staff are treated fairly when they make mistakes
22. Service users' needs are met during shift changes
23. It is hard to keep service users safe because so many quit their jobs
24. Staff feel safe reporting their mistakes

Communication

How often does the following happen within your unit? Never, Rarely, Sometimes, Often, Always

25. Staff are told what they need to know before taking care of a service user for the first time
26. Staff are informed soon when there is a change in a service user's care plan
27. We have all the information we need when service users are transferred from the hospital
28. When staff report something that could harm a service user, this is followed up
29. We discuss within our unit how we can prevent unwanted episodes to reoccur
30. Staff report if they see something that might harm a service user (physically or mentally)
31. Staff ideas and suggestions are valued
32. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
33. Staff opinions are ignored
34. Staff are provided all the information they need to take care of service users
35. It is easy for staff to speak up about problems

Your line manager

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

36. My line manager listens to staff ideas and suggestions about service users' safety
37. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
38. My line manager pays attention to service users' safety

Your unit

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

39. Service users are well cared for
40. Management asks staff how the service can improve safety
41. It is easy to implement changes to improve service users' safety
42. Something is always done to improve service users' safety
43. A good job is done in order to maintain service users' safety
44. Management listens to employees' ideas and proposals for how safety can be improved
45. The homecare services are safe for users
46. Management is in regular contact with service users to assess the care
47. Changes with a view to improve service users' safety are assessed

Overall assessment

48. Overall, how do you assess service users' safety in these homecare services?
Very poor
Poor
Satisfactory
Good
Very good

Appendix B. Full version *NHSOPSC* instrument (7 factors, 41 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.92/0.92	**Factor 1: Safety improvement actions**
1	Unit 1	0.46		U1. Service users are well cared for
2	Unit 2	0.69		U2. Management asks staff how the service can improve safety
3	Unit 3	0.63		U3. It is easy to implement changes to improve service users' safety
4	Unit 4	0.82		U4. Something is always done to improve service users' safety
5	Unit 5	0.82		U5. A good job is done in order to maintain service users' safety
6	Unit 6	0.62		U6. Management listens to employees' ideas and proposals for how safety can be improved
7	Unit 7	0.43		U7. The homecare services are safe for users
8	Unit 8	0.54		U8. Management is in regular contact with service users to assess the care
9	Unit 9	0.69		U9. Changes with a view to improve service users' safety are assessed
10	Communication 8	0.46		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.85/0.85	**Factor 2: Teamwork**
1	Work 1	0.83		W1. We treat each other with respect within our unit
2	Work 2	0.88		W2. We support each other within our unit
3	Work 4	0.40		W4. Staff follow standard procedures to care for service users
4	Work 5	0.66		W5. Staff feel they are part of a team
5	Work 7	0.35		W7. Staff get the training they need in our unit
6	Work 9	0.56		W9. When someone gets really busy in our unit, other staff help out
7	Work 13	0.34		W13. Staff understand the training they get
8	Work 15	0.32		W15. Staff are treated fairly when they make mistakes
C n	**Factor 3**		0.84/0.84	**Factor 3: Information flow**
1	Communication 1	0.72		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.69		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.56		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.51		C4. When staff report something that could harm a service user, this is followed up
5	Communication 5	0.38		C5. We discuss within our unit how we can prevent unwanted episodes to reoccur
6	Communication 10	0.62		C10. Staff are provided all the information they need to take care of service users
7	Work 11	0.39		W11. Staff receive enough training to know how to handle difficult service users
C n	**Factor 4**		0.87/0.87	**Factor 4: Management support**
1	Management 1	0.56		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.60		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.52		M3. My line manager pays attention to service users' safety
4	Communication 7	0.45		C7. Staff ideas and suggestions are valued
5	Communication 9r	0.42		C9r. Staff opinions are ignored
6	Communication 11	0.39		C11. It is easy for staff to speak up about problems
C n	**Factor 5**		0.62/0.56	**Factor 5: Compliance with procedures**
1	Work 6r	0.51		W6r. Staff use shortcuts to get their work done faster
2	Work 10r	0.40		W10r. Staff are blamed when a service user is harmed
3	Work 14r	0.47		W14r. To make work easier, staff often ignore procedures
4	Work 17r	0.43		W17r. It is hard to keep service users safe because so many quit their jobs
C n	**Factor 6**		0.47/0.65	**Factor 6: Managing workload**
1	Communication 6	0.37		C6. Staff report if they see something that might harm a service user (physically or mentally)
2	Work 3	0.46		W3. We have enough staff to handle the workload
3	Work 8r	0.42		W8r. Staff have to hurry because they have too much work to do
C n	**Factor 7**		0.67	**Factor 7: Reporting mistakes**
1	Work 12r	0.55		W12r. Staff are afraid to report their mistakes
2	Work 18	0.49		W18. Staff feel safe reporting their mistakes
	Overall (41 items)		0.95/0.95	

One item (W16) did not load with any factor. Items numbers marked with "r" were reversed in analyses.

Appendix C. Candidate short version 1 (6 factors, 27 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.91/0.91	**Factor 1: Safety improvement actions**
1	Unit 2	0.64		U2. Management asks staff how the service can improve safety
2	Unit 3	0.66		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.86		U4. Something is always done to improve service users' safety
4	Unit 5	0.77		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.54		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.47		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.68		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.49		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.84/0.84	**Factor 2: Teamwork**
1	Work 1	0.85		W1. We treat each other with respect within our unit
2	Work 2	0.94		W2. We support each other within our unit
3	Work 5	0.63		W5. Staff feel they are part of a team
4	Work 9	0.52		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.80/0.81	**Factor 3: Information flow**
1	Communication 1	0.73		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.71		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.55		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.45		C4. When staff report something that could harm a service user, this is followed up
5	Communication 10	0.60		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.87/0.88	**Factor 4: Management support**
1	Management 1	0.74		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.73		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.63		M3. My line manager pays attention to service users' safety
4	Communication 7	0.42		C7. Staff ideas and suggestions are valued
C n	**Factor 5**		0.64/0.64	**Factor 5: Compliance with procedures**
1	Work 6r	0.45		W6r. Staff use shortcuts to get their work done faster
2	Work 12r	0.71		W12r. Staff are afraid to report their mistakes
3	Work 14r	0.47		W14r. To make work easier, staff often ignore procedures
4	Work 18	0.43		W18. Staff feel safe reporting their mistakes
C n	**Factor 6**		0.61	**Factor 6: Managing workload**
1	Work 3	0.61		W3. We have enough staff to handle the workload
2	Work 8r	0.60		W8r. Staff have to hurry because they have too much work to do
	Overall (27 items)		0.93/0.93	

Analysis carried out using a three-stage factor analysis (principal axis factoring). NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7. Not included in any factors (no score): W15, W16. Factor loading < 0.4: W4 (0.34), W7 (0.37), W10r (0.33), W11 (0.37), W13 (0.35), W17r (0.33), C5 (0.33), C6 (0.38), C9r (-0.38), C11 (-0.35).

Items numbers marked with "r" were reversed in analyses.

Appendix D. Candidate short version 2 (4 factors, 19 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.91/0.91	**Factor 1: Safety improvement actions**
1	Unit 2	0.64		U2. Management asks staff how the service can improve safety
2	Unit 3	0.67		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.88		U4. Something is always done to improve service users' safety
4	Unit 5	0.79		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.54		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.48		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.69		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.50		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.84/0.84	**Factor 2: Teamwork**
1	Work 1	0.86		W1. We treat each other with respect within our unit
2	Work 2	0.96		W2. We support each other within our unit
3	Work 5	0.62		W5. Staff feel they are part of a team
4	Work 9	0.52		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.79/0.79	**Factor 3: Information flow**
1	Communication 1	0.77		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.72		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 10	0.66		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.87/0.88	**Factor 4: Management support**
1	Management 1	0.76		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.75		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.61		M3. My line manager pays attention to service users' safety
4	Communication 7	0.43		C7. Staff ideas and suggestions are valued
	Overall (19 items)		0.93/0.94	

Analysis carried out using a generalized partial credit model (GPCM) approach, followed by a two-stage factor analysis process (principal axis factoring). NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7.

GPCM assessment of boundary and category characteristic curves, and low discrimination parameters (coefficients < 1): W3 (0.61), W6 (0.31), W8 (0.26), W10 (0.41), W11 (0.97), W12 (0.50), W14 (0.65), W17 (0.38), C3 (0.71), C9 (0.81), C11 (0.92). Not included in any factors (no score): C4, C6. Factor loading < 0.4: W4 (0.38), W7 (0.37), W13 (0.34), W15 (0.31), W16 (0.31), W18 (0.33), C5 (0.30).

Appendix E. Correlation between factors in the factor analysis

Factor Correlation Matrix

Factor	1	2	3	4	5	6	7
1	1,000	,471	,295	,647	-,060	-,435	-,164
2	,471	1,000	,339	,446	,041	-,341	-,250
3	,295	,339	1,000	,337	-,137	-,244	-,304
4	,647	,446	,337	1,000	-,144	-,344	-,196
5	-,060	,041	-,137	-,144	1,000	,064	-,012
6	-,435	-,341	-,244	-,344	,064	1,000	,169
7	-,164	-,250	-,304	-,196	-,012	,169	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4	5	6
1	1,000	,454	,272	,619	-,591	,198
2	,454	1,000	,306	,394	-,424	,035
3	,272	,306	1,000	,304	-,265	,225
4	,619	,394	,304	1,000	-,450	,316
5	-,591	-,424	-,265	-,450	1,000	-,252
6	,198	,035	,225	,316	-,252	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4
1	1,000	,465	-,604	,642
2	,465	1,000	-,430	,438
3	-,604	-,430	1,000	-,496
4	,642	,438	-,496	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-6
		(*b*) Describe any methods used to examine subgroups and interactions	4-5
		(*c*) Explain how missing data were addressed	4,7,10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
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	3-4,6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	4,7,10
Outcome data	15*	Report numbers of outcome events or summary measures	7-10
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	6-10

		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	4-5
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	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
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	11

*Give information separately for exposed and unexposed groups.

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.

BMJ Open

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052293.R2
Article Type:	Original research
Date Submitted by the Author:	21-Mar-2022
Complete List of Authors:	Viksveen, Petter; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Røhne, Mette; SINTEF, SINTEF Digital, Health Grut, Lisbet; SINTEF, SINTEF Digital, Health Cappelen, Kathrine; University of South-Eastern Norway Faculty of Health and Social Sciences, Center for Caring Research South Wiig, Siri; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences Ree, Eline ; University of Stavanger, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Public health, Research methods
Keywords:	Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Health & safety < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, STATISTICS & RESEARCH METHODS

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Title page

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services

Petter Viksveen, Mette Røhne, Lisbet Grut, Kathrine Cappelen, Siri Wiig, Eline Ree

Corresponding author:
Dr. Petter Viksveen, PhD, Associate Professor
SHARE - Centre for Resilience in Healthcare
Department for Quality and Health Technology
Faculty of Health Sciences
University of Stavanger
Postboks 8600 Forus
4036 Stavanger, Norway
Tel + 47 51 83 27 37
Email petter.viksveen@uis.no
Website University of Stavanger https://www.uis.no/nb
Website SHARE - Centre for Resilience in Healthcare https://www.uis.no/en/share-centre-resilience-healthcare

Names, institutions, city and country for co-authors:
Dr. Mette Røhne, Department of Smart Sensor Systems, SINTEF Digital, Oslo, Norway.
Mrs. Lisbet Grut, Department of Health Research, SINTEF Digital, Oslo, Norway.
Dr. Kathrine Cappelen, Center for Caring Research South, Faculty of Health and Social Services, University of South- Eastern Norway, Porsgrunn, Norway.
Professor Siri Wiig, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.
Dr. Eline Ree, SHARE – Centre for Resilience in Healthcare, Department of Quality and Health Technology, Faculty of Health Sciences, University of Stavanger, Stavanger, Norway.

Keywords: patient safety, safety culture, health services research, healthcare quality improvement, evaluation methodology

Word count: 4804

Psychometric properties of the full and short version Nursing Home Survey on Patient Safety Culture (NHSOPSC) instrument: a cross-sectional study assessing patient safety culture in Norwegian homecare services

Abstract

Objectives: Measure patient safety culture in homecare services; test the psychometric properties of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument; and propose a short version *Homecare Services Survey on Patient Safety Culture* instrument for use in homecare services.
Design: Cross-sectional survey with psychometric testing.
Setting: Twenty-seven publicly funded homecare units in eight municipalities (six counties) in Norway.
Participants: Five-hundred-and-forty health personnel working in homecare services.
Interventions: Not applicable.
Primary and secondary outcome measures: Primary: Patient safety culture assessed using the *NHSOPSC* instrument. Secondary: Overall perception of service users' safety, service safety and overall care.
Methods: Psychometric testing of the *NHSOPSC* instrument using factor analysis and optimal test assembly (OTA) with generalized partial credit model (GPCM) to develop a short version instrument proposal.
Results: Most healthcare personnel rated patient safety culture in homecare services positively. A 19-item short version instrument for assessing patient safety culture had high internal consistency, and was considered to have sufficient concurrent and convergent validity. It explained a greater proportion of variance (59%) than the full version (50%). Short version factors included *safety improvement actions*, *teamwork*, *information flow*, and *management support*.
Conclusion: This study provides a first proposal for a short version *Homecare Services Survey on Patient Safety Culture* instrument to assess patient safety culture within homecare services. It needs further improvement, but provides a starting point for developing an improved valid and reliable short version instrument as part of assessment of patient safety and quality improvement processes.

Strengths and limitations of this study

- A strength of this article was that it provided first proposal for a short version instrument to assess patient safety culture in homecare services, entitled the *Homecare Services Survey on Patient Safety Culture*
- Another strength was the combined use of a factor analysis, generalized partial credit model (GPCM) and optimal test assembly OTA approach to assess internal consistency, concurrent and convergent validity
- A limitation was the lack of comparison to a "gold standard" instrument for assessment of convergent validity, although the use of three single-item outcomes compensated somewhat for this
- The largest study assessing patient safety culture in Norwegian homecare services, possibly worldwide
- A limitation was lack of random selection of participants, although variation in contextual settings contributes to strengthen generalizability of results, and a somewhat low response rate, although it was comparable to previous surveys

Introduction

A recent systematic review with a meta-analysis including over 70 studies worldwide with 330,000 patients, found that one in twenty experienced preventable health service inflicted harm (1). Harm

could take place in any clinical context, including primary, secondary and tertiary care, involving e.g. infections; diagnostic procedures; and the use of drugs, surgical or other therapeutic interventions. In 12% of patients, harm was severe or fatal. Estimates suggest that in primary and ambulatory care almost four in ten patients experience safety issues, resulting in increased need for hospitalization (2). Patient harm is a major global health burden costing trillions of dollars annually (3).

Considerable efforts have been made to improve patient safety over the last decades, resulting in some reduction in the prevalence of harm. For example, the mortality rate due to adverse effects of medical treatment decreased by 21% in the US from 1990 to 2016 (4). However, a significant proportion of patients are still exposed to risk and experience adverse events, some of which are fatal. In Norway, a recent review found that 4.2% of deaths in hospitals could probably have been avoided (5).

Improving patient safety measures within healthcare services is particularly important for older patients (70 years+) who have 20 times higher mortality rates due to adverse medical effects, compared to younger age groups (15-49 years) (4). Improved patient safety is crucial from a societal perspective as the number of older citizens will increase from 700 million to 1.5 billion worldwide over the next three decades (6). Most citizens wish to "age in place," which can be understood as living safely in their own home, regardless of age and ability (7). A high proportion of older citizens living at home can have significant societal benefits, by reducing the increasing burden to healthcare services and by limiting the need for nursing homes. However, healthcare services must adapt to the demographic shift and attend to the needs of a much larger proportion of older citizens, many of whom have chronic health conditions and will require homecare services (8).

To advance patient safety, the *National Patient Safety Foundation (NPSF)* recommended a total systems approach in 2015, where leaders should establish and sustain a safety culture at all levels of patient care, including homecare services (9). Although the understanding of *patient safety culture* varies among researchers, Halligan & Zecevic found in their review (10), that the UK Health and Safety Commission's definition (11) was most commonly used: "*The product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety programmes. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures." NPSF's* recommendations are supported by a systematic review which found that improvements in healthcare services' organizational culture were associated with positive patient outcomes (12). Although results were similar across clinical settings, most studies took place within the context of hospitals and none within homecare services. A scoping review assessing patient safety culture in care homes for older people found that most studies were carried out in the United States and within nursing homes rather than residential home settings (13). Since then, three studies have assessed patient safety culture in Norwegian homecare services (14-16). Two studies found better safety culture scores for homecare nursing compared to other healthcare settings, albeit there was room for improvement (14,16). The third identified transformational leadership as important in improving patient safety culture and work engagement in homecare services (15). These studies contribute to the evidence-base to support the *World Health Organization's* global patient safety action plan 2021–2030 policy to improve patient safety culture in order to eliminate avoidable harm in healthcare (17).

To assess patient safety culture, validated outcome measures are needed. Several instruments exist, out of which three have been recommended for use in EU Member States (18). Two of these instruments have been further tested and validated, the *Safety Attitudes Questionnaire (SAQ)* (19), and the *Hospital Survey on Patient Safety Culture (HSOPSC)* (20). The *HSOPSC* is completed by healthcare personnel and addresses core components of safety culture, including sharing attitudes, values, perceptions, competencies and behaviours. It was developed in 2004 for hospital contexts and has been found to be an efficient measure of patient safety culture (21). It has since then been modified and become the most commonly used instrument to assess patient safety

culture in primary care (22), such as the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)*, developed by *The Agency of Healthcare Research and Quality (AHRQ)* (23).

The *NHSOPSC* has been translated into Norwegian and was found to be a valid and reliable measure of patient safety culture within the context of nursing homes (24,25). A slightly modified version has been used in homecare services (26). There is a need to test the psychometric properties of the instrument in homecare services. Moreover, results of surveys in other fields of research suggests that questionnaire length is negatively associated with response rates (27,28). It is not unreasonable to assume that the length of the *NHSOPSC* instrument (41 items) poses increased burden on participants, thereby limiting its usefulness as a measure in clinical practice. A short version instrument could reduce participant burden and be introduced in routine practice.

The aims of this study were:

1) to measure patient safety culture in Norwegian homecare services;
2) to test the psychometric properties of the *NHSOPSC*; and
3) to propose a short version of the *NHSOPSC* for use in homecare services and test its psychometric properties.

Methods

Design

A cross-sectional and psychometric design was used to assess patient safety culture in homecare services in Norway using the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument. Health personnel working in 27 publicly funded homecare units in eight municipalities in six counties in Norway were recruited through two research projects (further information follows). Data from the two projects was merged and analysed collectively. An optimal test assembly (OTA) approach with psychometric testing was used to develop a proposal for a short version *NHSOPSC* instrument.

Clinical context

In Norway, healthcare provision is the responsibility of the government. It provides over 95% of all homecare services, with equal access for citizens regardless of socio-economic status, ethnicity or area of residence (29). The aim is for care recipients to stay at home as long as possible, and nursing homes are only used when citizens can no longer live in their home (30). Although there is variation between homecare services, they primarily consist of nursing at home, and to a smaller extent practical assistance to support a physically and socially active life. Public homecare services are adapted to individuals' care needs, based on assessments of a broad range of areas, including e.g. daily help required for treatment (e.g. medication administration), personal hygiene, rehabilitation, wound/palliative care, physical activity, housework, mental health management and social activities (31). Services may be time-limited or permanent, but must meet acceptable minimum care and safety standards. Management of homecare services is delegated to the 356 municipalities and services are provided by different categories of health personnel (e.g. nurses, general practitioners, physiotherapists, untrained healthcare workers).

Participants and setting

Purposeful sampling was used to increase generalizability of results, through inclusion of homecare services in different municipalities over a wide geographical area, due to the country's variation in contextual settings, such as municipality type (urban/rural), municipality size (median 26,000, range 4,600–79,000) and distance to hospitals.

Recruitment of homecare services took place through two projects: *Digital Solutions for Increased Quality, Improved Patient Safety and Efficient Use of Resources in Municipal Healthcare (DigiPAS)* by *SINTEF*, an independent private multidisciplinary research organization, in collaboration

with *the University of South-Eastern Norway*; and *Improving Quality and Safety in Primary Care – Implementing a Leadership Intervention in Nursing Homes and Homecare (SAFE-LEAD)*, (32) run by *SHARE–Centre for Resilience in Healthcare*, at the *University of Stavanger*. In the SAFE-LEAD project co-researchers from the *Centre for Development of Institutional and Homecare Services (USHT)* contacted managers in all homecare units with information about the project, followed by researchers meeting each unit. Homecare service managers provided researcher with email contact lists, which were used to send a link to the online questionnaire by email to employees. Five survey reminders were sent. The response rate was 57% (table 1).

Table 1. Response rates according to municipality size

	Invited (n)	Responders (n,%)	Municipality size (n)
Municipality 1	295	160 (54.2)	50–55,000
Municipality 2	230	140 (60.9)	25–30,000
Municipality 3	93	71 (76.3)	60–65,000
Municipality 4	75	65 (86.7)	15–20,000
Municipality 5	116	30 (25.9)	25–30,000
Municipality 6	46	27 (58.7)	< 5,000
Municipality 7	47	25 (53.2)	5–10,000
Municipality 8	39	22 (56.4)	70–75,000
Total	**941**	**540 (57.4)**	

Cumulative percent for 540 participants, missing values not included (n=28)

Data collection

Participants completed the survey digitally. Data collection took place from March 1st to April 8th 2018 in the SAFE-LEAD project, and March 26th to May 9th 2019 in the DigiPAS project. Response time was 20 and 14 minutes, respectively. Responses were automatically transferred to research centres.

Questionnaire and instrument

The questionnaire (appendix A) included the validated Norwegian version of the *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* instrument (24,26), overall perception of service safety (see *Optimal test assembly* section), and participant characteristics (age, position/education, years in current workplace, shift type, work hours per week, extent of patient contact).

NHSOPSC originally consisted of 42 items (12 dimensions, Cronbach's alpha 0.71-0.86) (US version) (23), whereas the Norwegian validated version consisted of 41 items (10 dimensions, Cronbach's alpha 0.55-0.90) (24,25): teamwork staffing, compliance with procedures, training and skills, non-punitive responses to mistakes, handoffs, feedback and communication about incidents, communication openness, supervisor expectations and actions promoting patient safety, and management and organizational learning. Wording was slightly modified to fit the homecare setting, by replacing "nursing homes" with "unit" and "patient" with "user" (15,16) (appendix A). Items were rated on five-point Likert scales, from 1 (never or totally disagree) to 5 (always or totally agree). The full-scale instrument is presented in appendix B, the developed short versions presented in appendixes C and D. The average percentage of positive scores was calculated for each individual dimension, in line with previous research, and an average of at least 60% positive responses was considered a good score, as this has been shown to indicate lower risk of adverse events (23,25,33).

Data analyses

Data were analysed to report on patient safety culture in homecare services, to test the psychometric properties of the *NHSOPSC* instrument, and to develop a proposal for a short version of *NHSOPSC* for use in homecare services. *NHSOPSC* instrument assessment was carried out by testing

internal consistency, factor analysis and a generalized partial credit model (GPCM) approach. Patient safety culture was reported using the best version of the *NHSOPSC* instrument identified through an optimal test assembly (OTA) approach, and reporting mean item scores and proportion of participants positively scoring instrument items and three single item outcomes. Data were normally distributed. Alpha was set to 0.05. Statistical analyses were carried out using SPSS (version 25.0) and GPCM analyses using STATA (version 16.1).

Factor analysis

Factor analysis was used to test the full version 41-item *NHSOPSC* instrument with data from 540 participants. Only factors with initial eigenvalue of min. 1 were included. For development of two candidate short version instruments, two of the 41 *NHSOPSC* instrument items were first removed, as they were outcomes rather than instrument items (*"The homecare services are safe for service users"* and *"Service users are well cared for"*). In factor analyses for short version 1 and 2, items with factor loadings (Λ) below 0.4 were excluded, as suggested by Stevens (34).

Based on previous publications, we expected factors to be correlated with each other. Nevertheless, we carried out initial testing of correlations using oblique rotation (direct oblimin) as suggested by Tabachnick and Fidell (35). For the full version instrument, eight out of 21 factor correlations were above 0.32 (maximum = 0.65), suggesting min. 10% overlap in variance among some factors (appendix E). Similarly, significant overlap was found for candidate short version instruments (short version 1: 6 of 15 factor correlations; and short version 2: 6 of 6 factor correlations). We did therefore not apply orthogonal rotation, but used oblique rotation.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy test was ideal for the full version instrument (0.95) and candidate short version 1 (0.94) and 2 (0.94). Bartlett's test of sphericity for the full version instrument indicated that 21 correlations significantly differed from zero ($\chi^2(820)=11886$, $p<0.001$), and 15 correlations for candidate short version 1 ($\chi^2(351)=7884$, $p<0.001$) and for six for short version 2 ($\chi^2(190)=6758$, $p<0.001$).

Generalized partial credit model (GPCM)

For development of the second candidate short version instrument, a generalized partial credit model (GPCM) was carried out prior to factor analysis (36). The partial credit helps to evaluate items that may be scored on a scale, instead of dichotomous outcomes. The generalized approach was used to determine measurement quality of items, rather than assuming that items were of equal discrimination. Items with high discrimination parameters are likely to contribute better at obtaining estimates of the latent trait of interest. GPCM was therefore used to assess each individual item's discrimination (precision) and the total instrument's function (TIF) consists of the sum of the individual polytomous items. Although the use of Likert scales implied that individual items contained ordinal data, the sum scores across instruments can be considered to be interval (37). The GPCM approach was therefore used, instead of the graded response model. Individual item information function (IIF) was assessed by boundary and category characteristic curves. Items with low discrimination parameters (coefficients < 1) were removed.

Optimal test assembly (OTA)

To determine whether either of the short version instruments could be recommended to replace the full version instrument, we applied an optimal test assembly (OTA) approach, partially based on recommendations by Harel and Baron (36). Our approach differed slightly from their suggestions, as our dataset did not include a second validated instrument for assessment of convergent validity. Instead, we compared correlation between instrument sum scores and three outcomes. Our OTA approach included a four-stage process to determine whether:

1) candidate short version instruments maintain 95% of Cronbach's alpha of the full-length instrument (internal consistency);
2) the correlation of short version instrument summed scores was at least 0.95 of the full-length instrument (concurrent validity);
3) the correlation of candidate short version instrument factor scores was at least 0.95 of the full-length instrument (concurrent validity);
4) the correlation of candidate short version instrument summed scores with three outcomes, were at least 0.95 of the full-length instrument (convergent validity).

Weaknesses associated with the use of Cronbach's alpha as a measure of internal consistency has been pointed out by others (e.g. 38). Therefore, we also calculated the omega coefficient.

The first of the three outcomes was a single item question (*"Overall, how do you consider users' safety when using these homecare services"*), used as an outcome in previous patient safety culture studies within the context of nursing homes (23,25) and homecare services (26). The other two outcomes were the two single items removed from the full version instrument as the first step in developing candidate short version instruments.

The OTA results, together with results of a factor analysis, were used to consider if any of the *NHSOPSC* instrument versions could be recommended for assessing patient safety culture within the context of homecare services.

Analysis of patient safety culture

Patient safety culture was assessed using the best version of the *NHSOPSC* instrument identified through the optimal test assembly (OTA) approach. Results included mean overall and factor scores, and proportion of items indicating participants' perception of a positive patient safety culture (scored as "agree" or "entirely agree", or "often" or "always"). Multiple regression analysis was used to determine influence of participants' age, education/background, number of years in current practice, number of hours worked per week, or municipality, on the instrument total score. There were no violations of linearity/undue influence of single cases on the model (Cook's distance=0.002) and no evidence of multicollinearity (tolerance >0.2). The plotted residuals did not suggest homoscedasticity. Standardized residuals were normally distributed, the normal probability plot was sufficiently linear, and the scatterplot did not show any specific pattern for standardized residuals. Pearson correlation was calculated to determine the association between the overall *NHSOPSC* score and each of the three individual outcomes.

Patient and public involvement

Stakeholder involvement was used in all phases of the SAFE-LEAD project, including representatives of patients/users and next-of-kin, a patient and user ombudsman, and managers in nursing homes and homecare services. Co-researchers from the Centre for Development of Institutional and Homecare Services (USHT) were involved in planning and recruitment of participants in this survey.

Results

A total of 540 health personnel working in homecare services participated (response rate 57%, table 1). Most were healthcare workers with upper secondary school education (45%) or healthcare personnel (min. Bachelor's degree) (36%) (table 2). The remaining were untrained care assistants (13%), managers (3%), administrative (1%) or other personnel (3%). The majority (93%) worked directly with service users most of the time. Most health personnel were from 30 to 59 years (73%), one in five was under 30 and one in ten above 60. Almost two out of three had practiced for min. six years, 30% had less than one year's experience.

Table 2. Participants' characteristics

	N (%)
Age group	
20–29 years	103 (19.1)
30–39 years	123 (22.8)
40–49 years	127 (23.5)
50–59 years	138 (25.6)
60+ years	49 (9.1)
Position/education	
Managers (incl. leaders at first-line level)	17 (3.1)
Healthcare personnel (min. bachelor's degree)	194 (35.9)
Healthcare workers (upper secondary school)	242 (44.8)
Care assistants (untrained)	68 (12.6)
Administrative personnel	5 (0.9)
Other	14 (2.6)
Number of years in current workplace	
< 1 year	163 (30.2)
1–5 years	38 (7.0)
6–10 years	122 (22.6)
11–15 years	84 (15.6)
16–20 years	81 (15.0)
21+ years	52 (9.6)
Amount of work per week	
< 15 hours	28 (5.2)
16–24 hours	103 (19.1)
25–35.5 hours	298 (55.2)
> 35.5 hours	111 (20.6)

Cumulative percent for 540 participants, missing values not included (n=28)

We will now present the process of developing a short version *NHSOPSC* proposal for use within homecare services. It involves development of two candidate short version instruments and comparison to the full version. The version fulfilling most criteria is selected as the final short version. We also present the psychometric properties of the full and short versions. Finally, we use the instrument to assess patient safety culture within the context of Norwegian homecare services.

Factors of full and candidate short version instruments

Analysis of the full version *NHSOPSC* instrument resulted in seven factors explaining 50.3% of the variance (Λ range 0.32–0.88). The analysis did not confirm the former 10-factor solution used in nursing homes (24) and homecare services (16) (appendix B). Candidate short version 1 resulted in six factors explaining 54.7% of the variance (Λ range 0.42–0.94). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (5 items); 4) management support (4 items); 5) compliance with procedures (4 items); and 6) managing workload (2 items) (appendix C). Candidate short version 2 resulted in four factors explaining 59.2% of the variance (Λ range 0.43–0.96). Factors included: 1) Safety improvement actions (8 items); 2) teamwork (4 items); 3) information flow (3 items); and 4) management support (4 items) (appendix D).

Internal consistency

All versions had high internal consistency (Cronbach's alpha 0.93–0.95) (table 3). The omega coefficient was found to be identical to Cronbach's alpha for the full version and short version 1 instrument, and marginally higher for short version 2 (0.93 versus 0.94). Short versions were both

within the boundary of the first OTA criterion by maintaining over 95% of Cronbach's alpha compared to the full version (short version 1: 97.9%, 2: 98.4%) (34).

Table 3. Patient safety culture measured using full and candidate *NHSOPSC* short version instruments

	Full version		Short version 1		Short version 2	
	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]	Mean (SD)[a]	α[b]
Items (n)	41		27		19	
Factors (n)	7		6		4	
Complete	3.8 (0.5)	0.95	3.7 (0.5)	0.93	3.8 (0.6)	0.93
% of full version				97.9%		98.4%
Factor 1: Safety improvement actions	3.8 (0.6)	0.92	3.7 (0.6)	0.91	3.7 (0.6)	0.91
Factor 2: Teamwork	3.9 (0.6)	0.85	4.1 (0.6)	0.84	4.1 (0.6)	0.84
Factor 3: Information flow	3.7 (0.6)	0.84	3.7 (0.6)	0.80	3.7 (0.7)	0.79
Factor 4: Management support	3.9 (0.7)	0.87	4.0 (0.7)	0.87	4.0 (0.7)	0.87
Factor 5: Compliance with procedures	3.8 (0.6)	0.62	3.7 (0.6)	0.64		
Factor 6: Managing workload	3.3 (0.6)	0.47	2.8 (0.8)	0.61		
Factor 7: Reporting mistakes	3.7 (0.8)	0.67				

a. Mean scores and standard deviation for complete instrument and instrument factors
b. α: instrument's internal consistency measured using Cronbach's alpha

Concurrent validity

Comparison of summed scores for short and full version instruments were above the minimum threshold of 0.95 (table 4). Results therefore fulfilled the criterion of the second OTA rule (36). Correlation coefficients for factor scores comparing short version 1 with the full version instrument ranged from 0.75 to 0.99, with four out of seven below the threshold of 0.95 (table 4). For short version 2, two out of four factor correlations were below the minimum, although not as low as for short version 1.

Table 4. Comparison of summed and factor scores for full and candidate *NHSOPSC* short version instruments

Full version	Short version 1		Short version 2	
	r[a]	sig.	r[a]	sig.
Sum[b]	0.99	0.000	0.96	0.000
Factor 1: Safety improvement actions	0.99	0.000	0.99	0.000
Factor 2: Teamwork	0.92	0.000	0.92	0.000
Factor 3: Information flow	0.96	0.000	0.91	0.000
Factor 4: Management support	0.96	0.000	0.96	0.000
Factor 5: Compliance with procedures	0.75	0.000		
Factor 6: Managing workload	0.93	0.000		
Factor 7: Reporting mistakes				

a. Pearson correlation b. Sum: total score of the scale

Convergent validity

Correlation coefficients for summed scores and short version 1 outcomes were from 89% to 104% of the full version instrument (table 5). Similarly, results for short version 2 were from 89% to 102% of the full version. Hence, results were within the 95% threshold level for OTA criterion for two of the comparisons, and below for one comparison.

Table 5. Correlation between instruments' summed scores and outcomes

Outcomes	Full version	Short version 1		Short version 2	
	r[a]	r[a]	% of full version	r[a]	% of full version
Overall safety of service users	0.61	0.59	95	0.58	95
The homecare services are safe for service users	0.67	0.59	89	0.60	89
Service users are well cared for	0.63	0.65	104	0.64	102

a. Pearson correlation

Instruments to assess patient safety culture in homecare services

The two candidate short version instruments fulfilled some, but not all, of the OTA criteria. Both short versions fulfilled the first two criteria (internal consistency, concurrent validity). For the third criterion (second part of concurrent validity), some factors were within the minimum threshold for concurrent validity, others were not. Short version 2 was however close to the minimum threshold. For the fourth criterion (convergent validity), both short versions were within the minimum threshold for two out of three outcomes, and slightly below for one. Factor analyses suggested short version 2 explained more of the variance (59.2%) than short version 1 (54.7%), and both did better than the full version (50.3%).

In summary, it was not possible to draw firm conclusions to determine which of the three versions should be preferred. However, the results favour short version 2 as it scored well on most tests, explained more of the variance, and the individual items fit well with the four factors which include: A) safety improvement actions; B) teamwork; C) information flow; and D) management support.

Patient safety culture in Norwegian homecare services

Employees' overall perception of a positive patient safety culture was suggested by the mean score of 3.8 (SD 0.6) and 69% of items scored positively in the 19-item short version 2 *NHSOPSC* instrument (table 6). Positive results were found for all four factors: "teamwork" (4.1, SD 0.7, 78%), "management support" (4.0, SD 0.7, 78%), "safety improvement actions" (3.7, SD 0.6, 63%) and "information flow" (3.7, SD 0.7, 64%). A linear regression did not suggest significant influence of age, education/background, years in current practice, hours worked per week, or municipality (data not shown).

The three single item outcomes indicated perception of positive patient safety culture: overall perception of service users' safety (4.0, SD 0.7, 75%), service safety (4.1, SD 0.7, 84%), and overall care (4.2, SD 0.7, 86%). Scores positively correlated with short version 2 *NHSOPSC* sum scores ($p<0.001$).

Table 6. Patient safety culture in Norwegian homecare services (n=540)[a]

	Mean (SD)	Positive responses (n, %)[b]
Overall score	**3.8 (0.6)**	**(69.4)**
Factor 1: Safety improvement actions	**3.7 (0.6)**	**(62.8)**
Item 1: Management asks staff how the services can improve patient safety (U2)	3.7 (0.9)	341 (61.3)
Item 2: It is easy to make changes to improve service users' safety (U3)	3.6 (0.8)	321 (57.7)

Item 3: The service is always doing something to improve service users' safety (U4)	3.7 (0.7)	366 (65.8)
Item 4: A good job is done to keep service users safe (U5)	3.9 (0.7)	422 (75.9)
Item 5: Management listens to staff ideas and suggestions to improve safety (U6)	3.9 (0.8)	423 (76.1)
Item 6: Management regularly stays in touch with service users in order to assess the care (U8)	3.2 (1.0)	214 (38.5)
Item 7: Changes to improve service users' safety are evaluated (U9)	3.5 (0.8)	293 (52.7)
Item 8: Within this unit, we discuss ways to keep service users safe from harm (C8)	3.9 (0.8)	424 (74.6)
Factor 2: Teamwork	**4.1 (0.7)**	**(78.0)**
Item 1: Staff in our unit treat each other with respect (W1)	4.2 (0.8)	449 (79.0)
Item 2: Staff within our unit support each other (W2)	4.2 (0.8)	459 (80.8)
Item 3: Staff feel like they are part of a team (W5)	4.0 (0.8)	444 (78.1)
Item 4: When someone gets really busy, other staff help out (W9)	4.0 (0.8)	421 (74.1)
Factor 3: Information flow	**3.7 (0.7)**	**(63.8)**
Item 1: Staff are told what they need to know before taking care of a service user for the first time (C1)	3.8 (0.8)	377 (66.4)
Item 2: Staff are told right away when there is a change in a service user's care plan (C2)	3.4 (0.9)	268 (47.2)
Item 3: Staff are given all the information they need to care for service users (C10)	3.9 (0.7)	442 (77.8)
Factor 4: Management support	**4.0 (0.7)**	**(77.8)**
Item 1: My supervisor listens to staff ideas and suggestions concerning service users' safety (M1)	4.1 (0.8)	447 (79.3)
Item 2: My supervisor says a good word to staff who follow the right procedures (M2)	4.0 (0.9)	428 (75.9)
Item 3: My supervisor pays attention to service users' safety (M3)	4.3 (0.7)	497 (88.1)
Item 4: Staff ideas and suggestions are valued (C7)	3.8 (0.8)	387 (68.1)

a. Based on the proposed short version 19-item *NHSOPSC* scale. b. "Positive responses" were defined as responding "agree" or "entirely agree", or "often" or "always" to individual items. Valid percent, missing data for factor 1 (n=12) and factor 4 (n=4), no missing data for factors 2 and 3.

Discussion

Results of this study suggest the majority of healthcare personnel rated patient safety culture positively in Norwegian homecare. This includes positive ratings for information flow, teamwork, management support, and patient safety actions. Results indicate that the *NHSOPSC* instrument could potentially be reduced to half the number of items. Psychometric testing suggested the short version instrument was comparable to the full version. An arising question is how the instrument compares to previous studies (e.g. 24,25). Three dimensions – *teamwork*, *information flow,* and *management* – were comparable to previous studies. The *Safety improvement actions* dimension encompassed several items from dimensions included in the original full version (*incident feedback/communication*; *communication openness*; *supervisor expectations and safety actions*; and *management/organizational learning*). However, the short version did not include *staffing*; *compliance with procedures*; *training and skills*; and *non-punitive responses to mistakes*.

Out of the other patient safety culture instruments recommended for use in EU member States (18), the *Safety Attitudes Questionnaire (SAQ)* has been tested and validated, also within the

context of Norwegian homecare services (19). It includes six dimensions, out of which two share considerable resemblance to *NHSOPSC* dimensions focusing on perceptions of *teamwork* and *management support*. *SAQ safety climate* and *working conditions* dimensions share some resemblance to items from different *NHSOPSC* dimensions. For example, items addressing feedback performance and learning from others' mistakes under *SAQ's* safety climate dimension, would fit under two different *NHSOPSC* dimensions (*management support* and *safety improvement action*). Furthermore, *SAQ* dimensions of *job satisfaction* and *stress recognition* are not covered by the *NHSOPSC* instrument. We suggest it might be more appropriate to assess *job satisfaction* as a separate outcome measure that may influence patient safety culture.

A significant advantage of the *NHSOPSC* instrument, in particular the short version, over the *SAQ* instrument, is the reduced burden it poses on health personnel in everyday practice (19 versus 62 items).

Differences between our current findings and previous studies using the *NHSOPSC* or *SAQ* instruments raise the question of which dimensions are needed to assess patient safety culture. The commonly used patient safety culture definition (11), emphasizes shared perceptions of safety importance, and communication within the context of trusting relationships. This is captured by both the full and short version *NHSOPSC* instrument. However, the definition provides a very general and overarching description of patient safety culture. Moreover, there is disagreement as to how patient safety culture should be defined (10). Lack of clarity in definitions and discrepancies between dimensions in the full version *NHSOPSC* instrument and previous research (24-26), raises questions about the instrument's validity and reliability, at least in Norwegian homecare service settings. Lack of consistency warrants further studies to develop agreement on the definition of patient safety culture and instruments to assess clinical practice and research.

Among original *NHSOPSC* dimensions not included in the short version, we suggest items should cover *staffing* and *non-punitive responses to mistakes*. These dimensions seem to be of significant importance to patient safety culture. Firstly, in previous research these had the highest need for improvement (39). Secondly, *staffing* has been found to have strong predictive value on health personnel's perception of patient safety (39-41) and patient safety outcomes (42-44) in different settings and countries. Thirdly, we consider *non-punitive responses to mistakes* important due to considerable variation between countries and clinical settings in blame-culture (16), which may significantly influence patient safety culture (39,40,45). Healthcare personnel in Norwegian studies score higher on *non-punitive responses to mistakes* compared to international studies (16), which might be explained by the non-hierarchical structure in Norway (46). Exclusion of these dimensions may limit the instrument's ability to assess important aspects of patient safety culture. However, items covering these two dimensions in the original *NHSOPSC* are not valid, at least not within the context of Norwegian homecare services. We therefore suggest new items should be developed to cover these dimensions and be tested with the other dimensions in a revised short version. Healthcare personnel with different backgrounds (e.g. nurses, general practitioners, physiotherapists, occupational therapists) should be involved in the development process to ensure relevance and face validity. Finally, we also recommend the instrument title reflects the contextual setting of homecare services, and therefore propose renaming it the *Homecare Services Survey on Patient Safety Culture*.

Strengths and limitations of this study

This was the second and largest study assessing patient safety culture in homecare services in Norway. To our best knowledge, it was the largest study assessing patient safety culture in homecare worldwide. Overall response rate was not ideal, but not far off from our previous survey (24), and comparable to research involving nurses (47). Although participants were not randomly selected, variation in contextual settings (e.g. geographical, distance to hospitals, urban/rural areas) was used to increase generalizability of results, and should be representative for Norwegian homecare services. Another limitation was variability in response rates between municipalities. Caution should

be made when generalizing findings to other countries with different structures and organization of services, and to other healthcare settings.

This was the first study developing a proposal for a short version instrument to assess patient safety culture within homecare services. The factor analysis and OTA approach was a strength of this study. It provides assessment of internal consistency, concurrent and convergent validity. Others found that inclusion of factors with initial eigenvalue of min. 1 may over- or underestimate the number of components (48). However, Velicer's Minimum Average Partial (MAP) test also resulted in a four-factor model for the recommended short version instrument (data not shown).

In lack of a "gold standard" instrument to assess convergent validity, we used single-item outcomes previously used (16,24,25,49,50). The use of single items might not capture variability and the use of an additional instrument such as the *Safety Attitudes Questionnaire (SAQ)* (19) is recommended to assess convergent validity in future studies. In the current study, we did however find comparable results using all three single-item outcomes. The GPCM approach helped to determine whether items were discriminable. In future studies, variance-based structural equation modelling (SEM) could be used as an addition to the OTA approach, to assess discriminant validity (51).

Conclusion

The aging population worldwide, with increased risk of adverse events within the context of citizens' homes, requires strengthened focus on patient safety within homecare services. The results of this study showed that the majority of home healthcare personnel rated patient safety culture positively. Patient safety culture is central for assessing and improving patient safety. Valid and reliable instruments are needed. The *Nursing Home Survey on Patient Safety Culture (NHSOPSC)* is the most commonly used instrument, but its length carries significant burden on personnel who struggle to carry out daily tasks. This article proposes the first short version of the *NHSOPSC* instrument which could serve as a starting point for an improved short version *Homecare Services Survey on Patient Safety Culture* instrument for assessing patient safety culture within homecare services. Psychometric tests indicated that the short version instrument was comparable to the full version, and both had high internal consistency. Nevertheless, there is a need to further develop a validated short-version instrument to ensure relevance and validity. A short version instrument would be less time-consuming and reduce burden on personnel. It is more likely to be used in routine practice, and to give higher response rates in research projects. Results could potentially be transferred to other clinical contexts.

Ethical considerations

The Regional Committees for Research Ethics in Norway found that the research was not governed by the Health Research Act. Both projects were assessed by the Norwegian Centre for Research Data (NSD) and were in line with legislation (SAFE-LEAD ID 52324; DigiPAS ID 561903). All participants gave written informed consent, and projects followed the Helsinki declaration. All study information was provided at the beginning of the questionnaire.

Competing interests statement

We have no competing interests

Data sharing statement

Data can be accessed by reasonable request to the lead author.

Funding

Data collection carried out as part of the: 'Improving Quality and Safety in Primary Care—Implementing a Leadership Intervention in Nursing Homes and Homecare' (SAFE-LEAD) was supported by The Research Council of Norway (RCN) grant number 256681/H10 and the University of

Stavanger, Norway. Data collection carried out as part of the "*Digital Solutions for Increased Quality and Improved Patient Safety*" (DigiPAS) project was funded by The Norwegian Regional Research Funds (RFF)/Oslofjord Fund grant number 285538 (project owner: Skien municipality).

Acknowledgment

Firstly, we thank homecare services and all individual participants agreeing to participate in the study. Thank you also to the following members of the SAFE-LEAD team: Co-researchers from the *Centre for Development of Institutional and Homecare Services (USHT)*: Elisabeth Holen-Rabbersvik, Marta Strandos, Line Hurup Thomsen, Berit Ullebust for help with recruitment of units to the project.

Contributorship statement

MR, LG, KC, SW and ER contributed to project design, recruitment and data collection. ALL authors participated in planning of analyses. PV and ER performed statistical analyses. PV drafted the manuscript, and all authors contributed to and approved the final submitted manuscript.

References

1. Panagioti M, Khan K, Keers RN, Abuzour A, Phipps D, Kontopantelis E, Bower P, Campbell S, Haneef R, Avery AJ, Ashcroft DM. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. *BMJ.* 2019;366:l4185. doi: https://doi.org/10.1136/bmj.l4185
2. Auraaen A, Slawomirski L, Klazinga N. *The economics of patient safety in primary and ambulatory care: Flying blind.* OECD Health Working Paper No. 106. DELSA/HEA/WD/HWP(2018)3. Available at URL https://www.oecd-ilibrary.org/content/paper/baf425ad-en
3. Slawomirski L, Auraaen A, Klazinga N. *The economics of patient safety. Strengthening a value-based approach to reducing patient harm at national level.* OECD Health Working Paper No. 96. DELSA/HEA/WD/HWP(2017)6. Available at URL https://www.oecd-ilibrary.org/docserver/5a9858cd-en.pdf?expires=1587099735&id=id&accname=guest&checksum=F933FA2A81C7352C5151517F558B8DA5
4. Sunshine JE, Meo N, Kassebaum NJ, Collison ML, Mokdad AH, Naghavi M. Association of Adverse Effects of Medical Treatment With Mortality in the United States: A Secondary Analysis of the Global Burden of Diseases, Injuries, and Risk Factors Study. *JAMA Netw Open*. 2019 Jan 4;2(1):e187041. doi: 10.1001/jamanetworkopen.2018.7041.
5. Rogne T, Nordseth T, Marhaug G, Berg EM, Tromsdal A, Sæther O, Gisvold S, Hatlen P, Hogan H, Solligård E. Rate of avoidable deaths in a Norwegian hospital trust as judged by retrospective chart review. *BMJ Qual Saf*. 2019 Jan;28(1):49-55. doi: 10.1136/bmjqs-2018-008053.
6. United Nations, Department of Economic and Social Affairs, Population Division (2019). *World Population Ageing 2019: Highlights* (ST/ESA/SER.A/430).
7. Centers for Disease Control and Prevention. *Healthy Places Terminology*, 2009. Available at URL https://www.cdc.gov/healthyplaces/terminology.htm
8. Thiem U, Hinrichs T, Muller CA, Holt-Noreiks S, Nagl A, Bucchi C, et al. Prerequisites for a new health care model for elderly people with multiple morbidities: Results and conclusions from 3 years of research in the PRISCUS consortium. *Z Gerontol Geriatr.* 2011;44(Suppl 2):101–112. https://doi.org/10.1007/s00391-011-0246-6
9. National Patient Safety Foundation. *Free from harm. Accelerating patient safety improvement fifteen years after to err is human.* Boston: National Patient Safety Foundation; 2015.
10. Halligan M, Zecevic A. Safety culture in healthcare: a review of concepts, dimensions, measures and progress. *BMJ Qual Saf*. 2011;20:338-343. http://dx.doi.org/10.1136/bmjqs.2010.040964
11. Health and Safety Commission. *Third Report: Organizing for Safety*. ACSNI Study Group on Human Factors. London: HMSO, 1993:23.

12. Braithwaite J, Herkes J, Ludlow K, Testa L, Lamprell G. Association between organisational and workplace cultures, and patient outcomes: systematic review. *BMJ Open.* 2017;7:e017708. doi:10.1136/bmjopen-2017-017708
13. Gartshore E, Waring J, Timmons S. Patient safety culture in care homes for older people: a scoping review. *BMC Health Serv Res.* 2017;17(1):752. doi: 10.1186/s12913-017-2713-2
14. Olsen RM, Bjerkan J. Patient safety culture in Norwegian home health nursing: a cross-sectional study of healthcare provider's perceptions of the teamwork and safety climates. *Saf Health.* 2017;3(1):15. doi: 10.1186/s40886-017-0066-5
15. Ree E, Wiig S. Linking transformational leadership, patient safety culture and work engagement in home care services. *Nurs Open.* 2019 Oct 8;7(1):256-264. doi: 10.1002/nop2.386. eCollection 2020 Jan.
16. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res*. 2019;19:607. doi: 10.1186/s12913-019-4456-8
17. World Health Organization (WHO). *Towards eliminating avoidable harm in health care. Global patient safety action plan 2021-2030*. Second Draft, November 2020.
18. European Union Network for Patient Safety (EUNetPaS). *Patient safety culture instruments used in member states.* European Society for Quality in Healthcare – Office for Quality Indicators. Aarhus, Denmark, March 2010. ISBN 978-87-993779-1-6.
19. Bondevik GT, Hofoss D, Husebø BS, Tveter Deilkås EC. Patient safety culture in Norwegian nursing homes. *BMC Health Serv Res*. 2017;17:424. doi: 10.1186/s12913-017-2387-9
20. Sorra JS, Nieva VF. *Hospital Survey on Patient Safety Culture.* Rockville, MD: Agency for Healthcare Research and Quality, 2004. [Accessed 02.03.2020]. Available at URL https://proqualis.net/sites/proqualis.net/files/User%20guide%20HSOPSC.pdf
21. Reis CT, Paiva SG, Sousa P. The patient safety culture: a systematic review by characteristics of Hospital Survey on Patient Safety Culture dimensions. *Int J Qual Health Care.* 2018 Nov 1;30(9):660-677. doi: 10.1093/intqhc/mzy080.
22. Lawati MHA, Dennis S, Short SD, Abdulhadi NN. Patient safety and safety culture in primary health care: a systematic review. *BMC Fam Pract.* 2018;19:104. https://doi.org/10.1186/s12875-018-0793-7
23. Sorra J, Franklin M, Streagle S. *Nursing Home Survey on Patient Safety Culture.* (Prepared by Westat, under Contract No. 233-02-0087). AHRQ Publication No. 08-0060. Rockville: Agency for Healthcare Research and Quality; 2008.
24. Cappelen K, Aase K, Storm M, Hetland J, Harris A. Psychometric properties of the Nursing Home Survey on Patient Safety Culture in Norwegian nursing homes. *BMC Health Serv Res.* 2016 Aug 27;16:446. doi: 10.1186/s12913-016-1706-x.
25. Cappelen K, Harris A, Aase K. Variability in staff perceptions of patient safety culture in Norwegian nursing homes—a longitudinal cross-sectional study. *Saf Health.* 2018;4(9).https://doi.org/10.1186/s40886-018-0076-y
26. Ree E, Wiig S. Employees' perceptions of patient safety culture in Norwegian nursing homes and home care services. *BMC Health Serv Res.* 2019 Aug 29;19(1):607. doi: 10.1186/s12913-019-4456-8.
27. Liu M, Wronski L. Examining completion rates in web surveys via over 25,000 real-world surveys. *Soc Sci Comput Rev.* 2018;36(1):116-124. doi: 10.1177/0894439317695581
28. Rolstad S, Adler J, Rydén A. Response burden and questionnaire length: Is shorter better? A review and meta-analysis. *Value in Health* 2011;14(8):1101-1108. https://doi.org/10.1016/j.jval.2011.06.003
29. Lindahl AK. The Norwegian Health Care System, 2015. In: Mossialos E, Wenzl M, Osborn R, Sarnak D. (Eds.) *2015 International profiles of health care systems.* The Commonwealth Fund: New York: January 2016.
30. Holm SG, Mathisen TA, Sæterstrand TM, Brinchmann BS. Allocation of home care services by municipalities in Norway: a document analysis. *BMC Health Serv Res.* 2017;17:673. doi: 10.1186/s12913-017-2623-3

31. Ringard Å, Sagan A, Sperre Saunes I, Lindahl AK. Norway: health system review. *Health Syst Transit.* 2013;15(8):1–162.
32. Wiig S, Ree E, Johannessen T, Strømme T, Storm M, Aase I, Ullebust B, Holen-Rabbersvik E, Hurup Thomsen L, Sandvik Pedersen AT, van de Bovenkamp H, Bal R, Aase K. Improving quality and safety in nursing homes and home care: the study protocol of a mixed-methods research design to implement a leadership intervention. *BMJ Open*. 2018;8:e020933. doi: 10.1136/bmjopen-2017-020933.
33. Haugen AS, Storm M. *Sikkerhetskultur i sykehus [Patient safety culture in hospitals]* [Norwegian]. In: Aase K, editor. Pasientsikkerhet - Teori og praksis. Oslo: Universitetsforlaget; 2015:77–86.
34. Stevens JP. *Applied multivariate statistics for the social sciences.* Fifth edition. Routledge, 1992.
35. Tabachnick BG, Fidell LS. *Using multivariate statistics* (5th ed.) Upper Saddle River, NR: Pearson Allyn & Bacon, 2007.
36. Harel D, Baron M, on behalf of the CSRG Investigators. Methods for shortening patient-reported outcome measures. *Stat Methods Med Res*. 2019 Oct-Nov;28(10-11):2992-3011. doi: 10.1177/0962280218795187
37. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Adv in Health Sci Educ.* 2010;15:625-632. doi: 10.1007/s10459-010-9222-y
38. Dunn TJ, Bagueley T, Brunsden V. From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. *Br J Psychol.* 2015;105:399-412. DOI:10.1111/bjop.12046
39. Gurková E, Zeleníková R, Friganovic A, Uchmanowicz I, Jarošová D, Papastavrou E, Žiaková K. Hospital safety climate from nurses' perspective in four European countries. *Int Nurs Rev.* 2020;67(2):208-217.
40. Alenius LS, Tishelman C, Runesdotter S, Lindqvist. Staffing and resource adequacy strongly related to RNs' assessment of patient safety: a national study of RNs working in acute-care hospitals in Sweden. *BMJ Qual Saf.* 2014;23(3):242-249.
41. Cho E, Lee, NJ b, Kim EY, Kim S, Lee K, Park, KO, et al. Nurse staffing level and overtime associated with patient safety, quality of care, and care left undone in hospitals: a cross-sectional study. *Int J Nurs Stud.* 2016;60:263-271.
42. Aiken LH, Sloane DM, Bruyneel L, Van den Heede K, Griffiths P, Busse R, et al. Nurse staffing and education and hospital mortality in nine European countries. A retrospective observational study. *Lancet.* 2014;383:1824–30.
43. Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Med Care. 2007*;45(12):1195-1204.
44. McHugh M, Rochman M, Sloane D, Berg R, Mancini M, Nadkarni V, et al. Better nurse staffing and nurse work environments associated with increased survival of in-hospital cardiac arrest patients. *Med Care.* 2016. doi:10.1097/MLR.0000000000000456.
45. Aase K, Shibevaag L (Eds.). *Researching patient safety and quality in healthcare.* A Nordic perspective. Boca Raton: Taylor & Francis Group; 2017.
46. Cook JV, Dickinson HO, Eccles MP. Response rates in postal surveys of healthcare professionals between 1996 and 2005: An observational study. *BMC Health Serv Res.* 2009;9(160). doi:10.1186/1472-6963-9-160
47. Albalawi A, Kidd L, Cowey E. Factors contributing to the patient safety culture in Saudi Arabia: a systematic review. *BMJ Open*. 2020;10:e0378875. doi:10.1136/bmjopen-2020-037875
48. Zwick WR, Velicer WF. Comparison of five rules for determining the number of components to retain. *Psychol Bull.* 1986;99(3):432-442.
49. Cappelen K, Harris A, Storm M, Aase K. Healthcare staff perceptions on patient safety culture in nursing home settings – A cross sectional study. *Open J Nurs.* 2017;7:1069-1085. https://doi.org/10.4236/ojn.2017.79078

50. Seljemo C, Viksveen P, Ree E. The role of transformational leadership, job demands and job resources for patient safety culture in Norwegian nursing homes: a cross sectional study. *BMC Health Serv Res* 2020;20:799. https://doi.org/10.1186/s12913-020-05671-y
51. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J of the Acad Mark Sci.* 2015;43:115-135. doi: 10.1007/s11747-014-0403-8

Appendix A. Survey questionnaire

1. Age
20 – 29 years
30 – 39 years
40 – 49 years
50 – 59 years
60+ years

2. What is your position/educational background?
Leader position with responsibility for personnel
Healthcare professional with min. three-year education from university or other higher education
Healthcare professional with education from high school or similar
Care assistant (untrained)
Administrative personnel (mercantile/financial/personnel)
Other

3. How long have you been working in this homecare service?
Less than 1 year
1 - 5 years
6 - 10 years
11 - 15 years
16 - 20 years
21 years or more

4. How many hours per week do you normally work?
Less than 15 hours/week
16 - 24 hours/week
25 - 35,5 hours/week
More than 35,5 hours/week

5. When do you most often work?
Daytime only
Two-split shift work
Three-split shift work
Regular evening shift
Regular nightshift
Other

6. Do you work directly with service users most of the time?
Yes
No

<u>About working within your unit</u>
To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree
7. We treat each other with respect within our unit
8. We support each other within our unit
9. We have enough staff to handle the workload
10. Staff follow standard procedures to care for service users
11. Staff feel they are part of a team
12. Staff use shortcuts to get their work done faster

13. Staff get the training they need in our unit
14. Staff have to hurry because they have too much work to do
15. When someone gets really busy in our unit, other staff help out
16. Staff are blamed when a service user is harmed
17. Staff receive enough training to know how to handle difficult service users
18. Staff are afraid to report their mistakes
19. Staff understand the training they get
20. To make work easier, staff often ignore procedures
21. Staff are treated fairly when they make mistakes
22. Service users' needs are met during shift changes
23. It is hard to keep service users safe because so many quit their jobs
24. Staff feel safe reporting their mistakes

Communication

How often does the following happen within your unit? Never, Rarely, Sometimes, Often, Always

25. Staff are told what they need to know before taking care of a service user for the first time
26. Staff are informed soon when there is a change in a service user's care plan
27. We have all the information we need when service users are transferred from the hospital
28. When staff report something that could harm a service user, this is followed up
29. We discuss within our unit how we can prevent unwanted episodes to reoccur
30. Staff report if they see something that might harm a service user (physically or mentally)
31. Staff ideas and suggestions are valued
32. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
33. Staff opinions are ignored
34. Staff are provided all the information they need to take care of service users
35. It is easy for staff to speak up about problems

Your line manager

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

36. My line manager listens to staff ideas and suggestions about service users' safety
37. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
38. My line manager pays attention to service users' safety

Your unit

To what extent do you agree or disagree to the following statements?
Entirely disagree, Disagree, Neither agree nor disagree, Agree, Entirely agree

39. Service users are well cared for
40. Management asks staff how the service can improve safety
41. It is easy to implement changes to improve service users' safety
42. Something is always done to improve service users' safety
43. A good job is done in order to maintain service users' safety
44. Management listens to employees' ideas and proposals for how safety can be improved
45. The homecare services are safe for users
46. Management is in regular contact with service users to assess the care
47. Changes with a view to improve service users' safety are assessed

Overall assessment

48. Overall, how do you assess service users' safety in these homecare services?
Very poor
Poor
Satisfactory
Good
Very good

Appendix B. Full version *NHSOPSC* instrument (7 factors, 41 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.92/0.92	**Factor 1: Safety improvement actions**
1	Unit 1	0.46		U1. Service users are well cared for
2	Unit 2	0.69		U2. Management asks staff how the service can improve safety
3	Unit 3	0.63		U3. It is easy to implement changes to improve service users' safety
4	Unit 4	0.82		U4. Something is always done to improve service users' safety
5	Unit 5	0.82		U5. A good job is done in order to maintain service users' safety
6	Unit 6	0.62		U6. Management listens to employees' ideas and proposals for how safety can be improved
7	Unit 7	0.43		U7. The homecare services are safe for users
8	Unit 8	0.54		U8. Management is in regular contact with service users to assess the care
9	Unit 9	0.69		U9. Changes with a view to improve service users' safety are assessed
10	Communication 8	0.46		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.85/0.85	**Factor 2: Teamwork**
1	Work 1	0.83		W1. We treat each other with respect within our unit
2	Work 2	0.88		W2. We support each other within our unit
3	Work 4	0.40		W4. Staff follow standard procedures to care for service users
4	Work 5	0.66		W5. Staff feel they are part of a team
5	Work 7	0.35		W7. Staff get the training they need in our unit
6	Work 9	0.56		W9. When someone gets really busy in our unit, other staff help out
7	Work 13	0.34		W13. Staff understand the training they get
8	Work 15	0.32		W15. Staff are treated fairly when they make mistakes
C n	**Factor 3**		0.84/0.84	**Factor 3: Information flow**
1	Communication 1	0.72		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.69		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.56		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.51		C4. When staff report something that could harm a service user, this is followed up
5	Communication 5	0.38		C5. We discuss within our unit how we can prevent unwanted episodes to reoccur
6	Communication 10	0.62		C10. Staff are provided all the information they need to take care of service users
7	Work 11	0.39		W11. Staff receive enough training to know how to handle difficult service users
C n	**Factor 4**		0.87/0.87	**Factor 4: Management support**
1	Management 1	0.56		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.60		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.52		M3. My line manager pays attention to service users' safety
4	Communication 7	0.45		C7. Staff ideas and suggestions are valued
5	Communication 9r	0.42		C9r. Staff opinions are ignored
6	Communication 11	0.39		C11. It is easy for staff to speak up about problems
C n	**Factor 5**		0.62/0.56	**Factor 5: Compliance with procedures**
1	Work 6r	0.51		W6r. Staff use shortcuts to get their work done faster
2	Work 10r	0.40		W10r. Staff are blamed when a service user is harmed
3	Work 14r	0.47		W14r. To make work easier, staff often ignore procedures
4	Work 17r	0.43		W17r. It is hard to keep service users safe because so many quit their jobs
C n	**Factor 6**		0.47/0.65	**Factor 6: Managing workload**
1	Communication 6	0.37		C6. Staff report if they see something that might harm a service user (physically or mentally)
2	Work 3	0.46		W3. We have enough staff to handle the workload
3	Work 8r	0.42		W8r. Staff have to hurry because they have too much work to do
C n	**Factor 7**		0.67	**Factor 7: Reporting mistakes**
1	Work 12r	0.55		W12r. Staff are afraid to report their mistakes
2	Work 18	0.49		W18. Staff feel safe reporting their mistakes
	Overall (41 items)		0.95/0.95	

One item (W16) did not load with any factor. Items numbers marked with "r" were reversed in analyses.

Appendix C. Candidate short version 1 (6 factors, 27 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.91/0.91	**Factor 1: Safety improvement actions**
1	Unit 2	0.64		U2. Management asks staff how the service can improve safety
2	Unit 3	0.66		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.86		U4. Something is always done to improve service users' safety
4	Unit 5	0.77		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.54		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.47		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.68		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.49		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.84/0.84	**Factor 2: Teamwork**
1	Work 1	0.85		W1. We treat each other with respect within our unit
2	Work 2	0.94		W2. We support each other within our unit
3	Work 5	0.63		W5. Staff feel they are part of a team
4	Work 9	0.52		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.80/0.81	**Factor 3: Information flow**
1	Communication 1	0.73		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.71		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 3	0.55		C3. We have all the information we need when service users are transferred from the hospital
4	Communication 4	0.45		C4. When staff report something that could harm a service user, this is followed up
5	Communication 10	0.60		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.87/0.88	**Factor 4: Management support**
1	Management 1	0.74		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.73		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.63		M3. My line manager pays attention to service users' safety
4	Communication 7	0.42		C7. Staff ideas and suggestions are valued
C n	**Factor 5**		0.64/0.64	**Factor 5: Compliance with procedures**
1	Work 6r	0.45		W6r. Staff use shortcuts to get their work done faster
2	Work 12r	0.71		W12r. Staff are afraid to report their mistakes
3	Work 14r	0.47		W14r. To make work easier, staff often ignore procedures
4	Work 18	0.43		W18. Staff feel safe reporting their mistakes
C n	**Factor 6**		0.61	**Factor 6: Managing workload**
1	Work 3	0.61		W3. We have enough staff to handle the workload
2	Work 8r	0.60		W8r. Staff have to hurry because they have too much work to do
	Overall (27 items)		0.93/0.93	

Analysis carried out using a three-stage factor analysis (principal axis factoring). NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7. Not included in any factors (no score): W15, W16. Factor loading < 0.4: W4 (0.34), W7 (0.37), W10r (0.33), W11 (0.37), W13 (0.35), W17r (0.33), C5 (0.33), C6 (0.38), C9r (-0.38), C11 (-0.35).

Items numbers marked with "r" were reversed in analyses.

Appendix D. Candidate short version 2 (4 factors, 19 items)

	Items	Factor loadings (Λ)	Cronbach's alpha/Omega coefficient	Question
C n	**Factor 1**		0.91/0.91	**Factor 1: Safety improvement actions**
1	Unit 2	0.64		U2. Management asks staff how the service can improve safety
2	Unit 3	0.67		U3. It is easy to implement changes to improve service users' safety
3	Unit 4	0.88		U4. Something is always done to improve service users' safety
4	Unit 5	0.79		U5. A good job is done in order to maintain service users' safety
5	Unit 6	0.54		U6. Management listens to employees' ideas and proposals for how safety can be improved
6	Unit 8	0.48		U8. Management is in regular contact with service users to assess the care
7	Unit 9	0.69		U9. Changes with a view to improve service users' safety are assessed
8	Communication 8	0.50		C8. We discuss within our unit various ways we can keep service users from harm (physically or mentally)
C n	**Factor 2**		0.84/0.84	**Factor 2: Teamwork**
1	Work 1	0.86		W1. We treat each other with respect within our unit
2	Work 2	0.96		W2. We support each other within our unit
3	Work 5	0.62		W5. Staff feel they are part of a team
4	Work 9	0.52		W9. When someone gets really busy in our unit, other staff help out
C n	**Factor 3**		0.79/0.79	**Factor 3: Information flow**
1	Communication 1	0.77		C1. Staff are told what they need to know before taking care of a service user for the first time
2	Communication 2	0.72		C2. Staff are informed soon when there is a change in a service user's care plan
3	Communication 10	0.66		C10. Staff are provided all the information they need to take care of service users
C n	**Factor 4**		0.87/0.88	**Factor 4: Management support**
1	Management 1	0.76		M1. My line manager listens to staff ideas and suggestions about service users' safety
2	Management 2	0.75		M2. Min line manager expresses him/herself positively when seeing that the work is carried out in correspondence with our procedures
3	Management 3	0.61		M3. My line manager pays attention to service users' safety
4	Communication 7	0.43		C7. Staff ideas and suggestions are valued
	Overall (19 items)		0.93/0.94	

Analysis carried out using a generalized partial credit model (GPCM) approach, followed by a two-stage factor analysis process (principal axis factoring). NHSOPSC instrument items removed (with reasons): Outcomes and not item variables: U1, U7.

GPCM assessment of boundary and category characteristic curves, and low discrimination parameters (coefficients < 1): W3 (0.61), W6 (0.31), W8 (0.26), W10 (0.41), W11 (0.97), W12 (0.50), W14 (0.65), W17 (0.38), C3 (0.71), C9 (0.81), C11 (0.92). Not included in any factors (no score): C4, C6. Factor loading < 0.4: W4 (0.38), W7 (0.37), W13 (0.34), W15 (0.31), W16 (0.31), W18 (0.33), C5 (0.30).

Appendix E. Correlation between factors in the factor analysis

Factor Correlation Matrix

Factor	1	2	3	4	5	6	7
1	1,000	,471	,295	,647	-,060	-,435	-,164
2	,471	1,000	,339	,446	,041	-,341	-,250
3	,295	,339	1,000	,337	-,137	-,244	-,304
4	,647	,446	,337	1,000	-,144	-,344	-,196
5	-,060	,041	-,137	-,144	1,000	,064	-,012
6	-,435	-,341	-,244	-,344	,064	1,000	,169
7	-,164	-,250	-,304	-,196	-,012	,169	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4	5	6
1	1,000	,454	,272	,619	-,591	,198
2	,454	1,000	,306	,394	-,424	,035
3	,272	,306	1,000	,304	-,265	,225
4	,619	,394	,304	1,000	-,450	,316
5	-,591	-,424	-,265	-,450	1,000	-,252
6	,198	,035	,225	,316	-,252	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

Factor Correlation Matrix

Factor	1	2	3	4
1	1,000	,465	-,604	,642
2	,465	1,000	-,430	,438
3	-,604	-,430	1,000	-,496
4	,642	,438	-,496	1,000

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4-5
Study size	10	Explain how the study size was arrived at	3-4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4-6
		(*b*) Describe any methods used to examine subgroups and interactions	4-5
		(*c*) Explain how missing data were addressed	4,7,10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
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	3-4,6
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	4,7,10
Outcome data	15*	Report numbers of outcome events or summary measures	7-10
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	6-10

		(*b*) Report category boundaries when continuous variables were categorized	6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	4-5
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	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
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	11

*Give information separately for exposed and unexposed groups.

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.