BMJ Open

Psychometric properties of Jenkins Sleep Scale: Internal consistency and factor structure in a working population of 80,000 adults

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-043276
Article Type:	Original research
Date Submitted by the Author:	11-Aug-2020
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Keywords:	SLEEP MEDICINE, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE

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Psychometric properties of Jenkins Sleep Scale: Internal consistency and factor structure in a working population of 80,000 adults

Running head: Psychometric properties of Jenkins Sleep Scale

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Keywords: sleep disorder, psychometrics, validity

ABSTRACT

Objective

To assess the internal consistency and construct validity of the Finnish translation of the Jenkins Sleep Scale (JSS) in a large, healthy working-age population with diverse work characteristics.

Methods

Survey-based study amongst employees of 10 towns and 6 hospital districts in Finland (the Finnish Public Sector study). The internal consistency was defined by a Cronbach's alpha. Exploratory and confirmatory factor analyses were used to evaluate the construct structure of the JSS.

Results

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their average age was 52.1 (13.2) years. Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points. The JSS demonstrated high internal consistency with an alpha of 0.80 (95% CI 0.xx-0.xx). Exploratory factor analysis supported a one-factor solution with eigenvalue of 1.94. Confirmatory factor analysis showed that all four items were positively correlated with a single common factor explaining 44% to 61% of common factor's variance.

Conclusions

The Finnish translation of Jenkins Sleep Scale was found to be a unidimensional scale with good internal consistency. As such, the scale may be recommended as a practicable questionnaire when studying sleep disorders in a healthy working-age population.

Strengths and limitations of this study

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS.

The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers.

Inequality in gender distribution may overestimate the prevalence of sleep disorders in the studied cohort.

The JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep disorders in a healthy working-age population.

INTRODUCTION

Several different questionnaires have been developed to assess the severity of sleep problems [1]. The Jenkins Sleep Scale (JSS), developed as a brief and standardized test for sleep disturbances in 1998, has been one of the most commonly used questionnaires in epidemiological studies [1-4]. The JSS has been translated in several languages [5-10] and found to be valid and reliable amongst patients with different health problems including rheumatoid arthritis [10], psoriatic arthritis [9], ankylosing spondylitis [7], fibromyalgia[5, 11], chest pain [12], and post cardiac surgery patients [2]. However, only a few studies have evaluated the psychometric properties of the JSS in large non-clinical populations [2, 3, 8, 13, 14].

Previous studies have found the JSS to be internally consistent amongst patients with fibromyalgia [5, 11], rheumatoid arthritis [10], ankylosing spondylitis [7] and psoriatic arthritis[9] as indicated by Cronbach's alphas between 0.7 and 0.9. Several studies has assessed the internal consistency of the JSS in general and/or healthy populations similarly reporting good to excellent Cronbach's alpha that vary between 0.8 and 0.9 [2, 3, 6, 8, 13, 14] Only three previous studies have assessed the factor structure of the JSS finding the JSS to be a unidimensional scale [3, 6, 8] The construct structure of the JSS analysis has been assessed by a single study using a confirmatory factor that produced strong correlations with common factor for all four items [3].

Overall, there is uncertainty concerning the psychometric behavior of the JSS especially regarding its factor structure in healthy and/or general populations. The psychometric properties of Finnish translation of the JSS have not been studied yet. To address this limitation, the aim of this study was to assess the internal consistency and construct validity of the Finnish translation of the JSS in a large healthy working-age population.

METHODS

Participants were from the Finnish Public Sector (FPS) study cohort of employees of 10 towns and 6 hospital districts[15]. Data were sourced from the survey in 2016 – 2017 administered to the FPS sub-cohorts (average response rate 70%). Individual-level survey data cannot be made publicly available, but information on the data and analyses are available upon request to the corresponding author. The ethics committee of the Hospital District of Helsinki and Uusimaa has approved the study.

Age was defined in full years at the time of survey response. Body mass index (BMI) was defined as weight in kg/height in m^2. The level of physical activity was calculated from the survey responses and converted into metabolic equivalent of task (MET). Alcohol consumption was obtained from the survey and converted into g/week. The respondents were asked about their usual amount of sleep hours per 24 hours with the following nine response alternatives: ≤6 hours, 6.5 hours, 7 hours, 7.5 hours, 8 hours, 8.5 hours, 9 hours, 9.5 hours, and ≥10 hours.

Jenkins Sleep Scale (JSS) is a four-item questionnaire to follow common sleep problems[2]. The frequency of sleep problems in the last month is evaluated using four items: the difficulty to fall asleep, wake up at night, difficulty to stay asleep, and nonrestorative sleep (i.e. waking up after the usual amount of sleep feeling tired and worn out). Each item is rated on a Likert-like scale from zero to five, where zero is "never", 1 is "1- 3 days", 2 is "about 1 night/week", 3 is "2-4 nights/week", 4 is "5-6 nights/week" and 5 is "almost every night". The total score is a simple sum of all four items' scores and ranges from zero (no sleep problems) to 20 (most sleep problems). The score of 11 is a cut-off – a score <12 is defined as little of sleep disturbances and a score >11 is understood as high frequency of sleep disturbances[16].

Patient and public involvement

Participants of research were not involved in setting the study question and outcome measures and were not involved in the design and implementation of the study or writing the manuscript.

Statistical analysis

Internal consistency and exploratory factor analysis

The internal consistency was defined by a Cronbach's alpha reported along with its one-sided (lower) 95% confidence limit (95% CL). The $\alpha \geq 0.9$ was considered excellent, ≥0.8 good, ≥0.7 acceptable, ≥0.6 questionable, ≥0.5 poor, and <0.5 was considered unacceptable. Exploratory factor analysis (EFA) was used to approximate the construct structure of the JSS. The goal was to determine whether the JSS

measures only one latent trait (= sleep disturbances) or if there are other possible significant latent variables affecting the results. The results were analyzed both numerically and graphically. Exploratory factor analysis (principal factors) was applied with a minimum eigenvalue for retention set at >1.0 (Kaiser's rule). The varimax rotation was applied. Retained and excluded factors were also explored visually on a scree plot along with the parallel analysis.

Confirmatory factor analysis

The estimation procedure used the maximum likelihood method considering covariances supplied as input being unbiased. For simplicity, the estimates were reported in standardized form as correlation coefficients. A correlation <0.2 was considered poor, from 0.21 to 0.4 fair, from 0.41 to 0.6 moderate, from 0.61 to 0.8 substantial, and >0.8 perfect. In addition, the coefficients of determination were calculated to show the proportion of variance in common "sleep disturbances" construct that can be explained by the items. Finally, the coefficient of determination for the entire model was calculated.

In order to assess how well the model matches the observed data, the root mean square error of approximation (RMSEA) was used as a primary index. First, the model fit was tested assuming there were no covariances between unique factors. After that, the modification indices suggested by the software were used to add covariance between factors (double-headed arrows in Figure 2) one at a time, each time testing the RMSEA closeness to the value of < 0.05, or, at least, <0.08 – the threshold for accepting the model fit. Every insertion was considered plausible if it made logical sense and did not violate the assumption that the common and the unique factors are uncorrelated. After achieving the RMSEA value of <0.05, no further covariances were imputed. The goodness of fit was assessed using a chi-square test. Also, the Akaike's and Bayesian information criteria (AIC and BIC), comparative fit index (CFI) and the Tucker-Lewis index (TLI) were calculated. The AIC and BIC were considered good if they were close to 1.0.

The analyses were performed using Stata/IC Statistical Software: Release 16. College Station (StataCorp LP, TX, USA).

RESULTS

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their mean age was 52.1 (standard deviation [SD] = 13.2) years, body mass index 26.2 (SD = 4.7) kg/m^2, physical activity 29.4 (SD = 25.3) METs/week, and alcohol consumption 49.7 (SD = 90.9) g/week (equivalent to 5 units of alcohol per week). Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points.

The JSS demonstrated a substantial internal consistency with alpha 0.80 (lower 95% CL 0.80). The exploratory factor analysis resulted in one retaining factor with eigenvalue of 1.94 based on Kaiser criterion (Table 1 and Figure 1). Three other factors had eigenvalues between -0.03 and -0.18 and thus explained variance less the observed variables.

The confirmatory factor analysis showed that all four items positively correlated with a common factor explaining from 44% up to 61% of the variance of the common factor (Table 2 and Figure 2). The highest correlation 0.78 (r^2=0.61) was observed for the third item “waking up and trouble falling asleep again”. Other items demonstrated similar and slightly lower correlations between 0.66 and 0.67 (r^2=0.44 to 0.45). The model obtained a good fit after adding one covariance between second and third items: 0.26 (95% confidence interval 0.25 to 0.28). After that, the RMSEA of the model was 0.03 (Table 3).

DISCUSSION

In this large cohort study, the JSS was found to be an internally consistent scale. Exploratory factor analysis suggested the unidimensionality of the JSS. In addition, confirmatory factor analysis demonstrated a single-factor structure with only one mild aberration; the JSS item "waking up and trouble falling asleep again" seemed to show higher coefficient of determination than any of the other items.

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS. The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers. However, the generalizability of the results might be compromised by the following aspects. The studied cohort was predominated by women. It has previously been stated that sleep problems are more common among women meaning that this inequality in gender distribution may overestimate the prevalence of sleep disorders in the studied cohort [3]. While overall working age could be understood as an age between early adulthood and the age of retirement, the mean age of the respondents was 52 years, covering mainly the last third of the working life span.

The results are in line with several previous studies that have found the JSS to be a unidimensional scale with excellent internal consistency [3, 6, 8]. The Cronbach's alpha of 0.8 seen in the present study was close to the estimates reported by previous research in both general population and populations of people with different health conditions [2, 3, 5-11, 13, 14]. While the JSS has been studied by employing alpha and exploratory factor analysis by several studies, a confirmatory factor analysis has previously been used by only a single study (Tibubos et al. 2020). The correlations of four items with a common factor seen in study by Tibubos et al. resembled the estimates observed in the present study with one exception. The present results demonstrated the greatest correlation for the item "waking up and trouble falling asleep again", being in line with Tibubos et al., but, contrary to our result, item "waking up feeling tired" had the smallest (out of four) estimate in their study. This difference might be explained by differences in the studied cohorts e.g. in gender distribution and work status. Indeed, the present study represents a population that is probably healthier than general population. In addition, it is possible, though unlikely, that some differences might have occurred due to the linguistic variability between the two translations.

Further research may reveal more details on the JSS psychometrics, for example, its properties based on an item response theory analysis. Especially confirmatory factor analysis may be recommended for future research, as the knowledge on the JSS factor structure is still scarce.

Conclusions

The JSS was found to be a unidimensional scale with good internal consistency. As such, the JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep disorders in a healthy working-age population.

TABLES AND FIGURES

Table 1. Exploratory factor analysis of loadings of the Jenkins Sleep Scale items

Jenkin's Sleep Scale Items	Factor #1	Uniqueness
Trouble falling asleep	0.62	0.61
Waking up but no trouble falling asleep again	0.72	0.48
Waking up and trouble falling asleep again	0.79	0.37
Waking up feeling tired	0.63	0.60

Table 2. Confirmatory factor analysis of Jenkins Sleep Scale – correlation between observed and predicted estimates (r) along with coefficient of determination (r^2)

Estimates	Variance			r	95% CI		r^2
	Fitted	Predicted	Residual		Lower	Upper	
Trouble falling asleep	1.63	0.71	0.92	0.66	0.66	0.67	0.44
Waking up but no trouble falling asleep again	2.83	1.29	1.55	0.67	0.67	0.68	0.45
Waking up and trouble falling asleep again	2.40	1.47	0.92	0.78	0.78	0.79	0.61
Waking up feeling tired	2.28	1.02	1.26	0.67	0.66	0.68	0.45
Overall							0.78

Table 3. Confirmatory factor analysis of Jenkins Sleep Scale– goodness of fit

Fit statistic	Value	Description
Likelihood ratio		
chi²	84.49	model vs. saturated
p-value	<0.01	
Population error		
RMSEA	0.03	Root mean squared error of approximation
90% CI, lower bound	0.03	
90% CI, upper bound	0.04	
p-value	1.00	Probability RMSEA <= 0.05
Information criteria		
AIC	1,036,000	Akaike's information criterion
BIC	1,037,000	Bayesian information criterion
Baseline comparison		
CFI	1.00	Comparative fit index
TLI	1.00	Tucker-Lewis index
Size of residuals		
SRMR	0.01	Standardized root mean squared residual
CD	0.78	Coefficient of determination

Contributorship statement

All the authors substantially contributed to the conception and design of the work, drafting the work and revised it critically for important intellectual content, interpreted the data, and finally approved the version published. All the authors achieved an agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. MS was responsible for the main data analysis. JV end MK were responsible for the acquisition of data. JV is a guarantor.

Competing interests

The authors do not have any associations with commercial entities that provided support for the work reported in the submitted manuscript. The authors do not have any associations with commercial entities that could be viewed as having an interest in the general area of the submitted manuscript. The authors do not have any similar financial associations involving their spouse or their children under 18 years of age. The authors do not have any non-financial associations that may be relevant to the submitted manuscript.

Funding

This study was supported by funding granted by the Juho Vainio Foundation, Finland (to TL); the Academy of Finland (Grants 286294, 294154 and 319246 to SS; 633666 to MK; 309526 to TL); the Finnish Ministry of Education and Culture (to SS); NordForsk (to MK and JV); the UK MRC (Grant K013351 to MK) and The Finnish Environment Fund (Grants 190172 and 118060 to SM)

Data sharing statement

The data generated by this research that supports the article will be made available through a request to a corresponding author forwarding the request to JE, who manages the data of the survey, upon publication of the article. Only anonymized questionnaire data is available to share.

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Figure 1. Exploratory factor analysis of Jenkins Sleep Scale – scree plot with parallel analysis

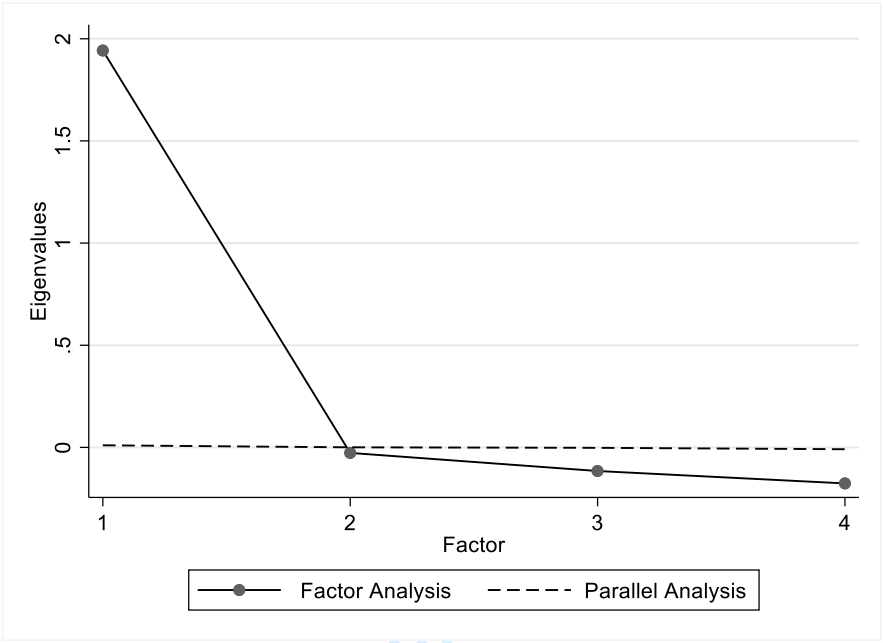
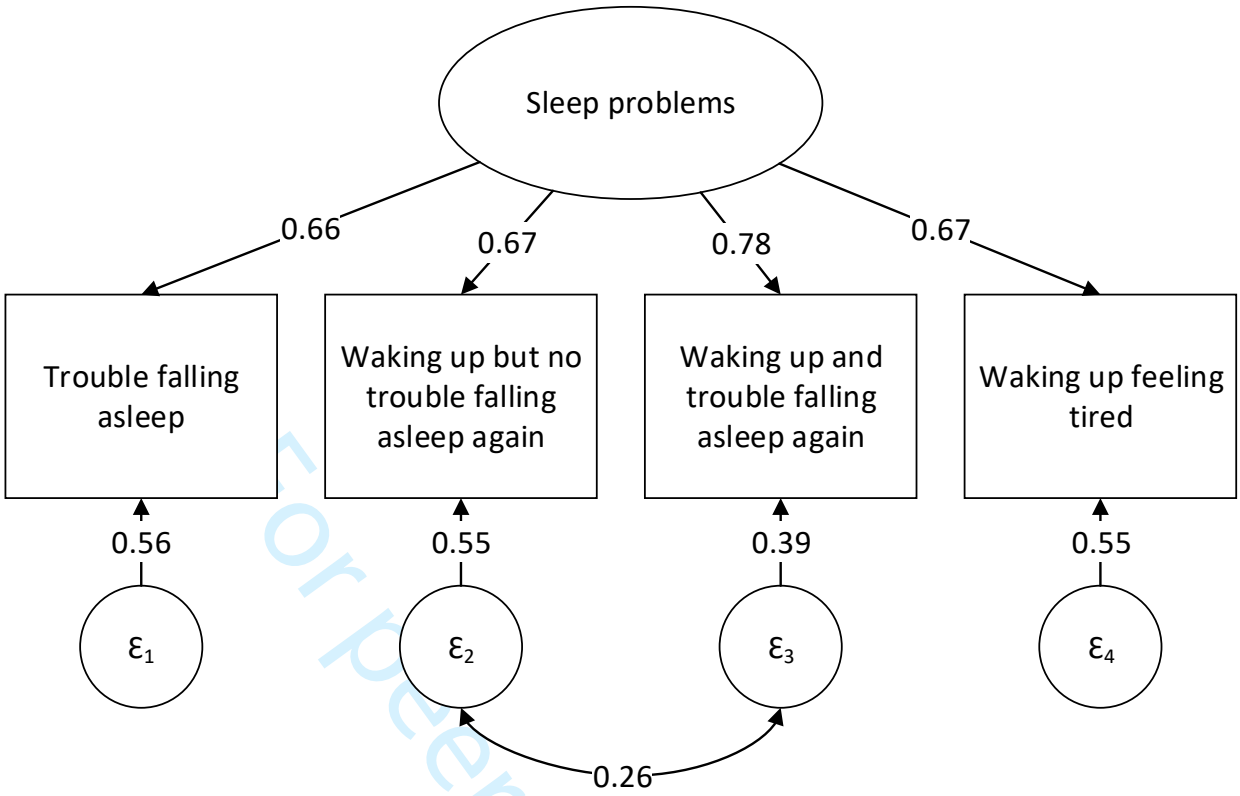


Figure 2. Confirmatory factor analysis of Jenkins Sleep Scale



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	#1	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	
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Purpose or research question	#4	Purpose of the study and specific objectives or questions	3

Methods			4
Qualitative approach and research paradigm	#5	Qualitative approach (e.g. ethnography, grounded theory, case study, phenomenolgy, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g. postpositivist, constructivist / interpretivist) is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.	4
Researcher characteristics and reflexivity	#6	Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability	1
Context	#7	Setting / site and salient contextual factors; rationale	
Sampling strategy	#8	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale	4
Ethical issues pertaining to human subjects	#9	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	4
Data collection methods	#10	Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources / methods, and modification of procedures in response to evolving study findings; rationale	4 / 5
Data collection instruments and technologies	#11	Description of instruments (e.g. interview guides, questionnaires) and devices (e.g. audio recorders) used for data collection; if / how the instruments(s) changed over the course of the study	4/5

Units of study	#12	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	4
Data processing	#13	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymisation / deidentification of excerpts	4/5
Data analysis	#14	Process by which inferences, themes, etc. were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale	4/5
Techniques to enhance trustworthiness	#15	Techniques to enhance trustworthiness and credibility of data analysis (e.g. member checking, audit trail, triangulation); rationale	4/5
Results/findings			
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Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts, photographs) to substantiate analytic findings	6
Discussion			7
Intergration with prior work, implications, transferability and contribution(s) to the field	#18	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application / generalizability; identification of unique contributions(s) to scholarship in a discipline or field	
Limitations	#19	Trustworthiness and limitations of findings	7
Other			
Conflicts of interest	#20	Potential sources of influence of perceived influence on study conduct and conclusions; how these were managed	7/8
Funding	#21	Sources of funding and other support; role of funders in data collection, interpretation and reporting	1

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-043276.R1
Article Type:	Original research
Date Submitted by the Author:	17-Nov-2020
Complete List of Authors:	Juhola, Juhani; TYKS Turku University Hospital, Physical and Rehabilitation medicine Arokoski, J. P. A.; Helsinki University Central Hospital, Department of Physical and rehabilitation medicine Ervasti, Jenni; Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, FI-00250, Helsinki, Finland, Kivimäki, Mika; University of Helsinki Faculty of Medicine, ; University College London, Dep. of Epidemiology and Public Health Vahtera, Jussi; Turun Yliopisto, Dep Public Health; Finnish Institute of Occupational Health, Myllyntausta, Saana; University of Turku, Saltychev, M; Turku University Hospital and University ofTurku, Turku, Finland , Department of Physical and Rehabilitation Medicine
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Research methods
Keywords:	SLEEP MEDICINE, EPIDEMIOLOGY, PUBLIC HEALTH

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Running head: Psychometric properties of Jenkins Sleep Scale

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Keywords: sleep disorder, psychometrics, validity

ABSTRACT

Objectives

To assess the internal consistency and construct validity of the Finnish translation of the Jenkins Sleep Scale (JSS) in a large healthy working-age population with diverse work characteristics.

Design

Survey-based cross-sectional cohort study.

Setting

Survey conducted by an institute of occupational health.

Participants

Employees of 10 towns and 6 hospital districts.

Primary and secondary outcome measures

The internal consistency defined by a Cronbach's alpha. Exploratory and confirmatory factor analyses to evaluate the construct structure of the JSS.

Results

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their average age was 52.1 (13.2) years. Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points. The JSS demonstrated high internal consistency with an alpha of 0.80 (lower 95% CL 0.80). Exploratory factor analysis supported a one-factor solution with eigenvalue of 1.94. Confirmatory factor analysis showed that all four items were positively correlated with a single common factor explaining 44% to 61% of common factor's variance.

Conclusions

The Finnish translation of Jenkins Sleep Scale was found to be a unidimensional scale with good internal consistency. As such, the scale may be recommended as a practicable questionnaire when studying sleep difficulties in a healthy working-age population.

Strengths and limitations of this study

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS.

The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers.

Inequality in gender distribution may overestimate the prevalence of sleep difficulties in the studied cohort.

The JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep difficulties in a healthy working-age population.

Contributorship statement

All the authors (JJ, SM, JA, JE, MS, MK and JV) substantially contributed to the conception and design of the work, drafting the work and revised it critically for important intellectual content, interpreted the data, and finally approved the version published. All the authors achieved an agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. JJ was responsible for preparing the first draft. MS was responsible for the main data analysis. JV end MK were responsible for the acquisition of data. JV was a guarantor.

Competing interests

The authors do not have any associations with commercial entities that provided support for the work reported in the submitted manuscript. The authors do not have any associations with commercial entities that could be viewed as having an interest in the general area of the submitted manuscript. The authors do not have any similar financial associations involving their spouse or their children under 18 years of age. The authors do not have any non-financial associations that may be relevant to the submitted manuscript.

Funding

This study was supported by funding granted by the Juho Vainio Foundation, Finland (to TL); the Academy of Finland (Grants 286294, 294154 and 319246 to SS; 633666 to MK; 309526 to TL); the Finnish Ministry of Education and Culture (to SS); NordForsk (to MK and JV); the UK MRC (Grant K013351 to MK) and The Finnish Environment Fund (Grants 190172 and 118060 to SM)

Data sharing statement

The data generated by this research that supports the article will be made available through a request to a corresponding author forwarding the request to JE, who manages the data of the survey, upon publication of the article. Only anonymized questionnaire data is available to share.

INTRODUCTION

Several different questionnaires have been developed to assess the severity of sleep problems [1]. The Jenkins Sleep Scale (JSS), developed as a brief and standardized test for sleep disturbances in 1988, has been one of the most commonly used questionnaires in epidemiological studies [1-4]. Comparing to other similar measures, the JSS is a short questionnaire focusing on roughly recognizing sleep difficulties. That is unlike to more complex scales, like Insomnia Severity Index, which quantify also the impact of sleep disturbance on the level of daily functioning. The JSS has been translated in several languages [5-10] and found to be valid and reliable amongst patients with different health problems including rheumatoid arthritis [10], psoriatic arthritis [9], ankylosing spondylitis [7], fibromyalgia[5 11], chest pain [12], post cardiac surgery patients [2], patients with cognitive disorders [13] and epilepsy [14]. However, only a few studies have evaluated the psychometric properties of the JSS in large non-clinical populations [2 3 8 15 16].

Previous studies have found the JSS to be internally consistent amongst patients with fibromyalgia [5 11], rheumatoid arthritis [10], ankylosing spondylitis [7] and psoriatic arthritis[9] as indicated by Cronbach's alphas between 0.7 and 0.9. Several studies has assessed the internal consistency of the JSS in general and/or healthy populations similarly reporting good to excellent Cronbach's alpha that vary between 0.8 and 0.9 [2 3 6 8 15 16]. Only three previous studies have assessed the factor structure of the JSS finding the JSS to be a unidimensional scale [3 6 8] The construct structure of the JSS analysis has been assessed by a single study using a confirmatory factor that produced strong correlations with common factor for all four items [3]. Like any brief screening instrument, the JSS has shortcomings, specifically the inability to address the spectrum of sleep difficulties. Hence it can only be used as a preliminary screener of sleep disturbance [17].

Overall, there is uncertainty concerning the psychometric behavior of the JSS especially regarding its factor structure in healthy and/or general populations. Concerning a general population, previous research mostly focused on the internal consistency of JSS and its reliability. Instead, other important points, like e.g. factors structure, remained practically unknown. Additionally, the psychometric properties of Finnish translation of the JSS have not been studied yet. To address this limitation, the aim of this study was to assess the internal consistency and construct validity of the Finnish translation of the JSS in a large healthy working-age population.

METHODS

The data were derived from the Finnish Public Sector (FPS) study, an on-going prospective cohort study of employees in the municipal services of 10 Finnish towns and 21 public hospitals. The eligible population from the register cohort of FPS (n=151 618) included those who had been employed for a minimum of 6 months at the participating organisations between 1991 and 2005. Employers' records have been used to identify the eligible employees for a nested survey cohort to whom questionnaire surveys have been repeated every 4 years since 2000 [18]. For this study, the data were sourced from the survey in 2016 – 2017 administered to the FPS sub-cohorts (average response rate 70%). Individual-level survey data cannot be made publicly available, but information on the data and analyses are available upon request to the corresponding author. The ethics committee of the Hospital District of Helsinki and Uusimaa has approved the study.

Age was defined in full years at the time of survey response. Body mass index (BMI) was defined as weight in kg/height in m^2. The level of physical activity was calculated from the survey responses and converted into metabolic equivalent of task (MET) . Alcohol consumption was obtained from the survey and converted into g/week. The respondents were asked about their usual amount of sleep hours per 24 hours with the following nine response alternatives: ≤6 hours, 6.5 hours, 7 hours, 7.5 hours, 8 hours, 8.5 hours, 9 hours, 9.5 hours, and ≥10 hours.

Jenkins Sleep Scale (JSS) is a four-item questionnaire to follow common sleep problems[2]. The frequency of sleep problems in the last month is evaluated using four items: the difficulty to fall asleep, wake up at night, difficulty to stay asleep, and nonrestorative sleep (i.e. waking up after the usual amount of sleep feeling tired and worn out). Each item is rated on a Likert-like scale from zero to five, where zero is "never", 1 is "1- 3 days", 2 is "about 1 night/week", 3 is "2-4 nights/week", 4 is "5-6 nights/week" and 5 is "almost every night". The total score is a simple sum of all four items' scores and ranges from zero (no sleep problems) to 20 (most sleep problems). The score of 11 is a cut-off – a score <12 is defined as little of sleep disturbances and a score >11 is understood as high frequency of sleep disturbances[19]. Another way to dichotomize the JSS is considering sleep difficulties being present if there is at least one "yes" response (>15 nights in the previous 4 weeks) to any item.

Patient and public involvement

Participants of research were not involved in setting the study question and outcome measures and were not involved in the design and implementation of the study or writing the manuscript.

Statistical analysis

Internal consistency and exploratory factor analysis

The internal consistency was defined by a Cronbach's alpha reported along with its one-sided (lower) 95% confidence limit (95% CL). The $\alpha \geq 0.9$ was considered excellent, ≥0.8 good, ≥0.7 acceptable, ≥0.6 questionable, ≥0.5 poor, and <0.5 was considered unacceptable [20]. Exploratory factor analysis (EFA) was used to approximate the construct structure of the JSS. The goal was to determine whether the JSS measures only one latent trait (= sleep disturbances) or if there are other possible significant latent variables affecting the results. The results were analyzed both numerically and graphically. Exploratory factor analysis (principal factors) was applied with a minimum eigenvalue for retention set at >1.0 (Kaiser's rule). The varimax rotation was applied. Retained and excluded factors were also explored visually on a scree plot along with the parallel analysis.

Confirmatory factor analysis

The estimation procedure used the maximum likelihood method considering covariances supplied as input being unbiased. For simplicity, the estimates were reported in standardized form as correlation coefficients. A correlation <0.2 was considered poor, from 0.21 to 0.4 fair, from 0.41 to 0.6 moderate, from 0.61 to 0.8 substantial, and >0.8 perfect [21]. In addition, the coefficients of determination were calculated to show the proportion of variance in common "sleep disturbances" construct that can be explained by the items. Finally, the coefficient of determination for the entire model was calculated.

In order to assess how well the model matches the observed data, the root mean square error of approximation (RMSEA) was used as a primary index. First, the model fit was tested assuming there were no covariances between unique factors. After that, the modification indices suggested by the software were used to add covariance between factors (double-headed arrows in Figure 1) one at a time, each time testing the RMSEA closeness to the value of < 0.05, or, at least, <0.08 – the threshold for accepting the model fit. Every insertion was considered plausible if it made logical sense and did not violate the assumption that the common and the unique factors are uncorrelated. After achieving the RMSEA value of <0.05, no further covariances were imputed. The goodness of fit was assessed using a chi-square test. Also, the Akaike's and Bayesian information criteria (AIC and BIC), comparative fit index (CFI) and the Tucker-Lewis index (TLI) were calculated. The AIC and BIC were considered good if they were close to 1.0.

The analyses were performed using Stata/IC Statistical Software: Release 16. College Station (StataCorp LP, TX, USA).

RESULTS

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their mean age was 52.1 (standard deviation [SD] = 13.2) years, body mass index 26.2 (SD = 4.7) kg/m^2, physical activity 29.4 (SD = 25.3) METs/week, and alcohol consumption 49.7 (SD = 90.9) g/week (equivalent to 5 units of alcohol per week). Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points.

The JSS demonstrated a substantial internal consistency with alpha 0.80 (lower 95% CL 0.80). The exploratory factor analysis resulted in one retaining factor with eigenvalue of 1.94 based on Kaiser criterion (Table 1 and Figure 2). Three other factors had eigenvalues between -0.03 and -0.18 and thus explained variance less the observed variables. The parallel analysis of scree plot confirmed the unidimensional structure of JSS.

The confirmatory factor analysis showed that all four items positively correlated with a common factor explaining from 44% up to 61% of the variance of the common factor (Table 2 and Figure 1). The highest correlation 0.78 (r^2=0.61) was observed for the third item “waking up and trouble falling asleep again”. Other items demonstrated similar and slightly lower correlations between 0.66 and 0.67 (r^2=0.44 to 0.45). The model obtained a good fit after adding one covariance between second and third items: 0.26 (95% confidence interval 0.25 to 0.28). After that, the RMSEA of the model was 0.03 (Table 3).

DISCUSSION

In this large cohort study, the JSS was found to be an internally consistent scale. Exploratory factor analysis suggested the unidimensionality of the JSS. In addition, confirmatory factor analysis demonstrated a single-factor structure with only one mild aberration; the JSS item "waking up and trouble falling asleep again" seemed to show higher coefficient of determination than any of the other items.

The generalizability of the results might be weakened by the gender disbalance of the studied cohort (women were predominated). This disbalance was due to the fact that fewer men are involved in the studied areas of public sector. Also, the mean age of study participants was 52 years and, therefore, the results described, in the first instance, people in the last third of their working life span. While been widely used for over two decades, the Finnish translation of JSS had never undergone a full linguistic validation process which might affect its equivalency with an English version. The response rate was 70% and there was no analysis if the non-respondents' demographic characteristics might affect the results.

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS. The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers. However, the generalizability of the results might be compromised by the following aspects. The studied cohort was predominated by women. It has previously been stated that sleep problems are more common among women meaning that this inequality in gender distribution may overestimate the prevalence of sleep difficulties in the studied cohort [3]. While overall working age could be understood as an age between early adulthood and the age of retirement, the mean age of the respondents was 52 years, covering mainly the last third of the working life span.

The results are in line with several previous studies that have found the JSS to be a unidimensional scale with excellent internal consistency [3 6 8]. The Cronbach's alpha of 0.8 seen in the present study was close to the estimates reported by previous research in both general population and populations of people with different health conditions [2 3 5-11 15 16]. While the JSS has been studied by employing alpha and exploratory factor analysis by several studies, a confirmatory factor analysis has previously been used by only a single study (Tibubos et al. 2020). The correlations of four items with a common factor seen in study by Tibubos et al. resembled the estimates observed in the present study with one exception. The present results demonstrated the greatest correlation for the item "waking up and trouble falling asleep again", being in line with Tibubos et al., but, contrary to our result, item "waking up feeling tired" had the smallest (out of four) estimate in their study. This difference might be explained by differences in the studied cohorts e.g. in gender distribution and work status. Indeed, the present study represents a population that is probably healthier than general population. In addition, it is possible, though unlikely, that some differences might have occurred due to the linguistic variability between the two translations.

Further research may reveal more details on the JSS psychometrics, for example, its properties based on an item response theory analysis. Especially confirmatory factor analysis may be recommended for future research, as the knowledge on the JSS factor structure is still scarce.

Conclusions

The JSS was found to be a unidimensional scale with good internal consistency. As such, the JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep difficulties in a healthy working-age population.

TABLES AND FIGURES

Table 1. Exploratory factor analysis of loadings of the Jenkins Sleep Scale items

Jenkins Sleep Scale Items	Factor #1	Uniqueness
Trouble falling asleep	0.62	0.61
Waking up but no trouble falling asleep again	0.72	0.48
Waking up and trouble falling asleep again	0.79	0.37
Waking up feeling tired	0.63	0.60

Table 2. Confirmatory factor analysis of Jenkins Sleep Scale – correlation between observed and predicted estimates (r) along with coefficient of determination (r^2)

Estimates	Variance			r	95% CI		r^2
	Fitted	Predicted	Residual		Lower	Upper	
Trouble falling asleep	1.63	0.71	0.92	0.66	0.66	0.67	0.44
Waking up but no trouble falling asleep again	2.83	1.29	1.55	0.67	0.67	0.68	0.45
Waking up and trouble falling asleep again	2.40	1.47	0.92	0.78	0.78	0.79	0.61
Waking up feeling tired	2.28	1.02	1.26	0.67	0.66	0.68	0.45
Overall							0.78

Table 3. Confirmatory factor analysis of Jenkins Sleep Scale– goodness of fit

Fit statistic	Value	Description
Likelihood ratio		
chi²	84.49	model vs. saturated
p-value	<0.01	
Population error		
RMSEA	0.03	Root mean squared error of approximation
90% CI, lower bound	0.03	
90% CI, upper bound	0.04	
p-value	1.00	Probability RMSEA <= 0.05
Information criteria		
AIC	1,036,000	Akaike's information criterion
BIC	1,037,000	Bayesian information criterion
Baseline comparison		
CFI	1.00	Comparative fit index
TLI	1.00	Tucker-Lewis index
Size of residuals		
SRMR	0.01	Standardized root mean squared residual
CD	0.78	Coefficient of determination

Figure 1. Confirmatory factor analysis of Jenkins Sleep Scale.

"ε"-circles represent a measurement error associated with an observed variable (variance that is predicted by the latent factor). Estimates placed between ε-errors and observed variables represent the amount of variance in higher level data that can be explained by a particular variable.

Figure 2. Exploratory factor analysis of Jenkins Sleep Scale – scree plot with parallel analysis.

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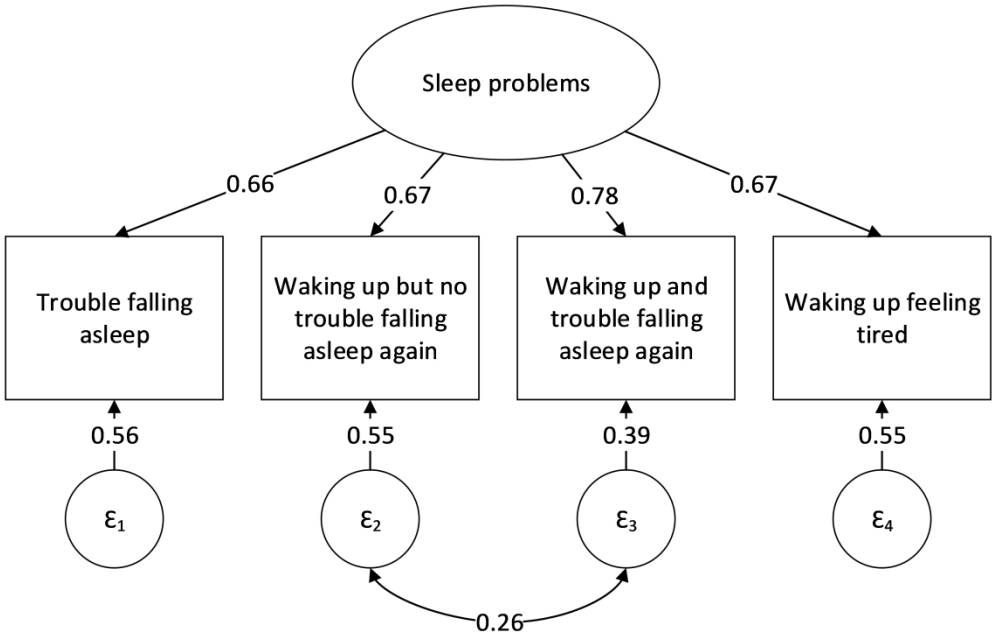

Figure 1. Confirmatory factor analysis of Jenkins Sleep Scale.
"ε"-circles represent a measurement error associated with an observed variable (variance that is predicted by the latent factor). Estimates placed between ε-errors and observed variables represent the amount of variance in higher level data that can be explained by a particular variable.

330x214mm (300 x 300 DPI)

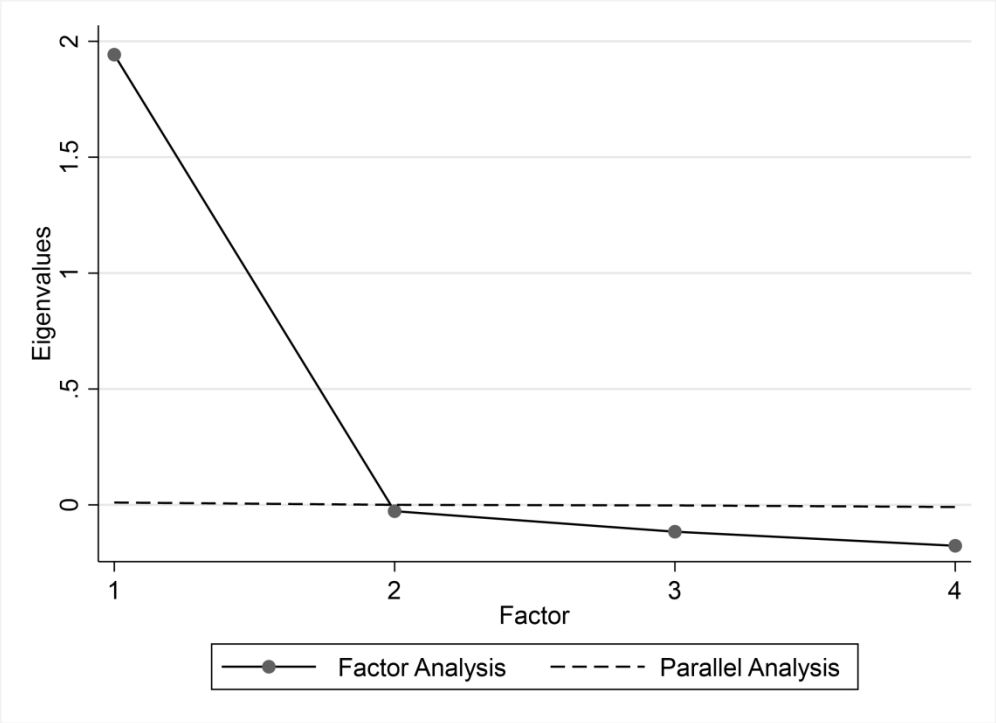

Figure 2. Exploratory factor analysis of Jenkins Sleep Scale – scree plot with parallel analysis.

233x169mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational 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	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
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	*5*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6

		(*e*) Describe any sensitivity analyses	6
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	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	7
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	7
		Cross-sectional study—Report numbers of outcome events or summary measures	7
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	7
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
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	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9
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	3

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Internal consistency and factor structure of Jenkins Sleep Scale – cross-sectional cohort study amongst 80,000 adults

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-043276.R2
Article Type:	Original research
Date Submitted by the Author:	04-Dec-2020
Complete List of Authors:	Juhola, Juhani; TYKS Turku University Hospital, Physical and Rehabilitation medicine Arokoski, J. P. A.; Helsinki University Central Hospital, Department of Physical and rehabilitation medicine Ervasti, Jenni; Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, FI-00250, Helsinki, Finland, Kivimäki, Mika; University of Helsinki Faculty of Medicine, ; University College London, Dep. of Epidemiology and Public Health Vahtera, Jussi; Turun Yliopisto, Dep Public Health; Finnish Institute of Occupational Health, Myllyntausta, Saana; University of Turku, Saltychev, M; Turku University Hospital and University ofTurku, Turku, Finland , Department of Physical and Rehabilitation Medicine
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Research methods
Keywords:	SLEEP MEDICINE, EPIDEMIOLOGY, PUBLIC HEALTH

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Internal consistency and factor structure of Jenkins Sleep Scale – cross-sectional cohort study amongst 80,000 adults

Running head: Psychometric properties of Jenkins Sleep Scale

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Keywords: sleep disorder, psychometrics, validity

ABSTRACT

Objectives

To assess the internal consistency and construct validity of the Finnish translation of the Jenkins Sleep Scale (JSS) in a large healthy working-age population with diverse work characteristics.

Design

Survey-based cross-sectional cohort study.

Setting

Survey conducted by an institute of occupational health.

Participants

Employees of 10 towns and 6 hospital districts.

Primary and secondary outcome measures

The internal consistency defined by a Cronbach's alpha. Exploratory and confirmatory factor analyses to evaluate the construct structure of the JSS.

Results

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their average age was 52.1 (13.2) years. Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points. The JSS demonstrated high internal consistency with an alpha of 0.80 (lower 95% CL 0.80). Exploratory factor analysis supported a one-factor solution with eigenvalue of 1.94. Confirmatory factor analysis showed that all four items were positively correlated with a single common factor explaining 44% to 61% of common factor's variance.

Conclusions

The Finnish translation of Jenkins Sleep Scale was found to be a unidimensional scale with good internal consistency. As such, the scale may be recommended as a practicable questionnaire when studying sleep difficulties in a healthy working-age population.

Strengths and limitations of this study

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS.

The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers.

Inequality in gender distribution may overestimate the prevalence of sleep difficulties in the studied cohort.

The JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep difficulties in a healthy working-age population.

Contributorship statement

All the authors (JJ, SM, JA, JE, MS, MK and JV) substantially contributed to the conception and design of the work, drafting the work and revised it critically for important intellectual content, interpreted the data, and finally approved the version published. All the authors achieved an agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. JJ was responsible for preparing the first draft. MS was responsible for the main data analysis. JV end MK were responsible for the acquisition of data. JV was a guarantor.

Competing interests

The authors do not have any associations with commercial entities that provided support for the work reported in the submitted manuscript. The authors do not have any associations with commercial entities that could be viewed as having an interest in the general area of the submitted manuscript. The authors do not have any similar financial associations involving their spouse or their children under 18 years of age. The authors do not have any non-financial associations that may be relevant to the submitted manuscript.

Funding

This study was supported by funding granted by the Juho Vainio Foundation, Finland (to TL); the Academy of Finland (Grants 286294, 294154 and 319246 to SS; 633666 to MK; 309526 to TL); the Finnish Ministry of Education and Culture (to SS); NordForsk (to MK and JV); the UK MRC (Grant K013351 to MK) and The Finnish Environment Fund (Grants 190172 and 118060 to SM)

Data sharing statement

The data generated by this research that supports the article will be made available through a request to a corresponding author forwarding the request to JE, who manages the data of the survey, upon publication of the article. Only anonymized questionnaire data is available to share.

INTRODUCTION

Several different questionnaires have been developed to assess the severity of sleep problems [1]. The Jenkins Sleep Scale (JSS), developed as a brief and standardized test for sleep disturbances in 1988, has been one of the most commonly used questionnaires in epidemiological studies [1-4]. Comparing to other similar measures, the JSS is a short questionnaire focusing on roughly recognizing sleep difficulties. That is unlike to more complex scales, like Insomnia Severity Index, which quantify also the impact of sleep disturbance on the level of daily functioning. The JSS has been translated in several languages [5-10] and found to be valid and reliable amongst patients with different health problems including rheumatoid arthritis [10], psoriatic arthritis [9], ankylosing spondylitis [7], fibromyalgia[5 11], chest pain [12], post cardiac surgery patients [2], patients with cognitive disorders [13] and epilepsy [14]. However, only a few studies have evaluated the psychometric properties of the JSS in large non-clinical populations [2 3 8 15 16].

Previous studies have found the JSS to be internally consistent amongst patients with fibromyalgia [5 11], rheumatoid arthritis [10], ankylosing spondylitis [7] and psoriatic arthritis[9] as indicated by Cronbach's alphas between 0.7 and 0.9. Several studies has assessed the internal consistency of the JSS in general and/or healthy populations similarly reporting good to excellent Cronbach's alpha that vary between 0.8 and 0.9 [2 3 6 8 15 16]. Only three previous studies have assessed the factor structure of the JSS finding the JSS to be a unidimensional scale [3 6 8] The construct structure of the JSS analysis has been assessed by a single study using a confirmatory factor that produced strong correlations with common factor for all four items [3]. Like any brief screening instrument, the JSS has shortcomings, specifically the inability to address the spectrum of sleep difficulties. Hence it can only be used as a preliminary screener of sleep disturbance [17].

Overall, there is uncertainty concerning the psychometric behavior of the JSS especially regarding its factor structure in healthy and/or general populations. Concerning a general population, previous research mostly focused on the internal consistency of JSS and its reliability. Instead, other important points, like e.g. factors structure, remained practically unknown. Additionally, the psychometric properties of Finnish translation of the JSS have not been studied yet. To address this limitation, the aim of this study was to assess the internal consistency and construct validity of the Finnish translation of the JSS in a large healthy working-age population.

METHODS

The data were derived from the Finnish Public Sector (FPS) study, an on-going prospective cohort study of employees in the municipal services of 10 Finnish towns and 21 public hospitals. The eligible population from the register cohort of FPS (n=151 618) included those who had been employed for a minimum of 6 months at the participating organisations between 1991 and 2005. Employers' records have been used to identify the eligible employees for a nested survey cohort to whom questionnaire surveys have been repeated every 4 years since 2000 [18]. For this study, the data were sourced from the survey in 2016 – 2017 administered to the FPS sub-cohorts (average response rate 70%). Individual-level survey data cannot be made publicly available, but information on the data and analyses are available upon request to the corresponding author. The ethics committee of the Hospital District of Helsinki and Uusimaa has approved the study.

Age was defined in full years at the time of survey response. Body mass index (BMI) was defined as weight in kg/height in m^2. The level of physical activity was calculated from the survey responses and converted into metabolic equivalent of task (MET) . Alcohol consumption was obtained from the survey and converted into g/week. The respondents were asked about their usual amount of sleep hours per 24 hours with the following nine response alternatives: ≤6 hours, 6.5 hours, 7 hours, 7.5 hours, 8 hours, 8.5 hours, 9 hours, 9.5 hours, and ≥10 hours.

Jenkins Sleep Scale (JSS) is a four-item questionnaire to follow common sleep problems[2]. The frequency of sleep problems in the last month is evaluated using four items: the difficulty to fall asleep, wake up at night, difficulty to stay asleep, and nonrestorative sleep (i.e. waking up after the usual amount of sleep feeling tired and worn out). Each item is rated on a Likert-like scale from zero to five, where zero is "never", 1 is "1- 3 days", 2 is "about 1 night/week", 3 is "2-4 nights/week", 4 is "5-6 nights/week" and 5 is "almost every night". The total score is a simple sum of all four items' scores and ranges from zero (no sleep problems) to 20 (most sleep problems). The score of 11 is a cut-off – a score <12 is defined as little of sleep disturbances and a score >11 is understood as high frequency of sleep disturbances[19]. Another way to dichotomize the JSS is considering sleep difficulties being present if there is at least one "yes" response (>15 nights in the previous 4 weeks) to any item.

Patient and public involvement

Participants of research were not involved in setting the study question and outcome measures and were not involved in the design and implementation of the study or writing the manuscript.

Statistical analysis

Internal consistency and exploratory factor analysis

The internal consistency was defined by a Cronbach's alpha reported along with its one-sided (lower) 95% confidence limit (95% CL). The $\alpha \geq 0.9$ was considered excellent, ≥0.8 good, ≥0.7 acceptable, ≥0.6 questionable, ≥0.5 poor, and <0.5 was considered unacceptable [20 21]. Exploratory factor analysis (EFA) was used to approximate the construct structure of the JSS. The goal was to determine whether the JSS measures only one latent trait (= sleep disturbances) or if there are other possible significant latent variables affecting the results. The results were analyzed both numerically and graphically. Exploratory factor analysis (principal factors) was applied with a minimum eigenvalue for retention set at >1.0 (Kaiser's rule). The varimax rotation was applied. Retained and excluded factors were also explored visually on a scree plot along with the parallel analysis.

Confirmatory factor analysis

The estimation procedure used the maximum likelihood method considering covariances supplied as input being unbiased. For simplicity, the estimates were reported in standardized form as correlation coefficients. A correlation <0.2 was considered poor, from 0.21 to 0.4 fair, from 0.41 to 0.6 moderate, from 0.61 to 0.8 substantial, and >0.8 perfect [22]. In addition, the coefficients of determination were calculated to show the proportion of variance in common "sleep disturbances" construct that can be explained by the items. Finally, the coefficient of determination for the entire model was calculated.

In order to assess how well the model matches the observed data, the root mean square error of approximation (RMSEA) was used as a primary index. First, the model fit was tested assuming there were no covariances between unique factors. After that, the modification indices suggested by the software were used to add covariance between factors (double-headed arrows in Figure 1) one at a time, each time testing the RMSEA closeness to the value of < 0.05, or, at least, <0.08 – the threshold for accepting the model fit. Every insertion was considered plausible if it made logical sense and did not violate the assumption that the common and the unique factors are uncorrelated. After achieving the RMSEA value of <0.05, no further covariances were imputed. The goodness of fit was assessed using a chi-square test. Also, the Akaike's and Bayesian information criteria (AIC and BIC), comparative fit index (CFI) and the Tucker-Lewis index (TLI) were calculated. The AIC and BIC were considered good if they were close to 1.0.

The analyses were performed using Stata/IC Statistical Software: Release 16. College Station (StataCorp LP, TX, USA).

RESULTS

Of 81,136 respondents, 14,890 (18%) were men and 66,246 (82%) were women. Their mean age was 52.1 (standard deviation [SD] = 13.2) years, body mass index 26.2 (SD = 4.7) kg/m^2, physical activity 29.4 (SD = 25.3) METs/week, and alcohol consumption 49.7 (SD = 90.9) g/week (equivalent to 5 units of alcohol per week). Of the respondents, 41,823 (52%) were sleeping seven or less hours per night. The mean JSS total score was 6.4 (4.8) points.

The JSS demonstrated a substantial internal consistency with alpha 0.80 (lower 95% CL 0.80). The exploratory factor analysis resulted in one retaining factor with eigenvalue of 1.94 based on Kaiser criterion (Table 1 and Figure 2). Three other factors had eigenvalues between -0.03 and -0.18 and thus explained variance less the observed variables. The parallel analysis of scree plot confirmed the unidimensional structure of JSS (Table 2).

The confirmatory factor analysis showed that all four items positively correlated with a common factor explaining from 44% up to 61% of the variance of the common factor (Table 3 and Figure 1). The highest correlation 0.78 (r^2=0.61) was observed for the third item “waking up and trouble falling asleep again”. Other items demonstrated similar and slightly lower correlations between 0.66 and 0.67 (r^2=0.44 to 0.45). The model obtained a good fit after adding one covariance between second and third items: 0.26 (95% confidence interval 0.25 to 0.28). After that, the RMSEA of the model was 0.03 (Table 4).

DISCUSSION

In this large cohort study, the JSS was found to be an internally consistent scale. Exploratory factor analysis suggested the unidimensionality of the JSS. In addition, confirmatory factor analysis demonstrated a single-factor structure with only one mild aberration; the JSS item "waking up and trouble falling asleep again" seemed to show higher coefficient of determination than any of the other items.

The generalizability of the results might be weakened by the gender disbalance of the studied cohort (women were predominated). This disbalance was due to the fact that fewer men are involved in the studied areas of public sector. Also, the mean age of study participants was 52 years and, therefore, the results described, in the first instance, people in the last third of their working life span. While it had been widely used for over two decades, the Finnish translation of JSS had never undergone a full linguistic validation process which might affect its equivalency with an English version. The response rate was 70% and there was no analysis of whether the non-respondents' demographic characteristics might affect the results.

To our knowledge, this was the first study on the psychometrics of the Finnish translation of the JSS. The cohort of over 80,000 respondents represented a wide spectrum of occupations from managers to manual workers. However, the generalizability of the results might be compromised by the following aspects. The studied cohort was predominated by women. It has previously been stated that sleep problems are more common among women meaning that this inequality in gender distribution may overestimate the prevalence of sleep difficulties in the studied cohort [3]. While overall working age could be understood as an age between early adulthood and the age of retirement, the mean age of the respondents was 52 years, covering mainly the last third of the working life span.

The results are in line with several previous studies that have found the JSS to be a unidimensional scale with excellent internal consistency [3 6 8]. The Cronbach's alpha of 0.8 seen in the present study was close to the estimates reported by previous research in both general population and populations of people with different health conditions [2 3 5-11 15 16]. While the JSS has been studied by employing alpha and exploratory factor analysis by several studies, a confirmatory factor analysis has previously been used by only a single study (Tibubos et al. 2020). The correlations of four items with a common factor seen in study by Tibubos et al. resembled the estimates observed in the present study with one exception. The present results demonstrated the greatest correlation for the item "waking up and trouble falling asleep again", being in line with Tibubos et al., but, contrary to our result, item "waking up feeling tired" had the smallest (out of four) estimate in their study. This difference might be explained by differences in the studied cohorts e.g. in gender distribution and work status. Indeed, the present study represents a population that is probably healthier than general population. In addition, it is possible, though unlikely, that some differences might have occurred due to the linguistic variability between the two translations.

Further research may reveal more details on the JSS psychometrics, for example, its properties based on an item response theory analysis. Especially confirmatory factor analysis may be recommended for future research, as the knowledge on the JSS factor structure is still scarce.

Conclusions

The JSS was found to be a unidimensional scale with good internal consistency. As such, the JSS may be recommended as an easy-to-do questionnaire instrument for the studying of sleep difficulties in a healthy working-age population.

TABLES AND FIGURES

Table 1. Exploratory factor analysis of loadings of the Jenkins Sleep Scale items

Jenkins Sleep Scale Items	Factor #1	Uniqueness
Trouble falling asleep	0.62	0.61
Waking up but no trouble falling asleep again	0.72	0.48
Waking up and trouble falling asleep again	0.79	0.37
Waking up feeling tired	0.63	0.60

Table 2. Parallel analysis for factor analysis (over 10 replications), eigenvalues.

Factors	Factor analysis	Parallel analysis	Difference
1	1.94	0.01	1.93
2	-0.03	0.00	-0.03
3	-0.12	0.00	-0.11
4	-0.18	-0.01	-0.17

Table 3. Confirmatory factor analysis of Jenkins Sleep Scale – correlation between observed and predicted estimates (r) along with coefficient of determination (r^2)

Estimates	Variance			r	95% CI		r^2
	Fitted	Predicted	Residual		Lower	Upper	
Trouble falling asleep	1.63	0.71	0.92	0.66	0.66	0.67	0.44
Waking up but no trouble falling asleep again	2.83	1.29	1.55	0.67	0.67	0.68	0.45
Waking up and trouble falling asleep again	2.40	1.47	0.92	0.78	0.78	0.79	0.61
Waking up feeling tired	2.28	1.02	1.26	0.67	0.66	0.68	0.45
Overall							0.78

Table 4. Confirmatory factor analysis of Jenkins Sleep Scale– goodness of fit

Fit statistic	Value	Description
Likelihood ratio		
chi²	84.49	model vs. saturated
p-value	<0.01	
Population error		
RMSEA	0.03	Root mean squared error of approximation
90% CI, lower bound	0.03	
90% CI, upper bound	0.04	
p-value	1.00	Probability RMSEA <= 0.05
Information criteria		
AIC	1,036,000	Akaike's information criterion
BIC	1,037,000	Bayesian information criterion
Baseline comparison		
CFI	1.00	Comparative fit index
TLI	1.00	Tucker-Lewis index
Size of residuals		
SRMR	0.01	Standardized root mean squared residual
CD	0.78	Coefficient of determination

Figure 1. Confirmatory factor analysis of Jenkins Sleep Scale.

"ε"-circles represent a measurement error associated with an observed variable (variance that is predicted by the latent factor). Estimates placed between ε-errors and observed variables represent the amount of variance in higher level data that can be explained by a particular variable.

Figure 2. Exploratory factor analysis of Jenkins Sleep Scale – scree plot with parallel analysis.

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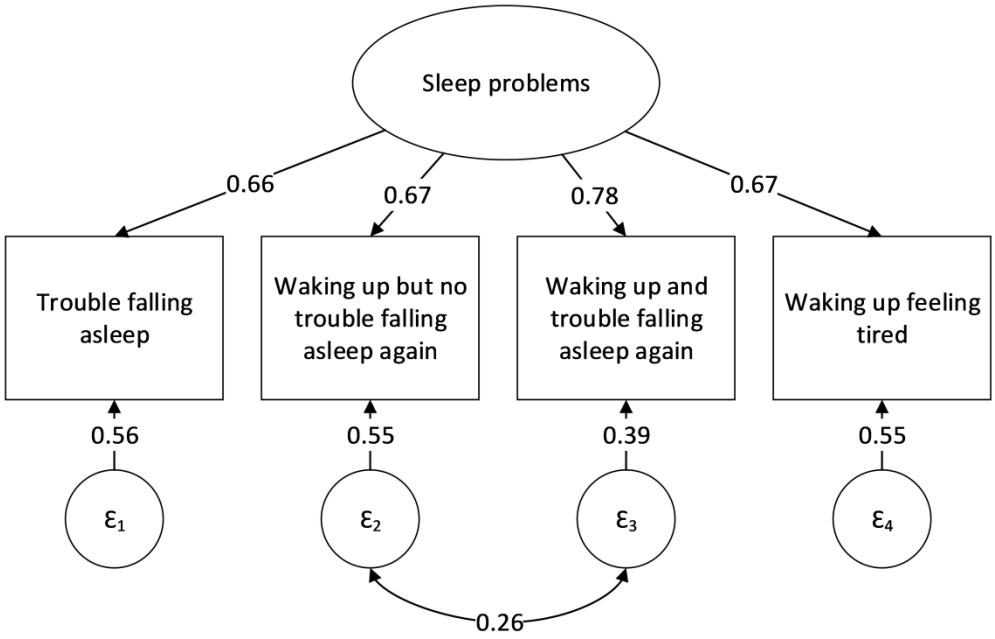

Figure 1. Confirmatory factor analysis of Jenkins Sleep Scale.
"ε"-circles represent a measurement error associated with an observed variable (variance that is predicted by the latent factor). Estimates placed between ε-errors and observed variables represent the amount of variance in higher level data that can be explained by a particular variable.

330x214mm (300 x 300 DPI)

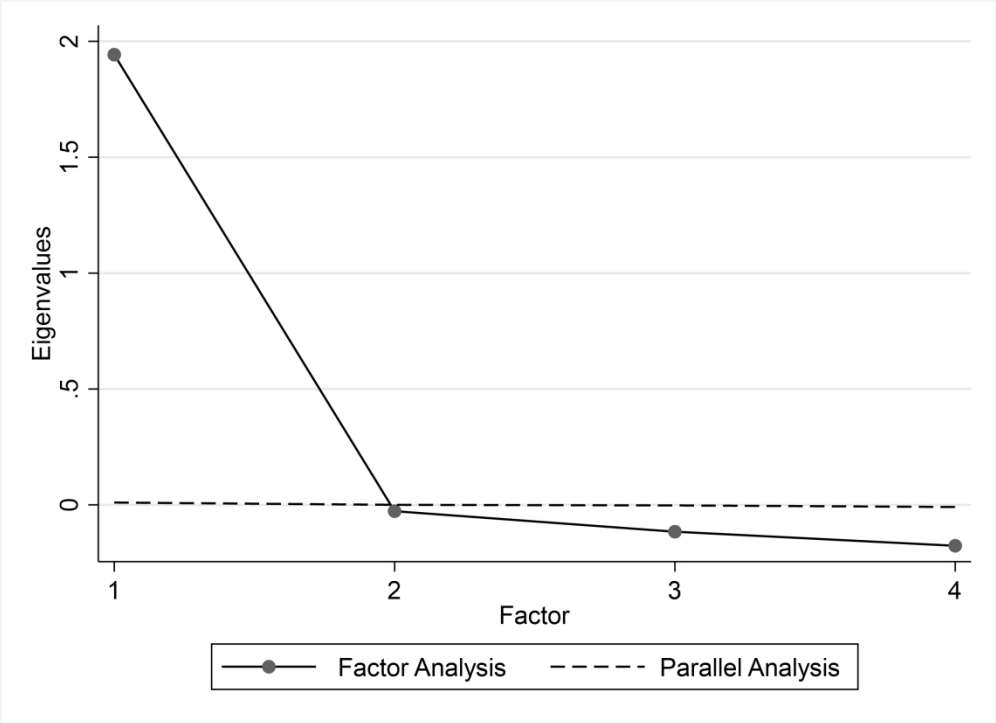

Figure 2. Exploratory factor analysis of Jenkins Sleep Scale – scree plot with parallel analysis.

233x169mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational 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	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
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	*5*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	6
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	6

		(*e*) Describe any sensitivity analyses	6
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	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	7
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*7*
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*7*
		Cross-sectional study—Report numbers of outcome events or summary measures	*7*
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	7
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
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	8
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-9
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	3