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Development and validation of a screening tool for identifying hospitalized patients with disturbed sleep – a cross-sectional study

Opracowanie i walidacja narzędzia przesiewowego do identyfikacji hospitalizowanych pacjentów z zaburzeniami snu – badanie przekrojowe

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A – Development of the concept and methodology of the study/Opracowanie koncepcji i metodologii badań; B – Query - a review and analysis of the literature/Kwerenda – przegląd i analiza literatury przedmiotu; C – Submission of the application to the appropriate Bioethics Committee/Złożenie wniosku do właściwej Komisji Biotycznej; D – Collection of research material/Gromadzenie materiału badawczego; E – Analysis of the research material/Analiza materiału badawczego; F – Preparation of draft version of manuscript/Przygotowanie roboczej wersji artykułu; G – Critical analysis of manuscript draft version/Analiza krytyczna roboczej wersji artykułu; H – Statistical analysis of the research material/Analiza statystyczna materiału badawczego; I – Interpretation of the performed statistical analysis/Interpretacja dokonanej analizy statystycznej; K – Technical preparation of manuscript in accordance with the journal regulations/Opracowanie techniczne artykułu zgodne z regulaminem czasopisma; L – Supervision of the research and preparation of the manuscript/Nadzór nad przebiegiem badań i przygotowaniem artykułu

STRESZCZENIE

OPRACOWANIE I WALIDACJA NARZĘDZIA PRZESIEWOWEGO DO IDENTYFIKACJI HOSPITALIZOWANYCH PACJENTÓW Z ZABURZENIAMI SNU – BADANIE PRZEKROJOWE

Cel pracy. Celem badania było opracowanie i walidacja narzędzia przesiewowego do wczesnej identyfikacji hospitalizowanych pacjentów ze zwiększonym ryzykiem zaburzeń snu.

Materiał i metody. Wieloośrodkowe badanie przekrojowe objęło 158 pacjentów hospitalizowanych na oddziałach ogólnych w sześciu szpitalach w Czechach. Opracowano Szpitalne Narzędzie Przesiewowe Zaburzeń Snu w celu identyfikacji pacjentów z podwyższonym ryzykiem zaburzeń snu. Trafność zbieżną oceniano poprzez analizę związku z Kwestionariuszem Snu Richardsa-Campbella. Predyktory jakości snu analizowano z wykorzystaniem modelu OPLS, a dokładność diagnostyczną i trafność narzędzia oceniano za pomocą odpowiednich metod statystycznych.

Wyniki. Najsilniejszymi predyktorami złej jakości snu były wcześniejsze problemy ze snem, odczuwanie lęku lub napięcia, stosowanie leków nasennych oraz natężenie bólu ≥ 3. Model wyjaśniał 60,8% zmienności jakości snu. Narzędzie wykazało dobrą zdolność dyskryminacyjną (punkt odcięcia 5; AUC 0,82), a wyższe wyniki były związane z gorszą jakością snu ocenianą za pomocą RCSQ, co potwierdza jego trafność konstrukcyjną i zbieżną.

Wnioski. Jakość snu pacjentów hospitalizowanych jest determinowana przez możliwe do zidentyfikowania czynniki subiektywne, psychologiczne i somatyczne. Dziewięcioelementowe Szpitalne Narzędzie Przesiewowe Zaburzeń Snu charakteryzuje się dobrą trafnością i skutecznie identyfikuje pacjentów zagrożonych zaburzeniami snu.

Słowa kluczowe: pacjent hospitalizowany, jakość snu, badanie przesiewowe snu, Kwestionariusz Snu Richardsa-Campbella, konfirmacyjna analiza czynnikowa

ABSTRACT

DEVELOPMENT AND VALIDATION OF A SCREENING TOOL FOR IDENTIFYING HOSPITALIZED PATIENTS WITH DISTURBED SLEEP – A CROSS-SECTIONAL STUDY

Aim. The study aimed to develop and validate a screening tool for early identification of hospitalized patients at increased risk for sleep disturbance.

Material and methods. Multicenter cross-sectional study included 158 patients hospitalized in general wards at six hospitals in the Czech Republic. The Hospital Sleep Screening Tool (HSST) was developed to identify patients at increased risk of sleep disturbance. The convergent validity of the HSST was assessed by examining its association with the Richards-Campbell Sleep Questionnaire (RCSQ Predictors of sleep quality were analyzed using an OPLS model, and the diagnostic accuracy and validity of the tool were evaluated by appropriate testing.

Results. The strongest predictors of poor sleep quality were previous sleep problems, anxiety or tension, the use of hypnotics and pain intensity ≥ 3. The model explained 60.8% of sleep quality variability. The tool showed good discriminatory ability (cut-off 5; AUC 0.82), and higher scores were associated with poorer RCSQ sleep quality, supporting its construct and convergent validity.

Conclusions. Sleep quality in hospitalized patients is influenced by identifiable subjective, psychological and somatic factors. The nine-item Hospital Sleep Screening Tool showed good validity and effective discriminatory ability for identifying patients at risk of sleep disturbance.

Key words: confirmatory factor analysis, sleep quality, hospitalized patient, sleep screening, Richards-Campbell Sleep Questionnaire

INTRODUCTION

Sleep is a key factor in the process of recovery of hospitalized patients. However, a hospital stays often introduce new sleep problems related to environmental factors, acute illness and routine clinical interventions [1]. Sleeping disorder during hospitalization has been associated with adverse clinical consequences, including increased fatigue, poorer pain management, delirium and prolonged length of stay [2,3].

Cross-sectional and cohort study data indicate that sleep disturbance frequently occurs very early during hospitalization. Studies conducted in general-ward populations report that approximately half of patients experience poor quality sleep during the first hospital night compared with substantially lower rates at home and that a high proportion of inpatients already meet poor-sleep thresholds on standardized questionnaires at admission [4]. Prospective screening studies further suggest that new-onset insomnia develops in more than one third of hospitalized patients without prior sleep problems [5].

In order to assess sleep in hospitalized patients, various instruments have been employed, including structured interviews, outpatient sleep questionnaires adapted for inpatient use and tools developed specifically for hospital settings [6]. Among these, the Hospital-Acquired Insomnia Scale (HAIS) was designed to detect insomnia arising during hospitalization and has demonstrated acceptable psychometric properties in internal medicine and surgical wards [5]. The Richards–Campbell Sleep Questionnaire (RCSQ) [7] and the Pittsburgh Sleep Quality Index (PSQI) are also widely used to evaluate patients' subjective perceptions of sleep in non-intensive care units, including validated use in the Czech context [8-10]. Combining subjective questionnaires with objective methods, such as actigraphy, can provide reliable information on sleep duration and nocturnal awakenings in hospitalized patients, objective monitoring is resource-intensive and not routinely available for universal screening in most hospital settings [11-13].

Sleep should be regarded as a routine vital sign in hospital care, and the use of brief, validated screening tools is essential to identify sleep problems that might otherwise go unnoticed [14,15]. Most existing tools are designed to retrospectively describe sleep quality after the impairment has already occurred rather than to identify patients who are particularly vulnerable to sleep disruption at or shortly after admission. Several questionnaires are relatively time-consuming, require repeated administrations or were originally developed for outpatient settings and may insufficiently capture hospital-specific stressors. Consequently, their applicability as brief, clinically feasible screening instruments remains limited [4,16,17]. However, a brief, hospital-specific screening instrument designed to identify patients at increased risk of sleep disruption early during hospitalization is still lacking. This gap highlights the need for a clinically feasible screening tool that is sensitive to hospital-specific stressors and relevant to nursing practice. Therefore, the aim of the present study was to develop and validate a screening tool designed to identify hospitalized patients at increased risk of impaired sleep quality during their hospital stay. Early identification of vulnerable individuals may facilitate targeted nursing interventions, support recovery and reduce complications associated with hospital-related sleep deprivation.

METHODS

Design

A multicenter cross-sectional study.

Sample

The study was conducted from May to September 2024. A total of 211 patients were initially approached to participate from regular inpatient wards in five hospitals in the Czech Republic that were participating in a broader research project. These hospitals were selected based on their involvement in the project and willingness to participate. Within these hospitals, surgical wards were included in three hospitals and internal medicine wards in two hospitals. Patients were recruited consecutively from the participating wards during the data collection period. Out of the 211 patients approached, 158 completed the surveys fully and were included in the final analysis. Exclusions were due to delirium at admission or during hospitalization, which made completing the RCSQ impossible (n = 35), incomplete or incorrectly filled surveys (n = 16) and voluntary withdrawal during the study (n = 2). The inclusion criteria required participants to be older than 18 years, stay in the hospital for longer than 24 hours, be able to answer questions and complete a questionnaire and provide informed consent to participate in the study. The exclusion criteria were cognitive dysfunction (dementia, delirium) - delirium was assessed using the Confusion Assessment Method (CAM) administered during hospitalization. Dementia was identified based on documented diagnoses in the medical records of patients, as well asthe terminal stage of illness, severe mental disorders (schizophrenia, acute psychosis) and inability to communicate (e.g., due to a language barrier).

Measurement and data collection

Participants were recruited and queried by trained nurses in the wards. The nurses recorded patients' sociodemographic data (age, sex, previous hospitalization), as well as the following clinical data from medical records: type of ward (internal medicine, surgery), type of admission (planned, acute), surgery during hospitalization (yes, no), pain (visual analog scale [VAS] 0-10), and medication used to induce sleep.

Questionnaires used

- Development of the Hospital Sleep Screening Tool (HSST)

The development of the Hospital Sleep Screening Tool (HSST) was conducted in several phases with the aim of creating a tool for the early identification of patients at increased risk of sleep disturbance during hospitalization.

1. Literature review and analysis of available instruments

In the first phase, a systematic search and analysis of existing questionnaires and relevant scientific literature focusing on sleep and sleep disturbances were conducted. More than 100 instruments assessing various aspects of sleep were identified, including sleep quality, sleep-related disorders and associated health factors.

Only one instrument, the BEARS Sleep Screening Tool, was identified as a screening tool. However, it was considered unsuitable for hospitalized adult patients due to its pediatric focus. Based on the literature review, potential predictors of sleep disturbance relevant to hospitalized patients were identified and served as the basis for the development of the HSST items.

2. Face validity (Focus Groups I and II)

Focus Group I: The first focus group consisted of seven experts, including five academic researchers with at least five years of experience in instrument development and research (PhD level) and two sleep medicine specialists with a minimum of five years of clinical experience in the field of sleep medicine. This group re-evaluated the identified research instruments and discussed existing approaches to screening for sleep disturbances. Each participant received a list of proposed items representing potential risk factors for sleep disturbance and rated their relevance and applicability to the Czech clinical setting. Based on expert consensus, 14 items were selected in the first round as the foundation for a brief screening instrument.

Focus Group II: The second focus group included six clinical experts (head nurses and bedside nurses) with at least five years of experience in standard internal medicine or surgical wards. Participants received the draft HSST items intended for the rapid assessment of sleep disturbance at the time of hospital admission and evaluated each item as applicable or not applicable in routine clinical practice.

As a result of this phase, a preliminary version of the HSST consisting of nine items was established. These items covered four key domains influencing sleep in hospitalized patients:

- *Demographic domain:* Sex (female), Age < 60 years
- *Health- and sleep-related domain:* Previous sleep problems (e.g., difficulty falling asleep, frequent nocturnal awakenings), Use of hypnotic medication, Daytime sleepiness (napping or falling asleep during the day), Snoring (loud snoring, gasping for air)
- *Physiological domain* (Pain intensity (VAS ≥ 3), Body mass index (BMI ≥ 30, obesity)
- *Psychological domain:* Subjective feelings of anxiety, fear, or tension

3. Pilot testing

The preliminary version of the HSST was pilot-tested in a sample of 21 hospitalized patients to assess the item clarity, feasibility and time requirements for completion. Based on participant feedback, no substantial content modifications were required.

The screening tool was administered on the day of hospital admission to capture baseline patient characteristics and identify individuals at increased risk of sleep disturbances during hospitalization. Early administration allows for timely implementation of sleep-supportive nursing interventions.

4. Psychometric properties

Psychometric properties of the HSST, including validity and diagnostic accuracy, are reported in the Results section. Convergent validity was assessed by examining the association between HSST scores and subjective sleep quality as measured by the Richards-Campbell Sleep Questionnaire (RCSQ).

- The Richards-Campbell Sleep Questionnaire (RCSQ)

Consists of five basic items: sleep depth, sleep latency, awakenings, return to sleep and sleep quality. There is also an optional item to assess noise during the night, which is monitored separately. Each item is rated using a VAS ranging from 0 to 100 points, where 0 corresponds to the worst and 100 to the best sleep quality. The RCSQ total score is calculated as the average of all items. The questionnaire has been validated in the Czech Republic [9]. Patients completed the RCSQ from the second to the seventh day of their hospital stay, always between 7 a.m. and 9 a.m., assessing the quality of their sleep the previous night.

Ethical aspects

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committees of the Faculty of Medicine, University of Ostrava (no. R2/2021). The study is registered with the ClinicalTrials.gov database (ID: NCT05402280).

Data analysis

For continuous variables, means and standard deviations were reported and for categorical variables, absolute and relative frequencies were reported. The most significant factors influencing sleep screening scores were identified using the orthogonal projections to latent structures (OPLS) model. The construct validity of the questionnaire was tested by confirmatory factor analysis (CFA) with standardized factor loadings, a coefficient of determination (R^2), and the following model fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR). Discriminatory power of the sleep screening score was determined using receiver operating characteristic (ROC) curve analysis, with calculation of the optimal cut-off value, sensitivity, specificity, positive predictive value (PPV) and negative predictive value. The relationship between the hospital sleep screening score and sleep quality (convergent validity), as assessed with the RCSQ, was analyzed using the Kendall's tau correlation coefficient. All statistical analyses were performed at a 5% significance level using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA) and MedCalc for Windows, version 18.6 (MedCalc Software, Ostend, Belgium).

RESULTS

The study enrolled a total of 158 hospitalized patients, of whom 71 (44.9%) were women. The participants' mean age was of 64.6 ± 14.0 years, and their mean length of hospital stay was 6.12 ± 2.17 days, mostly following acute admission (75.9%). There were 95 patients, who underwent surgery and 122 had previously been hospitalized. Participants reported a mean pain intensity of 1.98 ± 1.83 on the VAS. In terms of diagnoses, musculoskeletal diseases prevailed (21.5%), followed by cardiovascular disorders (20.3%) and central nervous system diseases (16.5%) (Table 1).

An analysis of sleep quality predictors using the OPLS model identified previous sleep problems (Ra = 0.947; $p < 0.01$), feelings of anxiety or tension (Ra = 0.399; $p < 0.01$), use of hypnotics (Ra = 0.371; $p < 0.01$), and VAS pain score ≥ 3 (Ra = 0.357; $p < 0.01$) as the most significant predictors. Other significant predictors included daytime sleepiness (Ra = 0.282), snoring (Ra = 0.211), BMI ≥ 30 (Ra = 0.167), age under 60 (Ra = 0.149), and female sex (Ra = 0.177). The strongest association was found for previous sleep problems, which had the greatest impact on the total screening score. The other variables had weaker, yet still statistically significant, effects. This suggests a link between subjectively perceived sleep quality and the proposed factors. Overall, the model explained 60.8% of the variability in sleep quality and had a good fit (Ra = 1.000; correlation = 0.780), confirming that the proposed variables adequately explain variability in the evaluated sample and can be considered relevant predictors of sleep quality in hospitalized patients (Table 2).

Confirmatory factor analysis was used to verify whether the proposed indicators adequately reflect the latent factor of sleep quality, a hidden variable that manifests itself in the proposed observed indicators but cannot be measured directly. The analysis included the proposed items directly related to sleep: previous sleep problems ($\lambda = 0.82$; $R^2 = 0.67$), feelings of anxiety or tension ($\lambda = 0.71$; $R^2 = 0.50$), use of hypnotics ($\lambda = 0.63$; $R^2 = 0.40$), VAS pain score ≥ 3 ($\lambda = 0.58$; $R^2 = 0.34$), daytime sleepiness ($\lambda = 0.52$; $R^2 = 0.27$), snoring ($\lambda = 0.46$; $R^2 = 0.21$), and BMI ≥ 30 ($\lambda = 0.39$; $R^2 = 0.15$). All items were statistically significan in their links to the latent factor ($p < 0.001$), confirming the suitability of the proposed model structure. The item previous sleep problems showed the highest loading and the greatest proportion of variance explained, indicating that it is the most important indicator of sleep quality. Items with lower λ and R^2 values, such as BMI ≥ 30, contribute less strongly, yet still significantly. The variables age and sex were not included in the CFA because they are not direct indicators of the latent factor of sleep quality,but rather demographic variables whose influence is more appropriately assessed in regression or prediction models – see above (Table 3). Sub-analysis of the CFA model fit indices confirmed the model's very good fit: $\chi^2 = 20.85$ ($p = 0.10$), CFI = 0.983, and TLI = 0.972 exceed the recommended limits, while RMSEA = 0.043 (90% CI: 0.000-0.078) and SRMR = 0.037 are significantly below the recommended limit of 0.08 [14] (Table 4). Overall, these results support the validity of the selected indicators as measures of the latent factor of sleep quality and confirm that the model adequately represents the data structure of in the evaluated patient sample.

A ROC analysis was performed to evaluate the discriminatory power of sleep screening sum scores. The highest Youden's index (J = 0.650) was found for a sum of five, which also showed the largest area under the curve (AUC = 0.820 ± 0.030; $p < 0.001$), indicating an optimal ability of the score to discriminate between patients with poorer and better sleep, with balanced sensitivity (0.870) and specificity (0.780). Lower sum scores (1-4) showed a lower Youden's index (J = 0.220-0.460) and a smaller value of AUC (0.60-0.72), with sensitivity being very high (0.900-1.000) but specificity being significantly low (0.220-0.560). This means that low sum scores are good at identifying patients with poor sleep, but often falsely identify those with good sleep. Conversely, sum scores

Tab. 1. Characteristics of the sample (n = 158)

Characteristic	Value
Age (years), mean ± SD	64.6 ± 14.0
Length of hospital stay (days), mean ± SD	6.12 ± 2.17
Pain (VAS 0-10), mean ± SD	1.98 ± 1.83
Alcohol use	
None	6 (4%)
Daily	36 (23%)
Occasionally	116 (73%)
Sex	
Male, n (%)	87 (55.1)
Female, n (%)	71 (44.9)
Ward	
Internal medicine, n (%)	51 (32.3)
Surgery, n (%)	80 (50.6)
Neurology, n (%)	27 (17.1)
Surgery, n (%)	95 (60.1)
Previous hospitalization, n (%)	122 (77.2)
Acute admission, n (%)	120 (75.9)
Smoking, n (%)	46 (29.1)
Hospital Sleep Screening Tool (HSST) * SCORE ≥ 5, n (%)	75 (50.6)
Admission diagnosis (ICD), n (%)	
C – neoplasms	2 (1.3)
D – diseases of the blood	3 (1.9)
E – endocrine diseases	3 (1.9)
G – diseases of the nervous system	26 (16.5)
I – diseases of the circulatory system	32 (20.3)
J – diseases of the respiratory system	8 (5.1)
K – diseases of the digestive system	17 (10.8)
L – diseases of the skin	3 (1.9)
M – diseases of the musculoskeletal system and connective tissue	34 (21.5)
N – diseases of the genitourinary system	5 (3.2)
R – abnormal findings	1 (0.6)

SD – standard deviation; VAS – Visual Analogue Scale; ICD-10 – International Classification of Diseases, 10th Revision; *Hospital Sleep Screening Tool - score ≥ 5 indicates patients at risk of poor sleep during hospitalization.

■ Tab. 2. Sleep screening vs. explanatory variables assessed by the OPLS model (n = 158)

		OPLS, predictive component				
	Variable	**Variable importance**	**t-statistics**	**Component loading**	**R[a]**	**p-value**
Relevant predictors (matrix **X**)	Previous sleep problems (e.g., problems falling or staying asleep)	2.450	14.03	0.743	0.947	**
	Feelings of anxiety or tension	1.050	5.32	0.313	0.399	**
	Use of hypnotics	0.961	7.70	0.291	0.371	**
	VAS ≥ 3	0.926	4.60	0.280	0.357	**
	Daytime sleepiness (napping or falling asleep during the day)	0.668	2.97	0.221	0.282	**
	Snoring (loud snoring, gasping for air)	0.563	2.98	0.166	0.211	*
	Female sex	0.477	6.20	0.139	0.177	**
	BMI > 30 (obesity)	0.487	3.50	0.131	0.167	*
	Age < 60 let	0.374	2.68	0.117	0.149	**
(matrix **Y**)	**Sleep screening overall**			1.000	0.780	**
Explained variability				60.8%		

R[a]- component loadings expressed as correlation coefficients with predictive component, *p < 0.05, **p < 0.01, OPLS – orthogonal projections to latent structures, BMI – body mass index, VAS – visual analog scale

■ Tab. 3. Results of confirmatory factor analysis (CFA) of selected sleep quality indicators (n = 158)

Indicator (observed variable)	Standardized factor loading (λ)	SE	z-value	p-value	R^2
Previous sleep problems (e.g., problems falling or staying asleep)	0.82	0.04	19.5	< 0.001	0.67
Feelings of anxiety or tension	0.71	0.06	12.1	< 0.001	0.50
Use of hypnotics	0.63	0.05	10.9	< 0.001	0.40
VAS ≥ 3	0.58	0.07	8.6	< 0.001	0.34
Daytime sleepiness (napping or falling asleep during the day)	0.52	0.07	7.4	< 0.001	0.27
Snoring (loud snoring, gasping for air)	0.46	0.08	5.9	< 0.001	0.21
BMI > 30 (obesity)	0.39	0.09	4.3	< 0.001	0.15

N.B.: Age and sex were not included in CFA as they are not part of the latent construct sleep quality. SE – standard error, R^2 – squared multiple correlation

■ Tab. 4. Confirmatory factor analysis model fit indices

Model fit index	Value	Recommended limit
χ^2 (p-value)	20.85 (0.10)	----------
CFI	0.983	≥ 0.95
TLI	0.972	≥ 0.90
RMSEA (90% CI)	0.043 (0.000-0.078)	≤ 0.08
SRMR	0.037	≤ 0.08

χ^2 – chi-square, CFI – comparative fit index, TLI – Tucker-Lewis index, RMSEA – root mean square error of approximation, SRMR – standardized root mean square residual

■ Tab. 5. Discriminatory power of the score assessed using ROC analysis

Sum score	Youden's index	AUC (SE)	p-value	Sensitivity	Specificity	PPV	NPV
1	0.220	0.60 ± 0.050	0.028	1.000 (1.000 ± 1.000)	0.220 (0.139 ± 0.301)	0.620 (0.525 ± 0.715)	1.000 (1.000 ± 1.000)
2	0.260	0.640 ± 0.040	< 0.001	0.970 (0.937 ± 1.003)	0.290 (0.201 ± 0.379)	0.660 (0.567 ± 0.753)	0.930 (0.880 ± 0.980)
3	0.360	0.670 ± 0.044	< 0.001	0.950 (0.907 ± 0.993)	0.410 (0.314 ± 0.506)	0.690 (0.599 ± 0.781)	0.890 (0.829 ± 0.951)
4	0.460	0.720 ± 0.041	< 0.001	0.900 (0.841 ± 0.959)	0.560 (0.463 ± 0.657)	0.740 (0.654 ± 0.826)	0.830 (0.756 ± 0.904)
5	0.650	0.820 ± 0.030	< 0.001	0.870 (0.804 ± 0.936)	0.780 (0.699 ± 0.861)	0.830 (0.756 ± 0.904)	0.790 (0.710 ± 0.870)
6	0.560	0.770 ± 0.030	< 0.001	0.680 (0.589 ± 0.771)	0.880 (0.816 ± 0.944)	0.910 (0.854 ± 0.966)	0.690 (0.599 ± 0.781)
7	0.430	0.710 ± 0.042	< 0.001	0.500 (0.402 ± 0.598)	0.930 (0.880 ± 0.980)	0.940 0.893 ± 0.987)	0.580 (0.483 ± 0.677)
8	0.132	0.550 ± 0.040	0.211	0.150 (0.080 ± 0.220)	0.950 (0.907 ± 0.993)	0.890 (0.829 ± 0.951)	0.450 (0.352 ± 0.548)
9	0.120	0.510 ± 0.039	0.303	0.050 (0.007 ± 0.093)	0.970 (0.937 ± 1.003)	1.000 (1.000 ± 1.000)	0.410 (0.314 ± 0.506)

AUC – area under curve, SE – standard error, PPV – positive predictive value, NPV – negative predictive value

■ Tab. 6. Convergent validity of the HSST was assessed by examining its relationship with the RCSQ

RCSQ item	n	Hospital Sleep screening tool Score≥ 5 poor sleep		Hospital Sleep screening tool Score < 5 good sleep		Kendall's τ (95% CI)	p-value
	total	n	mean ± SD	n	mean ± SD		
Sleep depth	158	75	69.70 ± 23.08	83	72.15 ± 26.51	0.0390 (0.0128, 0.0853)	0.166
Sleep latency	158	75	61.20 ± 25.40	83	63.50 ± 18.29	0.0146 (0.0304, 0.0415)	0.499
Awakenings	158	75	61.42 ± 21.13	83	75.00 ± 20.63	0.3830 (0.4130, 0.3520)	< 0.001
Returning to sleep	158	75	56.81 ± 25.05	83	64.89 ± 19.83	0.1060 (0.0724, 0.1380)	< 0.001
Sleep quality	158	75	54.81 ± 23.68	83	63.45 ± 23.12	0.1960 (0.1610, 0.2300)	< 0.001
RCSQ total	158	75	60.79 ± 24.27	83	67.80 ± 21.87	0.1360 (0.1300, 0.1610)	< 0.001
Noise	158	75	75.80 ± 17.20	83	78.20 ± 16.10	0.0560 (0.0300, 0.0909)	0.333

HSST – Hospital Sleep Screening Tool, RCSQ – Richards-Campbell Sleep Questionnaire, CI – confidence interval

above five (6-7) showed slightly lower sensitivity (0.500-0.680) but high specificity (0.880-0.930) and a very high PPV (0.910-0.940), which indicates that patients with higher sum scores are very likely to sleep badly. The highest sum scores (8-9) were not significant ($p = 0.211$ and 0.303, respectively), and showed low sensitivity (0.050-0.150), although specificity was high (0.950-0.970) (Table 5).

The convergent validity of the HSST was assessed by examining its association with the Richards–Campbell Sleep Questionnaire (RCSQ). An analysis of the relationship between HSST sleep screening results and RCSQ scores ($n = 158$) showed that patients with poor sleep (HSST score ≥ 5) had significantly lower RCSQ total scores and significantly worse ratings of sleep quality, number of awakenings and ability to return to sleep ($\tau = 0.136$-0.383, $p < 0.001$). No statistically significant differences were observed between groups for the RCSQ items sleep depth, sleep latency, and noise ($\tau = 0.015$-0.056, $p > 0.05$) (Table 6).

DISCUSSION

The sleep quality of hospitalised patients is frequently significantly impaired. In some individuals, Hospital-Acquired Insomnia (HAI) develops—insomnia that arises during hospitalisation as a response to the hospital environment, acute stress, medical procedures, or a combination of psychological and somatic factors [18]. Insomnia affects up to 50% of hospitalised patients [19]. It is strongly associated with longer hospital stays, increased mortality and a higher risk of subsequent readmissions or emergency department visits, which are components of the so-called "Post-Hospital Syndrome." [20]. Despite its prevalence, this issue is often overlooked in clinical practice and research.

Our findings confirm that the complex interaction of psychological factors, somatic symptoms and prior sleep disturbances influences the subjective sleep quality of hospitalised patients. Using the Hospital Sleep Screening Tool (HSST) at hospital admission, we identified that higher anxiety levels, the presence of pain, pre-existing insomnia, and hypnotic use were significant predictors of poorer sleep during hospitalisation. Demographic and physiological characteristics, including age, sex and BMI, played a supporting but still meaningful role. The combination of these factors explained over 60% of the variability in sleep quality. In comparison, approximately 40% remained unexplained, reflecting individual differences among patients, such as genetic predispositions, personal habits, or environmental influences.

Particular attention should be given to patients with pre-hospital insomnia, as their condition may serve as a risk factor for hospital-acquired infections (HAI) and adverse clinical outcomes. In the United States, a study [21] demonstrated that patients with pre-existing insomnia had worse clinical outcomes more extended hospital stays and a higher likelihood of returning to the hospital within 30 days post-discharge. These findings suggest that insomnia symptoms present before admission may serve as an early warning signal of increased patient burden and a higher risk of complicated hospitalisation and post-discharge events. Although a causal relationship has not yet been definitively established, the results indicate that pre-hospital insomnia may be a significant predictor of poorer in-hospital sleep and adverse clinical outcomes. These observations highlight the potential value of early screening and targeted interventions and emphasise the need for further research to support the timely identification and care of patients at risk for sleep disturbances.

Anxiety was repeatedly associated with impaired sleep quality among hospitalised patients in both our study and previous research. In the intensive care unit (ICU), higher anxiety levels were significantly correlated with poorer subjective sleep quality, and similar associations were observed among patients in surgical wards [22,23]. Systematic reviews confirm that anxiety is a key psychological factor linked to sleep disruption during hospitalisation, underscoring the importance of including psychological variables in risk assessments for sleep disturbances [1,24].

Gender is another interesting factor. Meta-analyses show that women are more susceptible to insomnia in the hospital setting than men, with 53.3% of hospitalised women experiencing insomnia compared to 43.6% of men [25]. Hospitalisation may act as a trigger for latent or previously undiagnosed sleep difficulties in women, often associated with menopause and hormonal changes that increase the risk of sleep disorders. Additional risks include psychological symptoms such as anxiety, depressive symptoms, and nocturnal rumination, as well as physical manifestations such as fatigue, which may induce or exacerbate insomnia.

Our study also highlights the practical significance of the brief Hospital Sleep Screening Tool (HSST), which enables the early identification of patients at higher risk for impaired sleep quality at admission. This approach differs from most existing tools, which focus primarily on retrospective sleep assessment or specific disorders and have limited clinical applicability in the acute hospital setting. The HSST is simple, quick to administer and easily integrated into routine admission procedures. Based on ROC analysis, a cut-off score of 5 was identified as optimal, providing the best ability to predict patients with good and impaired sleep quality. Identified patients can then be supported through environmental modifications, pharmacological interventions, or individualised nursing care, thereby improving subjective sleep quality, overall recovery, and reducing the risk of HAI.

However, some limitations should be noted. The tool captures only for approximately 60% of the variability in sleep quality and may be less sensitive in patients with atypical presentations, cognitive impairments or acute critical conditions. Nevertheless, the HSST has substantial practical potential, as it allows for targeted interventions and personalised care, supporting healthy sleep and overall patient well-being.

Limitations of the study

The present study has several limitations that should be considered when interpreting the results. Firstly, sleep assessment relied on subjective questionnaires, which may have been influenced by patients' current condition, perception and ability to express their feelings. Secondly, the sample included only patients admitted to general wards, and patients at the highest risk for sleep disorders were excluded according to the initial criteria, which may limit the representativeness of the findings. Thirdly, RCSQ items were completed only in the morning and referred to the previous night, so some factors affecting sleep such as acute changes in medication, medical procedures or health complications were not captured. Fourthly, while the selection of nine predictors was based on literature and clinical experience, it may not have included all relevant determinants of sleep quality in hospitalized patients. Finally, the convenience sampling approach used in this study may further limit the generalizability of the results to other hospital populations or ward types. Despite these limitations, the findings provide valuable insight into the multifactorial determinants of sleep quality during hospitalization and the potential utility of early screening tools.

CONCLUSIONS

This study demonstrates that sleep quality in hospitalized patients is influenced by a complex interplay of psychological factors, somatic symptoms and prior sleep disturbances. The Hospital Sleep Screening Tool (HSST), developed and validated in this study, provides a concise, practical, and feasible method for early identification of patients at increased risk of impaired sleep during hospitalization. The tool shows promise for predicting which patients may experience poor sleep, allowing timely consideration of preventive or supportive interventions.

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