Developing an Alternative Version of the Epworth Sleepiness Scale to Assess Daytime Sleepiness in Adults with Physical or Mental Disabilities

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Keywords

Sleepiness · Epworth Sleepiness Scale · Geriatric assessment · Psychometrics · Diagnostic techniques and procedures

Abstract

Introduction: Excessive daytime sleepiness (EDS) is a frequent symptom with many possible causes, and many of these can be treated. EDS and its underlying causes have been associated with various negative health consequences. Recognition of EDS is thus an important public health concern. The concept of EDS is, however, not yet well defined, and different measures are used to diagnose EDS. The Epworth Sleepiness Scale (ESS) is the most widely used tool to assess daytime sleepiness in a broad range of populations. Its applicability in patients exhibiting physical or mental disabilities, like older multimorbid patients, is limited, since the ESS was not developed and validated in this patient group. **Methods:** Within an expert study with 35 sleep medicine experts and a pilot study with 52 geriatric in-patients, who frequently exhibit physical or mental disabilities, and patients' close relatives, we adapted the original ESS to develop an alternative version to assess daytime sleepiness in adults with physical or mental disabilities (ESS-ALT). **Results:** In this

adapted version, items 3 (sitting inactively in a public place) and 8 (sleepy in traffic) were replaced by 2 new items (sitting in a waiting room, sitting and eating a meal) and an interview format was used. This ESS-ALT achieved fewer missing responses (23 vs. 73%) and a higher level of internal consistency (Cronbach's $\alpha = 0.64$ vs. 0.23) than the original ESS while keeping its somnificity structure. **Conclusion:** The ESS-ALT achieves better psychometric properties than the original ESS for individuals with physical or mental disabilities.

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Published by S. Karger AG, Basel

Introduction

Excessive daytime sleepiness (EDS) and frequent napping represent a major symptom of sleep disorders (such as obstructive sleep apnea-hypopnea syndrome, restless legs syndrome, narcolepsy, and idiopathic hypersomnia) and many diseases (e.g., cardiovascular illnesses, infections), and a frequent medication side effect [1]. EDS has been associated with a variety of serious health conse-

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quences, such as falling [2], deficits in general health, functional status and quality of life [3–5], cognitive decline [6, 7], depression [8–10], stroke [11], cardiovascular morbidity and mortality [12, 13], and all-cause mortality [13–15]. Identification of EDS is an important public health concern because early treatment of its underlying causes can improve patient outcome [16]. Still, EDS is often neglected in the clinical routine, most probably because a clear definition of EDS is lacking [17, 18].

The Epworth Sleepiness Scale (ESS) is the most widely used tool to assess daytime sleepiness [19]. Although the ESS has been developed and validated in middle-aged white community-dwelling subjects [20, 21], it is routinely used in a variety of populations, including older persons and different ethnicities [19]. In older individuals, especially item 8 of the ESS asking for sleepiness in traffic (in a car while stopped for a few minutes in the traffic) shows insufficient psychometric properties, such as low item-total scale correlation, low convergent validity, and frequent missing responses [22–25].

A validated German version of the ESS is available [26], which also suffered from inadequate psychometric properties for item 8 in older individuals [27]. Children had similar problems with the ESS as older subjects because of limitations in their comprehension of the questions and limitations in their life experiences. These were overcome by the development of the ESS for children and adolescents (ESS-CHAD) [28, 29]. Previous research suggests that daytime sleepiness is a multidimensional phenomenon, composed of chronobiological, homeostatic, psychological, medical, and possibly other aspects including age. The various methods and questionnaires available measure different aspects of daytime sleepiness and it seems appropriate to use more than 1 method to assess daytime sleepiness [30].

Due to the demographic aging in Western societies and the increasing prevalence of physical and mental disabilities with age, simple and valid tools for the assessment of EDS in patients exhibiting physical or mental disabilities are needed. Except the three-item ODSI (Observation and Interview-Based Diurnal Sleepiness Inventory) [31] such tools are lacking. In order to offer an additional comprehensive questionnaire to assess EDS in older patients, we now developed, in a 2-step model, a modified version of the ESS suitable for patients exhibiting physical or mental disabilities. In an expert survey, we evaluated difficulties when using the ESS in older persons and identified alternative items, which were rated as more adequate for the assessment of EDS in older patients often exhibiting physical or mental disabilities. In a pilot study

with 52 geriatric in-patients and close relatives, we assessed the reliability and validity of the original and alternative items to construct a modified version of the ESS for the assessment of EDS in patients exhibiting physical or mental disabilities (ESS-ALT).

Expert Survey

Expert Survey Methods

In the formal item-generation phase, 9 alternative items were identified by literature review and input from experts in sleep research and sleep medicine, as well as from nursing staff and patients. These items were rated according to their adequacy to assess daytime sleepiness in older individuals, who often suffer from physical or mental disabilities, in a standardized expert survey which was conducted at the 27th annual conference of the German Society for Sleep Research and Sleep Medicine (DGSM e.V.) in November 2019. Additionally, this standardized interview evaluated problems experienced with the original ESS in the clinical routine and asked for possible solutions. A total of 35 sleep medicine experts took part in the survey.

Expert Survey Results

Of the 35 sleep medicine experts, 30 (86%) regularly used the ESS in their clinical routine. No alternative questionnaire was used to assess daytime sleepiness. According to the expert opinion (free response format, thus >1 answer possible), the ESS was difficult to administer, especially in older patients (37%), foreign patients (14%), patients with cognitive deficits (11%), and patients without a driver's license/patients not using a car (9%); 34% of the experts reported having no difficulties to administer the ESS in their clinical routine. Regarding single items of the ESS, especially item 8 caused problems due to frequent missing responses and queries (Table 1). More than 30% of the experts rated this item as not adequate to assess daytime sleepiness because driving a car does not apply to a broad range of persons. Also sitting in a car (item 4) and sitting in a public place (item 3) was judged not to apply to a considerable proportion of people (Table 1). The experts furthermore stated that item 5 (lying down to rest in the afternoon) was often not answered by older patients because they consider it normal to take a nap in the afternoon and experts also fear that this item does not discriminate sleepy from non-sleepy older subjects because it is rare for older individuals not to sleep in the afternoon. Item 2 (watching TV) was criticized because it is not formulated precisely enough since

Table 1. Expert opinion regarding items of the ESS with frequent missing responses, frequent queries, and evaluation as “not adequate” to assess daytime sleepiness

Item	Frequent missing responses, %	Frequent queries, %	“Not adequate,” %
ESS1 Sitting and reading	3	0	0
ESS2 Watching TV	9	6	9
ESS3 Sitting inactively in a public place	11	0	9
ESS4 As a passenger in a car	9	3	11
ESS5 Lying down to rest in the afternoon	14	6	9
ESS6 Sitting and talking to someone	0	0	0
ESS7 Sitting quietly after lunch	3	3	0
ESS8 In a car while stopped	46	14	31
No problematic items	43	71	60

Data represent the percentage of expert responses given in a free response format, thus more than one answer was possible and percentages may not add up to 100%.

Table 2. Expert opinion regarding patient/relative feedback on the ESS as well as feedback from medical staff directly applying the ESS

Patients/relatives		Medical staff	
+	–	+	–
Short	Version for relatives lacking	Simple to administer	High number of missing responses
Simple		Good patient acceptance	Often disagreement between patient and relative
Assesses symptoms of daytime sleepiness		Assesses symptoms of daytime sleepiness	Does not measure daytime sleepiness in a reliable way
		Adequate as self-report	Patients often need assistance

no time of the day is fixed and patients sometimes ask which TV program is meant since different programs differ in their somnificity. Taking everything into account, based on the expert survey items 1 (sitting and reading), 6 (sitting and talking to someone), and 7 (sitting quietly after lunch) were found most suitable, and item 8 (in a car while stopped for a few minutes in the traffic) least suitable to assess daytime sleepiness.

According to the experts, the feedback from patients and their relatives regarding the adequacy of the ESS to assess daytime sleepiness was rather positive. The ESS was rated as short, and a simple tool which assesses symptoms of daytime sleepiness (Table 2). However, the feedback from persons who directly apply the ESS was mixed, also revealing difficulties for some patients in answering all questions on their own, which leads to a high number of missing responses and reduced reliability to assess daytime sleepiness (Table 2).

Of the 9 alternative items which were identified by literature review and input from expert sleep researchers and sleep medical specialists, nursing staff, and patients, the expert survey identified 7 items which received a median rating of at least moderate adequacy to assess daytime sleepiness in older individuals. Alternative item 8 (sitting in a waiting room) was rated as most adequate, alternative item 6 (during restaurant visit) as least adequate, and alternative item 9 (sitting and waiting for the bus) had the highest variability (Table 3).

Suggestions of the experts to improve the assessment of EDS in older subjects included an interview format and a format to be able to question close relatives/other people with insight into the patient’s sleepiness, an item with a free response format, items assessing sleep propensity during leisure activities commonly performed by older persons such as playing with grandchildren, as well as items assessing actual sleep time during the night and

Table 3. Expert opinion regarding alternative items to assess daytime sleepiness in older subjects

Item	Adequacy				median
	0 none, %	1 slight, %	2 moderate, %	3 high, %	
ALT1 Sitting on a park bench	26.7	26.7	23.3	23.3	1
ALT2 During lunch	16.1	12.9	22.6	48.4	2
ALT3 During breakfast	12.9	16.1	22.6	48.4	2
ALT4 Sitting and talking in a small group	3.3	10.0	20.0	66.7	3
ALT5 During a train ride	22.6	19.4	12.9	45.2	2
ALT6 During a restaurant visit	31.0	24.1	17.2	27.6	1
ALT7 During a family celebration	19.4	0.0	45.2	35.5	2
ALT8 Sitting in a waiting room	3.1	6.3	15.6	75.0	3
ALT9 Sitting and waiting for the bus	32.3	6.5	29.0	32.3	2

day. An interview format and a format to be able to question close relatives/other people with insight into the older patient's sleepiness as well as items assessing actual sleep time during the day were methods previously used in the 3-item ODSI [31, 32]. Most experts (42%) suggested a maximum of 10 items for a screening tool to assess daytime sleepiness in older persons, 8 items, like in the original ESS, was suggested as the maximum by 19% of all experts.

Discussion Expert Survey

In line with previous studies which applied the ESS in the older general population [22, 25, 33] or older patient samples [24, 27, 34], the expert survey identified problems in administering the ESS in older individuals, especially regarding the items assessing sleep propensity in a car, since such situations are not encountered any more.

Patient Study

Patient Study Methods

Based on the results of the expert survey, we tested the original ESS and the 7 alternative items which received a median expert rating of at least moderate adequacy (median score ≥ 2 ; Table 3) to assess daytime sleepiness in older persons in a pilot patient study. We included 1 additional item assessing sleep propensity during typical leisure activities of older individuals (crossword, Sudoku, parlor games) which was suggested by most of the expert survey participants. We tested the 8 original ESS items and 8 new items in the interview form in a sample of 52 in-patients ≥ 65 years of the geriatric department of the Alfried Krupp Hospital in Essen, Germany, and their

close relatives. Patients exhibiting an unstable clinical condition, palliative condition, or severe frailty (entirely dependent on nursing care, life expectancy < 6 months) were not included. To better clarify the concept of sleep propensity, we introduced the following short example before administering the 8 original ESS items and 8 new items: "I would never doze off while I am talking to you, but there is a high chance of dozing off when I am listening to a relaxing CD after work in the evening."

For each of the 16 items in total we assessed: (1) sleep propensity (0 = never to 3 = high chance), (2) whether patients needed help from the nursing staff to answer the item, (3) if patients needed help why they needed help, (4) whether patients could not answer the items, (5) if patients could not answer the item why they could not answer, (6) time needed to answer the item, (7) the adequacy to assess daytime sleepiness (0 = not at all to 3 = well suited). In 2 additional questions with a free response format, we evaluated points of criticism and ideas for improvement.

Patient Study Measures

Epworth Sleepiness Scale

The ESS is an 8-item self-report measure of EDS [20, 21]. Respondents indicate on a 4-point Likert-type scale (0 = never, 3 = high chance) how likely they would be to doze off or fall asleep in 8 different situations based on their usual way of life in recent times. By asking for the likelihood of dozing off or falling asleep in a specific situation instead of how often they do so, the ESS tries to overcome the fact that people have different daily routines. Furthermore, respondents are asked to distinguish dozing behavior from feeling tired. If a person has not been in some of the situations recently, he/she is asked to

estimate how each situation might affect him/her. Of note, we used the 1997 version of the ESS in the present study, which included an extra sentence of instructions to respondents – “it is important that you answer each question as best you can” to reduce the frequency of missing responses [21]. A person’s likelihood of dozing off or falling asleep in one situation (situational sleep propensity) does not necessarily relate to that in other situations. The 8 situations of the ESS are often part of daily life and were chosen on a priori grounds to vary in their somnificity. Somnificity is defined as the general characteristic of a posture, activity, and environmental situation that reflects its capacity to facilitate sleep onset in a majority of persons. For example, item 5 (lying down to rest) represents a situation with a high somnificity, whereas item 6 (sitting and talking) is characterized usually by low somnificity [18]. Responses to the 8 items are summed to yield a total score from 0 to 24. The ESS total score represents a person’s average sleep propensity in daily life with scores of >10 indicting EDS, that is, the tendency to doze off in situations that seldom facilitate dozing in normal individuals [21]. This longer-term, persistent component of daytime sleepiness may be influenced by several factors such as inherently different levels of sleep propensity or the presence of chronic sleep disorders such as obstructive sleep apnea, narcolepsy, or periodic limb movement disorder. It is suggested that a person’s general sleep propensity becomes incorporated into everyday life and determines the likelihood of dozing off or staying awake in various situations [18]. The ESS, ESS-CHAD, and ESS-ALT are subject to copyright (© M.W. Johns 1990, 1997, 2015, 2020). Authorized versions of these questionnaires are made available in various formats, including electronic versions, and in many different languages from Mapi Research Trust, as described in www.epworthsleepiness-scale.com.

New Items

Based on the above-mentioned results of the expert survey (Table 3), the following 8 new items were tested in the patient study: NEW1 during lunch, NEW2 during breakfast, NEW3 sitting and talking in a small group, NEW4 during a train ride, NEW5 during a family celebration, NEW6 sitting in a waiting room, NEW7 sitting and waiting for the bus, NEW8 during crossword, Sudoku, or parlor games.

Additional Measures

Demographic and medical characteristics were collected from patient records. Standardized height and

weight measurements were used to calculate body mass index (BMI; kg/m²). Mobility was assessed by the Barthel index [35] and De Morton mobility index [36]. Frailty was assessed by the Clinical Frailty Scale [37]. Cognitive function was assessed by the Mini-Mental State Examination [38]. Depressive symptoms were assessed by the short form of the Geriatric Depression Scale [39].

Patient Study Statistical Analysis

Continuous data are presented as the mean (SD) for normally distributed data or median (Q1–Q3) for non-normally distributed data; categorical data are shown as the number (%). Statistical comparisons between patients with missing and complete responses in the original ESS or the ESS-ALT were performed by Student *t* test for normally distributed data, by Mann-Whitney test for non-normally distributed data, and by χ^2 test or Fisher’s exact test for categorical data. Statistical comparisons between scores of the original and new ESS items were performed by Wilcoxon signed-rank test. Internal consistency of the scales was assessed by calculating the item to total correlation and the Cronbach’s α coefficient. All hypothesis tests used two-sided tests, and *p* values <0.05 were considered statistically significant. Missing values were excluded listwise. All analyses were done with IBM SPSS Statistics 21 for Windows (IBM Corporation, Armonk, NY, USA).

Patient Study Results

Patient Characteristics

Fifty-two patients aged 65 years or older (mean 84.0, SD 6.4, range 66–96, 32.7% males) admitted to the Geriatrics Department of the Alfried Krupp Hospital in Essen, Germany, in November and December 2019 were included. The clinical characteristics of the patient cohort are presented in Table 4. Most patients were admitted electively (75%) and orthopedic problems were the most frequent reason for hospital admission (58%). Patients exhibited a high level of comorbidities (median number of diseases = 11, Q1–Q3 = 7–13). Frailty and mobility impairment characterizing physical disability was moderate, cognitive deficits characterizing mental disability were rather mild. None of the patients regularly took sleep medication, only 1 patient had a history of sleep disorders. Most patients lived alone without external help so that it was difficult to obtain close relative responses regarding the patients’ daytime sleepiness: a close relative could be recruited for only 7 patients.

Table 4. Characteristics of the patient study cohort ($n = 52$)

Variables	Patient cohort characteristics	Missing responses
Age, years	84.0±6.4	0 (0.0)
Sex, male	17 (32.7)	0 (0.0)
Emergency admission	13 (25.0)	0 (0.0)
Elective admission	39 (75.0)	
Main diagnosis at admission		0 (0.0)
Cardiovascular	10 (19.2)	
Neurological	6 (11.5)	
Pulmonary	3 (5.8)	
Gastroenterological	2 (3.8)	
Nephrological	1 (1.9)	
Orthopedic	30 (57.7)	
Number of diseases	11.0 (7.3–13.8)	0 (0.0)
Number of medications	7.4±2.8	0 (0.0)
Hypnotics	11 (21.2)	0 (0.0)
History of stroke	4 (7.7)	0 (0.0)
History of coronary heart disease	32 (61.5)	0 (0.0)
NYHA classes of heart failure		0 (0.0)
I	25 (48.1)	
II	10 (19.2)	
III	11 (21.2)	
IV	6 (11.5)	
Arrhythmia	24 (46.2)	0 (0.0)
Anemia	37 (71.2)	0 (0.0)
Dementia	14 (26.9)	0 (0.0)
Thyroid dysfunction	7 (13.5)	4 (7.7)
Cancer	10 (19.2)	0 (0.0)
Osteoporosis	19 (36.5)	5 (9.6)
Arthrosis	17 (32.7)	0 (0.0)
Chronic obstructive pulmonary disease	7 (13.5)	0 (0.0)
Arterial hypertension	44 (84.6)	0 (0.0)
Diabetes mellitus	16 (30.8)	0 (0.0)
Hypercholesterolemia	9 (17.3)	10 (19.2)
Current smoking	0 (0.0)	1 (1.9)
Former smoker	7 (13.5)	
Never smoked	44 (84.6)	
BMI	24.4 (22.2;26.8)	1 (1.9)
Renal insufficiency	34 (65.4)	0 (0.0)
Hearing loss		1 (1.9)
None	2 (3.8)	
Slight	47 (90.4)	
Moderate	1 (1.9)	
Deaf	1 (1.9)	
Visual impairment		1 (1.9)
None	4 (7.7)	
Slight	44 (84.6)	
Moderate	1 (1.9)	
Blind	2 (3.8)	
Barthel index	41.0±16.7	0 (0.0)
De Morton mobility index	35.0 (26.0–44.0)	7 (13.5)
Mini-Mental State Examination	27.5 (23.8–29.0)	2 (3.8)
Geriatric depression scale	3.0 (2.0–5.0)	1 (1.9)
Clinical frailty scale	6.0 (5.0–6.0)	2 (3.8)
Fall during the last 3 months	27 (51.9)	0 (0.0)
Housing situation		0 (0.0)
With partner/family	12 (23.1)	
Alone, with external support	4 (7.7)	
Alone, without external support	31 (59.6)	
Nursing home	4 (7.7)	
Assisted living	1 (1.9)	

Data are presented as the mean ± SD, n (%), or median (Q1–Q3).

Table 5. Responses and scores of the original ESS items based on patient's self-report ($n = 52$)

Item	Chance of dozing off, n (%)					Median score (Q1–Q3)	Mean score (SD)
	0 never	1 slight	2 moderate	3 high	missing		
ESS1 Sitting and reading	25 (48.1)	6 (11.5)	8 (15.4)	8 (15.4)	5 (9.6)	0 (0–2)	0.98 (1.19)
ESS2 Watching TV	17 (32.7)	13 (25.0)	17 (32.7)	4 (7.7)	1 (1.9)	1 (0–2)	1.16 (0.99)
ESS3 Sitting inactively in a public place	27 (51.9)	3 (5.8)	3 (5.8)	0 (0.0)	19 (36.5)	0 (0–0)	0.27 (0.63)
ESS4 As a passenger in a car	36 (69.2)	7 (13.5)	5 (9.6)	3 (5.8)	1 (1.9)	0 (0–1)	0.51 (0.90)
ESS5 Lying down to rest in the afternoon	8 (15.4)	8 (15.4)	12 (23.1)	20 (38.5)	4 (7.7)	2 (1–3)	1.92 (1.13)
ESS6 Sitting and talking to someone	48 (92.3)	3 (5.8)	1 (1.9)	0 (0.0)	0 (0.0)	0 (0–0)	0.10 (0.36)
ESS7 Sitting quietly after lunch	18 (34.6)	15 (28.8)	14 (26.9)	4 (7.7)	1 (1.9)	1 (0–2)	1.08 (0.98)
ESS8 In a car while stopped	15 (28.8)	1 (1.9)	0 (0.0)	0 (0.0)	36 (69.2)	0 (0–0)	0.06 (0.25)
ESS Total					38 (73.1)	5 (3–7)	5.14 (2.28)

Patient and Close Relative Responses to the 8 Original ESS Items

Many of the geriatric patients were not able to answer item 3 (sitting inactively in a public place, 37%) and item 8 (in a car while stopped, 69%). Complete responses for all 8 original ESS items allowing a valid calculation of the total score were only obtained for 14 of the 52 patients (27%; Table 5). Patients reported that they were not in these situations as reason for the missing responses, which was confirmed by the responses of their close relatives ($n = 7$; online suppl. Table 1; for all online suppl. material, see www.karger.com/doi/10.1159/000511361). Patients with missing responses in the original ESS differed from those with complete data mainly by being more often female, suffering more often from tumor, exhibiting more often osteoporosis and dementia, and showing lower levels of mobility (online suppl. Table 2). Consequently, both limited experience due to mental or physical disability and limited cognitive capacity due to mental disability might contribute to missing responses for the original ESS items.

Patients did not need a lot of help from the interviewer to answer the items (online suppl. Table 3). Only at the beginning with item 1 (sitting and reading) 12% needed help: the response format had to be repeated, the situation had to be repeated, and the situation had to be described in more detail (patients asked which literature because their sleepiness depends on the content of the literature). Furthermore, patients did not need a lot of time to answer the questions, most being answered within 2 s (online suppl. Table 3). Patients rated the adequacy of the ESS items to assess their daytime sleepiness mostly as moderate or high except for items 3 (sitting inactively in a public place), 6 (sitting and talking to someone), and 8 (in a car while stopped), which were rated as only slightly ad-

equated (item 3) or not adequate (items 6 and 8; online suppl. Table 3). Close relative adequacy evaluations agreed with patient adequacy evaluations (online suppl. Table 4).

Patient and Close Relative Responses to the 8 New Items

As with the original ESS items, we observed missing responses for items covering situations where geriatric patients reported that they no longer experience these situations, like riding a train (item 4, 50%), taking the bus (item 7, 42%), or doing a crossword, Sudoku, or playing parlor games (item 8, 27%; Table 6). All new items were very economic because none of the patients needed help to answer the items and all items were answered very quickly (online suppl. Table 5). Patients rated the new items mostly as inadequate to assess their daytime sleepiness (online suppl. Table 5). Close relative responses agreed with patient responses (online suppl. Tables 6, 7).

Adaptation of the ESS to Assess Daytime Sleepiness in Older Subjects Often Exhibiting Physical or Mental Disabilities (ESS-ALT)

Responses from experts, patients, and close relatives (Tables 1, 5; online suppl. Table 1) showed that item 3 (sitting inactively in a public place) and item 8 (in a car while stopped) of the original ESS were not adequate to assess daytime sleepiness in older individuals who often exhibit physical or mental disabilities. We decided to replace these with new items with similar somnificity and a low number of missing responses. In the present study, the rankings of somnificity (from highest to lowest: items 5, 2, 7, 1, 4, 3, 6, 8; Table 5) for the original ESS items were

Table 6. Responses and scores of the new items based on patient's self-report ($n = 52$)

Item	Chance of dozing off, n (%)					Median score (Q1–Q3)	Mean score (SD)
	0 never	1 slight	2 moderate	3 high	missing		
NEW1 During lunch	50 (96.2)	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0–0)	0.04 (0.19)
NEW2 During breakfast	50 (96.2)	2 (3.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0–0)	0.04 (0.19)
NEW3 Sitting and talking in a small group	46 (88.5)	5 (9.6)	1 (1.9)	0 (0.0)	0 (0.0)	0 (0–0)	0.13 (0.40)
NEW4 During a train ride	12 (23.1)	5 (9.6)	8 (15.4)	1 (1.9)	26 (50.0)	1 (0–2)	0.92 (0.98)
NEW5 During a family celebration	49 (94.2)	0 (0)	1 (1.9)	0 (0.0)	2 (3.8)	0 (0–0)	0.04 (0.28)
NEW6 Sitting in a waiting room	43 (82.7)	4 (7.7)	2 (3.8)	0 (0.0)	3 (5.8)	0 (0–0)	0.16 (0.47)
NEW7 Sitting and waiting for the bus	28 (53.8)	1 (1.9)	1 (1.9)	0 (0.0)	22 (42.3)	0 (0–0)	0.10 (0.40)
NEW8 During crossword, Sudoku, or parlor games	32 (61.5)	3 (5.8)	3 (5.8)	0 (0.0)	14 (26.9)	0 (0–0)	0.24 (0.59)

similar as described before for different samples, ranging from patients with sleep disorders to healthy students [18]. Only item 7 (sitting quietly after a lunch without alcohol) received higher somnificity ratings in our cohort of geriatric patients, most probably due to routine afternoon napping often observed in older people [18].

The somnificity ratings for the original ESS item 3 (sitting inactively in a public place) did not significantly differ from those for the new item 6 (sitting in a waiting room, $z = -0.58$, $p = 0.564$). It also matches by content because in both situations subjects sit passively. The somnificity ratings for the original ESS item 8 (in a car while stopped) did not significantly differ from those for the new item 1 (during lunch) or new item 2 (during breakfast, $z = -1.00$, $p = 0.317$). It also matches by content because in all situations subjects engage in active motor behavior and need high levels of alertness. The new item 8 is very similar to the ODSI item 1 [31]: “Do you fall asleep or do you feel sleepy during basic activities of daily living (washing, dressing, eating, talking, driving or similar conditions ...)?”

Our proposed changes to the original ESS items are comparable to those performed for the construction of the ESS-CHAD, which offers the possibility to take advantage of the previously validated items of the ESS-CHAD [28, 29]. Item 3 of the original ESS (sitting inactive in a public place, e.g., a theatre or a meeting), was changed to “in a classroom at school” in the ESS-CHAD. Similarly, we changed item 3 of the original ESS to “sitting in a waiting room” because older, often multimorbid individuals with physical or mental disabilities more often sit in a waiting room than in a theatre or meeting. Item 8 of the original ESS (in a car, while stopped for a few minutes in the traffic) was changed to “sitting and eating a meal” in the ESS-CHAD to overcome the problem that children

and adolescents do not drive a car. Since our new ESS items “during lunch” and “during breakfast” achieved the same somnificity ratings, which were similar to the somnificity ratings for the original ESS item 8 (in a car, while stopped for a few minutes in the traffic), we decided to change the original ESS item 8 into “sitting and eating a meal” as was done in the ESS-CHAD [28, 29]. With that change, we put an emphasis on the posture of “sitting,” rather than which meal they are having.

For the ESS-ALT total score, only 12 of our 52 patients (23%) had missing values (online suppl. Table 9) whereas for the original ESS this proportion was much higher (73%, $n = 38$; Table 5). This lower number of missing responses was also observed for close relatives (29 vs. 57%; online suppl. Tables 1, 8). The ESS-ALT total score ranged from 0 to 14, measures of central tendency were higher (median = 5.5, Q1–Q3 = 3.3–8.8, mean = 6.0, SD = 3.7) than for the total score of the original ESS (median = 5.0, Q1–Q3 = 3.0–7.0, mean = 5.1, SD = 2.3). In contrast to the original ESS, missing responses in the ESS-ALT were similarly frequent in males and females. As for the original ESS, patients with missing responses in the ESS-ALT more often suffered from dementia and lower levels of mobility than those with complete data (online suppl. Table 9). However, the level of mobility and frequency of dementia differed to a lesser degree between participants with incomplete versus complete data for the ESS-ALT than for the original ESS (online suppl. Tables 2, 9), implying the ESS-ALT is now more adequate for women and those with physical or mental disabilities than the original ESS.

All ESS-ALT item scores are moderately correlated with the ESS-ALT total score (Table 7) and the ESS-ALT shows a considerably higher level of internal consistency (Cronbach's $\alpha = 0.64$) compared with the original ESS

Table 7. Adapted version of the ESS (ESS-ALT) based on patient's self-report ($n = 52$)

Item	Reliability and validity			
	missing responses, n (%)	difficulty, %	corrected item, total correlation	Cronbach's α^3
ESS-ALT1 Sitting and reading	5 (9.6)	32.6	0.47	0.56
ESS-ALT2 Watching TV	1 (1.9)	38.6	0.40	0.59
ESS-ALT3 Sitting in a waiting room ¹	3 (5.8)	5.4	0.36	0.61
ESS-ALT4 As a passenger in the car	1 (1.9)	17.0	0.16	0.66
ESS-ALT5 Lying down in the afternoon	4 (7.7)	63.9	0.54	0.53
ESS-ALT6 Sitting and talking	0 (0.0)	3.2	0.28	0.63
ESS-ALT7 Sitting quietly after a lunch	1 (1.9)	35.9	0.34	0.61
ESS-ALT8 Sitting and eating a meal ²	0 (0.0)	1.3	0.36	0.63
ESS-ALT Total	12 (23.1)			0.64

¹ ESS3 (sitting inactively in a public place), was replaced by NEW6 (sitting in a waiting room).

² ESS8 (sleepy in traffic) was replaced by NEW2 (during breakfast, now termed "sitting and eating a meal").

³ If the item was deleted.

Table 8. Final English version of the ESS-ALT approved by M.W. Johns

ESS-ALT items

1. Sitting and reading
2. Watching TV or a video
3. Sitting in a waiting room
4. As a passenger in a car or a bus for about half an hour
5. Lying down to rest in the afternoon
6. Sitting and talking to someone
7. Sitting quietly by yourself after lunch
8. Sitting and eating a meal

(Cronbach's $\alpha = 0.23$), even though high internal consistency and unidimensionality are no prerequisite for the reliability and validity of the ESS since it comprises situations which differ in their capacity to facilitate sleep onset (somniaficity).

In a personal communication with M.W. Johns, we discussed our above-mentioned study results achieved in a sample of German geriatric patients using a German adaptation of the ESS as an alternative to assess daytime sleepiness in patients with physical and mental disabilities (ESS-ALT). We agreed on using the following items as the final translated English version of the ESS-ALT (Table 8) to integrate our novel findings, that is replace the third item of the original ESS (sitting inactive in a public place, e.g., a theatre or a meeting) with the item "in a waiting room," incorporating the validated changes

previously made in the ESS-CHAD. This English version of the ESS-ALT, like the original ESS and ESS-CHAD, is subject to copyright (© M.W. Johns 1990, 1997, 2015, 2020). Authorized versions of these questionnaires are made available from Mapi Research Trust, as described in www.epworthsleepinessscale.com.

Discussion

Principal Findings

Via a systematic analysis of responses from sleep researchers and sleep medical specialists, nursing staff, geriatric patients and their close relatives, we were able to adapt the original ESS to make it a more adequate alternative for the assessment of daytime sleepiness in adults with physical or mental disabilities. This new ESS-ALT achieves better psychometric properties than the original ESS, including a lower number of missing responses (23 vs. 73%) and higher level of internal consistency (Cronbach's $\alpha = 0.64$ vs. 0.23), while keeping the somnificity structure of the original ESS, including situations with low, moderate, and high probability of dozing off or falling asleep.

Comparison with Other Studies

In a previous study with geriatric in-patients, the German version of the ESS was shown to be inadequate to assess daytime sleepiness since only 36% were able to complete it [27]. In that study, as in our current work, physical disability and dementia were associated with

missing responses. Item 8 (in a car while stopped) had an especially high number of missing responses (60%), but also items 1 (sitting and reading), 3 (sitting inactively in a public place), and 4 (passenger in a car) were not answered by a considerable number of geriatric patients (13, 21, and 14%, respectively) [27]. Similarly, for the French version of the ESS it has been shown that only 40% of patients from 2 university-based geriatric outpatient clinics were able to answer all items [23]. Missing values occurred mostly for items 1 (11%), 3 (22%), and 8 (41%). The authors suggested that missing responses might be explained by the fact that patients were generally not in these situations anymore [23]. We have confirmed this by the evaluation of reasons for missing responses in our study. Also for the original English version of the ESS, item 8 had inadequate psychometric properties: in a large sample of the population-based Study of Osteoporotic Fractures, the item-total scale correlation was only 0.26 in 2,662 white women aged ≥ 70 years [22]. Based on such problems with item 8, the ESS was also applied without this item in older individuals [24, 33] or missing values were substituted by the median of subjects with the same sex and age [4]. However, a methodologically sound construction of a scale to assess daytime sleepiness in older persons exhibiting physical or mental disabilities was missing, which we have now realized with the ESS-ALT. Despite this novel methodologically sound construction it has to be considered that the participants of the expert survey were limited to attendees at a single conference in a single country, and there were no clear mechanisms for selection and consensus. In addition, it is only possible to generalize our results to a limited extent because our sample was composed only of older adults. Reliability and validity in younger adults with physical or mental disabilities need to be established. In the future, the ESS-ALT will be validated against measures of sleep such as polysomnography and pupillometry in subjects and patients with sleep disorders at different ages.

Acknowledgements

The authors express their gratitude to all study participants. We thank Mrs. Nickel-Gögel for her contribution to the geriatric assessment.

Statement of Ethics

The present study complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The study was approved by the Ethics Committee of the University of Duisburg-Essen, Germany (19-8875-BO). All participants gave their written informed consent.

Conflict of Interest Statement

Dr. Johns is the owner of the copyright of ESS, ESS-CHAD, and ESS-ALT. All other authors declare no potential conflicts of interest.

Funding Sources

This work was supported by the Paul Kuth Foundation. The funder had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author Contributions

J.G., A.-C.S., and H.F.: study conception. M.C.I.L., I.G., A.-C.S., and H.F.: data acquisition. M.C.I.L. and J.G.: data analysis. J.G., M.C.I.L., H.F., M.W.J., D.M.H., and T.P.: data interpretation. J.G. wrote the manuscript. All authors revised the manuscript critically for important intellectual content, gave final approval of the version to be published, and 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.

References

- 1 Bittencourt LR, Silva RS, Santos RF, Pires ML, Mello MT. [Excessive daytime sleepiness]. *Braz J Psychiatry*. 2005 May;27(Suppl 1):16–21. Portuguese.
- 2 Brassington GS, King AC, Bliwise DL. Sleep problems as a risk factor for falls in a sample of community-dwelling adults aged 64–99 years. *J Am Geriatr Soc*. 2000 Oct;48(10):1234–40.
- 3 Briones B, Adams N, Strauss M, Rosenberg C, Whalen C, Carskadon M, et al. Relationship between sleepiness and general health status. *Sleep*. 1996 Sep;19(7):583–8.
- 4 Whitney CW, Enright PL, Newman AB, Bonekat W, Foley D, Quan SF. Correlates of daytime sleepiness in 4578 elderly persons: the Cardiovascular Health Study. *Sleep*. 1998; 21(1):27–36.
- 5 Wu S, Wang R, Ma X, Zhao Y, Yan X, He J. Excessive daytime sleepiness assessed by the Epworth Sleepiness Scale and its association with health related quality of life: a population-based study in China. *BMC Public Health*. 2012 Oct;12(1):849.
- 6 Cohen-Zion M, Stepnowsky C, Marler, Shochat T, Kripke DF, Ancoli-Israel S. Changes in cognitive function associated with sleep disordered breathing in older people. *J Am Geriatr Soc*. 2001 Dec;49(12):1622–7.

- 7 Merlino G, Piani A, Gigli GL, Cancelli I, Rinaldi A, Baroselli A, et al. Daytime sleepiness is associated with dementia and cognitive decline in older Italian adults: a population-based study. *Sleep Med*. 2010 Apr;11(4):372–7.
- 8 Hayley AC, Williams LJ, Berk M, Kennedy GA, Jacka FN, Pasco JA. The relationship between excessive daytime sleepiness and depressive and anxiety disorders in women. *Aust N Z J Psychiatry*. 2013 Aug;47(8):772–8.
- 9 Maglione JE, Ancoli-Israel S, Peters KW, Paudel ML, Yaffe K, Ensrud KE, et al. Depressive symptoms and subjective and objective sleep in community-dwelling older women. *J Am Geriatr Soc*. 2012 Apr;60(4):635–43.
- 10 Paudel ML, Taylor BC, Diem SJ, Stone KL, Ancoli-Israel S, Redline S, et al.; Osteoporotic Fractures in Men Study Group. Association between depressive symptoms and sleep disturbances in community-dwelling older men. *J Am Geriatr Soc*. 2008 Jul;56(7):1228–35.
- 11 Davies DP, Rodgers H, Walshaw D, James OF, Gibson GJ. Snoring, daytime sleepiness and stroke: a case-control study of first-ever stroke. *J Sleep Res*. 2003 Dec;12(4):313–8.
- 12 Empana JP, Dauvilliers Y, Dartigues JF, Ritchie K, Gariepy J, Jouven X, et al. Excessive daytime sleepiness is an independent risk indicator for cardiovascular mortality in community-dwelling elderly: the three city study. *Stroke*. 2009 Apr;40(4):1219–24.
- 13 Newman AB, Spiekerman CF, Enright P, Lefkowitz D, Manolio T, Reynolds CF, et al.; The Cardiovascular Health Study Research Group. Daytime sleepiness predicts mortality and cardiovascular disease in older adults. *J Am Geriatr Soc*. 2000 Feb;48(2):115–23.
- 14 Foley DJ, Monjan AA, Brown SL, Simonsick EM, Wallace RB, Blazer DG. Sleep complaints among elderly persons: an epidemiologic study of three communities. *Sleep*. 1995 Jul;18(6):425–32.
- 15 Ganguli M, Reynolds CF, Gilby JE. Prevalence and persistence of sleep complaints in a rural older community sample: the MoVIES project. *J Am Geriatr Soc*. 1996 Jul;44(7):778–84.
- 16 Onen F, Higgins S, Onen SH. Falling-asleep-related injured falls in the elderly. *J Am Med Dir Assoc*. 2009 Mar;10(3):207–10.
- 17 Johns M. The assessment of sleepiness in human drug trials: a new perspective. *Curr Psychopharmacol*. 2019;8(1):5–26.
- 18 Johns MW. A new perspective on sleepiness. *Sleep Biol Rhythms*. 2010;8(3):170–9.
- 19 Kendzerska TB, Smith PM, Brignardello-Petersen R, Leung RS, Tomlinson GA. Evaluation of the measurement properties of the Epworth sleepiness scale: a systematic review. *Sleep Med Rev*. 2014 Aug;18(4):321–31.
- 20 Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep*. 1991 Dec;14(6):540–5.
- 21 Johns M, Hocking B. Daytime sleepiness and sleep habits of Australian workers. *Sleep*. 1997 Oct;20(10):844–9.
- 22 Beaudreau SA, Spira AP, Stewart A, Kezirian EJ, Lui LY, Ensrud K, et al.; Study of Osteoporotic Fractures. Validation of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in older black and white women. *Sleep Med*. 2012 Jan;13(1):36–42.
- 23 Onen F, Moreau T, Gooneratne NS, Petit C, Falissard B, Onen SH. Limits of the Epworth Sleepiness Scale in older adults. *Sleep Breath*. 2013 Mar;17(1):343–50.
- 24 Skibitsky M, Edelen MO, Martin JL, Harker J, Alessi C, Saliba D. Can standardized sleep questionnaires be used to identify excessive daytime sleeping in older post-acute rehabilitation patients? *J Am Med Dir Assoc*. 2012 Feb;13(2):127–35.
- 25 Spira AP, Beaudreau SA, Stone KL, Kezirian EJ, Lui LY, Redline S, et al.; Osteoporotic Fractures in Men Study. Reliability and validity of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in older men. *J Gerontol A Biol Sci Med Sci*. 2012 Apr;67(4):433–9.
- 26 Bloch KE, Schoch OD, Zhang JN, Russi EW. German version of the Epworth Sleepiness Scale. *Respiration*. 1999;66(5):440–7.
- 27 Frohnhofen H, Popp R, Willmann V, Heuer HC, Firat A. Feasibility of the Epworth Sleepiness Scale in a sample of geriatric in-hospital patients. *J Physiol Pharmacol*. 2009 Nov;60(Suppl 5):45–9.
- 28 Janssen KC, Phillipson S, O'Connor J, Johns MW. Validation of the Epworth Sleepiness Scale for Children and Adolescents using Rasch analysis. *Sleep Med*. 2017 May;33:30–5.
- 29 Johns M. The assessment of sleepiness in children and adolescents. *Sleep Biol Rhythms*. 2015;13(Suppl 1):97.
- 30 Peter-Derex L, Subtil F, Lemaitre G, Ricordeau F, Bastuji H, Bridoux A, et al. Observation and Interview-based Diurnal Sleepiness Inventory for measurement of sleepiness in patients referred for narcolepsy or idiopathic hypersomnia. *J Clin Sleep Med*. 2020 Sep;16(9):1507–15.
- 31 Onen F, Lalanne C, Pak VM, Gooneratne N, Falissard B, Onen SH. A three-item instrument for measuring daytime sleepiness: the Observation and Interview Based Diurnal Sleepiness Inventory (ODSI). *J Clin Sleep Med*. 2016 Apr;12(4):505–12.
- 32 Pak VM, Onen SH, Gooneratne NS, Falissard B, Onen F. Observation and Interview-Based Diurnal Sleepiness Inventory for measurement of sleepiness in older adults. *Nat Sci Sleep*. 2017 Sep;9:241–7.
- 33 Kezirian EJ, Harrison SL, Ancoli-Israel S, Redline S, Ensrud K, Goldberg AN, et al.; Study of Osteoporotic in Men Research Group. Behavioral correlates of sleep-disordered breathing in older men. *Sleep*. 2009 Feb;32(2):253–61.
- 34 Onen F, Onen SH. Fundamentals of quality of life and daytime sleepiness measurements in older sleep apnea patients. *Sleep Med*. 2010;11(3):332.
- 35 Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. *Md State Med J*. 1965 Feb;14:61–5.
- 36 de Morton NA, Brusco NK, Wood L, Lawler K, Taylor NF. The de Morton Mobility Index (DEMMI) provides a valid method for measuring and monitoring the mobility of patients making the transition from hospital to the community: an observational study. *J Physiother*. 2011;57(2):109–16.
- 37 Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ*. 2005 Aug 30;173(5):489–95.
- 38 Folstein MF, Folstein SE, McHugh PR. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975 Nov;12(3):189–98.
- 39 Yesavage JA, Sheikh JI. 9/Geriatric Depression Scale (GDS). *Clin Gerontol*. 1986;5(1-2):165–73.