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Determination of the Role of Subjective Investigation Methods in Assessment of Measures of Sleep Quality

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Objectives. To assess the accuracy of questions for determining the quality and duration of sleep. **Materials and methods.** An in-depth study was performed with assessment of sleep parameters in 136 patients, 49 of these undergoing polysomnographic (PSG) investigations. Subjectively, sleep was assessed using the Sleep Quality Questionnaire and the Pittsburgh Sleep Quality Index; objective assessments were obtained from PSG recordings. **Results.** Sleep quality in the laboratory was assessed as "Worse than at home" by one third of respondents. Sleep duration in this group was 1.5 h shorter than in the group assessing sleep in the laboratory as "Just as good at home." Despite this, most respondents slept longer in the laboratory than they had averaged over the preceding month. Overall sleep evaluation showed that 59% of respondents noted sleep disturbance. Nocturnal sleep duration by PSG data was 6.6 [3; 9] h, compared with self-assessments of 7 [3; 10] h ($p = 0.06$); average sleep duration was 8 [5; 10] h ($p = 0.005$); assessments over the last month gave 7 [5; 9] h. **Conclusions.** Assessment of sleep quality in the laboratory as "worse than at home" was linked with subjectively shorter sleep durations. Subjective assessment of sleep duration and the time of falling asleep the evening before were quite accurate, in contrast to subjective assessments of the number of nocturnal wakings. Assessment of mean sleep duration depended on how the question was formulated.

Keywords: sleep quality, sleep duration, polysomnography, questionnaires.

Recent years have seen the appearance of ever more data providing evidence of a link between sleep duration and quality and diseases of various organs and systems [1, 2]. The widespread provision of electricity [3] and the busy-ness of the population limit opportunities for sleep and decrease its duration [4]. Poor sleep quality can be a symptom of many serious diseases (neurological diseases, psychiatric disorders, endocrine system pathology, gastrointestinal tract and lung diseases, states associated with chronic pain syndrome, etc.). In addition, a direct link between sleep quality and death rates was found [5], along with U-shaped relationships between sleep duration, obesity, and lethality [6]. The International Classification of Sleep Disorders edition 2 (ICSD-2) identifies more than 90 sleep disorders or pathological states associated with sleep. Among these, the commonest are insomnia, snoring, and sleep apnea syndrome, narcolepsy, motor disorders, etc. Patients are often unaware that sleep disorders affect the courses of other diseases and their prognoses, though most are able to evaluate their own sleep quality.

Sleep quality is a complex phenomenon which is influenced by parameters such as its duration, the time of falling asleep, the number of nocturnal wakings, the time of going to bed, the time of waking, and the structure of sleep, i.e., the contents of the different sleep stages, their ratios, and also sleep efficiency [7].

Complete and multidisciplinary investigation of patients complaining of poor sleep quality requires a complex approach. Apart from standard procedures (presenting complaints, disease and life history, physical examination), a number of diagnostic investigations must also be carried out to evaluate the qualitative and quantitative characteristics of sleep. Diagnostic methods can be subjective and objective.

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Subjective methods include both general questionnaires helping orient in relation to the more basic characteristics of the patient's sleep (identification of the patient's specific complaints, detailed study of the order of the day and the patient's sleep-related habits, examination of sleep diary), and specific features to identify particular sleep impairments and daytime symptoms arising when sleep quality is degraded: the Pittsburgh Sleep Quality Index, the Epworth Sleepiness Scale, the Karolinska Sleepiness Scale, the Stanford Sleepiness Scale, the Insomnia Severity Index, the Athens Insomnia Scale, the Fatigue Severity Scale, etc. These questionnaires were developed abroad and have not been validated in Russia. The questionnaire most frequently used in Russian practice is the questionnaire developed by Professor Ya. I. Levin et al. giving a points evaluation of the subjective characteristics of sleep [8], which assesses only the main subjective sleep measures.

Procedure used for determining sleep quality are not only long-lasting and laborious, but can be linked with a number of difficulties in both objective and subjective assessment. The gold standard for assessment of sleep quality is polysomnography (PSG). PSG is a complex method of assessing sleep in which a variety of physiological parameters are recorded, including the electroencephalogram (EEG). PSG is an expensive and costly investigation from the point of view of materials and human resources, which limits its use and makes it accessible mostly in large medical centers and specialized laboratories. Also, because of the multitude of electrodes and the fact that patients find themselves in a novel context, they have difficulty falling asleep, which can result in a reduction in nocturnal sleep quality when PSG is carried out and prevents adequate assessment (or decreases the accuracy of the assessment) of impairments. Ambulatory cardiorespiratory monitors, which are widely used in Russia for assessing respiratory disorders, do not include recording of the EEG and do not allow the structure of sleep to be characterized. Actigraphs used for assessing sleep duration and quality, as well as the time of falling asleep and nocturnal awakenings on the basis of movement activity [9], have not received wide use in Russia because of their high cost and the limited number of specialists trained in analyzing actigraphy results.

In summary, there is a noncorrespondence between the need for diagnosis of impairments to sleep quality and existing capacities. In addition, because of restrictions to consultation times, the doctor may not obtain responses to many of the questions in standard questionnaires. Thus, there is value in evaluating the accuracy of the questions used. Thus, the aim of the present work was to assess the accuracy of questions seeking to identify sleep quality and duration.

Materials and Methods. The study cohort consisted of 136 patients (63 men and 73 women, mean age 52 [19; 87] years) who took part in the epidemiological study "Epidemiology of cardiovascular diseases in different regions of Russia" (ESSE-RF) based at the Almazov North-Western Federal Medical Research Center, Russian Ministry of Health, whose protocol has been published elsewhere [10], and who took part in additional structured interviews and underwent PSG.

Sensitivity and specificity were assessed using the Pittsburgh Sleep Quality Index and the Sleep Quality Questionnaire constructed by the Somnology Working Group of the Arterial Hypertension Research Division of the Almazov Center for detection of nonspecific complaints of sleep impairments and focused diagnoses of specific impairments. The Pittsburgh Sleep Quality Index was selected because it is the most widely used in Russia both in clinical work and in scientific investigations for the primary complex evaluation of sleep impairments.

Questions from the Sleep Quality Questionnaire addressing nocturnal sleep in the laboratory were analyzed: "How many hours did you sleep today?" and "How did you sleep today?" (with response options: "Significantly worse than usual," "Slightly worse than usual," "As usual," "Better than usual"). These questions were chosen because of the need to evaluate the effects of being in the laboratory on sleep quality. Other questions from this questionnaire included in the analysis addressed sleep at home: "How many hours do you usually sleep?" and "On average, how long does it take you to go to sleep (minutes)?" Answers to the question "Are you affected by impaired sleep?" were presented as categorial variables ("Yes/No; if yes, then please specify"). Visual analog scales (VAS) were also used to evaluate sleep quality in responses to the question "Please mark a vertical line on the scale to show your usual sleep quality from low (0%) to high (100%)."

The Pittsburgh Sleep Quality Index was developed to evaluate sleep quality during the preceding month [11]. The questionnaire contains 19 points for assessing sleep in terms of seven components: subjective sleep quality, sleep latency, sleep duration, subjective assessment of the adequacy of sleep quality, impairments to sleep quality, use of hypnotic medications, and impairments of daytime functioning. The total score for all components of the scale is in the range 0–21 – scores $\leq$5 points are associated with high sleep quality and scores of $\geq$6 points with poor sleep quality.

Sleep parameters were assessed by individual comparison with PSG results using the following questions from the Pittsburgh Sleep Quality Index: "During the past month, how many hours of actual sleep did you get at night?" and "How long (in minutes) has it taken you to fall asleep each night)in the last month)?"

The question "During the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?" has the following response options: "Not during the past month," "Less than once a week," "Once or twice a week," and three or more times a week." The question "During the past month, how would you rate your sleep quality overall?" had the response options "Very bad," "Fairly bad," "Fairly good," and "Very good." The

question "Do twitching legs disturb you during sleep?, had the following respnse options: "Less than once a week," "Once or twice a week," and "Three or more times a week."

Respondents were asked to complete the questionnaires on their own and ensure that they familiarized themselves with the instructions first.

Sleep was assessed objectively using PSG data (Embla N7000, Natus, USA) in hospital conditions. The following parameters were evaluated: EEG (leads C3, C4, O1, and O2), respiratory flow, chest and abdominal wall movement, electromyogram, electrocardiogram, pulsoximetry, electrocoagulogram, and lower limb movement. PSG was performed in 49 patients (21 men, 28 women). Age was 55 [29, 67] years and body mass index was 25.2 [15.5; 48.2] kg/m^2. Analysis of sleep structure and measures of respiration during sleep were carried out as specified by the American Academy of Sleep Medicine 2014 (version 2.03) [12].

All patients signed informed consent to take part and for data to be processed.

Statistical processing analyzed questionnaire results separately and significance was then calculated by analysis of PSG data. Comparative analysis included the following PSG components: sleep time, sleep efficiency (ratio of sleep time to time spent in bed), time of going to sleep (time from switching off the light to onset of sleep stage 1), number of wakings, time of waking after going to sleep (total duration of periods of waking after onset of the first episode of sleep (wake after sleep onset, WASO) giving the median and the spread of the minimum and maximum.

Analyses were run in IBM SPSS Statistics v.21. Comparative analysis of predictive value was carried out using Fisher's test, the χ^2 test, the odds ratio, and significance intervals; sensitivity and specificity were evaluated, along with the prognostic value of the results. The critical significance level was taken as $p < 0.05$.

Results. PSG results showed that sleep duration was 6.7 [4.2, 9.4] h, efficiency was 77 [47; 97]%, time to fall asleep was 10.5 [2.5, 200.5] min, the number of wakings after going to sleep was 58 [2; 278] per h, and the apnea/hypopnea index was 2.9 [0.3; 73] episodes per hour of sleep. Analysis of questions evaluated how satisfactory sleep was using the response options for the question "How did you sleep today?" Unsatisfactory sleep quality was reported by 16 respondents (33%): "Significantly worse than usual" or "Slightly worse than usual;" 30 patients (61%) responded "As usual" or "Even better" and three (6%) left this question unanswered. In addition, responses to the question "Please indicate your sleep quality as a percentage (0% = worst)" among the group of respondents with unsatisfactory sleep quality gave a sleep quality level of 55 (2–95)%, compared with 70 (5–99)% in the group not complaining of sleep quality during the preceding night. Sleep efficiency based on PSG data in groups of participants with satisfactory and unsatisfactory sleep quality was 76 [49; 94]% and 81 [47; 97]%, respectively. On the other hand, intragroup comparison in subjects with low sleep quality showed a reduction in sleep efficiency on the basis of this question as compared with PSG results, though the difference did not reach statistical significance; the group with high sleep quality on PSG data also experienced decreased efficiency ($p = 0.006$).

In response to the next question logically related to unsatisfactory sleep quality, "Are you affected by impaired sleep?," 15 participants (31%) responded negatively, 29 (59%) positively, and five (10%) gave no response. Six participants denying sleep impairments noted unsatisfactory sleep quality in the previous night. At the same time, only eight of the respondents recognizing that they had sleep problems had had unsatisfactory sleep quality the previous night. Comparative analysis showed that there were no significant differences between sleep quality using this questionnaire and sleep efficiency from PSG data or between sleep duration from the questionnaire data and PSG results

Sleep duration the previous night assessed from questionnaire responses was 7 [3, 10] h, compared with 6.6 [3; 9] h based on PSG data. The usual sleep duration from questionnaire data was 8 (5–10) h, which was longer than indicated by PSG results ($p = 0.005$). Mean sleep duration in the previous night was also compared in relation to satisfaction and dissatisfaction with sleep quality. In people with unsatisfactory sleep quality, sleep duration from PSG data was slightly longer, at 6.3 (4.5–7.5) h, than from the questionnaire, which was 6 (3–9) h. At the same time, respondents who subjectively assessed sleep quality as normal reported longer sleep durations than demonstrated by PSG data – 7.5 [5, 10] and 6.7 [3; 9.4] h, respectively ($p = 0.013$). In addition, despite the absence of any significant differences in sleep duration between the two groups as assessed b PSG – 6.3 [4.5; 7.5] and 6.7 [3; 9.4] h, respectively – subjective sleep duration the previous night was 1.5 h shorter in the group with unsatisfactory sleep – 6 [3; 9] and 7.5 [5; 20] h, respectively.

Comparative analysis of the number of wakings during the previous night using questionnaire and PSG data indicated that all participants underassessed waking frequency: 1 [0; 10] and 23 [2; 83] per h, respectively ($p < 0.0001$). Significant differences in subjective and objective assessments of the time taken to go to were seen: questionnaire data indicated that the whole-group mean waking time for going to sleep was 16.7 [1.5; 200.5] min, while PSG data gave 27.5 [5; 120] min.

It is interesting that responses to the analogous question on the Pittsburgh Sleep Quality Index ("How many minutes does it take you to go to sleep?") give a time of 20 [1; 120] min, which also showed no statistically significant difference from the PSG result. Mean sleep duration (during the last month) on the Pittsburgh Sleep Quality Index was 7 [5, 9] h, which was significantly shorter than the subjectively assessed sleep duration in the previous night and the usual duration of sleep on the Sleep Quality Questionnaire ($p = 0.07$ and $p = 0.012$, respectively).

TABLE 1. Comparative Evaluation of Objective PSG Sleep Measures in Group with Different Frequencies of Low-Quality Sleep on the Pittsburgh Questionnaire, *Me* [min; max]

PSG parameter	Groups with low-quality sleep	
	≤2 times a week (n = 41)	≥3 times a week (n = 8)
Sleep efficiency, %	76 [49; 97]	82.5 [47; 93]
Sleep duration, h	6.8 [4.5; 9]	6.5 [4.2; 7.9]
time to go to sleep, min	15.9 [3; 167]	16.3 [4.3; 54]
Duration of first stage of sleep, %	7.5 [1.3; 30]	5.3 [2.6; 21]*
Duration of second stage of sleep, %	48.5 [19; 62]	50 [29; 68]
Duration of third stage of sleep, %	20 [5.3; 44]	23 [12; 36]
Duration of REM stage of sleep, %	21 [11; 31]	21 [14; 24]
WASO, min	25.5 [5; 120]	20 [6; 237]
Number of sleep cycles, n	4 [2; 7]	4 [1; 5]
Number of wakings, n	24.5 [6; 83]	19 [8; 35]
Index of microwakings, episodes per hour of sleep	7 [2; 85]	3.7 [2; 21]
Index of periodic lower limb movements, episodes per hour of sleep	5 [0; 60]	3.8 [0; 26]
Index of apnea-hypopnea, episodes per hour of sleep	3 [1; 73]	1.8 [0.6; 59]
Mean oxygen saturation, S_aO_2, %	94.7 [90; 97]	94.6 [89; 97]

*$p < 0.05$.

In addition, responses to the question "How often have you had difficulty going to sleep in the last month?" were analyzed. Response options "Never," "Less than once a week," and "Once or twice a week," which were defined as rare recording of low-quality sleep, were given by 41 respondents (83.7%), while the response "More than three times a week" (frequent recording of low-quality sleep) was given by eight participants (16.3%). There were no differences in sleep duration in groups with rarely and frequently recorded low-quality sleep on the Pittsburgh Sleep Quality Index – 7 [5; 9] and 7.8 [6; 9], respectively. There were also no differences between these groups on assessment of sleep duration from PSG data – 6.8 [2.9; 9.4] and 6.4 [4.2; 7.9] h, respectively. Intragroup comparison revealed no differences between sleep duration data from the Pittsburgh Sleep Quality Index and PSG in the groups reporting rare low-quality sleep. However, sleep duration from PSG data was significantly shorter in people with low-quality sleep (three or more times a week) compared with the Pittsburgh questionnaire ($p = 0.025$).

Results obtained by comparison of PSG data in people with low-quality sleep recorded less than and more than three times a week are shown in Table 1. It is interesting to note the fact that despite the absence of any significant differences, median sleep efficiency was better in people with frequent poor sleep three or more times a week, the total duration of the first sleep stage S1 was shorter in those complaining of sleep problems, and there was a tendency to a smaller number of wakings than in people complaining of low-quality sleep less than three times a week.

Analogous comparisons were performed for evaluation of responses to the question "How would you describe the quality of your sleep in the last month?" in the Pittsburgh Sleep Quality Index. The response options were: "Very poor," "Fairly poor," Quite good," and "Very good." The first two and last two responses were combined for analysis into subgroups with unsatisfactory and satisfactory sleep quality, respectively. The distribution of responses to this question was as follows: six respondents (12%) characterized their sleep as "Very poor," 16 (33%) as "Fairly poor," 15 (31%) as "Quite good," and 12 (24%) left this question unanswered. There were no participants in the cohort evaluating sleep quality as "Very good." In addition, the analysis results showed that of all patients with unsatisfactory sleep quality, only six showed reduced sleep quality more than once a week, while 16 subjects of this group had reduced sleep quality less often than once a week. At the same time, six members of the group with satisfactory sleep quality noted poor quality more than once a week, while eight experienced poor sleep quality less than once a week.

The next stage in the analysis was comparison of sleep duration using the Pittsburgh Sleep Quality Index in people with satisfactory and unsatisfactory sleep quality (Table 2).

No significant differences were found – 7.5 [5; 9] and 7 [5; 9] h, respectively, though attention is drawn to the

TABLE 2. Comparative Evaluation of PSG Sleep Measures in Group with Unsatisfactory and Satisfactory Sleep Quality on the Pittsburgh Questionnaire, *Me* [min; max]

PSG parameter	Groups with low-quality sleep	
	less than 3 times a week (n = 41)	more than 3 times a week (n = 41)
Sleep efficiency, %	87 [53; 97]	74 [47; 94]*
Sleep duration, h	6.9 ± 1.3	6.2 ± 1.6
time to go to sleep, min	10.8 [3; 111]	15 [3; 201]
Duration of first stage of sleep, %	6.3 [1.3; 10]	6.8 [2; 30]
Duration of second stage of sleep, %	50 [19; 62]	45 [29; 68]
Duration of third stage of sleep, %	20 [11; 44]	23 [5; 36]
Duration of REM stage of sleep, %	23 [14; 31]	19 [11; 34]
WASO, min	42 [2; 255]	41 [6; 278]
Number of sleep cycles, n	4 [3; 7]	4 [1; 6]
Number of wakings, n	23 [6; 43]	19 [8; 83]
Index of microwakings, episodes per hour of sleep	4.6 [2; 85]	9.5 [2; 61]
Index of periodic lower limb movements, episodes per hour of sleep	0.5 [0; 60]	0.8 [0; 37]
Index of apnoea-hypopnea, episodes per hour of sleep	2.6 [0.6; 7.8]	5.1 [0.3; 73]
Mean oxygen saturation, S_aO_2, %	96 [90; 98]	94 [89; 98]

*$p < 0.05$.

fact that PSG data indicated that people with satisfactory sleep quality had shorter sleep durations than people with low-quality sleep – 6.4 [2.9; 8.8] and 6.8 [4.8; 9.4] h, respectively ($p = 0.2$). There was also a tendency to overestimate sleep duration on this question as compared with PSG results in people with satisfactory sleep quality. Comparison of sleep parameters using PSG data in groups with unsatisfactory and satisfactory sleep quality on the Pittsburgh Sleep Quality Index showed that the only significant difference was in sleep efficiency – 87 [53; 97]% and 74 [14; 94]%, respectively ($p = 0.042$).

Discussion. The results obtained here did not provide for any unambiguous recommendation to use questionnaire questions giving precise evaluations of sleep duration and quality. The subjective sleep time is perceived by many as the time of going to bed. Sleep duration is assessed using PSG data by subtracting the time taken to go to sleep and the duration of waking after going to sleep. Nocturnal wakings themselves, like the levels of particular sleep phases, can influence the subjective assessment of sleep quality. Our study sought to identify the causes underlying differences in sleep duration or quality while in the laboratory.

Not all study participants slept equally well in the laboratory. Subjectively, one in three subjects assessed sleep quality during laboratory sleep as lower than usual. These results are not inconsistent with observations in routine practice: most clinicians find that novel sleeping conditions and cumbersome equipment can influence sleep quality and duration. A number of scientific studies designed to avoid this situation run PSG for two nights and analyze data collected on the second night [13]. The so-called "first night" effect consists of increases in the time taken to go to sleep, delayed onset of REM, a low level of REM sleep, and a lower level of sleep efficiency [14]. At the same time, patients with depression and suffering from sleep impairments showed the opposite effect, with better sleep characteristics during PSG in the first night [15].

Sleep quality can be evaluated using a variety of approaches. The present study used both qualitative and quantitative measures. Assessment of mean sleep quality on a VAS did not indicate how sleep quality changed in the laboratory. Visual scales are used throughout the world to assess the dynamics of changes in various sleep parameters during treatment without being confined to assessment of sleep quality [16].

PSG data indicate that differences between groups of participants noting unsatisfactory and good sleep quality were significant only in terms of the level of the first stage. Respondents subjectively assessing sleep quality as unsatisfactory were more accurate on this assessment than those evaluating sleep as good, which decreased its efficiency. Sleep efficiency in the group with subjectively low sleep quality was better than in the group with subjectively high quality. The authors of a study, which included young wom-

en given the opportunity to sleep for different periods, of 6 h and 1 h, for 10 days were among the first to identify factors for assessment of good sleep. The study results indicated that a predictor for good sleep was a level of sleep efficiency of greater than 87%, while the stage structure was not. Sleep quality also improved towards the time of the acrophase of the circadian temperature rhythm (17:00–21:00) [7]. Studies in a group of elderly people showed that the main predictor of satisfactory sleep was not its duration, but the amount of deep sleep [17], which was not assessed in the present investigation.

Evaluation of the question of the presence of sleep impairments did not identify any correlation with sleep quality during the previous night. Respondents were able to provide quite accurate estimates of sleep duration the previous night, as compared with PSG data. Mean sleep duration in the questionnaire was addressed by several questions – which gave different results. Subjectively, respondents evaluated sleep duration in the laboratory as the same as in the answer to the question "On average how many hours a night have you slept in the last month?" for the Pittsburgh Sleep Quality Index – 7 [3; 10] and 7 [5; 9] h ($p = 0.07$) and 1 h shorter than in the answer to the question "How many hours do you usually sleep?" from the Sleep Quality Questionnaire – 8 [5; 10] h ($p = 0.012$). These differences may be due to different subjective assessments of sleep duration and the early start of the PSG (PSG recording ended at an average of 20–21 h) and the absence of factors limiting the opportunity to go to sleep at home (social activity, television, internet, etc.). Going back to the primary source, subjective and objective assessments of sleep duration were not different during validation of the Pittsburgh Sleep Quality Index [18]. Data have also been obtained in specific groups, for example, patients with insomnia [19]. There were certain individual differences in subjective assessments of sleep duration and quality. Subjective underestimation of sleep duration and quality is often incorporated into a separate category of insomnia – paradoxical insomnia [20, 21]. The study reported by Mercer et al. [22] showed that subjects with "good sleep" overestimated their sleep duration, while those evaluating their sleep as "poor" underestimated it.

Objective assessment of sleep by PSG identified a shorter duration of sleep than the usual duration on this question – 6.7 [4.2; 9.4] and 8 [5–10] h, respectively ($p = 0.005$), while there was no difference in mean sleep duration in the last month – 7 [5; 9] h ($p = 0.4$). A high frequency of low-quality sleep in the last month was noted by 16.3% of subjects. PSG data did not confirm any differences in subjective assessments of the frequency of low-quality sleep. The group with unsatisfactory sleep quality overestimated sleep duration by almost 1.5 h as compared with PSG data. All these differences provide evidence that PSG is not always the method of choice for assessing sleep, especially in out-patient conditions. In this situation, the variant of choice is use of a sleep diary in which the patient records data in the morning after waking up, or use of actigraphy along with a sleep diary [9].

Subjective assessment of nocturnal waking is also difficult. This is associated with the fact that macro-wakings, which are shown by PSG to last more than 15 sec, are often not perceived during sleep. The frequency of nocturnal wakings was 1 [0; 10] by questionnaire data and 23 [2; 83] by PSG data ($p < 0.0001$). Despite the significant spread in values and the divergence between subjective and objective evaluations of the time taken to go to sleep, these differences were not significant ($p = 0.9$). In the literature, one explanation for underestimation of sleep duration in patients with insomnia is their inability to evaluate time [23]. In clinical practice, diagnosis and selection of treatment tactics for these patients is difficult [24] and patients often require psychiatric consultations and observation.

Sleep duration in people subjectively evaluating laboratory sleep as "worse than at home" was, according to the questionnaire, shorter, despite identical sleep duration on the PSG. Most respondents slept longer in the laboratory than they did on average during the previous month. Accurate subjective evaluation of the number of nocturnal wakings is difficult.

Sleep quality in the laboratory could affect assessments of sleep duration. Respondents denying any changes in sleep quality overestimated their sleep duration.

When using questionnaires it is important to separate sleep duration in the previous night and the mean (overall/in the last month) sleep duration. Assessment of mean sleep duration can be different when different time frames are used. Thus, subjective sleep duration in the last month was greater than simply the mean sleep duration.

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