# The Minimal Insomnia Symptom Scale (MISS): A Brief Measure of Sleeping Difficulties 

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#### Abstract

To evaluate basic psychometric properties and obtain normative values for a novel 3-item scale, the Minimal Insomnia Symptom Scale (MISS), a sleep questionnaire was sent out to a randomly selected sample of the general population, aged 20-64 years. Responses were obtained from 1075 subjects corresponding to a response rate of $78 \%$. Results showed that MISS possessed satisfactory reliability and validity. Women scored significantly higher than men while there was no age relationship. A receiver operating characteristic curve analysis revealed that MISS was able to distinguish subjects with a clinical insomnia according to ICD-10 research criteria. The main advantage of MISS over other insomnia instruments is its brevity and ease of use. Evidence was provided for the utility of MISS in epidemiological settings. MISS also showed promise as a convenient ultra-short screening measure of insomnia in health care settings.


## Introduction

Sleeping difficulties are a common problem in our society. For the individual, it is not only causing considerable distress but also lowered mood and cognitive impairment during the day. Insomnia has traditionally been regarded as a symptom of various underlying disorders or conditions but is now being conceptualized as a disorder of its own (1), albeit with a high rate of co-morbidity (2).

Furthermore, during the last decades persistent sleeping difficulties have been recognised as a risk factor for developing other disorders. For example, Mallon has reported from a longitudinal study that women with moderate complaints of insomnia at baseline suffered a significantly increased risk for being depressed 12 years later (3), while men with severe complaints of insomnia at baseline suffered a risk for developing diabetes after 12 years (4). Men with moderate complaints of insomnia at baseline even suffered an increased risk of death from coronary artery disease 12 years later (5).

Insomnia symptoms have a strong tendency to become persistent. For example, Mallon has reported that about $75 \%$ of subjects with moderate insomnia symptoms at baseline continued to have such symptoms at the 12 -years follow-up (3). Also, there is growing evidence that sleeping difficulties have become more prevalent in
recent years (e.g. 6, 7). Therefore, the recognition of sleeping difficulties is important in both epidemiological health surveys and in clinical practice.

In the tenth revision of the International Classification of Diseases, ICD-10, by the World Health Organisation (8), the cardinal symptoms of insomnia are described as difficulty falling asleep or maintaining sleep, or non-refreshing sleep. For diagnosis, there are additional criteria to be fulfilled regarding duration of symptoms and frequency of symptoms. Further, the insomnia diagnosis requires that the nighttime symptoms result in impaired daytime functioning. Very similar key criteria have been proposed by the American Psychiatric Association in their Diagnostic and Statistical Manual on Mental Disorders, DSM-IV (9) and by the American Academy of Sleep Medicine in their International Classification of Sleep Disorders, ICSD-2 (10). While defined and detailed diagnostic criteria for insomnia are crucial for a proper evaluation of patients in clinical practice, there is still a need for a short and graded measure of sleeping difficulties for the initial assessment.

Uppsala Sleep Inventory (USI) is a comprehensive measure of sleep habits, sleep disturbances, and related matters. It was introduced by Hetta and research collaborators more than twenty years ago (11). Since then the entire questionnaire, or selected sections of it, has been used in several epidemiological surveys, for example in the Gävle-Dala district (12), in a study on insufficient sleep in the general population (13), in an elderly population (14), and in the Örebro Insomnia Cohort (15). It has also been used in various patient populations, e.g. in Sjögren's syndrome (16), in systemic lupus erythematosus (17), in ankylosing spondylitis (18), in Wilson's disease (19), in chronic heart failure (20), in coronary artery disease (21), and in patients on dialysis treatment (22). Further, it has been used in a 12-year follow-up study of a middle-aged population (3-5) and some of its items have also been subject to a validation study against polysomnography (23). USI includes three items that tap the cardinal symptoms of insomnia, i.e., difficulties falling asleep, night awakenings, and not becoming rested by sleep. Subjects are requested to rate how much of a problem they have with these symptoms by use of five response categories. Results in earlier studies have typically been reported as proportions of moderate or severe problems for each item. To take full advantage of the graded response format it was suggested to calculate a composite score from the three items. The resulting ultra-short scale, with a total score ranging from 0 to 12, was named the Minimal Insomnia Symptom Scale (MISS).

The aims of the present study was (a) to evaluate a simple and brief measure of insomnia symptoms, the MISS, for possible use in epidemiological settings and in clinical practice, (b) to assess its basic psychometric properties, and (3) to provide normative data from the general population.

## Methods

## Subjects

A randomly selected sample of 1400 subjects, 713 males and 687 females, aged 20-64 years, and living in the municipality of Enköping in mid-Sweden, was drawn from the population register. Twenty-one subjects were excluded; 4 subjects were unable to respond properly due to severe handicaps, 16 had moved to another address, and 1 had died before receiving the questionnaire. Thus, 1379 subjects were eligible for participation. After two reminders responses were obtained from 1075 subjects, which corresponds to a response rate of $78.0 \%$.

## Questionnaire

The questionnaire had a four-page format and included 67 items. Besides items on basic demographics and several items from USI there was the eight-item Vicious cycles of sleeplessness scale (24) and the Epworth Sleepiness Scale (25). Results concerning these latter scales will be presented elsewhere. One question about sleep quality during the last three months was adopted from the Basic Nordic Sleep Questionnaire (BNSQ; 26). Clinical insomnia was determined according to ICD-10 research criteria (8), i.e. affirmative answers to each of the following four questions: (a) having sleeping difficulties, (b) with a frequency of at least three times a week, (c) and a duration of at least one month, (d) and perceiving major daytime consequences from poor sleep (e.g., tiredness, irritation, depression, concentration difficulties, impaired functioning in daily life, or a reduced capacity for work). The questionnaire also asked whether the subjects approved to participate again and receive another questionnaire at a later time.

## Procedure

The questionnaires were sent out by post (in June) with an attached pre-stamped envelope. A cover letter explained the purpose of the study and the subjects were invited to participate. Full anonymity protection was ensured. Reminders were sent to those who had not yet responded after two and four weeks, respectively. After six months another almost identical questionnaire was sent to those 923 subjects who had approved to participate again and a total of 755 subjects responded to the second survey. The study was approved by the Ethics Committee of the Faculty of Medicine at Uppsala University.

## Statistics

Statistical analyses were performed by use of SPSS 12.0.1 for Windows (SPSS Inc.). Internal consistency was assessed by calculation of Cronbach's coefficient alpha. In the subsample that responded a second time after 6 months, test-retest reliability was investigated by intraclass correlation (ICC), and sensitivity to change
was assessed by use of paired $t$ tests. The discriminative accuracy of MISS was tested against self-assessed clinical insomnia according to ICD-10 research criteria (8). Consequently, to investigate the effectiveness of MISS as a continuous measure a receiver operating characteristic (ROC) curve analysis was performed and the area under the curve (AUC) was calculated. Various cut-off levels of the MISS score were tested with regard to sensitivity, specificity, and positive and negative predictive values (PPV, NPV). The Youle index (i.e. sensitivity + specificity-1) was used to determine the optimal cut-off level. Sensitivity is the proportion of subjects with clinical insomnia who score above the threshold, while specificity is the proportion of subjects without clinical insomnia who score below the threshold. The PPV is the proportion of subjects who score above the threshold and actually have clinical insomnia, while the NPV is the proportion of subjects who score below the threshold and actually do not have clinical insomnia.

## Results

## 1. Basic psychometric properties and normative values

As can be seen in Table 1 all response categories were adequately endorsed. The distribution of scores was positively skewed (see Figure 1) which would be expected since items measure symptoms of a disorder that is not normally distributed in the population.

Table 2 shows means, SDs and medians for individual MISS items and the total score. It also displays the reliability analysis and shows that item-total correlation coefficients for MISS items were adequate. It also reveals that the alpha coefficient for the total score was satisfactory and that the deletion of any individual item did not result in a higher alpha for the total score. Thus, all three items contributed to the internal consistency of the scale.

Table 1. Endorsement rates (in percent) of the response categories for individual MISS items

|  | None <br> $(0)$ | Small <br> $(1)$ | Moderate <br> $(2)$ | Severe <br> $(3)$ | Very severe <br> $(4)$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Problems with: |  |  |  |  |  |
| - difficulties falling asleep | 54.3 | 22.4 | 15.3 | 6.2 | 1.9 |
| - night awakenings | 31.3 | 33.4 | 22.5 | 8.8 | 4.1 |
| - not being rested by sleep | 27.8 | 27.8 | 26.6 | 13.1 | 4.7 |



Figure 1. The frequency distribution of MISS scores among all subjects ( $\mathrm{N}=1045$ ).

Table 2. Means, SDs and medians for MISS item scores and total score and reliability analysis

|  | Mean | SD |  | Corrected <br> item-total <br> correlation | Alpha <br> if item <br> deleted |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Problems with: |  |  |  |  |  |
| - difficulties falling asleep | 0.79 | 1.03 | 1 | .54 | .65 |
| - night awakenings | 1.20 | 1.10 | 1 | .54 | .65 |
| - not being rested by sleep | 1.39 | 1.16 | 1 | .57 | .61 |
| Total score | 3.38 | 2.65 | 3 | $.55^{\text {a }}$ | $.73^{\text {b }}$ |

$a=$ Averaged item-total correlation, $b=$ Alpha for the total score

The relationship between the BNSQ question about sleep quality and MISS total score was then explored. The correlation coefficient was found to be high with $r=.76$. Then a comparison of MISS scores was made between subjects with varying sleep quality according to their answers on the BNSQ question. A one-way ANOVA showed an overall significant difference between the groups ( $\mathrm{F}=355.0$; $\mathrm{p}<0.0001$ ), and a post hoc Scheffé test showed that each group differed significantly $(\mathrm{p}<0.0001)$ from the others. Figure 2 illustrates that a poorer sleep quality was related to higher MISS scores.

Table 3 provides normative values for MISS scores and are presented separately for men and women and for the three age groups. A 2-way ANOVA revealed a significant effect of Sex ( $\mathrm{F}=13.3$; $\mathrm{p}<0.001$ ) but no effect of Age Groups ( $\mathrm{F}=1.4$; n.s.) and no interaction between Sex and Age Groups ( $\mathrm{F}=0.62$; n.s.).

Table 3. Normative values for MISS scores separated for sex and age groups

|  | Women |  | Men | SD |
| :--- | :--- | :--- | :--- | :--- |
| Age groups | Mean | SD | Mean | 2.38 |
| $20-34$ years | 3.36 | 2.62 | 2.95 | 2.48 |
| $35-49$ years | 3.90 | 2.96 | 3.06 | 2.46 |
| 50-64 years | 3.71 | 2.74 | 3.16 | 2.45 |
| Total | 3.68 | 2.80 | 3.07 |  |



Figure 2. Means and SDs of MISS scores according to ratings of sleep quality in five response categories.

## 2. ROC analysis and cut-off points

To assess the ability of MISS to discriminate subjects fulfilling ICD-10 research criteria (8) for insomnia from the other subjects a ROC analysis was performed. The ROC curve for MISS is presented in Figure 3. Area under the curve was 0.92 ( $\mathrm{SE}=0.01 ; 95 \% \mathrm{CI}: 0.89-0.94$ ) which was significantly different from chance.

Various cut-off levels of the MISS score were then tested with regard to sensitivity, specificity, PPV and NPV. Table 4 shows operating characteristics of MISS at three different cut-off levels. According to the Youle index, a cut-off level at $\geq 6$ would be optimal and is therefore suggested. In the present population $22.5 \%$ of all subjects scored above this cut-off.

## 3. Sensitivity to change

The questionnaire was administered twice with a 6 -months interval. To evaluate test-retest reliability MISS scores were compared between the first and second survey and the correlation was found to be high with an ICC coefficient of 0.79 . Since prevalence of insomnia can be assumed to have changed over a 6 -months time, comparisons were also made separately in groups of subjects according to their

Table 4. Sensitivity, specificity, positive predictive value (PPV), negative predicted value (NPV), and Youle index at three cut-off points of MISS score with ICD-10 research criteria for insomnia as criterion standard

| Cut-off score | Prevalence <br> $(\%)$ | Sensitivity <br> $(\%)$ | Specificity <br> $(\%)$ | PPV <br> $(\%)$ | NPV <br> $(\%)$ | Youle index |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $\geq 5$ | 31.0 | 0.90 | 0.77 | 0.34 | 0.98 | 0.67 |
| $\geq 6$ | 22.5 | 0.82 | 0.86 | 0.44 | 0.97 | 0.68 |
| $\geq 7$ | 13.8 | 0.66 | 0.93 | 0.57 | 0.95 | 0.59 |




Figure 3. Receiver operating characteristic (ROC) curve for changes in scores on MISS with fulfillment of ICD-10 research criteria for insomnia as standard criterion.

Figure 4. Mean MISS scores at baseline and after six months separated according to fulfillment of ICD-10 research criteria for insomnia ( $\mathrm{n}=755$ ).
fulfillment of the insomnia research criteria (see Figure 4). Paired $t$ tests revealed that there was a strong trend for an increase ( $\mathrm{m}=+0.80 ; t=2.0 ; \mathrm{p}=0.053$ ) in those 29 subjects who deteriorated while there was a significant decrease ( $\mathrm{m}=-1.06 ; t=2.9$; $\mathrm{p}<0.01$ ) in those 35 subjects who improved. MISS scores for subjects who fulfilled criteria at both times $(\mathrm{n}=56)$ or at neither time $(\mathrm{n}=596)$ did not differ significantly between the two occasions.

## Discussion

The major aim of the present study was to evaluate some psychometric properties of a novel brief scale about sleeping difficulties. Results have shown that MISS possessed adequate reliability and validity. Normative data for the general population were presented which facilitates the interpretation of individual scores. The scale was shown to be stable over six months and was also sensitive to change in insomnia status according to ICD-10 (8) research criteria. The MISS consists of three items tapping the cardinal symptoms of insomnia, i.e. difficulties initiating sleep, difficulties maintaining sleep, and non-restorative sleep. The intercorrelations between items were high. While the first two items concern sleep directly the third item concerns the effects of sleep on wakefulness. Nevertheless, results suggest a close relationship between all three key symptoms in a normal population.
As already mentioned in the introduction, there are at least two main areas where there is a need for a brief instrument to assess insomnia symptoms. To begin with, information about sleeping difficulties is often of interest in epidemiological investigations of other health related aspects. Such investigations are important in exploring factors behind the development of common disorders. This is of particular importance since insomnia has been shown to be associated with a number of diseases and a putative risk factor for developing a number of other disorders of both psychiatric and somatic nature. Hence, there is an obvious need for a few reliable and valid key items about insomnia symptoms that could be included in health surveys that not specifically focus on sleep. Results of the present study provide evidence that MISS may serve as such a tool pertinent for use in epidemiological settings. Secondly, it is increasingly recognised that sleep complaints are even more prevalent in patients with various diseases than in subjects from the general population. Consequently, there is a need for a simple screening instrument, which can be used to assess sleeping difficulties in clinical health care settings. Due to time constraints such an instrument has to be brief and easy to administer. In hospital care MISS could be used routinely by nurses in health assessment and evaluation of their patients' sleeping difficulties. Finally, treatment outcome may be another important area where MISS could be applied. In the evaluation of both pharmacological and psychological treatment there is a need for a simple and sensitive measure of insomnia severity.

There are already some valid and reliable insomnia scales with excellent psychometric properties that are used internationally, e.g. the Pittsburgh Sleep Quality Index (27) and the Insomnia Severity Index (28). These scales have become indispensable for the more thorough evaluation of insomnia patients. However, they may be too long to incorporate in epidemiological health surveys. They may also be too time-consuming and complicated both to administer and to evaluate as initial screening tools in clinical routine. A main advantage of MISS over these and other measures of insomnia is its brevity and ease of use that makes it possible to complete the scale in a moment.

Though a graded measure is useful to detect differences both within and between
individuals it is often desirable to define a cut-off level in order to identify subjects with a possible clinical insomnia. A score of at least 6 was suggested to characterize subjects with clinical insomnia. By choosing this level equal weight was given to sensitivity and specificity. In clinical practice however, it is often more important to estimate the probability of clinical insomnia in a given individual. In these cases the predictive values of a cut-off level is a more pertinent measure. The present results from the general population indicated a rather low PPV but since predictive values are dependent on the prevalence in the studied population a higher PPV (and a lower NPV) would be expected in a patient population. Further studies are needed in this respect.

There are some obvious limitations with regard to the scale. While possibly useful for screening purposes, MISS is too short to provide a full description of the sleeping difficulties of an individual. However, once the MISS has detected insomnia symptoms other more comprehensive questionnaires could be applied. Further, although closely related to the research criteria for insomnia MISS cannot be used for diagnostic purposes. Also, MISS items are based upon the individual's own assessment of how much of a problem his sleeping difficulties constitutes and no information is given of its frequency of occurrence nor of quantitative measures, e.g. how long it takes to fall asleep and the number of night awakenings, etc. While these measures certainly are of interest, insomnia is based upon the subject's own perception of his or her sleeping difficulties and it is also these subjective complaints that bring the patient to seek help.

Another limitation of the present study is that ICD-10 research criteria (8), used for the validity assessment, were self-assessed while the fulfillment of insomnia criteria ideally should have been judged by a clinician. However, this is difficult to perform in large epidemiological surveys of practical reasons. It should also be kept in mind that the psychometric properties reported here are confined to studies on the general population. It is therefore a need for further testing of MISS in a clinical setting. As a final note, MISS does not evaluate insomnia symptoms during a defined time period. A time frame may be used, especially when repeated measures are obtained. Also this aspect needs further study. In future studies, MISS should be compared to other, internationally established scales to assess its convergent and divergent validity. Besides further data from the general population, data should also be obtained from clinical insomnia samples. Although some evidence for sensitivity to change was found in the present study, further longitudinal studies involving both pharmacological and psychological treatments are needed in this respect.

In conclusion, the present study has provided preliminary evidence for the usefulness of the MISS in epidemiological studies and in non-clinical settings. This self-rated scale may also have a potential utility as a screening measure in health care.

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