Symptoms in the general Norwegian adult population - prevalence and associated factors

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Abstract

Background Patients’ own perceptions and evaluations of symptoms, functioning and other health-related factors, i.e. Patient Reported Outcomes (PROs), are important elements for providing good patient care. Symptoms are subjective and best elicited by the patient orally or by using PRO measures (PROMs). Reference values on frequently used PROMs facilitate the interpretation of PROMs scores both in clinics and research settings, by comparing patient data with relevant samples from the general population. Objectives Study objectives were to (1) present reference values for the M.D. Anderson Symptom inventory (MDASI) (2) examine the occurrence and intensity of symptoms assessed by the MDASI in a general Norwegian adult population sample, and (3) examine factors associated with higher symptom burden defined as the sum score of all symptoms, and factors associated with symptoms’ interference on functions Methods In 2015, MDASI was sent by mail to a representative sample of the general Norwegian adult population (N = 6165). Medical comorbidities were assessed by the Self-Administered Comorbidity Questionnaire. Depression was self-reported on the Patient Health Questionnaire 9 (PHQ-9). Linear multivariable regression analysis was used to examine for factors associated with MDASI sum score and factors associated with symptoms’ interference on functions. Results The response rate was 36%. More females (54%) than males (46%) responded. Mean age was 55 years (SD 14). The most frequent symptoms were fatigue (59.7%), drowsiness (56.2%) and pain (56.1%). Fatigue, pain and disturbed sleep had the highest mean scores. The presence of one or more comorbidities, increasing PHQ-9 score and lower level of education were associated with higher MDASI sum score (p<0.001). The MDASI sum score and the PHQ-9 score were positively associated with all interference items (p<0.001) except for walking (p=0.22). Conclusion This study provides the first Norwegian reference values for the MDASI. The presence of one or more comorbidities, higher level of depressive symptoms and lower level of education were significantly associated with higher MDASI sum score. These covariates must be controlled for when using the reference values.

Introduction

Patient Reported Outcomes (PROs) are patients’ own perceptions and evaluations of symptoms, functioning and other health-related factors, and are important elements for providing good patient care (1). A symptom is defined as any subjective evidence of a disease, health condition, or treatment-related effect that can be noticed and known only by the patient (1). In contrast, a “sign” is any objective evidence of disease that can be identified by health care personnel by observations, examinations, biomarkers, imaging etc. or may be noticed and reported by the patient (1). Symptoms may indicate the presence of a disease or a disorder but may also reflect normal variations in physical or psychological states as commonly experienced by most individuals. Symptoms are common in the general population (2-5). A large Danish nationwide cohort study with 49 706 respondents representative of the general population demonstrated that symptoms were common; about 9 out of 10 respondents reported at least one symptom within the preceding four weeks (2). Other population studies have reported that 75% and 90% had experienced at least one symptom in the previous two weeks and 30 days respectively (3, 5). Some symptoms have low positive predictive value for disease while others are stronger predictors (6). As this may vary for different symptoms across diseased populations, reference values from the general population will provide important information about the symptoms’ predictive values for disease. The prevalence of symptoms in the general population is found to be associated with factors such as chronic conditions, age, employment status, living situation and psychiatric disorders (3, 7). The number of symptoms is also documented to have a linear relationship with functional status (4).

Patient-Reported Outcome Measures (PROMs) denote any standardized measure of a PRO, i.e. a questionnaire, of a patient’s health and quality of life (QoL) (8). These questionnaires are intended for self-completion by patients, in the form of the traditional paper forms or more recently in electronic formats (e-PROMs) for use on different platforms, e.g. cell phones, computers, tablets etc. (9). PROMs provide information that comes directly from the patient (8). In clinical care, PROMs can be used alongside laboratory tests and imaging, if properly assessed and followed. Regular and systematic use of PROMs may improve communication between patients and health care providers (10) and be used to monitor treatment response and detect unrecognized problems or problems not reported spontaneously by the patient (11). Beyond their clinical utility, PROMs are increasingly being used as outcomes in epidemiologic, health economic and clinical research (12). PROMS are also central components of patient-centered care (13, 14). Recent studies suggested that active use of PROMs during treatment for advanced cancer may even prolong survival (15-17).

Clinicians or researchers often request reference data to facilitate the interpretation of patient data or study results (18). Reference values for PROMs facilitate the interpretation of PROMs scores both in clinics and research settings, by comparing patient data with relevant samples from the general population. Reference values may also be used to evaluate the relative symptom burden of a disease (19). Hence, a number of datasets with population-based reference data have been published and are frequently being used,
e.g. the Patient-Reported Outcomes Measurement Information System (19), European Organisation for Research and Treatment of Cancer (EORTC) Core Quality of Life Questionnaire C30 (20) and the Functional Assessment of Cancer Therapy-General (21). Reference values make comparisons between samples possible, but this requires adjusting for known variables that affect the outcomes, e.g. age, sex, residence, education, comorbidities and other sociodemographic variables (20, 22). The relevance of valid reference data is illustrated in follow-up studies among cancer survivors, which may go beyond 20 years post-treatment. During such a long period, common age-related health problems and life events may influence which symptoms the cancer survivors experience and how they perceive their QoL and level of functioning. By comparing with data from the general population one can ascertain if cancer survivors are at excess risk for specific symptoms and health problems compared to individuals with similar age, sex and other background variables.

The M.D. Anderson Symptom Inventory (MDASI) is a brief, reliable and valid tool for self-report of symptoms commonly experienced by patients with cancer and also assesses their impact on daily functioning (23). The MDASI is frequently used in clinical cancer care (24, 25). However, all MDASI symptoms are prevalent in the general population. Reference values for the MDASI from the general adult population therefore allow for interpretation of scores from patient samples and for comparison across studies and between relevant populations samples. Up until now, there are no reference values for the MDASI from the Norwegian population, nor have we found this from other countries.

On this background, study objectives were to (1) present reference values for the M.D. Anderson Symptom inventory (MDASI) (2) examine the occurrence and intensity of symptoms assessed by the MDASI in a general Norwegian adult population sample, and (3) examine factors associated with higher symptom burden defined as the sum score of all symptoms, and factors associated with symptoms’ interference on functions.

**Methods**

**Data collection**

In the spring 2015, 6165 subjects, aged 18-80 years, and representative of the general Norwegian adult population with respect to age, gender and place of residence, were randomly drawn by Bring Dialog (26). They received a mailed questionnaire packet on paper containing the Short-Form Health Survey (SF-36), version 1 (27, 28), the M.D. Anderson Symptom Inventory (MDASI) (23), the Fatigue Questionnaire (FQ) (29) and the Patient Health Questionnaire-9 (PHQ-9) (30, 31). The questionnaire packet also included questions covering 13 comorbidities (32) and 14 questions related to sociodemographics, physical activity, general health and contact with health care providers. Background variables (see below), comorbidities, the MDASI and the PHQ-9 were used in this study.

**Background variables**

Background variables included year of birth, sex, and level of education. Education was divided into three groups referring to highest level of completed education: second level, first stage (elementary and/or primary school); second level, second stage (high school); and third level (university college or university). Comorbidities were self-reported on a modified version of the Self-Administered Comorbidity Questionnaire (SCQ) (32). The subjects were asked “do you have, or have you ever had, any of the following diseases/problems?”.

**Instruments**

*The M.D. Anderson Symptom Inventory (MDASI)*

The M. D. Anderson Symptom Inventory (MDASI) was developed by the Pain Research Group at M. D. Anderson Cancer Center at the University of Texas. Validation studies have shown that the MDASI is useful for symptom surveys, clinical trials, and patient follow-up care (24, 33, 34). MDASI is designed for use in cancer populations (23), hence applies to patients with various cancer diagnoses and types of treatment. MDASI assesses the severity of 13 frequent symptoms experienced during the last 24 hours (pain, fatigue, nausea, sleep disturbance, distress, shortness of breath, difficulty remembering, lack of appetite, drowsiness, dry mouth, sadness, vomiting, numbness/tingling) in patients with cancer. The response alternatives are 0-10 on numerical rating scales, with 0 meaning “not present” and 10 meaning “as bad as you can imagine”. In this study, a cut off $\geq 1$ was chosen to denote any presence of a symptom. These 13 items not only account for the most frequently reported symptoms by cancer patients, but they are also common reasons for contact with the health care system in the general population (23, 35). In addition, the MDASI includes another six questions on
how much the symptoms interfere with general activity, mood, work, relations with other people, walking and enjoyment of life. The interference items are also measured on 0-10 scales, with 0 meaning "did not interfere," and 10 meaning "interfered completely". The first introductory sentence in the MDASI refers to people with cancer "people with cancer frequently have symptoms that are caused by their disease or by their treatment". For the purpose of this survey, the sentence was changed to: "many people often have symptoms due to injuries or disease". Thus, the word cancer was omitted from the questionnaire.

The translation of MDASI into Norwegian followed the multi-step, well-established 2009 procedures developed by the EORTC Quality of Life Group (36). Two independent forward translations from English to Norwegian were done by native speakers of Norwegian language, translations were reviewed to reach a reconciled version, prior to two independent back translations into English. When comparing the versions, no translation problems became apparent. The Norwegian version of the MDASI was proof-read and pilot-tested in six persons who found the comprehensibility satisfactory according to the EORTC debriefing interviews (36). Permission to translate and use the MDASI was obtained from MD Anderson, TX, USA.

The Patient Health Questionnaire-9 (PHQ-9)

PHQ-9 is a nine-item questionnaire designed to screen for depression (31). The nine items correspond to the DSM-5 diagnostic criteria for major depressive disorder (37). The response alternatives are the frequency to which these symptoms have been bothersome during the past two weeks, divided in four categories: 0= not at all, 1= several days, 2= more than half of the days and 3= nearly every day. "Major depression" is diagnosed if five or more of the symptoms have been present at least "more than half the days" in the past two weeks provided that one of these is item 1 (depressed mood) or item 2 (anhedonia). As a severity measure, the PHQ-9 score ranges from 0-27, since each item can be scored from 0 to 3. In the present study, the four somatic depression symptoms in the PHQ-9 are excluded to avoid overlap with MDASI (sleep-problems, fatigue, weight/appetite change and psychomotor retardation). The instrument will hereafter be referred to as the PHQ. Here, the score ranges from 0-15. We have previously shown that the agreement between the 9 - and 5 - item versions in detecting depression was excellent (38).

Statistical analysis

Standard descriptive analyses were used with the baseline characteristics. Variables examined included age, gender and education. The number of age groups was limited to six: 18-29, 30-39, 40-49, 50-59, 60-69, and 70-80 years. The number of comorbidities were grouped as follows: Category 0 (no comorbidity), category 1 (1-2 comorbidities) and category 2 (≥ 3 comorbidities). Basic descriptive analyses were used for the number and intensity of MDASI symptoms. The total MDASI sum score for the 13 symptoms was calculated (possible range 0-130; the sum of scores for the 13 individual symptoms).

Associations between the MDASI sum score as the dependent variable, and age, sex, education, comorbidity and depression as independent variables were analyzed using linear multivariable regression. Univariable linear regression was used to examine for factors associated with MDASI sum score. Variables from the univariable analyses with a p-value ≤ 0.10 were included in the multivariable regression model, which also included sex and age regardless of the significance in the univariable analyses. The six MDASI interference items were used as dependent variables in separate analyses. The corresponding effect sizes are reported as unstandardized coefficients and 95% confidence interval (CI). A p-value of <0.05 was used to denote statistical significance.

The statistical software applied was IBM SPSS Statistics for Windows, version 25.0, (IBM Corporation, Armonk, NY, USA).

Ethical considerations

The study was performed according to the rules of the Helsinki declaration. All respondents received written information about the study. Return of the questionnaires was taken to indicate written, informed consent. The Regional Committee for Medical and Health Research Ethics (REC) South East Norway approved the survey (2014/1172).

Results

The overall response rate was 36%. Of the 2130 returned questionnaires, 23 were blank, 21 had no data on sex, and 65 had responded to less than half of the individual MDASI symptoms. All these respondents were omitted, giving a sample of 2021. Missing values of the MDASI ranged from 0.1% (n=3, numbness) to 1.4% (n=28, fatigue).
More females (54%) than males (46%) responded. As shown in a previous publication from the same material (28), the response rate for both men and women was 5% in the youngest age group (≤ 29 years) which was significantly lower compared to the other groups (p<0.001). Mean age of the study sample was 55 years (SD 14) (table 1). Forty-six percent of the respondents had university college or university education.

Table 2 shows the frequency of comorbidities. Forty-two percent reported no comorbidities, 45% reported one or two while 13% reported three comorbidities or more. The most frequent were hypertension, arthrosis and depression. Arthrosis and depression were more common in women (23.6% and 15.3% vs. 12.5% and 9.3 %), while there was no difference regarding hypertension between men and women. Depression was more common among women in the youngest age group (23.1%) compared to women ≥ 70 years (15.3%).

The most frequent symptoms (cut off ≥1) were fatigue (59.7%), drowsiness (56.2%) and pain (56.1%). When using a cut off ≥3, the prevalence was 34.8% for fatigue, 34.2% for pain and 26.7% for drowsiness (table 3). The mean scores for the 13 symptoms by age and gender are presented in table 4. Fatigue, pain and disturbed sleep had the highest mean scores overall (figure 1). Fatigue had the highest mean score; 2.39 in women and 1.90 in men. The mean scores for fatigue were highest in the youngest age group (<30 years), with higher score for women (3.45) than in men (2.36). Overall, the mean scores for pain were 2.24 in women and 1.94 in men, and the mean scores for disturbed sleep were 1.93 in women and 1.42 in men.

Univariable regression analysis showed a significant positive association between the presence of one or more comorbidities (p<0.001) and between PHQ- score and MDASI sum score (p<0.001). Level of education was also associated with MDASI sum score (p<0.001), while no association was found with age (p=0.5). Further, because of the low response rate in youngest age group separate analyses were done without this age group yielding similar results.

Multivariable linear regressions (table 5) showed positive significant associations between the MDASI sum score and depression on the PHQ (p<0.001) and the presence of one or more comorbidities (p<0.001). Participants with the highest education level had significantly lower MDASI sum score than respondents with education in second level, first stage (p=0.006) and second level, second stage (p=0.003). Females had significantly higher MDASI sum score than males in univariable analyses (p=0.001), but not in the multivariable regression model. The overall model fit was $R^2 = 0.45$.

Each interference item was used as the dependent variable in separate multivariable linear regression analyses (table 6), with age, sex, education, comorbidity, PHQ score and MDASI sum score as independent variables. Comorbidities, PHQ score and MDASI sum score were significantly associated with both general activity and work as the dependent variables (p≤0.001). Increased number of comorbidities and higher MDASI sum score were significantly associated with higher score on the interference item walking (p<0.001). Further, the multivariable regression analyses showed that PHQ score and MDASI sum score were significantly associated (p<0.001) with mood, relations and enjoyment of life as dependent variables.

Discussion

This study provides the first Norwegian reference values for the MDASI based on data from 2021 men and women aged 18-80 years collected in 2015. The most frequent symptoms overall were fatigue, drowsiness and pain. Fatigue, pain and disturbed sleep had the highest mean scores. The mean scores for fatigue were highest in the youngest age group (18-29 years). The presence of one or more comorbidities, increasing levels of depressive symptoms and lower level of education were significantly associated with a higher MDASI sum score. Comorbidity showed the strongest association; having three or more comorbidities increased the MDASI sum score with 10 points in average. Sex was not significantly associated with MDASI sum score when education, depression and comorbidities were controlled for in the regression model.

The Health Study of Nord-Trøndelag County (HUNT 3) found that the prevalence of chronic pain was 36% among women and 25% among men, and that the prevalence increased with age (39). A random sample of participants were followed with annual measures over 4 years (40). Here, pain intensity ranging from no pain to very mild, mild, moderate, severe and very severe pain was included to identify clinically important pain. A cut-off between mild and moderate pain may identify individuals with complex pain (41). In our study, a cut-off ≥1 was chosen to identify the presence of a symptom. By increasing the cut off to ≥3, the prevalence was about 34% for pain, which corresponds to the finding in the HUNT 3 study.
Previous studies have shown that women generally report a higher number of symptoms than men (3, 5, 42, 43). A Norwegian population study (43) also found that women reported a higher number of symptoms than men, although the association between somatic symptoms and anxiety and depression was equally strong in men and women indicating that the difference in prevalence of these conditions between the sexes could not explain the difference in the reported number of somatic symptoms. Elnegaard et al. (2) found no sex differences for almost 2/3 of the reported symptoms leading to contact with a general practitioner in their population study. In our study, more females (15%) than males (9%) reported depression on the PHQ-9. This might explain why sex was not associated with symptom sum score when controlling for depression.

Across the lifespan, depression is almost twice as common in women as in men. The prevalence of major depressive episode worldwide is approximately 5% (44). However, major depressive disorder is different from feelings of sadness which also may lead to increased symptom score. The PHQ-9 is a tool that can be used to identify and assess depression, but it is important to also assess contextual factors like alternative psychiatric diagnoses, a medical illness, or the side-effects of medication (45). We used the PHQ-9 as a measure of depressive symptoms, and not as a measure of depressive disorder. Symptom criteria for depression overlap symptoms of cancer and other comorbidities, e.g. fatigue, poor appetite and sleep problems (46). In patients with increased symptom burden, exclusion of somatic symptom criteria in the PHQ-9 may reduce the likelihood of being false positive categorized as depressed (38). In this study, the four somatic depression symptoms in the PHQ-9 were excluded to avoid overlap with the MDASI. We found a significant association between higher levels of depressive symptoms and higher MDASI sum score.

Comorbidity, depression and MDASI sum score were significantly associated with the interference items general activity and work. Depression and MDASI sum score were negatively associated with enjoyment, mood and relations to other people. Bruusgaard et al. (4) found a strong linear association between the number of self-reported symptoms and decreased functional status in the Norwegian Ullensaker population study. Anxiety and depression were symptoms that had substantially higher explanatory power on functional status than other symptoms (4). This in line with the findings in our study, with depressive symptoms being associated with all interference items but walking. These findings indicate that interference is influenced by other variables than just symptoms. This does not only apply to the emotional domains like enjoyment and mood, but also to the more functional ones like work and general activity.

**Limitations**

The randomly drawn sample was assumed to be representative of the general Norwegian population with respect to age, sex, and place of living. However, only 36% of the sample responded to the survey. Compared to collection of Norwegian reference values for the SF-36 in 1996 and 2002 this response rate was low (28). The decline in response rates from 67% in 1996 to 36% in 2015 is in line with other postal surveys (3, 22, 50, 51). Another Norwegian study found that health-related quality of life was relatively stable in two cross-sectional studies over an eight year period despite the response rate being 68% in the first study and 35% in the second (52). Surveys are used to describe large populations, and high response rates are valued to reduce the risk of bias. However, nonresponse bias is only indirectly related to nonresponse rates and there is little empirical support for the notion that low response rates are more prone to nonresponse bias than samples with higher response rates (53). The fact that response rates in sample surveys in general have declined over the past decades is challenging for population studies (53). Innovation in epidemiologic studies should involve development of recruitment techniques that optimize participation (54). A large Danish population study from 2015 (2) used web-
based questionnaires and had a response rate of 52%. In our study, the paper-based questionnaire was not available in an electronic version.

According to Statistics Norway, 18% of the population was 67 years or above, while 27% of the responders were in the same age group (28). About 21% of the population in this study was between 18 and 29 years, while only 5% of this age group participated in the survey. The high mean symptom scores for the youngest age group may not be representative for the general population in the same age, due to the very low response rate in this age group. For the older population, the opposite pattern was observed. The relatively high symptom scores in the youngest age group compared to the older age groups may indicate an unhealthy bias in the youngest age group and a healthy bias among the older age groups. Taken together, these factors suggest that the reference values might be biased due to selection among the youngest participants. Regrettably, our data did not permit further analyses to illuminate this.

Conclusion
This study provides the first Norwegian reference values for the MDASI. The presence of one or more comorbidities, increased levels of depressive symptoms and lower level of education were significantly associated with higher MDASI sum score. These covariates must be controlled for when using the reference values.

Declarations
Ethics approval and consent to participate
The study was performed according to the rules of the Helsinki declaration. All respondents received written information about the study. Return of the questionnaires was taken to indicate written, informed consent. The Regional Committee for Medical and Health Research Ethics (REC) South East Norway approved the survey (2014/1172).

Consent for publication
Not applicable

Availability of data and materials
The dataset used and analysed during the current study is available from the corresponding author on reasonable request.

Competing interests
HK, KSG, ØS, CEK and MJH have no declared conflicts of interests. Eir Solutions AS was established in 2015 with SK, JHL, and NTNU Technology Transfer AS as shareholders. No income, dividend, or financial benefits are related to the work presented here nor in relation to Eir in any way.

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Authors contributions
Conzeptualization: JHL, MJH. Methodology: MJH, KSG, JHL. Formal analysis: HK, ØS. Project administration: MJH, KSG, JHL. Writing original draft: HK. Supervision, writing-review and editing: JHL, KSG, SK, ØS, CEK, MJH. All authors read and approved the final manuscript.

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Tables

Table 1. Background characteristics, and mean MDASI sum score.

| Variables                        | Population (N = 2021) | Mean MDASI sum score (SD)* |
|----------------------------------|-----------------------|----------------------------|
| **Age**                          |                       |                            |
| Mean (±SD)                       | 55 (14)               |                            |
| Min.-Max.                        | 18-79                 |                            |
| Age groups, N (%)                |                       |                            |
| ≤29 years                        | 101 (5.0)             | 18.78 (20.24)              |
| 30-39 years                      | 197 (9.7)             | 15.76 (18.89)              |
| 40-49 years                      | 390 (19.3)            | 14.68 (18.15)              |
| 50-59 years                      | 467 (23.1)            | 15.46 (17.88)              |
| 60-69 years                      | 499 (24.7)            | 15.13 (18.63)              |
| ≥70 years                        | 367 (18.2)            | 15.84 (17.91)              |
| **Gender, N (%)**                |                       |                            |
| Women                            | 1101 (54)             | 16.71 (18.83)              |
| Men                              | 920 (46)              | 14.03 (17.65)              |
| **Education, N (%), Missing 10 (0.5)** |            |                            |
| Second level, first stage        | 344 (17.1)            | 18.63 (20.55)              |
| Second level, second stage       | 751 (37.3)            | 16.98 (19.57)              |
| Third level (university college or university) | 916 (45.5) | 12.98 (15.95) |
| **Number of comorbidities, N (%)** |                       |                            |
| 0                                | 856 (42)              |                            |
| 1-2                              | 912 (45)              |                            |
| ≥3                               | 253 (13)              |                            |

*Min-max 0-130

Table 2. Comorbidities *, overall and by sex
### Table 3. Frequency of symptoms (MDASI score), N (%)

| Symptom                        | MDASI score ≥ 1 | MDASI score ≥ 3 |
|--------------------------------|-----------------|-----------------|
| Pain                           | 1125 (56.1)     | 692 (34.5)      |
| Fatigue (tiredness)            | 1190 (59.7)     | 704 (35.3)      |
| Nausea                         | 305 (15.3)      | 134 (1.3)       |
| Disturbed sleep                | 913 (45.5)      | 507 (25.3)      |
| Being distressed               | 913 (45.5)      | 433 (21.6)      |
| Shortness of breath            | 600 (30.0)      | 289 (14.4)      |
| Remembering                    | 699 (34.9)      | 276 (13.8)      |
| Lack of appetite               | 357 (17.8)      | 148 (7.4)       |
| Drowsy                         | 1127 (56.2)     | 540 (26.9)      |
| Dry mouth                      | 578 (28.8)      | 285 (14.2)      |
| Sad                            | 789 (39.2)      | 374 (18.6)      |
| Vomiting                       | 164 (8.1)       | 69 (3.4)        |
| Numbness or tingling           | 503 (24.9)      | 265 (13.1)      |

*The Self-Administered Comorbidity Questionnaire (32)

### Table 4. Mean MDASI scores (SD)* by sex and age groups, N = 2021
**Table 5.** Multiple linear regression on the MDASI sum score with age, sex, education, comorbidity and depression as explanatory variables (N=2021)

| Items                  | 18-29 years | 30-39 years | 40-49 years | 50-59 years | 60-69 years | 70-80 years | Total |
|------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------|
| Age groups             | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M | W | M |
| Age groups             | (n=64) | (n=36) | (n=115) | (n=80) | (n=162) | (n=227) | (n=242) | (n=251) | (n=182) | (n=174) | (n=1084) | (n=914) | (n=1101) | (n=920) |
| winters                | 1.69 | 1.17 | 1.69 | 1.64 | 2.22 | 1.90 | 2.39 | 1.97 | 2.53 | 2.04 | 2.21 | 2.10 | 2.24 | 1.94 |
| winters                | (2.44) | (2.12) | (2.49) | (2.35) | (2.71) | (2.34) | (2.65) | (2.58) | (2.46) | (2.46) | (2.58) | (2.51) | (2.66) | (2.46) |
| depression             | 3.45 | 2.36 | 2.87 | 1.96 | 2.53 | 1.94 | 2.57 | 1.87 | 2.03 | 1.90 | 1.78 | 1.60 | 2.39 | 1.96 |
| depression             | (2.86) | (2.58) | (2.75) | (2.32) | (2.78) | (2.43) | (2.67) | (2.39) | (2.61) | (2.31) | (2.20) | (2.23) | (2.66) | (2.34) |
| ede/feeling            | 1.03 | 0.56 | 0.74 | 0.28 | 0.64 | 0.22 | 0.55 | 0.41 | 0.40 | 0.24 | 0.51 | 0.40 | 0.57 | 0.32 |
| ede/feeling            | (2.03) | (1.59) | (1.62) | (0.97) | (1.70) | (0.83) | (1.61) | (1.51) | (1.40) | (0.84) | (1.37) | (1.28) | (1.58) | (1.16) |
| rbed sleep             | 2.47 | 1.92 | 1.70 | 1.57 | 1.87 | 1.26 | 2.05 | 1.56 | 1.83 | 1.44 | 1.95 | 1.23 | 1.93 | 1.42 |
| rbed sleep             | (3.41) | (3.00) | (2.54) | (2.53) | (2.84) | (2.26) | (2.68) | (2.41) | (2.53) | (2.34) | (2.48) | (2.10) | (2.68) | (2.34) |
| rbed sleep             | (2.55) | (2.72) | 2.00 | 1.84 | 1.63 | 1.09 | 1.58 | 1.39 | 1.58 | 1.18 | 1.54 | 1.09 | 1.68 | 1.27 |
| rbed sleep             | (3.12) | (2.25) | (2.70) | (2.24) | (2.54) | (2.12) | (2.27) | (2.32) | (2.40) | (2.13) | (2.22) | (1.83) | (2.46) | (2.14) |
| rbed sleep             | 0.88 | 0.58 | 0.64 | 0.99 | 0.66 | 0.72 | 0.67 | 0.85 | 1.20 | 1.19 | 1.45 | 1.36 | 0.93 | 1.02 |
| rbed sleep             | (1.88) | (1.34) | (1.60) | (2.11) | (1.76) | (1.77) | (1.69) | (1.78) | (2.30) | (1.22) | (2.43) | (1.98) | (2.02) | (1.94) |
| rbed sleep             | 1.39 | 0.64 | 1.07 | 0.62 | 1.17 | 0.67 | 0.98 | 0.78 | 0.86 | 0.88 | 1.01 | 1.40 | 1.03 | 0.89 |
| rbed sleep             | (2.64) | (1.48) | (2.12) | (1.72) | (2.24) | (1.52) | (1.83) | (1.57) | (1.65) | (1.50) | (1.63) | (2.11) | (1.94) | (1.69) |
| rbed sleep             | 0.83 | 1.00 | 0.80 | 0.38 | 0.34 | 0.36 | 0.47 | 0.52 | 0.53 | 0.54 | 0.66 | 0.55 | 0.55 | 0.51 |
| rbed sleep             | (1.92) | (1.97) | (2.07) | (1.34) | (1.12) | (1.22) | (1.35) | (1.60) | (1.62) | (1.49) | (1.61) | (1.34) | (1.55) | (1.46) |
| rbed sleep             | 2.66 | 2.17 | 2.26 | 1.89 | 1.96 | 1.84 | 1.98 | 1.75 | 1.57 | 1.73 | 1.63 | 1.56 | 1.89 | 1.75 |
| rbed sleep             | (2.62) | (2.74) | (2.71) | (2.51) | (2.55) | (2.31) | (2.49) | (2.46) | (2.26) | (2.20) | (2.26) | (2.09) | (2.46) | (2.31) |
| rbed sleep             | 0.55 | 0.92 | 0.59 | 0.59 | 0.65 | 0.68 | 1.08 | 0.76 | 1.14 | 1.10 | 1.66 | 1.40 | 1.02 | 0.95 |
| rbed sleep             | (1.23) | (2.03) | (1.72) | (1.74) | (1.86) | (1.69) | (2.23) | (1.80) | (2.22) | (1.84) | (2.54) | (2.32) | (2.14) | (2.02) |
| rbed sleep             | 2.15 | 1.67 | 1.84 | 1.48 | 1.48 | 1.03 | 1.34 | 1.19 | 1.29 | 1.02 | 1.22 | 1.14 | 1.44 | 1.12 |
| rbed sleep             | (2.70) | (2.78) | (2.89) | (1.86) | (2.44) | (2.04) | (2.2) | (2.19) | (2.32) | (1.94) | (2.16) | (2.17) | (2.39) | (2.10) |
| rbed sleep             | 0.58 | 0.17 | 0.30 | 0.31 | 0.26 | 0.11 | 0.26 | 0.23 | 0.19 | 0.26 | 0.35 | 0.25 | 0.28 | 0.22 |
| rbed sleep             | (1.81) | (0.70) | (1.16) | (1.11) | (1.26) | (0.63) | (1.23) | (1.09) | (1.03) | (1.04) | (1.18) | (1.11) | (1.22) | (1.00) |
| rbed sleep             | 0.57 | 0.50 | 0.71 | 0.59 | 0.92 | 0.74 | 0.85 | 0.82 | 1.01 | 0.80 | 1.11 | 0.85 | 0.91 | 0.77 |
| rbed sleep             | (1.37) | (1.40) | (1.67) | (1.57) | (2.21) | (1.76) | (1.85) | (1.88) | (2.11) | (1.89) | (2.07) | (1.66) | (1.99) | (1.79) |

W: women; M: men

*0 (“not present”) to 10 (“as bad as you can imagine”) NRS scale
### MDASI sum score*

| Age groups       | B   | 95% CI        | p    |
|------------------|-----|---------------|------|
| 18-29 years      | 0.397 | -2.761, 3.555 | 0.805 |
| 30-39 years      | -0.449 | -2.983, 2.087 | 0.728 |
| 40-49 years      | -1.214 | -3.318, 0.890 | 0.258 |
| 50-59 years      | 0.735  | -1.244, 2.715 | 0.466 |
| 60-69 years      | 0.292  | -1.583, 2.167 | 0.760 |
| 70-80 years (ref)| -    |               |      |

| Sex              | B   | 95% CI        | p    |
|------------------|-----|---------------|------|
| Women            | 0.99 | -0.222, 2.202 | 0.109 |
| Men (ref)        | -   |               |      |

| Education        | B   | 95% CI        | p    |
|------------------|-----|---------------|------|
| Second level, first stage | 2.591 | 0.759, 4.423 | 0.006 |
| Second level, second stage | 2.029 | 0.695, 3.363 | 0.003 |
| Third level (ref)| -   |               |      |

| Comorbidities    | B   | 95% CI        | p    |
|------------------|-----|---------------|------|
| 0 (ref)          | -   |               |      |
| 1-2              | 3.452 | 2.116, 4.789 | 0.000 |
| ≥3               | 10.693 | 8.627, 12.760 | 0.000 |

| Depression       | B   | 95% CI        | p    |
|------------------|-----|---------------|------|
| PHQ score        | 4.685 | 4.412, 4.958 | 0.000 |

*Demographic and disease-related variables that were significantly correlated with MDASI sum score in the univariable analyses were entered as covariates

**Table 6.** Multiple linear regression with the six interference items as the outcomes for all respondents included (N=2021) *
| General activity | Mood | Working | Relations | Walking | Enjoyment of life |
|------------------|------|---------|-----------|---------|------------------|
|                  | Adjusted $R^2 = 0.460$ | Adjusted $R^2 = 0.584$ | Adjusted $R^2 = 0.516$ | Adjusted $R^2 = 0.543$ | Adjusted $R^2 = 0.291$ | Adjusted $R^2 = 0.589$ |
|                  | B    | 95% CI  | p         | B    | 95% CI  | p         | B    | 95% CI  | p         | B    | 95% CI  | p         |
|                  | 0.100 | -0.339, 0.655 | 0.66 | 0.32, 0.995 | 0.000 | 0.04 | -0.39, 0.48 | 0.848 | 0.43 | 0.08, 0.77 | 0.016 | -0.98 | -1.42, -0.54 | 0.000 | -0.25 | -0.60, 0.11 | 0.176 |
|                  | 0.181 | 0.173, 0.316 | 0.58 | 0.32, 0.85 | 0.000 | 0.27 | -0.08, 0.62 | 0.126 | 0.35 | 0.08, 0.63 | 0.012 | -0.77 | -1.12, -0.42 | 0.000 | -0.10 | -0.39, 0.18 | 0.473 |
|                  | 0.381 | 0.087, 0.011 | 0.54 | 0.32, 0.76 | 0.000 | 0.37 | 0.08, 0.65 | 0.013 | 0.36 | 0.13, 0.59 | 0.002 | -0.53 | -0.83, -0.24 | 0.000 | -0.02 | -0.26, 0.22 | 0.657 |
|                  | 0.233 | -0.044, 0.099 | 0.13 | -0.08, 0.34 | 0.213 | 0.07 | -0.20, 0.34 | 0.610 | 0.07 | -0.15, 0.28 | 0.546 | -0.38 | -0.66, -0.10 | 0.007 | -0.06 | -0.28, 0.17 | 0.628 |
|                  | -0.036, 0.489 | 0.091 | 0.07 | -0.30, 0.27 | 0.502 | 0.04 | -0.22, 0.296 | 0.771 | 0.14 | -0.07, 0.35 | 0.187 | -0.14 | -0.41, 0.12 | 0.287 | 0.06 | -0.16, 0.27 | 0.609 |

* Demographic and disease-related variables that were significantly correlated with MDASI sum score in the univariable analyses were entered as covariates

**Figures**
Figure 1

Distribution of scores 0-10 on pain, fatigue, sleep