



Prevalence of insomnia in a general adult population cohort using different diagnostic criteria: The seventh survey of the Tromsø study 2015–2016

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ABSTRACT

Insomnia disorder is a subjective complaint of sleep dissatisfaction including both night-time and daytime symptoms. Currently there are three commonly used diagnostic manuals each with their own set of criteria, which is often credited for the wide range in insomnia prevalence reported by population-based studies, especially those with self-reported insomnia. However, there are limited studies directly comparing different criteria and little is known about associations with health outcomes. Thus, the aim of this study was to compare the most commonly used diagnostic criteria for insomnia from the literature and to explore the associations with a range of physical and mental health outcomes. We used data from 21,083 women and men from the seventh survey of the population-based Tromsø Study which included adults aged 40–99 years. A revised version of the Bergen Insomnia Scale was used to define insomnia based on the 4th (revised) and 5th edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR and DSM5), the 10th edition of the International Classification of Diseases (ICD-10), and the 3rd edition of the International Classification of Sleep Disorders (ICSD-3). We found the following prevalence of insomnia: DSM-IV-TR 23.6 %, DSM5 8.5 %, ICD-10 9.9 % and ICSD-3 20.0 %. When looking at each symptom, we found over half the participants classified as having insomnia using the DSM-IV-TR and ICSD-3 criteria did not report having impaired daytime functioning at least three days per week. Overall, participants with DSM5 and ICD-10 insomnia appeared to have worse health profiles, based on a higher percentage meeting the cut-off for possible anxiety or depression, reporting a psychological problem or chronic pain, and using antidepressants, painkillers or sleeping pills. However logistic regression models showed largely the same health factors had the same association with the odds for being classified as having insomnia disorder from each set of criteria. Overall, this study suggests that insomnia prevalence may be overestimated if daytime symptoms are not adequately included in accordance with current guidelines.

1. Introduction

Insomnia disorder is primarily based on subjective complaints of sleep dissatisfaction and the occurrence of both night-time and daytime symptoms. However the precise definition of what this constitutes depends on the criteria being used. The first classification of sleep disorders was published in 1979 and since then the diagnostic criteria for sleep disorders including insomnia disorder have continued to evolve [1]. Today, the three most commonly used diagnostic manuals for insomnia disorder are: the 5th edition of Diagnostic and Statistical Manual of Mental Disorders (DSM5) [2], the 10th edition of the International Classification of Diseases (ICD) [3], and the 3rd edition of the

International Classification of Sleep Disorders (ICSD-3) [4]. Although each manual broadly describes insomnia disorder in similar ways, there are subtle differences. The consequence of which is a wide range in the prevalence of insomnia disorder being reported. In the general adult population, from ten European countries over the past twenty years, insomnia disorder prevalence has been reported from 5.7 % to 19 % [5], with the majority of studies basing their definition of insomnia disorder on the revised version of the previous edition (4th) of the DSM (DSM-IV-TR). When assessing insomnia using self-report scales, as is the case in population-based studies, additional layers of complexity arise, meaning the distinction between fulfilling the criteria for insomnia disorder and experiencing insomnia symptoms can become confused.

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Firstly, the validity of self-report scales can vary, which may also depend on the population being assessed [6]. Secondly, not all criteria outlined in the diagnostic manuals are routinely addressed, such as: that the sleep complaint occurs despite adequate opportunity to sleep; or not better explained by another condition; or the use of a substance such as hypnotics. Thirdly, the interpretation of criteria can also differ. Nevertheless, self-report scales are an important tool when assessing large populations.

In this study we aimed to compare the most commonly used diagnostic criteria for insomnia disorder in adult population-based studies, thus we focused on the DSM5, ICD-10 and ICSD-3 diagnostic criteria. In addition, we included the older DSM-IV-TR criteria as this was used for many of the general population-based studies still cited today. A newer edition of the ICD (ICD-11) has recently been released, but since this has not been used in any population-based studies to our knowledge as of yet, we used the previous ICD-10 criteria. The requirement of at least one night-time symptom of either difficulty initiating sleep or maintaining sleep is consistent across all diagnostic manuals, with early morning awakenings being added to more recent manuals and non-restorative sleep being removed as it was deemed not specific to insomnia. All manuals also require at least one day-time symptom such as impairment in daily functioning (i.e., daytime impairment), sleepiness or distress. The main differences between the manuals is how the requirement for an overall dissatisfaction with sleep is treated. Although a dissatisfaction with sleep is required by all manuals, how it is included in the bulleted criteria differs. This is particularly relevant to scales and questionnaires as they tend to be based only on these bulleted criteria rather than the overall descriptions in the manuals. In the DSM5 a general complaint of dissatisfaction with sleep quantity or quality is required along with the other symptoms. While the ICD-10 outlines that an unsatisfactory quantity or quality of sleep is associated with daytime distress or impairment. In this study we have interpreted this as both daytime symptoms assessed must be present (i.e., a dissatisfaction with sleep and daytime impairment) to meet DSM5 and ICD-10 criteria. In the case of the ICSD-3 criteria, sleep dissatisfaction is listed as one of nine possible daytime complaints, however only one is required to be present for that criteria to be met. Thus, in contrast to the DSM5 and ICD-10, in the ICSD-3 sleep dissatisfaction may be considered being an optional symptom rather than a requirement. A second distinction between the manuals is the duration that symptoms must be present for, with the ICD-10 requiring at least 1 month and the DSM5 and ICSD-3 at least 3 months. For comparison, the DSM-IV-TR criteria did not have a separate requirement for sleep dissatisfaction as a criteria and symptoms were required for at least 1 month. Since, we aimed to compare criteria most commonly used in population studies, we chose to follow the bulleted criteria for each manual.

Direct comparisons of different criteria within the same population are limited. In a stratified probability adult sample ($n = 10,094$) selected to match the US census, 3.9 % of participants were classified as having insomnia based the ICD-10 criteria, 14.7 % from the 2nd edition of the ICSD (ICSD-II) and 22.1 % from the DSM-IV-TR criteria [7]. A similar pattern was found in a general adult population sample ($n = 2011$) in Hong Kong: 4.7 % for ICD-10, 15.1 % for ICSD-II, 22.1 % for DSM-IV-TR [8], and 10.8 % for DSM5. Interestingly a different pattern has been found in an adolescent general population ($n = 384$), with more participants being classified as having insomnia disorder using the ICSD-II criteria (10.9 %) compared to the DSM-IV-TR criteria (7.8 %) [9].

The association of insomnia classified through different criteria to other health outcomes is even more limited. Roth and colleagues [7] in their study, examined associations between insomnia and perceived health. They found ICD-10 insomnia to be significantly associated with worse perceived health compared to ICSD-II and DSM-IV-TR insomnia. However, participants who were only classified as having DSM-IV-TR insomnia (and not ICD-10 or ICSD-II) also had significant decrement in perceived health and hence it was concluded that although the ICD-10 criteria were targeting the more severe cases, the DSM-IV-TR criteria

captured the vast majority of clinically relevant cases [7]. In a comparison of the DSM-IV-TR and DSM5 criteria in an adult population reporting a sleep problem, a higher incidence of possible anxiety and depression was found in participants with DSM5 classified insomnia [10]. Associations of specific health symptoms and insomnia classified from different criteria in a general population is lacking.

Hence, the aim of this study was to: 1) compare the prevalence of insomnia using four of the most commonly used diagnostic criteria for insomnia in a general population cohort; and 2) explore the socio-demographic and health profiles of individuals defined as having insomnia from each diagnostic criteria.

2. Methods

2.1. Study population

The Tromsø Study is a Norwegian general population health study, where both complete birth cohorts and random samples of the population in Tromsø, Norway, have been invited to take part. Seven repeated surveys have been conducted from 1974 to 2016 (Tromsø1-Tromsø7) with $N = 45,473$ women and men attending one or more surveys [11]. Data collection includes questionnaires and interviews, biological sampling, and clinical examinations. In this study, data was taken from Tromsø7 (2015–2016) [12], where all women and men aged ≥ 40 years, registered in the municipality of Tromsø ($N = 32,591$) were invited to participate with 65 % ($N = 21,083$) attending. Participants had a mean age of 57 years ($SD = 11$) and 52.5 % were female ($n = 11,074$). Education attainment was up to primary and part of secondary education for 23.2 % ($n = 4796$) of the whole population, 27.8 % ($n = 5756$) completed upper secondary education, 19.4 % ($n = 4008$) tertiary education of less than 4 years and 29.7 % ($n = 6145$) with tertiary education of more than 4 years. The Tromsø7 data collection was approved by the Regional Committee for Medical and Health Research Ethics North (ref. 2014/940). All participants gave written informed consent.

2.2. Measures

Insomnia symptoms were assessed using a modified version of the Bergen Insomnia Scale (BIS) [13]. BIS was originally designed to assess DSM-IV [14] criteria for insomnia disorder using six items. Four items assessed night-time symptoms: difficulty initiating sleep (DIS); difficulty maintaining sleep (BMS); early morning awakening (EMA); and non-restorative sleep (NRS), and two items assess daytime symptoms: daytime impairment (DI); and dissatisfaction with sleep (DWS). In the original BIS, participants report the number of days per week (0–7) they experienced each sleep problem for the *past month*. In Tromsø7, duration (i.e., in past month) was removed from each item, and instead duration of any sleep problem was assessed with an additional item: ‘If you have sleep problems, for how long have they lasted?’. Response options for this item were: ‘Do not have sleep problems’, ‘Less than 1 week’, ‘1–3 weeks’, ‘1 month’, ‘2 months’, ‘3 months’, ‘4–6 months’, ‘7–12 months’, ‘1–5 years’, ‘6–10 years’ and ‘More than 10 years’. These seven items were used to determine insomnia based on the DSM-IV-TR, DSM5, ICD-10 and ICSD-3 criteria as shown in Table 1.

Symptoms of anxiety and depression were measured using the Hopkins Symptoms Check list-10 (HSCL-10), consisting of ten items regarding symptoms of anxiety and depression scored from 1 (no symptoms) to 4 (moderate/high symptoms). A mean score was calculated and a validated mean cut-off value at 1.85 [15] was set to predict symptoms of anxiety and depression.

Psychological problems were assessed by the item ‘Do you have, or have you ever had, psychological problems for which you have sought help?’ with three responses ‘No’, ‘Yes, now’ and ‘Yes, previously’.

Chronic pain was addressed by the item: ‘Do you have persistent or constantly recurring pain that has lasted for 3 months or more’ with responses: ‘No’ or ‘Yes’.

Table 1
Items used to fulfil different diagnostic criteria.

	Night-time symptoms	Daytime symptoms	Duration
DSM-IV-TR	DIS \geq 3 days AND/OR DMS \geq 3 days AND/OR EMA \geq 3 days AND/OR NRS \geq 3 days	DWS \geq 3 days AND/OR DI \geq 3 days	DUR \geq 1 month
DSM5	DIS \geq 3 days AND/OR DMS \geq 3 days AND/OR EMA \geq 3 days	DWS \geq 3 days AND DI \geq 3 days	DUR \geq 3 months
ICSD-3	DIS \geq 3 days AND/OR DMS \geq 3 days AND/OR EMA \geq 3 days	DWS \geq 3 days AND/OR DI \geq 3 days	DUR \geq 3 months
ICD-10	DIS \geq 3 days AND/OR DMS \geq 3 days AND/OR NRS \geq 3 days	DWS \geq 3 days AND DI \geq 3 days	DUR \geq 1 month

To meet each criteria for insomnia the conditions must be met from each column. DWS = Dissatisfaction with sleep; DIS = Difficulty initiating sleep DMS = Difficulty maintain sleep; EMA = Early morning awakening; NRS= Non-restorative sleep; DI = Daytime Impairment; DUR = Duration.

Medication use was assessed by three separate items: ‘In the last 4 weeks, how often have you used the following medicines?’ for sleeping pills, antidepressants, and prescribed painkillers; with responses ‘Not used’, ‘Less frequently than every week’, ‘Every week, but not daily’, ‘Daily’.

Physical activity was measured by the validated Saltin and Grimby questionnaire [16] consisting of one item to rank leisure-time physical activity level during the last year, choosing one of four options categorized as sedentary, light, moderate, or vigorous physical activity.

Sociodemographic variables included were age, sex, highest level of completed education, and body mass index (BMI) calculated by body weight in kilograms divided by body height in meters squared (kg/m²) measured by trained personnel using a Jenix DS-102 height and weight scale (Dong Sahn Jenix, Seoul, Korea).

2.3. Data analyses

Insomnia presence or absence was calculated for the whole population using each diagnostic criteria as described in Table 1. Descriptive data of all sociodemographic factors and health symptoms assessed were calculated for individuals with or without insomnia according to each set of criteria. Data presented was for those individuals classified as having insomnia. For each insomnia symptom, the number and percentage of individuals above or below the cutoff for the presence of that symptom (i.e., 3 days per week) was calculated according to each criteria. Multifactorial logistic regression models were used to assess the association between insomnia prevalence and the assessed sociodemographic and health symptoms, one for each insomnia diagnostic criteria. Categorical variables in the models were referenced to being male, not having a psychological problem, not having chronic pain, not using antidepressants, prescribed painkillers or sleeping pills in the last 4 weeks, and having a sedentary physical activity level. Descriptive data are presented as mean and standard deviation or count and percentage unless stated. Statistical analysis was performed using R (version 3.4.4), with the R package nlme for logistic regression models.

3. Results

3.1. Insomnia symptoms

Insomnia prevalence defined by each criteria ranged from 8.5 to 23.6 % (Table 2). The DSM5 and ICD-10 criteria had the lowest prevalence of insomnia of 8.5 % and 9.9 % respectively. The highest prevalence of insomnia of 20.0 % and 23.6 %, were defined by the ICSD-3 and DSM-IV-TR criteria respectively.

The prevalence of each insomnia symptom for individuals defined as having insomnia using each set of criteria are shown in Table 3. Similar levels of night-time symptoms are found for each criteria. However, DSM5 and ICSD-3 have 2–15 % more people reaching the cut off for sleep onset latency, wake after sleep onset and early morning awakenings, with DSM5 having the highest numbers. In terms of daytime symptoms, all participants reach the cut off for daytime impairment and dissatisfaction with sleep for DSM5 and ICD-10, which is to be expected as both of these daytime symptoms are required for these criteria. However, for DSM-IV-TR and ICSD-3, though both show a majority of individuals reaching cut off for dissatisfaction with sleep (97.8 and 98.4 % respectively), only 45 % reach cut off for daytime impairment. Still, it is the inclusion of daytime impairment as an alternative criterion to dissatisfaction to sleep which drives the increased prevalence using these criteria compared to the DSM5/ICD-10 criteria. The duration that symptoms have been experienced by individuals with insomnia from each set of criteria are also largely similar. Moreover, despite DSM-IV-TR and ICD-10 including individual with insomnia symptoms of 1–2 months, this accounts for only 2.8 and 1.8 % of the individuals defined as having insomnia. In all cases, the majority of individuals report having insomnia symptoms for over a year.

3.2. Health profiles

Sociodemographic and health symptom profiles for participants who met the criteria for insomnia from each diagnostic criteria are shown in Table 4. Participants with insomnia from each criteria show a similar sex ratio, with females being more likely to have insomnia than males for each criteria and to be of a similar age on average.

Participants with DSM5 or ICD-10 insomnia do appear to be more likely to reach the cut off for possible anxiety or depression: 38.6 % and 39.8 % of individuals compared to 25.3 % and 26.3 % for DSM-IV-TR and ICSD-3 respectively. Participants with DSM5 or ICD-10 insomnia also appear to be more likely to report having a current or previous psychological problem, have chronic pain, and use antidepressants, painkillers or sleeping pills than those with DSM-IV-TR or ICSD-3 insomnia.

Multivariate logistic regression models showed a fairly consistent pattern of significant factors associated with insomnia across the different criteria (Table 5). Higher levels of symptoms of anxiety and depression as reported using the HSCL-10, being female, having chronic pain, and taking pain killers and sleeping pills were all significantly associated with having higher odds of having insomnia for all sets of criteria. With the exception that the odds ratio for taking pain killers less than every week for individuals defined as having insomnia using the ICD-10 criteria did not reach significance. The odd ratios for having a higher BMI and being older, although significant for all (apart from DSM-IV-TR for age), were all just above or below 1, suggesting little or no impact on increasing or decreasing the odds of having insomnia. Interestingly, having a current psychological problem and taking antidepressants less than every week or daily were significantly associated with having lower odds of having insomnia for all sets of criteria apart from ICD-10 for antidepressant usage. Finally, physical activity was only found to have a significant odds ratio for DSM-5 criteria, where doing light physical activity compared to sedentary behavior was associated with lower odds of having insomnia.

Table 2
Prevalence of insomnia from different diagnostic criteria: The Tromsø Study 2015–2016.

	DSM-IV-TR (n = 19,832)		DSM5 (n = 19,800)		ICSD-3 (n = 19,800)		ICD-10 (n = 19,652)	
	n	%	n	%	n	%	n	%
Insomnia	4689	23.6	1687	8.5	3957	20.0	1954	9.9
No insomnia	15,143	76.4	18,113	91.5	15,843	80.0	17,698	90.1

Table 3
Prevalence of insomnia symptoms above and below cut off (i.e. 3 days per week) and duration of symptoms for participants classified as having insomnia based on each criteria.

		DSM-IV-TR insomnia		DSM5 insomnia		ICSD-3 insomnia		ICD-10 insomnia	
		n	%	n	%	n	%	n	%
Sleep onset latency	Below cut off	1942	41.7	505	30.0	1285	32.6	752	38.6
	Above cut off	2717	58.3	1178	70.0	2652	67.4	1196	61.4
Wake after sleep onset	Below cut off	2001	43.4	462	27.8	1340	34.5	707	36.7
	Above cut off	2606	56.6	1201	72.2	2546	65.5	1218	63.3
Early morning awakening	Below cut off	1816	39.4	427	25.7	1175	30.2	678	35.3
	Above cut off	2789	60.6	1237	74.3	2715	69.8	1245	64.7
Non-restorative sleep	Below cut off	754	16.3	120	7.2	736	18.9	107	5.5
	Above cut off	3878	83.7	1550	92.8	3167	81.1	1833	94.5
Daytime impairment	Below cut off	2494	54.4	0	0.0	2102	54.4	0	0.0
	Above cut off	2091	45.6	1687	100.0	1761	45.6	1954	100.0
Dissatisfaction with sleep	Below cut off	105	2.2	0	0.0	62	1.6	0	0.0
	Above cut off	4569	97.8	1687	100.0	3883	98.4	1954	100.0
Duration of symptoms	No sleeping problem	0	0.0	0	0.0	0	0.0	0	0.0
	Less than 1 week	0	0.0	0	0.0	0	0.0	0	0.0
	1–3 weeks	0	0.0	0	0.0	0	0.0	0	0.0
	1 month	58	1.2	0	0.0	0	0.0	18	0.9
	2 months	75	1.6	0	0.0	0	0.0	18	0.9
	3 months	78	1.7	26	1.5	67	1.7	28	1.4
	4–6 months	151	3.2	43	2.5	127	3.2	48	2.5
	7–12 months	322	6.9	88	5.2	268	6.8	111	5.7
	1–5 years	1682	35.9	605	35.9	1442	36.4	696	35.6
	6–10 years	868	18.5	345	20.5	752	19.0	393	20.1
More than 10 years	1455	31.0	580	34.4	1301	32.9	642	32.9	

4. Discussion

In this middle to older aged adult general population, we found that 8.5 % of the participants were classified as having DSM5 insomnia, 9.9 % ICD-10 insomnia, 20.0 % ICSD-3 insomnia and 23.6 % DSM-IV-TR insomnia. The prevalence of DSM5 and DSM-IV-TR insomnia are similar to those previously reported in adults when diagnostic manuals have been compared [7,8]. ICSD insomnia was around 5 % higher than previously reported, however previously the second edition of the criteria were used, compared to the third edition used in this study. ICD-10 insomnia was also around 5 % higher than previously reported using the same edition of the criteria. In addition, both Chung et al. and Roth et al. examined populations aged 18 years and over compared to 40 years and over in our population. Since insomnia prevalence tends to increase with age [5,17], our older on average population may also explain the higher prevalence. However overall, rates of DSM5 and ICD-10 insomnia are consistently around 10 % lower than the DSM-IV-TR and ICSD-3/II criteria.

As previously discussed, broadly the two main differences between the diagnostic manuals are: 1) the requirement for both daytime dissatisfaction with sleep and daytime impairment compared to at least one of the criteria being present and 2) the minimum requirement for symptoms to be present for one or three months. In this study we have interpreted the DSM5 and ICD-10 criteria to require both daytime symptoms to be present, while the DSM-IV-TR and ICSD-3 to require only (at least) one daytime symptom to be present. When looking at the individual symptom items from the BIS, we found that in participants who satisfied the DMS-IV-TR and ICSD-3 criteria for insomnia disorder,

more than half did not meet the criteria for daytime impairment, while 97–98 % met the cut off for dissatisfaction with sleep. Whereas, as expected, for both DSM5 and ICD-10 all participants met the cut off for daytime impairment and dissatisfaction with sleep as defined by the criteria. A substantial difference in the duration of symptoms being reported was not found however, with only 2–3% of participants reporting symptoms for 1–2 months for DSM-IV-TR and ICSD-3, who would have been otherwise excluded from an insomnia classification using the DSM5 or ICD-10. Thus, in this study we find that the difference in insomnia prevalence between the criteria with the highest prevalence (DSM-IV-TR and ICSD-3) and lowest (DSM5 and ICD-10) is driven by the requirement to have the daytime symptom of daytime impairment at least three times a week. Since daytime impairment was reported by fewer participants compared to dissatisfaction with sleep, the requirement of both for the DSM5 and ICD-10 criteria results in fewer participants meeting these criteria compared to the ICSD-3 and DSM-IV-TR where the presence of dissatisfaction with sleep is sufficient to meet these criteria. The importance of daytime impairment as a feature of insomnia disorder is seen as central to the diagnosis with the 2005 NIH consensus report on chronic insomnia stating: ‘The importance of sleep disruptions often rests with its impact on the individual’s daytime function’ [18]. Although, the current diagnostic criteria do include the requirement for daytime impairment, it is important to remember that prevalence reported in many studies is based on having this daytime symptom criteria as optional. One may argue that dissatisfaction with sleep is also a daytime symptom, but it is still difficult to consider dissatisfaction with sleep as synonymous with daytime impairment. Which, based on the findings in our study, may suggest an

Table 4
Sociodemographic and health profiles for individuals classified as having insomnia from different diagnostic criteria: The Tromsø Study 2015–2016.

		DSM-IV-TR		DSM5		ICSD-3		ICD-10	
		M	SD	M	SD	M	SD	M	SD
Age		56.31	10.86	55.18	10.38	57.13	10.96	54.49	10.26
BMI		27.72	4.92	27.88	5.08	27.71	4.90	27.88	5.09
		N	%	n	%	n	%	n	%
Sex	Female	2915	62.2	1107	65.6	2524	63.8	1261	64.5
	Male	1774	37.8	580	34.4	1433	36.2	693	35.5
HSCL-10 ^a	No anxiety/depression	3454	74.7	1003	60.2	2876	73.7	1184	61.4
	Symptoms of anxiety/depression	1172	25.3	662	39.8	1027	26.3	744	38.6
Psychological problems	No	3450	76.4	1117	69.1	2882	75.8	1306	69.7
	Yes, now	433	9.6	227	14.0	380	10.0	256	13.7
	Yes, previously	634	14.0	272	16.8	540	14.2	313	16.7
Antidepressants	Not used in last 4 weeks	4144	94.2	1435	91.6	3466	94.0	1678	91.8
	Less than every week	27	0.6	10	0.6	20	0.5	12	0.7
	Every week, but not daily	19	0.4	9	0.6	17	0.5	9	0.5
	Daily	208	4.7	112	7.2	183	5.0	128	7.0
Chronic pain	No	1790	41.7	506	32.8	1460	40.6	605	33.6
	Yes	2500	58.3	1035	67.2	2135	59.4	1195	66.4
Prescribed painkillers	Not used in last 4 weeks	3296	72.9	1072	65.8	2704	71.1	1278	67.6
	Less than every week	432	9.6	165	10.1	378	9.9	185	9.8
	Every week, but not daily	438	9.7	204	12.5	407	10.7	220	11.6
	Daily	357	7.9	188	11.5	316	8.3	207	11.0
Sleeping pills	Not used in last 4 weeks	3455	76.7	1147	71.0	2812	74.2	1376	73.4
	Less than every week	433	9.6	179	11.1	399	10.5	190	10.1
	Every week, but not daily	354	7.9	168	10.4	342	9.0	175	9.3
	Daily	262	5.8	121	7.5	238	6.3	134	7.1
Leisure-time physical activity level	Sedentary	779	17.1	331	20.3	668	17.5	377	19.8
	Light	2736	60.2	956	58.5	2294	60.0	1114	58.6
	Moderate	908	20.0	300	18.4	756	19.8	356	18.7
	Vigorous	123	2.7	46	2.8	102	2.7	53	2.8

^a Dichotomisation of HSCL-10 score based on cut off.

Table 5
Logistic regression models of health factors associated with insomnia for each diagnostic criteria: The Tromsø Study 2015–2016.

	DSM-IV-TR				DSM-5				ICSD-3				ICD-10			
	OR	CI	p		OR	CI	p		OR	CI	p		OR	CI	p	
Age	1.00	0.99	1.00	0.407	0.99	0.98	1.00	0.004	1.01	1.01	1.01	<0.001	0.98	0.97	0.99	<0.001
SCL mean	12.09	10.63	13.77	<0.001	8.90	7.67	0.34	<0.001	9.42	8.29	0.71	<0.001	9.57	8.29	1.07	<0.001
BMI	1.02	1.01	1.03	<0.001	1.02	1.01	1.03	0.003	1.02	1.01	1.03	<0.001	1.02	1.01	1.03	0.002
Sex: Male	0.00				0.00				0.00				0.00			
Female	1.21	1.11	1.32	<0.001	1.29	1.13	1.48	<0.001	1.32	1.20	1.45	<0.001	1.25	1.10	1.41	0.001
Psychological problems: No	0.00				0.00				0.00				0.00			
Current	0.62	0.49	0.77	<0.001	0.70	0.53	0.91	0.008	0.66	0.52	0.83	<0.001	0.66	0.51	0.85	0.002
Previous	0.88	0.76	1.01	0.068	0.93	0.77	1.12	0.438	0.89	0.77	1.03	0.118	0.91	0.76	1.09	0.314
Chronic pain: No	0.00				0.00				0.00				0.00			
Yes	1.86	1.70	2.04	<0.001	2.01	1.75	2.31	<0.001	1.82	1.65	2.00	<0.001	2.07	1.82	2.35	<0.001
Antidepressants: Not used	0.00				0.00				0.00				0.00			
Less than every week	0.42	0.22	0.78	0.007	0.38	0.15	0.90	0.038	0.25	0.12	0.49	<0.001	0.50	0.20	1.10	0.102
Every week not daily	0.86	0.29	2.57	0.789	0.93	0.29	2.73	0.894	0.71	0.24	2.08	0.538	0.77	0.25	2.25	0.644
Daily	0.59	0.43	0.80	0.001	0.70	0.49	0.98	0.043	0.54	0.39	0.73	<0.001	0.80	0.57	1.12	0.203
Pain killers: Not used	0.00				0.00				0.00				0.00			
Less than every week	1.33	1.13	1.56	0.001	1.29	1.03	1.61	0.024	1.42	1.20	1.67	<0.001	1.21	0.97	1.49	0.082
Every week not daily	1.40	1.16	1.67	<0.001	1.56	1.25	1.95	<0.001	1.64	1.37	1.96	<0.001	1.41	1.13	1.75	0.002
Daily	1.50	1.21	1.86	<0.001	1.98	1.53	2.54	<0.001	1.51	1.21	1.88	<0.001	1.87	1.46	2.38	<0.001
Sleeping pills: Not used	0.00				0.00				0.00				0.00			
Less than every week	3.50	2.89	4.24	<0.001	2.70	2.12	3.40	<0.001	3.67	3.03	4.45	<0.001	2.41	1.91	3.03	<0.001
Every week not daily	5.93	4.53	7.81	<0.001	3.33	2.54	4.34	<0.001	6.29	4.86	8.20	<0.001	3.04	2.33	3.97	<0.001
Daily	3.68	2.71	5.02	<0.001	1.84	1.29	2.59	0.001	3.15	2.34	4.24	<0.001	2.00	1.42	2.79	<0.001
Physical activity: Sedentary	0.00				0.00				0.00				0.00			
Light	1.04	0.92	1.17	0.578	0.83	0.70	0.99	0.035	1.00	0.88	1.14	0.974	0.86	0.73	1.02	0.076
Moderate	0.98	0.84	1.13	0.735	0.82	0.66	1.01	0.059	0.98	0.84	1.14	0.779	0.84	0.69	1.02	0.085
Vigorous	0.99	0.75	1.30	0.950	0.86	0.56	1.29	0.492	1.11	0.83	1.49	0.467	0.88	0.59	1.28	0.503

overestimation of the prevalence of insomnia in studies not explicitly demanding both dissatisfaction with sleep and daytime symptoms to be present (e.g. Refs. [19–21]). More specifically, this may be particularly the case when using criteria that allow only one item assessing daytime impairment.

In this population, participants classified as having insomnia based on the DSM5 and ICD-10 criteria did appear to have worse health profiles, with a higher percentage meeting the cut-off for possible anxiety or depression, reporting a psychological problem and chronic pain and using antidepressants, painkillers and sleeping pills. Although, the differences were modest, they represent a large number of people suggesting those individuals classified as having insomnia based on the DSM5 and ICD-10 criteria may be more likely to have comorbid complaints. This is consistent with the limited existing literature, where ICD-10 and DSM5 insomnia have both been associated with worse health outcomes when compared to other diagnostic criteria [7,10]. However, from the multivariate logistic regression models we found being female, higher anxiety and depression symptoms, having chronic pain and using pain killers and sleeping pills were associated with higher odds of being classified as having insomnia disorder for all sets of criteria. Although it is not possible to directly compare the models since there is overlap in the participants included, overall these findings suggests that participants classified as having insomnia from each set of criteria have largely similar health profiles, although potentially vary in the degree of severity.

The finding that having a current psychological problem and taking antidepressants was associated with lower odds of being classified as having insomnia, was surprising, however. Antidepressant usage is widespread for both psychological problems and insomnia, largely as a better alternative to hypnotics in the case of insomnia. However, despite the evidence base for the use of antidepressants to treat insomnia being consider too low quality at present by a recent Cochrane review [22], there is some evidence that antidepressants may improve insomnia symptoms [23]. Thus, our finding may reflect that individuals taking antidepressants may have a benefit in terms of insomnia symptoms, compared to individuals taking sleeping medication which may reflect a more serious condition.

4.1. Study considerations

The strength of this study is the use of a large general population-based study, using validated tools to measure insomnia and other health and lifestyle variables. However, there are several limitations to be considered. Firstly, as with all questionnaire-based assessments of insomnia, classification of insomnia is limited by self-report of symptoms and could be precluded by other factors such as having an adequate opportunity to sleep, another sleep disorder, medication including hypnotics, or co-morbid conditions. The questionnaire used to assess insomnia symptoms (the BIS) was originally developed to assess DSM-IV-TR insomnia and though it has been modified to allow a broader assessment of symptoms, not all aspects of each criteria manual will have been met. This is particularly relevant to the day-time symptoms denoted by each manual, as some manuals, for example the ICSD-3 having a wide range of day-time symptoms that may be present, that may only be partially covered by the items used in the BIS. Finally, the population used here is of middle to older-aged adults, thus generalizability to other age ranges is limited and further research is needed to explore these relationships in other populations.

5. Conclusion

The aim of this study was to highlight the differences in the diagnostic criteria for the classification of insomnia disorder and to explore potential differences in measures of mental and physical health. As expected, we found marked differences in the prevalence of insomnia derived from the different criteria. This was found to be driven by the

classification of over half the participants with insomnia using the ICSD-3 criteria not reaching the cut off for daytime impairment. In this study, this finding stems from our interpretation of the DSM5 and ICD-10 criteria to require both daytime impairment and sleep dissatisfaction to be present compared to the ICSD-3 where only one had to be met. This interpretation is however not universal as the DSM5 criteria sometimes are interpreted as requiring only one daytime symptom (e.g. Refs. [19–21]) along with one night-time symptom. In a clinical setting, where a dissatisfaction with sleep can be assumed in a help seeking population, this may not have large consequences. But as we have shown in this study, this potential difference in interpretation can influence prevalence rates of insomnia to a large extent in a population survey setting, and should be addressed in future studies. Future studies should also consider presenting data on individual symptoms to allow for a fuller assessment of the population. Moreover, in terms of the health profiles assessed in this study, potentially clinically relevant differences were seen between the criteria in terms of the numbers of potential individuals who may be in need of services, with participants classified as having insomnia from the DSM-5 and ICD-10 criteria having higher levels of several physical and mental health factors. However, a similar pattern of factors was found to be associated with insomnia using all sets of criteria, suggesting that the levels of these factors may differ, but the composition of factors is largely consistent. Overall, this study highlights the importance of careful mapping of dissatisfaction with sleep and daytime symptoms in future research on insomnia and its consequences.

CRedit authorship contribution statement

Kate Porcheret: Writing – original draft, Formal analysis. **Laila A. Hopstock:** Writing – review & editing, Data curation, Conceptualization. **Kristian Bernhard Nilsen:** Writing – review & editing, Conceptualization.

Declaration of competing interest

None.

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References

- [1] Poon SH, Quek SY, Lee TS. Insomnia disorders: nosology and classification past, present, and future. *J Neuropsychiatry Clin Neurosci* 2021;33(3):194–200. <https://doi.org/10.1176/appi.neuropsych.20080206>.
- [2] American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. fifth ed. American Psychiatric Publishing; 2013.
- [3] World Health Organisation. *The ICD-10 classification of mental and behavioural disorders*. World Health Organization; 1993.
- [4] American Academy of Sleep Medicine. *International classification of sleep disorders coding*. third ed. ed. Darien, IL: American Academy of Sleep Medicine; 2014.
- [5] Riemann D, Baglioni C, Bassetti C, Bjorvatn B, Dolenc Groselj L, Ellis JG, Espie CA, Garcia-Borreguero D, Gjerstad M, Gonçalves M, Hertenstein E, Jansson-Fröjmark M, Jennum PJ, Leger D, Nissen C, Parrino L, Paunio T, Pevernagie D, Verbraecken J, Weß H-G, Wichniak A, Zavalko I, Arnardottir ES, Deleau O-C, Strazisar B, Zoetmulder M, Spiegelhalder K. European guideline for the diagnosis and treatment of insomnia. *J Sleep Res* 2017;26(6):675–700.
- [6] Filosa J, Omland PM, Langsrud K, Hagen K, Engström M, Drange OK, Knutsen AJ, Brenner E, Kallestad H, Sand T. Validation of insomnia questionnaires in the general population: the Nord-Trøndelag Health Study (HUNT). *J Sleep Res* 2021;30(1):e13222.
- [7] Roth T, Coulouvrat C, Hajak G, Lakoma MD, Sampson NA, Shahly V, Kessler RC. Prevalence and perceived health associated with insomnia based on DSM-IV-TR; international statistical classification of Diseases and related health problems, tenth revision; and research diagnostic criteria/international classification of sleep

- disorders, second edition criteria: results from the America insomnia survey. *Biol Psychiatr* 2011;69(6):592–600. <https://doi.org/10.1016/j.biopsych.2010.10.023>.
- [8] Chung K-F, Yeung W-F, Ho FY-Y, Yung K-P, Yu Y-M, Kwok C-W. Cross-cultural and comparative epidemiology of insomnia: the diagnostic and statistical manual (DSM), international classification of Diseases (ICD) and international classification of sleep disorders (ICSD). *Sleep Med* 2015;16(4):477–82. <https://doi.org/10.1016/j.sleep.2014.10.018>.
- [9] Dohnt H, Gradisar M, Short MA. Insomnia and its symptoms in adolescents: comparing DSM-IV and ICSD-II diagnostic criteria. *J Clin Sleep Med* 2012;8(3):295–9. <https://doi.org/10.5664/jcsm.1918>.
- [10] Olufsen IS, Sørensen ME, Bjorvatn B. New diagnostic criteria for insomnia and the association between insomnia, anxiety and depression. *Tidsskr Nor Laegeforen* 2020;140(1). <https://doi.org/10.4045/tidsskr.19.0041>.
- [11] Jacobsen BK, Eggen AE, Mathiesen EB, Wilsgaard T, Njølstad I. Cohort profile: the Tromsø study. *Int J Epidemiol* 2011;41(4):961–7. <https://doi.org/10.1093/ije/dyr049>.
- [12] Hopstock LA, Grimsgaard S, Johansen H, Kanstad K, Wilsgaard T, Eggen AE. The seventh survey of the Tromsø Study (Tromsø7) 2015–2016: study design, data collection, attendance, and prevalence of risk factors and disease in a multipurpose population-based health survey. *Scand J Publ Health* 2022;50(7):919–29. <https://doi.org/10.1177/14034948221092294>.
- [13] Pallesen S, Bjorvatn B, Nordhus IH, Sivertsen B, Hjørnevik M, Morin CM. A new scale for measuring insomnia: the Bergen Insomnia Scale. *Percept Mot Skills* 2008;107(3):691–706. <https://doi.org/10.2466/pms.107.3.691-706>.
- [14] American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. fourth ed. American Psychiatric Publishing; 2000.
- [15] Strand BH, Dalgard OS, Tambs K, Rognerud M. Measuring the mental health status of the Norwegian population: a comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nord J Psychiatr* 2003;57(2):113–8. <https://doi.org/10.1080/08039480310000932>.
- [16] Grimby G, Börjesson M, Jonsdottir IH, Schnohr P, Thelle DS, Saltin B. The "Saltin-Grimby physical activity level scale" and its application to health research. *Scand J Med Sci Sports* 2015;25(Suppl 4):119–25. <https://doi.org/10.1111/sms.12611>.
- [17] Sivertsen B, Krokstad S, Øverland S, Mykletun A. The epidemiology of insomnia: associations with physical and mental health. The HUNT-2 study. *J Psychosom Res* 2009;67(2):109–16.
- [18] National Institute of Health. National institutes of health state of the science conference statement on manifestations and management of chronic insomnia in adults, June 13–15, 2005. *Sleep* 2005;28(9):1049–57.
- [19] Sivertsen B, Pallesen S, Friborg O, Nilsen KB, Bakke OK, Goll JB, Hopstock LA. Sleep patterns and insomnia in a large population-based study of middle-aged and older adults: the Tromsø study 2015–2016. *J Sleep Res* 2021;30(1):e13095.
- [20] de Entrambasaguas M, Romero O, Guevara JAC, de Larrinaga AÁR, Cañellas F, Salud JP, Díaz HP. The prevalence of insomnia in Spain: a stepwise addition of ICSD-3 diagnostic criteria and notes. *Sleep Epidemiology* 2023;3:100053.
- [21] Torsvik S, Bjorvatn B, Eliassen KE, Forthun I. Prevalence of insomnia and hypnotic use in Norwegian patients visiting their general practitioner. *Fam Pract* 2023;40(2):352–9.
- [22] Everitt H, Baldwin DS, Stuart B, Lipinska G, Mayers A, Malizia AL, Manson CC, Wilson S. Antidepressants for insomnia in adults. *Cochrane Database Syst Rev* 2018;5(5):Cd010753.
- [23] Pan B, Ge L, Lai H, Hou L, Tian C, Wang Q, Yang K, Lu Y, Zhu H, Li M, Wang D, Li X, Zhang Y, Gao Y, Liu M, Ding G, Tian J. The comparative effectiveness and safety of insomnia drugs: a systematic review and network meta-analysis of 153 randomized trials. *Drugs* 2023. New Zealand: © 2023. The Author(s), under exclusive licence to Springer Nature Switzerland AG; 2023. p. 587–619.