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Associations of common chronic non-communicable diseases and medical conditions with sleep-related problems in a population-based health examination study☆

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ABSTRACT

A cross-sectional population-based survey, the National FINRISK 2012 Study, designed to monitor chronic diseases and their risk factors in Finland. A random sample of 10,000 adults aged 25–74 years, and of them, 64% (n=6424) participated the study. Participants subjectively reported the total durations for sleep and naps (n=6238), sleep quality (n=5878), bedtimes and wake-up times separately for working days and weekends yielding the amount of sleep debt (n=5878), and the seasonal variation in sleep duration (n=4852). The participants were asked whether they were diagnosed or treated for common chronic diseases in the past 12 months. Logistic regression models were adopted to analysis and adjusted for a range of covariates as potential confounding factors. Total sleep duration and nap duration prolonged in depression and other mental disorder ($p < .001$ for all). Seasonal variation in sleep duration was associated with depression ($p=.014$), hypertension ($p=.018$) and angina pectoris ($p=.024$). Participants with gallstones, cardiac insufficiency, depression, or degenerative arthritis had poor sleep quality (odds ratios of 1.6–6.3, $p=.001$ or less for each). Those with degenerative arthritis had sleep debt less ($p < .05$) and those with angina pectoris more ($p < .05$) than individuals without these medical conditions. Depression is significantly associated with sleep problems, albeit no sleep debt. Cardiovascular diseases, degenerative arthritis, and gallstones had significant associations with one or more sleep problems. There is therefore a need for more successful management of sleep problems in chronic diseases to improve the quality of life, to reduce treatment relapses, and to increase health and longevity in a population.

1. Introduction

It is estimated that as high as a third of the general population suffers from sleep-related problems [1]. For example in Finland, around 10–14% of the adult population has reportedly suffered from insomnia-related symptoms [2] and 9% of daytime sleepiness [3]. Studies suggest that sleep-related problems are associated with lifestyle and socio-demographic factors such as smoking, exercise, gender, age, and education [2,4–7]. Besides, earlier studies also suggest that sleep-related problems and chronic non-communicable diseases have a bidirectional relationship: it can exacerbate chronic conditions, disrupt treatment, and increases social disability and vice versa [8–10]. Specifically, poor sleep prospectively associates with all-cause of mortality and morbidity, for example, by increasing inflammation, stress, blood pressure, impaired blood glucose control, and breathing problems [11–13]. Further, sleep-related problems decrease the quality of life and productivity and diminish the coping capacity for chronically ill patients, which in turn accelerate the disease's progression [14,15]. According to a most recent study, patients who have asthma, chronic lung disease, diabetes, and strokes reported significantly higher sleep problems [16]. Several other studies suggest that common pathophysiological mechanisms co-occur in sleep-related problems and chronic diseases [12,17]. However, it is not yet clear if the treatment of patients' sleep-related problems could result in

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significant clinical improvement and reduced mortality [15]. Nevertheless, understanding this relationship could give a new perspective on the course, outcomes, and treatment options. Therefore, in this study, we have examined the associations of sleep-related problems and some of the most common chronic non-communicable diseases and medical conditions in Finland.

2. Participants and methods

The National FINRISK Study is a large cross-sectional population-based survey on risk factors for chronic diseases. The surveys were conducted at five-year intervals since 1972 by using independent, random, and representative population samples. In 2012, ten thousand randomly chosen inhabitants, aged between 25 and 74 years old, were invited to participate in the survey. Based on the information provided by the Finnish Population Information System, the target survey sample was stratified, with strata of 2000 for five geographical areas each, according to the gender and 10-year age groups. Altogether 64% (n=6424) of those invited, participated the survey. The participants were asked to fill in the study questionnaires, which they had received beforehand by mail, and to participate in a health examination organized in a local health care center.

3. Sleep parameters

Information on the following sleep-related parameters was available: the total durations of sleep (in hours and minutes) and naps (in hours and minutes) from 6242 participants, the bedtimes (as clock time) and the wake-up times (as clock time) separately for weekdays and weekends, sleep debt (the sum of the differences in bedtimes and wake-up times during weekdays and weekends), and sleep quality as "Yes" or "No" to the question "Do you think you sleep enough?" from 5878 participants, the seasonal variations in sleep duration as scored on a Likert scale of 0 (no variation), 1 (slight variation), 2 (moderate variation) or 3 (marked variation) from 4852 participants.

4. Covariates

The National FINRISK 2012 study survey included a self-administered set of questionnaires with questions on socioeconomic factors, medical history, health behavior, and psychosocial factors, physical examination of health status, and laboratory measures for further analyses.

Socioeconomic covariates were age and body-mass index (BMI) as continuous variable, gender as male or female, marital status as living with somebody (either married, cohabitating or registered partnership) or alone (either single, separated or divorced, or widowed), education as low (less than four years of high school), medium (either high school only or 1–3 years post high school) or high level (4 or more years post high school), region as living in North Karelia & Kuopio, North Savo, Turku & Loimaa, Helsinki & Vantaa, or Oulu.

Lifestyle covariates were smoking as smokers (smoked daily or occasionally) and non-smokers (not at all), alcohol consumption as alcohol consumption (at least once or more than once a month) or no alcohol consumption (no alcohol consumption at all) and exercise as regular exercise (exercise several times a week or at least 3–4 h per week) or no-exercise (exercise less than 3 h per week).

Common chronic non-communicable diseases and medical conditions were assessed by responses to the question "Has a medical doctor diagnosed or treated you for any of the following diseases during the past year (last 12 months)?: Cardiovascular diseases (CVDs) symptoms including hypertension (increased blood pressure), high cholesterol, cardiac insufficiency, effort angina (angina pectoris), diabetes, cancer, bronchial asthma, chronic obstructive pulmonary disorders (COPD), gallstone (gallbladder inflammation), rheumatoid arthritis, other disease of the joints, degenerative arthritis of the back (other illness of the back), depression, other psychological illnesses, renal failure, and proteinuria". Responses were dichotomized into "Yes" and "No," and this information was available from all the participants.

5. Statistical analyses

Logistic regression models with non-communicable chronic diseases and medical conditions as dependent and the sleep parameters as independent explanatory variables (total sleep and nap durations, sleep quality, bedtimes and wake-up times during weekdays and weekends, sleep debt, and the seasonal variation in sleep duration) were analyzed separately to calculate the odds ratio (OR) after controlling for the covariates (age, gender, education, marital status, region, alcohol consumption, smoking, physical activity, and BMI). Participants with good sleep quality and those with no seasonal variations in sleep duration were used as the reference categories in the analysis. The data were analyzed with IBM SPSS Statistics 21 software.

6. Ethics

The data collection was collected according to the guidelines of the Declaration of Helsinki and international ethical standards. The Ethics Committee of the Hospital District of Helsinki and Uusimaa evaluated and approved the research protocols. The ethical steering committee within National Institute for Health and Welfare gave permission for the sub-study and provided the data. All the participants gave a written informed consent either in Finnish or Swedish language.

7. Results

A total of 6424 participants completed the survey. The descriptive data on the background variables for the participants (3383 women and 3041 men) are given in Table 1, and those of their sleep in Table 2.

The timing of sleep was reported for weekdays and weekends separately for each chronic disease or medical condition (see supplementary tables 1–2). Concerning bedtimes, those with depression or other mental disorders had later bedtimes on weekdays and weekends when compared to those without disorders. Later bedtimes on weekdays were present also in those with cancer, COPD or gallstones, as compared with those not having these conditions. For the remaining, those having a medical condition had earlier bedtimes than those not having the medical condition in question. Concerning the wake-up time, those with depression or other mental disorder, bronchial asthma, or gallstones had a later wake-up time on weekdays as well as in weekend, as compared with those not having these conditions. Those having rheumatoid or degenerative arthritis had an earlier wake-up time both on weekdays and in weekend than those not having these conditions. For the remaining, those with a medical condition had a later wake-up time on weekdays but an earlier wake-up time in weekend, as compared with those not having the medical condition in question.

In the present study, total sleep duration was prolonged in most of the medical conditions and diseases assessed, significantly in depression ($p < .001$) and other mental health disorder ($p < .001$). Similarly, total naptime was prolonged in all the medical conditions and diseases, except in gallstones and rheumatoid arthritis, and significantly in depression ($p < .001$) and other mental health disorder ($p < .001$). Seasonal variation in sleep duration was significantly associated with angina pectoris ($p=.024$), depression ($p=.014$) and hypertension ($p=.018$). All the medical conditions and diseases had the increased odds for poor sleep quality, significantly in gallstones ($p=.001$), cardiac insufficiency ($p=.001$), depression ($p < .001$), and degenerative arthritis ($p < .001$). Participants with degenerative arthritis had sleep debt significantly less and those with angina pectoris significantly more than individuals without these medical conditions (see Table 3).

Table 1
Background characteristics of the participants.

Background measures	Frequency (n)	%
Age (n=6424), mean (s.d.)=51.06 (14.07) years		
25–34 years	1044	16.3
35–44 years	1193	18.6
45–54 years	1302	20.3
55–64 years	1397	21.7
65–74 years	1488	23.2
BMI (n=5814), mean (s.d.)=27.11 (4.99)		
Underweight (< 18)	25	.4
Normal (18–24.99)	2154	37.0
Overweight (25–29.99)	2249	38.7
Obese (> 30)	1386	23.8
Gender (n=6424)		
Male	3041	47.3
Female	3383	52.7
Living status[a](n=6408)		
Together	4605	71.9
Alone	1803	28.1
Education level[b](n=6310)		
Low	2125	33.7
Medium	2115	33.5
High	2070	32.8
Region of residence (n=6424)		
North Karelia & Kuopio	1282	20.0
North Savo	1334	20.8
Turku & Loimaa	1262	19.6
Helsinki & Vantaa	1219	19.0
Oulu	1327	20.7
Smoking[c](n=6096)		
Smokers	1447	43.0
Non-smokers	1921	57.0
Alcohol intake[d](n=6403)		
Alcohol intake	5582	87.2
No alcohol intake	821	12.8
Physical activity[e](n=6383)		
Regular exercise	4997	78.3
No exercise	1386	21.7

s.d.=standard deviation; BMI=body-mass index.

[a] together (either married, cohabitating, or registered partnership), alone (either single, separated, divorced, or widowed).

[b] low (less than 4 years of high-school), medium (either only high-school or 1–3 years post-high-school), high (4 or more years post-high-school) level.

[c] smokers (either smoked daily or occasionally), non-smokers (smoked not at all).

[d] alcohol intake (at least once or more than once a month), no alcohol intake (not at all or quit using alcohol).

[e] regular exercise (at least 3–4 h per week or several times a week), no exercise (less than 3 h per week).

8. Discussion

To our knowledge, there area limited number of population studies that has assessed the associations of sleep-related problems with chronic medical conditions and diseases at large. A large cross-sectional survey from China, among participants aged between 18 and 75 years old, suggested that there was an association between poor sleep quality and short sleep duration (≤6 h) with type-2 diabetes [18]. Similarly, a more recent population survey from the UK, among participants aged between 37 and 63 years, replicated poor sleep duration to be high-risk characteristics of both CVD and type 2 diabetes [19]. In the present population study, not only CVDs but also depression, degenerative arthritis, and gallstones were significantly associated with one or more sleep problems including sleep and nap duration, seasonal variation in sleep duration, poor sleep quality, and sleep debt. Angina pectoris was significantly associated with increased seasonal variation in sleep duration and sleep debt. Degenerative arthritis was significantly associated with poor sleep quality and increased sleep debt. Depression was significantly associated with total sleep and nap duration, increased seasonal variations in sleep duration, and increased odds for poor sleep quality.

The world health organization recognized CVDs as the leading cause of global mortality, accounting for 46.2% (17.5 million) of deaths caused by non-communicable diseases [20]. Inadequate sleep was associated with increased risk of developing CVDs [21]. Usually, short sleep duration was associated with cardiovascular disease-related mortality and long sleep duration with non-cardiovascular related mortality [22]. Further, short sleep duration was significant risk factor for hypertension [23]. Self-reported hypertension was associated with sleep problems also in Finland [16]. In the present study, CVD risk factors were significantly associated with one or more sleep problems. For example, cardiac insufficiency was significantly associated with increased odds for poor sleep quality. Hypertension was significantly associated with increased odds in seasonal variation in sleep duration. Likewise, angina pectoris was associated with both seasonal variation and sleep debt. The results are in line with the existing studies, that reports higher morbidity, mortality and hospitalization rates for CVDs [24,25]. According to the evidence, poor sleep quality and short sleep duration (< 6 h per night) were independent risk factors for type 2 diabetes [18,26,27]. Hormonal changes, due to sleep debt, contribute to insulin resistance, which could, therefore, be a risk factor for diabetes. In a case-control study, 34% of diabetic patients reported sleep-related problems compared to 8% of controls [14]. Many experimental studies indicated that short sleep duration (< 7 h/night) and poor sleep quality decreased glucose tolerance and reduced insulin sensitivity, which showed the link between diabetes and sleep problem [28–30]. Another study reported that circadian misalignment, which commonly occurs as a consequence of poor sleep, disturbed glucose-insulin metabolism and substrate-oxidation, thereby suggesting further associations between sleep and diabetes [31]. However, in contrary to earlier evidence, the present study showed no significant associations between sleep problems and diabetes. In like manner, sleep problem was also a common complaint of cancer patients [32]. As cited in the review by Roscoe and colleagues [33], many studies have reported a strong correlation between cancer-related fatigue and sleep problems such as poor sleep quality, difficulties of falling asleep, and poor sleep efficiency. Symptoms such as pain, melancholy, loss of concentration as well as a decrease in other cognitive functions clusters in cancer patients [34–36]. In contrary to earlier findings, the present study showed no significant association between sleep parameters and cancer. On the other hand, patients with lung diseases often had poor sleep quality due to abnormalities in breathing during sleep [37]. In a large multi-country survey, the likelihood of sleep problem was significantly higher among older asthmatics (≥50years) than other chronic diseases in Finland [16]. In the present study, the odds for poor sleep quality were increased more than 1.5-fold among those with respiratory disease. In 1989, Hyyppä and Kronholm [38] found an association between somatic diseases and poor quality of sleep among Finnish population. Likewise, acid-related gastrointestinal diseases were important determinants of poor sleep quality among elderly Finns [39]. In line with the available evidence, gallstones and degenerative arthritis in the present study were significantly associated with the increased odds of poor sleep quality. Furthermore, epidemiological and clinical studies have reported a strong correlation between sleep problems and depression [40,41]. In a large community-based population study, short sleep duration, and increased sleep disturbances were independently associated with increased cortisol secretion suggesting chronic stress [42]. In line with the existing evidence, in the present study depression was associated with range of sleep problems including inadequate total sleep and nap duration, seasonal variations in sleep duration, and poor sleep quality. Likewise, other mental disorders were associated with inadequate total sleep and nap duration. To our knowledge, no prior studies have directly assessed the associations of renal failure and proteinuria with sleep-related problems. However, some earlier studies have shown that sleep problems had increased the risk of CVDs, hypertension, diabetes, and obesity, all of which were implicated in the etiology of chronic kidney diseases [43]. More recent studies have indicated sleep problems also among kidney patients

Table 2
Descriptive data on sleep parameters by the background characteristics.

	Sleep parameters																			
	Sleep duration, hours				Sleep+nap, hours				Sleep debt, hours				Seasonal variation in sleep duration				Sleep quality			
	M	n	s.d.	%	M	n	s.d.	%	M	n	s.d.	%	No	%	Yes	%	Poor	%	Good	%
Age, years																				
25–34	7.60	1029	1.00	16.50	7.78	982	1.32	16.70	−3.21	1003	2.46	17.60	180	3.70	498	10.30	193	3.30	776	13.20
35–44	7.53	1169	1.03	18.70	7.72	1123	1.43	19.10	−2.78	1143	1.99	20.10	197	4.10	624	12.90	194	3.30	900	15.30
45–54	7.40	1274	1.07	20.40	7.63	1224	1.41	20.80	−2.61	1216	2.00	21.40	221	4.60	766	15.80	185	3.10	1017	17.30
55–64	7.36	1352	1.18	21.70	7.68	1242	1.45	21.10	−1.96	1215	1.80	21.30	305	6.30	805	16.60	177	3.00	1095	18.60
65–74	7.54	1414	1.15	22.70	7.95	1307	1.51	22.20	−.63	1117	.96	19.60	413	8.50	843	17.40	90	1.50	1252	21.30
Total	7.48	6238	1.10	100	7.76	5878	1.43	100	−2.22	5694	2.09	100	1316	27.10	3536	72.90	839	14.30	5040	85.70
Body-mass index																				
< 18	7.11	25	1.36	.40	7.52	24	1.22	.50	−2.31	24	2.16	.50	5	.10	16	.30	8	.20	15	.30
18–24.99	7.55	2104	1.07	37.20	7.75	2000	1.32	37.50	−2.45	1966	1.98	38.10	455	9.40	1345	27.80	328	6.20	1653	31.10
25–29.99	7.44	2192	1.06	38.80	7.66	2067	1.44	38.80	−2.07	1980	2.13	38.40	539	11.10	1329	27.40	270	5.10	1800	33.90
> 30	7.44	1328	1.14	23.50	7.90	1242	1.52	23.30	−2.05	1192	2.00	23.10	315	6.50	838	17.30	156	2.90	1084	20.40
Total	7.48	5649	1.09	100	7.75	5333	1.42	100	−2.21	5162	2.05	100	1314	27.10	3528	72.90	762	14.30	4552	85.70
Gender																				
Male	7.37	2957	1.10	47.40	7.71	2809	1.44	47.80	−2.16	2652	2.10	46.60	717	14.80	1485	30.60	351	6.00	2416	41.10
Female	7.58	3281	1.08	52.60	7.80	3069	1.43	52.20	−2.28	3042	2.08	53.40	599	12.30	2051	42.30	488	8.30	2624	44.60
Total	7.48	6238	1.10	100	7.76	5878	1.43	100	−2.22	5694	2.09	100	1316	27.10	3536	72.90	839	14.30	5040	85.70
Living status[a]																				
Together	7.51	4492	1.05	72.20	7.77	4260	1.36	72.60	−2.19	4148	1.90	73.00	985	20.30	2565	52.90	586	10.00	3675	62.60
Alone	7.40	1733	1.21	27.80	7.73	1610	1.61	27.40	−2.30	1536	2.52	27.00	329	6.80	966	19.90	251	4.30	1356	23.10
Total	7.48	6225	1.10	100	7.76	5870	1.43	100	−2.22	5684	2.09	100	1314	27.10	3531	72.90	837	14.30	5031	85.70
Education level[b]																				
Low	7.41	2039	1.16	33.20	7.71	1879	1.59	32.40	−2.24	1789	2.38	31.80	457	9.60	1131	23.70	269	4.60	1627	28.10
Medium	7.48	2025	1.10	33.00	7.76	1925	1.43	33.20	−2.23	1850	2.09	32.90	413	8.60	1163	24.30	265	4.60	1658	28.70
High	7.55	2079	1.01	33.80	7.80	1999	1.25	34.40	−2.19	1985	1.79	35.30	421	8.80	1197	25.00	292	5.00	1674	28.90
Total	7.48	6143	1.09	100	7.76	5803	1.43	100	−2.22	5624	2.09	100	1291	27.00	3491	73.00	826	14.30	4959	85.70
Region of residence																				
North Karelia & Kuopio	7.50	1270	1.16	20.40	7.67	1243	1.70	21.10	−2.08	1088	2.06	19.10	248	5.10	798	16.40	150	2.60	1038	17.70
North Savo	7.52	1299	1.06	20.80	7.82	1260	1.32	21.40	−2.08	1244	1.96	21.80	262	5.40	736	15.20	151	2.60	1076	18.30
Turku & Loimaa	7.45	1221	1.11	19.60	7.74	1128	1.35	19.20	−2.35	1128	2.14	19.80	259	5.30	668	13.80	189	3.20	956	16.30
Helsinki & Vantaa	7.45	1179	1.10	18.90	7.73	1087	1.31	18.50	−2.43	1089	2.22	19.10	279	5.80	592	12.20	190	3.20	915	15.60
Oulu	7.49	1269	1.06	20.30	7.82	1160	1.43	19.70	−2.19	1145	2.04	20.10	268	5.50	742	15.30	159	2.70	1055	17.90
Total	7.48	6238	1.10	100	7.76	5878	1.43	100	−2.22	5694	2.09	100	1316	27.10	3536	72.90	839	14.30	5040	85.70
Smoking[c]																				
Smokers	7.37	1405	1.17	43.00	7.76	1322	1.37	42.90	−2.58	1265	2.68	42.60	252	10.20	706	28.60	193	6.30	1111	36.10
Non-smokers	7.45	1865	1.08	57.00	7.73	1757	1.48	57.10	−2.21	1704	1.90	57.40	414	16.80	1094	44.40	247	8.00	1524	49.60
Total	7.41	3270	1.12	100	7.74	3079	1.43	100	−2.37	2969	2.27	100	666	27.00	1800	73.00	440	14.30	2635	85.70
Alcohol intake[d]																				
Alcohol intake	7.48	5440	1.08	87.40	7.73	5141	1.39	87.60	−2.31	5017	2.09	88.30	1129	23.30	3109	64.20	745	12.70	4395	74.90
No alcohol intake	7.51	784	1.21	12.60	7.90	726	1.72	12.40	−1.57	667	1.99	11.70	186	3.80	419	8.70	93	1.60	631	10.80
Total	7.48	6224	1.10	100	7.75	5867	1.43	100	−2.22	5684	2.09	100	1315	27.20	3528	72.80	838	14.30	5026	85.70
Physical activity[e]																				
Regular exercise	7.51	4877	1.04	78.50	7.75	4615	1.38	78.80	−2.18	4476	2.06	78.80	1008	20.80	2877	59.40	590	10.10	4041	69.10
No exercise	7.39	1333	1.28	21.50	7.77	1243	1.63	21.20	−2.38	1202	2.20	21.20	305	6.30	651	13.40	244	4.20	977	16.70
Total	7.48	6210	1.10	100	7.75	5858	1.43	100	−2.22	5678	2.09	100	1313	27.10	3528	72.90	834	14.30	5018	85.70

M=mean value; s.d.=standard deviation.
[a] together (either married, cohabitating, or registered partnership), alone (either single, separated, divorced, or widowed).
[b] low (less than 4 years of high-school), medium (either only high-school or 1–3 years post-high-school), high (4 or more years post-high-school) level.
[c] smokers (either smoked daily or occasionally), non-smokers (smoked not at all).
[d] alcohol intake (at least once or more than once a month), no alcohol intake (not at all or quit using alcohol).
[e] regular exercise (at least 3–4 h per week or several times a week), no exercise (less than 3 h per week).

[44,45]. In line with the existing evidence, the present study too showed that all of the sleep problems increased the odds of renal failure.

Often, many risk factors attributing in the etiology of chronic diseases are preventable. Sleep health is one such aspect of diseases prevention. There were multiple evidences that mortality and diseases risk factors were associated with sleep problems. Especially, long and short duration sleep was associated with disease and mortality, most commonly in cardiovascular diseases, hypertension, hormones and endocrine functions [21,46,47]. Sleep duration of 7–8 h reduced the

Table 3
Diagnosed or treated chronic diseases or medical conditions as explained by the sleep parameters.

Chronic diseases andmedical conditions[a]	Prevalence, n (%)		Sleep parameters				
			Sleep duration	Nap duration	Seasonal variationin sleep duration[b]	Poor sleep quality[c]	Sleep debt
	No	Yes	n=6238 B (SE) p	n=6238 B (SE) p	n=5879 OR (95% CI) p	n=5878 OR (95% CI) p	n=5694 B (SE) p
Hypertension	4701 (74.2)	1634 (25.8)	1.067 (.044)	1.007 (.036)	1.328 (1.05–1.68)**	1.182 (.87–1.59)	1.032 (.025)
High cholesterol	5019 (79.3)	1307 (20.7)	.978 (.044)	1.044 (.036)	1.013 (.80–1.27)	1.196 (.88–1.61)	1.031 (.026)
Cardiac insufficiency	6151 (97.1)	186 (2.9)	.948 (.094)	1.088 (.081)	1.064 (.64–1.76)	2.725 (1.51–4.91)***	.962 (.070)
Angina pectoris	6137 (96.8)	203 (3.2)	.900 (.090)	1.030 (.076)	1.960 (1.09–3.52)*	1.552 (.79–3.01)	1.110 (.049)*
Diabetes	5877 (92.7)	462 (7.3)	1.079 (.067)	1.092 (.057)	.993 (.70–1.40)	1.364 (.84–2.19)	1.059 (.043)
Cancer	6202 (97.8)	142 (2.2)	1.055 (.117)	1.193 (.103)	1.158 (.62–2.15)	1.869 (.87–3.97)	.899 (.087)
Bronchial asthma	5854 (92.4)	480 (7.6)	1.028 (.064)	1.074 (.054)	1.158 (.80–1.66)	1.435 (.96–2.14)	1.000 (.035)
Chronic obstructivepulmonary disease	6266 (98.8)	73 (1.2)	1.177 (.122)	1.128 (.105)	.917 (.48–1.74)	1.502 (.58–2.84)	.963 (.111)
Gallstones	6278 (99.0)	64 (1.0)	.789 (.173)	.912 (.145)	1.144 (.35–3.67)	6.259 (2.22–17.58)***	.863 (.122)
Rheumatoid arthritis	6201 (97.9)	134 (2.1)	1.042 (.113)	.984 (.097)	1.207 (.62–2.32)	1.266 (.57–2.77)	1.020 (.069)
Other joint disease	5440 (86.0)	883 (14.0)	1.011 (.051)	1.023 (.042)	1.302 (.97–1.73)	1.334 (.93–1.90)	.979 (.032)
Degenerative arthritis	5149 (81.4)	1178 (18.6)	.946 (.043)	1.002 (.035)	1.223 (.96–1.55)	1.639 (1.24–2.15)****	.931 (.027)**
Depression	5827 (92.0)	507 (8.0)	1.291 (.060)****	1.281 (.053)****	1.622 (1.10–2.38)**	1.899 (1.34–2.68)****	1.048 (.029)
Other mental disorder	6174 (97.4)	164 (2.6)	1.605 (.093)****	1.460 (.081)****	.956 (.54–1.68)	1.342 (.77–2.32)	1.047 (.041)
Renal failure	6299 (99.4)	40 (.6)	1.045 (.205)	1.270 (.191)	2.615 (.56–12.16)	1.866 (.48–7.13)	1.065 (.063)
Proteinuria	6247 (98.8)	76 (1.2)	.911 (.166)	1.014 (.010)	3.959 (.91–17.19)	1.412 (.51–3.85)	1.060 (.086)

Covariates in the models included age, gender, living status, education, region, smoking, alcohol intake, physical activity, and body-mass index. Reference group:
[a] no medical condition.
[b] no seasonal variation in sleep duration.
[c] good sleep quality.
* p= < .05.
** p= < .01.
*** p= < .001.
**** p= < .0001.

relative risk for all-cause mortality by double compared to shorter and longer durations [48]. For sleep debt duration, Lohr and Gingery reported that even a 30-min difference in sleep duration on weekdays could adversely impact health and cause diseases as compared to weekends [49]. Next, cardiovascular and metabolic changes were common in sleep-related problems causing chronic diseases thus degrading sleep quality [50]. Further, there is emerging evidence that inconsistent sleep duration and poor sleep efficiency were related to adiposity, which is comorbidity in chronic diseases [51,52].

9. Limitations and strengths

There are several limitations to our study. First, sleep-related problems were subjectively measured; therefore, some misclassifications might have occurred. Nonetheless, questions about self-reported sleep problems for timing and duration have demonstrated good validity compared with quantitative sleep assessments [53]. Second, the study design was cross-sectional and therefore the causation between sleep-related problems and chronic diseases cannot be inferred with the significant associations observed in the results. Further, long-term monitoring of sleep is required to detect changes in sleep over time; hence the results are to be cautiously interpreted. Lastly, the novel findings of the present study should be cautiously interpreted due to a small number of cases in some of the disease groups.

Despite several limitations of this study, there are also several strengths. First, the results are fairly generalizable and the potential risk of selection bias is reduced, since the dataset was based on a large population who were randomly selected from a national registry. Second, the study has a reliable study design as it is conducted at every five-year interval in Finland. Third, the diseases reported in this study were not only based on the subjective responses of the participants but were also clinically verified by following up the medication participants used as well as with previous diagnoses assessed by a medical doctor.

However, a longitudinal investigation is warranted to better understand the associations of sleep problems and chronic diseases. Current understanding of possible association suggests that interventions targeting sleep problems in chronic diseases could provide promising potential treatments. Given the emerging results suggesting many sleep problems in some of the most common chronic diseases, it should follow the targeted treatment of sleep problems that may positively affect diseases treatment.

10. Conclusion

According to the study results sleep problems is prevalent and distressing in chronic diseases. It indicates a possibility of alteration in circadian rhythms disruptions in chronic diseases that significantly impairs the quality of life leading to further progression of diseases. Therefore, to improve the quality of life and to reduce treatment relapses, there is a need for more successful management of sleep health in chronic diseases. This could plausibly enable good sleep health and increase longevity in the population.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.slsci.2016.11.003.

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