Sleep Difficulties and the Development of Depression and Anxiety: A Longitudinal Study of Young Australian Women

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Abstract

Purpose: Previous longitudinal studies have demonstrated that poor sleep may precede depression and anxiety. The current study examined the association between self-reported sleeping difficulties and new onset depression and anxiety in young women.

Methods: A nationally representative sample of 9,683 young women from the Australia Longitudinal Study of Women's Health was analyzed. Women were surveyed in 2000 (aged 22 to 25 years), 2003, 2006 and 2009. Generalized estimating equations were used to examine the association between sleeping difficulties in 2000 and new-onset depression (excluding postnatal depression) and anxiety at each subsequent survey.

Results: Significant increased risk of new onset depression (OR=2.6 in 2003; OR=4.4 in 2006; OR=4.4 in 2009) and anxiety (OR=2.4 in 2006; OR=2.9 in 2009) was found at each follow-up survey in women who reported sleeping difficulties "often" in 2000.

Conclusion: Further research is needed to uncover the mechanisms underlying the link between sleep problems and mental health.

Introduction

Depression is one of the leading global burdens of disease, and is estimated to be one of the top three health concerns by 2020 (Murray and Lopez 1997). In Australia, depression and anxiety contribute the largest proportion of burden of disease for women, accounting for around 10% of the total female burden (Begg et al. 2007). In particular, the incidence of depression in young women is three times greater than in young men, and it is the leading cause of morbidity in young Australian women (Carr-Gregg et al. 2003).

Given this widespread disease burden, it is important to identify possible underlying triggers or indicators of the increasing prevalence of mental illness in our society. Many risk factors for mental illness have been identified in addition to female gender, such as poor coping strategies, genetic factors, negative cognitive style, and an adverse response to stress (Spasojević and Alloy 2001; Dobson and Dozois 2011; Drake et al. 2004). Sleep disturbance has also been highlighted as a potential risk factor for depression (Baglioni et al. 2011). Insomnia itself is extremely prevalent, with approximately 30% of adults reporting one or more symptoms of insomnia at any given time (Dodge et al. 1995). An estimated 6% of the population meet the DSM-IV criteria for Primary Insomnia (Ohayon 2002), defined as difficulties initiating or maintaining sleep, or non-restorative sleep, persisting for at least four weeks. Of relevance, female gender is also a risk factor for insomnia. Young adult women are almost twice as likely to experience poor sleep than young men, and this risk increases with age (Byles et al. 2003). Specifically in women, poor sleep is associated with a number of negative health outcomes (Leineweber et al. 2003; Blackwell et al. 2006). Thus, young women appear to be a particularly vulnerable group to both insomnia and depression.

Bouts of insomnia are often reported in patients with depression, and often precede the onset of depressive episodes. Large population studies have found that distinct symptoms of insomnia separately predicted reported (Jansson-Fröjmark and Lindblom 2008; Szklo-Coxe et al. 2010), and incident treatment for (Salo et al. 2012), depression at 3 to 4 years follow up, after controlling for baseline psychological distress and anxiety in addition to age, sex, socioeconomic status, night/shift work, health behaviors, and physical health. Other studies, however, have failed to find an association between insomnia and depression over time (Neckelmann et al. 2007). A recent meta-analysis revealed a two-fold increased risk of new incidences of depression in those with insomnia at baseline (Baglioni et al. 2011). While there is less evidence for the relationship between sleep disturbance and anxiety, some studies have found that chronic insomnia predicted first onset of anxiety (Jansson-Fröjmark and Lindblom 2008; Neckelmann et al. 2007; Breslau et al. 1996) and panic disorder (Weissman et al. 1997). One of the limitations of these studies is that the majority of them report combined odds ratios values for both men and women. Therefore these studies lack generalizability of their findings with respect to gender.

These previous studies have examined associations between clinically-diagnosed insomnia and mental health outcomes, however, subjective sleep complaints may also be clinically useful and accurate. Subjective sleep measures are highly correlated with objective measures of sleep, even in depressed individuals (Armitage 1997). Even at the symptoms level, sub-clinical subjective sleep complaints have also been found to precede episodes of depression (Gillin, 1998; Szklo-Coxe et al. 2010). Thus, examining self-reported sleeping problems is important to study in this context.

The prevalence of insomnia and mental illness varies across the life span (Byles et al. 2003; Wittchen et al. 1994; Jorm 2000). Studies that have examined associations between insomnia and mental health outcomes in older cohorts have found increased risk of depression (Yokoyama et al. 2010; Roberts et al. 2000), and associations with poorer quality of life in women (Byles et al. 2005). Less research has been conducted in younger age groups, who are at particular risk of insomnia and alterations in circadian timing due to developmental and social influences (Colrain and Baker 2011). This age group also presents an important stage of life where early interventions or treatment of sleeping problems may have significant clinical implications. Studies of adolescents (Roane and Taylor 2008; Roberts et al. 2002; Roberts and Duong 2013) and young adults (Breslau et al. 1996; Buysse et al. 2008) have found that those with self-reported sleeping difficulties had an increased risk of subsequent depression, controlling for gender and baseline depression. While the majority of these studies have only used short follow up periods, there is some evidence that risk of mental health concerns may also increase over longer periods of sleeping difficulties (Buysse et al. 2008; Chang et al. 1997. Examining the trajectory of the link between sleeping problems and mental health outcomes over longer time periods will allow us to determine whether these associations worsen over time, or vary with age, thus more deeply informing our understanding of this phenomenon and intervention efforts.

The aim of the current study was to examine potential predictive relationships between self-reported sleeping problems and depression and anxiety over nine years in a large community sample of young Australian women. The prevalence of depression and anxiety, and the

relationship between sleeping difficulties and depression and antidepressant use across surveys, was also explored.

Methods

Data collection

Data from a longitudinal cohort study (Australian Longitudinal Study on Women's Health, ALSWH), which is designed to track the health of women over a period of up to 20 years, was used. The current study focused on the young cohort, which included women aged 22 to 27 years in 2000; the year of the first data point in the current study. The ALWSH sample was drawn from the database of the Health Insurance Commission, the universal provider of basic health insurance, which involves all women in Australia (including women who reside in Australia but who do not have permanent residency status). The participants in the survey are broadly representative of the Australian population, however, women from rural and remote areas were sampled at twice the rate of women in urban areas. The surveys collected demographic and health data using a wide range of questionnaire items measuring physical, social, mental health status, exercise and diet, and healthcare use (including use of medications). All women had completed comprehensive health surveys in 1996, 2000, 2003, 2006 and 2009; there was no question regarding depression in the 1996 survey therefore only the last four collection years were used in the current analyses. The sample consisted of 9,683 young women at the 2000 survey, 9,078 women in the 2003 survey, 9,140 in the 2006 survey and 8,196 women responded in 2009. The actual survey questions can be viewed on the Internet (www.alswh.org.au/for-researchers/surveys), along with details of where specific questions have been validated or used previously (Australian Longitudinal Study on Women's Health 2011).

Measures

Psychological variables

A number of items relating to mental health status were assessed. Respondents were asked "In the last 3 years, have you been diagnosed or treated for a) depression (not postnatal) or b) anxiety disorder?" Respondents were also asked "In the past 12 months, have you had c) depression or d) episodes of intense anxiety?" rated on a 4-point scale ranging from 0 (never), 1 (rarely), 2 (sometimes), and 3 (often).

Sleeping difficulty

One item relating to *sleeping difficulty* asked participants whether they had experienced sleeping difficulties in the last 12 months, rated on a 4-point scale ranging from 0 (never), 1 (rarely), 2 (sometimes), and 3 (often). Sleeping difficulties "often" was used as the independent variable.

Demographics and selected variables

A question regarding *education level* was categorized across seven levels (no formal qualification, Year 10, Year 12, trade/apprenticeship, certificate/diploma, university degree, and higher university degree). The *frequency of binge-drinking* question asked how often respondents had five or more standard drinks of alcohol on one occasion categorized across 5 levels ("never" to "more than once a week"). *History of abuse* (physical, emotional or sexual, or harassment) was also recorded and score dichotomously (yes or no). One question concerning *body weight dissatisfaction* asked "How much would you like to weigh now?" and the 6 options ranged from 1 (happy as I am), 2 (1–5 kg more), 3 (over 5 kg more), 4 (1–5 kg less), 5 (6–10 kg less), to 6

(over 10 kg less). A dichotomous variable was obtained by combining the first five options into

one category, and the last option became a second category; thus, this variable only related to

dissatisfaction with being 10kg over their current weight. The above four variables were included

in the adjusted regression model as they had been found in a previous study using this dataset

(2003 survey) to make a significant contribution to sleep difficulty when a range of other

variables (including depression and anxiety) were controlled (Bruck and Astbury 2012).

Respondents were also asked whether they had used different types of *medication* ("prescription

medication for your nerves", "prescription medication to help you sleep" and "prescription

medication for depression") over the past 4 weeks.

Statistical Analyses

Statistical analyses were performed using R (R Foundation for Statistical Computing, 2008).

Prevalence statistics were generated for each of the variables (sleeping difficulty, depression

status, anxiety status) at each survey. An area-weighting variable was used to adjust for the

oversampling of women in rural and remote areas, to provide a more accurate representation of

the prevalence rates of Australian population.

Generalized estimating equations (GEE) were used to examine the association between self-

reported sleeping difficulties in the last 12 months at the 2000 survey and a report of a diagnosis

in the past 3 years of a) depression (excluding postnatal depression) and b) anxiety at each

subsequent survey. The comparison group was women who reported sleeping difficulties but did

not report a diagnosis of depression or anxiety in 2003, respectively (i.e. those women from 2000

who continued to report sleeping difficulties but did not report any mental health concerns).

Adjusted models were also fitted using education level, history of abuse, dissatisfaction with body weight and binge drinking reported in 2000 as covariates, as there variables were significantly associated with sleeping difficulties in our previous analysis of this database (Bruck and Astbury 2012). Women who reported a previous diagnosis or symptoms (in last 12 months "often") of depression or anxiety at the 2000 survey, with or without co-existing sleeping difficulties, were excluded from the depression and anxiety analyses. Additionally, women who reported antidepressant use at the 2000 survey were also excluded from the analyses, leaving 5,705 in the final sample.

The method of GEE was chosen as it is the most convenient and appropriate method to analyse the longitudinal data, particularly given that the dependent variable was dichotomous. GEE has a number of appealing properties: It is almost as efficient as those based on the full likelihood, and it is robust to miss-specification of the within person correlations. However, it should be emphasized that for GEE to be unbiased, missing data should be missing completely at random (MCAR). If the data is only missing at random (MAR), that is the probability of missingness depends on observed variables, then the GEE analysis will be biased. To overcome this limitation, multiple imputation was carried out using the mice package (Van Buuren and Groothius-Oudshoorn 2011) in R to produce 25 imputed data sets. For the imputations, binary variables were imputed using logistic regression and ordinal variables were imputed using proportional odds logistic regression, and each variable was used as the response with the other variables as explanatory variables, and 25 iterations were performed. The GEE analysis was then repeated for each imputed data set and the results were combined using Rubin's method, where the final estimate for each parameter was the mean estimate over the imputed analyses, and the

standard error was the square root of a weighted average of the within-analyses variances and the variance of the estimates between analyses.

Results

Response rates

The response rates were 68.0% (N=9,683), 63.7% (N=9,078), 64.2% (N=9,140) and 57.6% (N=8,196) for years 2000, 2003, 2006 and 2009 respectively.

Sample characteristics

Sample characteristics are presented in Table I. The majority of the respondents in 2000 were not married, had tertiary education, and had a professional or clerical/ service worker occupation. The prevalence figures for sleeping difficulties, depression diagnosis and symptoms, anxiety diagnosis and symptoms, and comorbid depression and anxiety for all women who responded at each survey are displayed in Table II. Sleeping difficulties "often" were reported by 10.1% of the sample in 2000, and this prevalence remained steady across subsequent surveys. Depression diagnosis increased steadily across the 4 surveys, from 11.6% in 2000 to 17.7% in 2009. A gradual increase in self-reported anxiety diagnosis across each survey, from 4.7% to almost 10%, was also observed. A small proportion (2.9%) of women reported both a depression and anxiety in 2000, and this prevalence also increased slightly across each survey, to 6.8% in 2009.

Figure 1 depicts the percentage of women who reported a depression diagnosis and antidepressant use, as a function of the frequency of sleeping difficulties, at each survey. The prevalence of depression increased with increasing sleeping difficulties. For example, in 2003

18.5% of women with sleeping difficulties "often" reported a diagnosis of depression, compared to only 3.6% who reported sleeping difficulties rarely. This pattern was similar across all three surveys. The prevalence of antidepressant use reported by women self-reporting a depression diagnosis ranged from 29% to 47% in the 2003 and 2006 surveys, and was stable across sleeping difficulty categories (question regarding antidepressant use was not asked in 2009). There was a significant proportion of women who reported a depression diagnosis and no or rare sleeping problems across all three surveys (6.3% in 2003; 8.8% in 2006 and 15.2% in 2009).

GEE analysis

Results from the GEE unadjusted model indicated that young women who reported sleeping difficulties (but no depression) in 2000 had an increased risk of developing depression in subsequent years (Table III). The unadjusted model showed, for example, that the odds ratio (OR) of a woman reporting a diagnosis of depression in 2009 was 4.42 if she had reported sleeping difficulties 'often' in 2000 (but no depression symptoms, diagnosis or medication). These associations remained significant in the adjusted model, controlling for history of abuse, education level, body weight dissatisfaction and binge drinking reported in 2000. However, only history of abuse and education level were significantly associated, with those women having a 16% and 28% increased chance of developing depression if they reported a history of abuse or a lower education level, respectively. In addition, as the frequency of self-reported sleeping difficulties increased, so too did the risk of later depression. Similarly, risk of anxiety also increased across years in women who reported sleeping difficulties at the 2000 survey (Table IV). The OR associations were lower for anxiety than for depression, but many associations remained significant for anxiety.

Discussion

The current study examined the risk of developing new onset depression and anxiety during a nine-year follow-up in young women who reported sleeping difficulties. Moderate to strong associations were found between frequent sleeping difficulties and self-reported diagnosis of depression and anxiety. These findings reflect and advance those of previous studies in a number of ways. Firstly, this study has assessed sleeping problems and mental health in one of the largest cohorts of young women to our knowledge. Secondly, we have examined the role of sleeping difficulties in a population who are particularly vulnerable to both insomnia and depression (i.e. young women). Thirdly, the longitudinal nature of the data allowed us to follow the time course of new episodes of depression and anxiety in women who reported sleeping difficulties at baseline over almost a decade.

Results from our GEE analysis indicated that greater subjective reports of sleeping difficulties resulted in higher ORs of reporting a diagnosis of depression. This is in line with previous studies reporting an increased risk of new onset depression in individuals with insomnia in different population groups. A meta-analysis by Baglioni et al. (2011) found a two-fold increase in depression risk in patients with insomnia; this is compared to a four-fold increased risk with frequent sleeping difficulty found in the current study. The higher ORs found in our study may reflect the population we have studied, who experience higher incidences of both depression and insomnia. Significant alterations in sleep are observed during late adolescence to young adulthood as part of the normal developmental process, including profound changes in both the timing and quantity of sleep. In isolation, these changes are not detrimental to the well-being of

young adults, however, when combined with factors such engagement in more social activities, electronic media (Shochat et al. 2010), and other obligations (e.g. work, study, sport) (Carskadon 2002), sleep duration and quality may be reduced. Taken together, this stage of life represents a vulnerable period regarding the maturational integration of top-down control of emotional processes, and susceptibility to sleep difficulties, which together may lead to an increased risk of mental health problems (Gangwisch et al. 2010). The higher OR in the current study, however, may also be accounted for by the retrospective self-reported method used and broad assessment of sleeping difficulties in the survey. These associations require further investigation using more specific and defined measures of sleeping problems, and clinical diagnosis of depression and anxiety in order to tease these issues apart.

This study is one of the few longitudinal analyses that have examined the role of sleeping problems in the development of anxiety. Sleeping difficulties significantly predicted a self-reported anxiety diagnosis six to nine years later, with a two-fold increased risk, in line with a previous prospective analysis over three years (Breslau et al. 1996). These data are in contrast to Johnston et al. (2006) who found that prior insomnia did not predict future first-onset anxiety in a retrospective analysis. Given that this study was in adolescents, the authors suggested that cases in which insomnia precedes anxiety disorders may develop further into adulthood. Sleeping problems are often exacerbated by worry or concern about sleep, thus, it is plausible that sleeping problems initially increase anxiety specifically about sleep, which over time evolves to become more generalized anxiety. The association between sleep and anxiety is complex, and future research is needed to determine whether sleep difficulties reflect a predisposition or risk factor for new onset anxiety.

The prevalence of frequent sleeping difficulties "often" was relatively stable across the 9 year period at around 10%, similar to the prevalence of insomnia in this age group in the general community (Ohayon and Reynolds 2009; Hillman and Lack 2013). Thus, self-reported sleeping problems in the current study were reported to a similar rate as the prevalence of clinical insomnia. The subjective experience of poor sleep has also been linked to depression in previous studies (Gillin 1998; Szklo-Coxe et al. 2010), indicating that subjective measures of sleeping problems may have important clinical utility. The addition of severity categories of self-reported sleeping difficulties allowed for the examination of relationships between severity of sleeping problems and risk of depression and anxiety. Consistent with previous studies (Salo et al. 2012), as self-reported sleeping difficulty severity increased, so too did the risk of depression in the current cohort.

Despite the growing number of studies highlighting the link between insomnia and the development of depression and anxiety, we are still irresolute as to how these conditions are linked. On one hand, sleep disturbance may be a prodromal symptom, marking the onset of clinical depression or anxiety disorder. Another hypothesis is that there may be a co-susceptibility to both insomnia and depression in some individuals, but with different time courses. Sleep disturbances may represent a biological vulnerability to depression, with those who are susceptible to insomnia also having a vulnerability to depression. The time course of the two morbidities may be different, whereby insomnia appears first.

Alternatively, sleep disturbance may play a more *causative* role in the development of mental health issues. A recent study in predominantly female twin pairs found that sleep duration moderated genetic influences on self-reported depressive symptoms, suggesting a gene-environment interaction between depression and sleep duration (Watson et al., 2014). The genetic risk for depression increased in those twins who were outside of the normal sleep duration range of 7-8.5h/night. Laboratory studies suggest that sleep loss may lead to cognitive and affective alterations that result in depressed mood (even in those who were not susceptible). For example, sleep loss undermines emotional regulation and stability (Yoo et al. 2007), and may alter neural processes that may contribute to the symptomatology of depression (Novati et al. 2008). From a cognitive perspective, sleep disturbances may alter our cognitions, resulting in a loss of control/helplessness/hopelessness. Thoughts associated with insomnia may activate similar thoughts common in depression; lying awake in the dark presents a tabula rasa for depressive rumination that may trigger a depressive episode. From a biological standpoint, insomnia may promote circadian misalignment that may contribute to decrements in diurnal mood and performance. There is recent evidence that sleep disturbance is associated with an increased inflammatory state (Madje and Krueger 2005). Patient populations (Motivala et al. 2007; Jackson and Bruck 2013) and healthy individuals (Mills et al. 2007) with sleep disturbance have been found to have elevated levels of inflammatory markers, particularly IL-6. Specifically for women, increased inflammatory markers are also evident during pregnancy, and may be associated with pregnancy complications (Okun et al. 2007; Okun et al. 2013). It has been hypothesized that sleeping difficulties may increase the risk of depression through these inflammatory processes.

There are also social factors that may explain this link. Insomnia is related to decreased quality of life, social and interpersonal functioning, and workplace performance, and any of these could result in levels of distress or life events that may trigger, maintain, or worsen mental health issues. It is likely that there is not a simple cause-effect relationship between sleep and mental health, but rather a bidirectional and complex interplay which may vary across time. In all of these hypotheses, treatment of insomnia is possibly a key element in the prevention of depression and anxiety later in life; our data would suggest even up to a decade later.

Limitations

There are a number of limitations that are inherent to survey data, such as the self-reported nature of the data collected. In particular, reports of a mental illness diagnosis were not clinically confirmed. The survey also included a relatively broad question regarding the respondent's level of self-reported sleeping problems over the previous year. Respondents were not asked about specific insomnia symptoms (e.g. difficulties falling asleep) or whether a diagnosis of insomnia had been made. While a positive answer to this question would most likely be given by women who had insomnia or poor sleep (e.g. difficulties initiating or maintaining sleep), it may also include women who have other sleep disorders such as restless legs syndrome or hypersomnia. Therefore, these findings cannot be extrapolated to specific clinical sleep disorder such as insomnia. Future longitudinal studies would benefit from including clinical assessments of both depression and sleep disorders. There was a drop-out rate of 37% by the 2009 survey, which may have caused a selection-bias. There are also a number of other extraneous factors that may have played a role in sleeping difficulties in this cohort, including contraceptive use, child birth or rearing and family history of sleep disorders. In addition, there was a slight sample bias to

women with higher socio-economic status, and the survey underrepresented minority groups (including indigenous and those with limited English literacy) (Lee et al. 2005). Given that there may be higher incidences of mental health concerns and sleeping problems among those in lower socio-economic and minority groups (Hall et al. 2008; Paine et al. 2004), the findings of the current study may underestimate the actual prevalence rates and risks in the Australian community. On the other hand, given the high attrition rate and self-report nature of the data, it is plausible that those respondents that were retained were those who were more engaged in the health care system, and therefore there may have been an overestimation of the risk and/or morbidity.

Future research would also benefit from determining what insomnia subtypes are most vulnerable to depression (Yokoyama et al. 2010), and whether the risk differs between those with chronic and acute insomnia. It is important to understand what neurobiological, cognitive or psychological mechanisms underlie the link between sleep disturbance and mood disorder in order to appropriately and effectively combat both conditions.

Conclusion and Implications

Self-reported frequent sleep difficulties in women aged in their early twenties, who had not experienced mental health problems previously, strongly predicted the subsequent development of depression over the next decade, with analyses yielding a four-fold risk. Similarly, self-reported sleeping problems also predicted a two-fold increased risk of anxiety. The documented relationship between sleep difficulties and depression was higher than previously reported, and twice the level of the conclusion from a meta-analysis (Baglioni et al. 2011). This may be a

result of the population group under study - young women - who are known to be particularly susceptible to both insomnia and depression.

Preliminary evidence suggests improved outcomes in patients who are concurrently treated for depression and sleep problems (Manber et al. 2008). Treatment strategies addressing sleep difficulties could be a key preventative measure for reducing the incidence of depression in some cases, particularly in younger adults and adolescents (Clarke and Harvey 2012). Future longitudinal research examining mental health outcomes in those who have sought treatment for their sleeping problems compared to those who have not had treatment would help to confirm this hypothesis. Studies such as these highlight the importance of addressing sleeping issues within the context of mental health, and developing potential novel treatments (that include improving sleep) for reducing or even preventing mental illness.

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Conflict of Interest disclosure

Dr. Jackson, Professor Byles and Professor Bruck declare that they have no conflicts of interest.

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Fig. 1 Percentage of women who reported antidepressant use (black bars) among women with depression (grey bars), as a function of sleeping difficulty frequency. The 2009 survey did not include a question regarding antidepressant use, therefore this data is not available for this survey. Note: All the above graphs exclude women who, in 2000, reported a previous mental health diagnosis, symptoms of anxiety or depression in past 12 months, and/or antidepressant use.
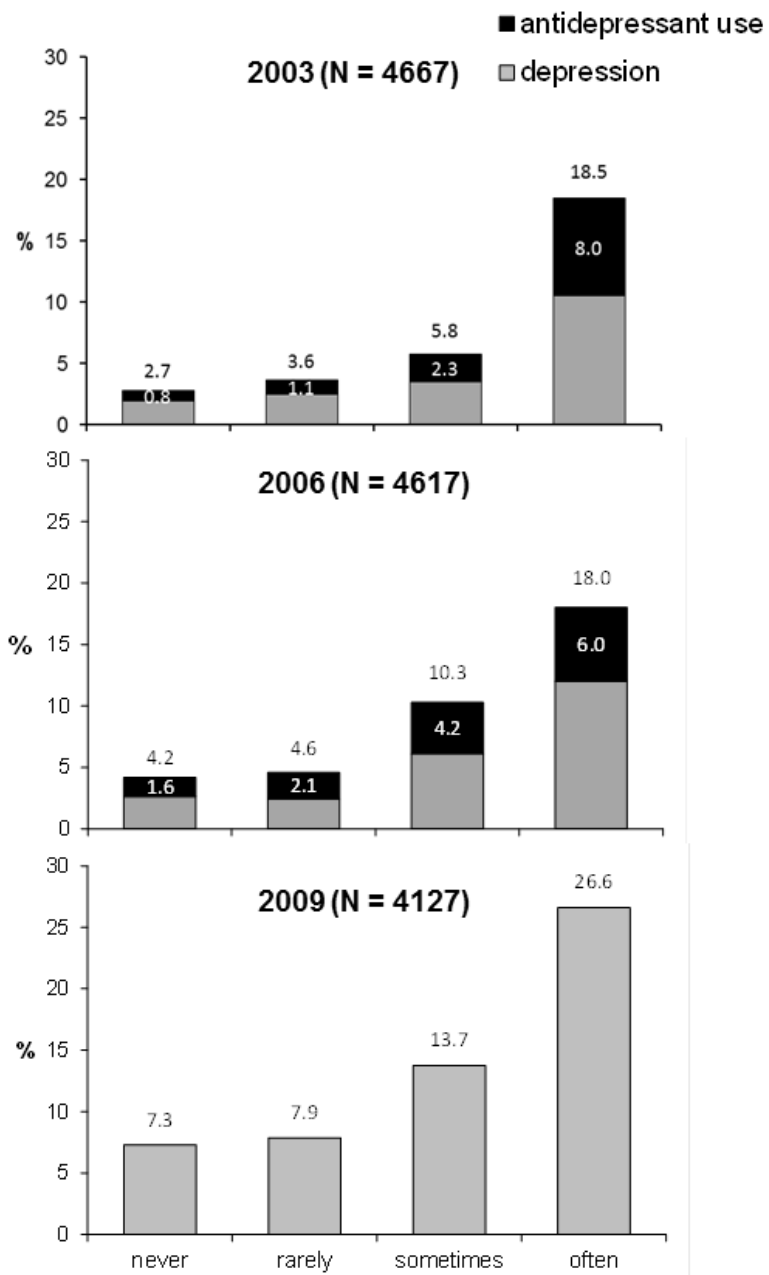
Table I Sample characteristics in 2000 (N=9683).

	N	%	Valid %
Marital status			
Never married	7045	72.8	73.3
Married	2361	24.4	24.6
Separated/Divorced	196	2.0	2.0
Widowed	5	0.1	0.1
No response	76	0.8	
Highest education			
No formal education	144	1.5	1.5
Year 10 or equivalent	907	9.4	9.7
Year 12 or equivalent	2251	23.2	24.1
Trade/apprenticeship	293	3.0	3.1
Certificate/diploma	1974	20.4	21.2
University degree	3204	33.1	34.3
Higher university degree	560	5.8	6.0
No response	350	3.6	
Occupation			
Manager/administrator	458	4.7	5.0
Professional	3249	33.6	35.8
Associate professional	594	6.1	6.5
Tradeperson	332	3.4	3.7
Clerical/service worker	3118	32.2	34.3
Intermediate production or transport worker	50	0.5	0.6
Labourer	344	3.6	3.8
No paid job	941	9.7	10.4
No Response	597	6.2	
Medication for nerves			
Yes	161	1.7	1.7
No	9250	95.5	98.3
No response	272	2.8	
Medication for sleep			
Yes	242	2.5	2.6
No	9169	94.7	97.4
No response	272	2.8	
Medication for depression			
Yes	427	4.4	4.5
No	8984	92.8	95.5
No response	272	2.8	
Binge drinking			
Do not drink alcohol	858	8.9	9.0
Never	1828	18.9	19.1
Less than once a month	3583	37.0	37.5
About once a month	1931	19.9	20.2
About once a week	1192	12.3	12.5
More than once a week	174	1.8	1.8
No response	117	1.2	
Body weight dissatisfaction			
Happy as I am/<10kg more/<10kg less	7917	81.8	82.9
Over 10kg less	1632	16.9	17.1
No response	134	1.4	
History of abuse			
Yes	3717	38.4	39.0
No	5589	57.7	58.6
Don't want to answer	230	2.4	2.4
No response	147	1.5	

Table II Cross-sectional prevalence (%) of sleeping difficulties, mental health diagnoses, and depression and anxiety symptoms of the study sample at each survey

	2000 (N=9683)		2003 (N=9078)		2006 (N=9140)		2009 (N=8196)	
	N	%	N	%	N	%	N	%
Depression Diagnosis in last 3 years								
Yes	1114	11.6	1124	12.6	1162	13.5	1338	17.7
No	8466	88.4	7808	87.4	7445	86.5	6227	82.3
No Response	103		146		533		631	
Anxiety Diagnosis in last 3 years								
Yes	453	4.7	545	6.1	623	7.2	753	10.0
No	9127	95.3	8387	93.9	7984	92.8	6812	90.0
No Response	103		146		533		631	
Comorbid Diagnoses in last 3 years								
Depression Only	835	8.7	790	8.8	784	9.1	825	10.9
Anxiety Only	174	1.8	211	2.4	245	2.8	240	3.2
Both	279	2.9	334	3.7	378	4.4	513	6.8
Neither	8292	86.6	7597	85.1	7200	83.7	5987	79.1
No Response	103		146		533		631	
Sleeping Difficulties in last 3 years								
Never	5882	60.9	4427	48.9	3851	42.5	3524	43.6
Rarely	1042	10.8	1771	19.6	2025	22.3	1720	21.3
Sometimes	1762	18.2	2020	22.3	2223	24.5	1956	24.2
Often	980	10.1	835	9.2	965	10.6	878	10.9
No Response	17		25		76		118	
Depression Symptoms in last 12 months								
Never	6675	69.1	5817	64.3	5836	64.5	5152	63.8
Rarely	1014	10.5	1349	14.9	1348	14.9	1234	15.3
Sometimes	1324	13.7	1334	14.7	1297	14.3	1144	14.2
Often	653	6.8	553	6.1	564	6.2	544	6.7
No Response	17		25		96		122	
Anxiety Symptoms in last 12 months								
Never	7875	81.5	7253	80.1	7119	78.7	6281	77.8
Rarely	973	10.1	986	10.9	1103	12.2	1019	12.6
Sometimes	593	6.1	590	6.5	609	6.7	584	7.2
Often	225	2.3	224	2.5	214	2.4	190	2.4
No Response	17		25		95		122	

% - valid percentage of total responders at each survey

^ In past 4 years for the 2000 survey

Table III Adjusted and unadjusted models for the association between sleeping difficulties in 2000 and self-reported depression diagnosis at each follow up survey (N=5702).

Depression Diagnosis	Sleeping Difficulty in 2000	Model 1 OR	95% CI		Model 2 OR	95% CI	
2003	Never	1.00			1.00		
	Rarely	1.10	0.62	1.93	1.07	0.61	1.89
	Sometimes	**1.92**	1.33	2.79	**1.81**	1.24	2.64
	Often	**2.64**	1.63	4.29	**2.30**	1.50	3.78
2006	Never	**1.52**	1.15	1.94	**1.53**	1.20	1.95
	Rarely	**2.47**	1.62	3.43	**2.26**	1.48	3.43
	Sometimes	**2.52**	1.72	3.41	**2.28**	1.60	3.25
	Often	**4.40**	2.86	6.98	**4.21**	2.82	6.28
2009	Never	**2.57**	2.08	3.16	**2.59**	2.10	3.20
	Rarely	**2.41**	1.56	3.73	**2.40**	1.55	3.74
	Sometimes	**3.43**	2.49	4.74	**3.28**	2.37	4.54
	Often	**4.42**	2.81	6.96	**3.94**	2.49	6.22
	Lower education level				0.78	0.71	0.85
	Body weight dissatisfaction				**1.03**	0.99	1.07
	Binge drinking				1.00	0.99	1.00
	History of abuse				**1.16**	1.10	1.22

OR, Odd Ratio; CI, confidence interval. Significant ORs are in bold
Model 1 crude
Model 2 adjusted for education level, body weight dissatisfaction, history of abuse and binge drinking in 2000

Table IV Adjusted and unadjusted models for the association between sleeping difficulties in 2000 and self-reported anxiety diagnosis in each follow-up survey (N=5702).

Anxiety Diagnosis	Sleeping difficulty frequency in 2000	Model 1			Model 2		
		OR	95% CI		OR	95% CI	
2003	Never	1			1		
	Rarely	1.08	0.52	2.24	1.05	0.51	2.19
	Sometimes	**2.05**	1.36	3.11	**2.05**	1.29	2.97
	Often	1.48	0.74	2.97	1.48	0.65	2.65
2006	Never	**1.32**	0.97	1.79	**1.32**	0.97	1.80
	Rarely	**1.93**	1.08	3.44	**1.89**	1.06	3.37
	Sometimes	**1.85**	1.10	3.11	**1.76**	1.04	2.97
	Often	**2.39**	1.32	4.33	**2.13**	1.18	3.86
2009	Never	**2.15**	1.59	2.90	**2.16**	1.60	2.91
	Rarely	**2.42**	1.39	4.21	**2.37**	1.36	4.13
	Sometimes	**2.97**	1.89	4.66	**2.83**	1.80	4.46
	Often	**2.90**	1.63	5.16	**2.58**	1.45	4.59
	Lower education level				0.87	0.77	0.97
	Body weight dissatisfaction				1.00	0.95	1.06
	Binge drinking				1.00	0.98	1.01
	History of abuse				**1.18**	1.10	1.28

OR, Odd Ratio; CI, confidence interval. Significant ORs are in bold
Model 1 crude
Model 2 adjusted for education level, body weight dissatisfaction, history of abuse and binge drinking in 2000