A bidirectional relationship between anxiety and depression, and insomnia? A prospective study in the general population

Markus Jansson-Fröjmark*, Karin Lindblom

Department of Behavioral, Social, and Legal Sciences, Örebro University, Örebro, Sweden

Abstract

Objective: The purpose of this study was to examine whether there is a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia over the course of a year. **Methods:** A randomly selected sample of 3000 participants from the general population filled out a baseline survey (N=1812) and a 1-year follow-up survey (N=1498) on anxiety, depression, and insomnia. **Results:** On cross-sectional analyses, bivariate correlations showed that anxiety, depression, and insomnia were significantly intercorrelated (ϕ=.31–.54). On prospective analyses, logistic regression analyses demonstrated that anxiety at baseline [odds ratio (OR)=4.27 (8% of variance)] and depression at baseline [OR=2.28 (2% of variance)] were related to new cases of insomnia on follow-up. Furthermore, insomnia at baseline was related to new episodes of high anxiety and high depression on follow-up [OR=2.30 (2% of variance) and OR=3.51 (4% of variance), respectively]. **Conclusion:** Evidence suggests that there is a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia. This suggests that anxiety, depression, and insomnia are intertwined over time, implying implications for theoretical conceptualizations and interventions.

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Introduction

Insomnia is a prevalent condition worldwide and is often defined as a complaint of poor or unsatisfactory sleep with associated severe distress, as well as social, interpersonal, and occupational impairment [1–4]. While high levels of anxiety and depression are frequently evident in patients with insomnia [5], there are also high rates of sleep disturbances in patients with anxiety or depressive disorders [6]. In sum, this implies that there is an intriguing interrelationship between, on one hand, anxiety and depression and, on the other hand, insomnia.

An improved understanding of the relationship between, on one hand, anxiety and depression and, on the other hand, insomnia might provide for a detailed theoretical under-

standing of problems and guidelines on the tailoring of interventions to different stages of anxiety, depression, and insomnia development. One initial notion on how to understand the interrelationship between anxiety, depression, and insomnia might be that anxiety, depression, and insomnia may simply co-occur, and this may perhaps be explained by other precipitating or maintaining mechanisms. A second possibility is that insomnia might be epiphenomenal to anxiety and depression, but also that anxiety and depression might be epiphenomenal to insomnia. A third possibility might be that anxiety and depression act as risk factors for insomnia. Although there is a lack of research on the role of anxiety in insomnia, a few studies suggest that anxiety may be a risk factor for future insomnia [7–10]. The relationship between depression and future insomnia is more conflicting; while two longitudinal studies found evidence for depression as a risk factor for developing insomnia [7,10], two studies demonstrated that prior depression was not associated with the onset of insomnia based on

* Corresponding author. Department of Behavioral, Social, and Legal Sciences, Örebro University, SE-701 82 Örebro, Sweden.

E-mail address: markus.jansson@bsr.oru.se (M. Jansson-Fröjmark).

retrospective reports [8,9]. A final possibility is that insomnia may act as a risk factor for anxiety and depression [11]. This notion has been the subject of several studies, and review articles show that insomnia is consistently related to the development of anxiety and depressive disorders [12–14].

The literature thus points towards an enticing association between, on one hand, anxiety and depression and, on the other hand, insomnia. A critical question would be: Is there a bidirectional relationship between anxiety and depression, and insomnia? In theoretical terms, this would imply that the association between, on one hand, anxiety and depression and, on the other hand, insomnia is not simply a cause–effect relationship, but instead a complex bidirectional one, where anxiety and depression influence insomnia, or vice versa. Although the possibility of a bidirectional relationship has been examined retrospectively in two studies in the community [8,9], no longitudinal study in the general population has yet specifically explored the notion of a bidirectional relationship between anxiety and depression, and insomnia.

A number of methodological problems have hindered progress in the area as a whole. An initial problem is the almost exclusive use of patient samples, cross-sectional designs, and retrospective reports despite the methodological problems involved. Prospective designs with nonclinical samples are thus warranted, since they allow for stronger conclusions to be drawn. A second problem is that previous research has almost exclusively focused on persistent conditions rather than on the development of a new episode of such problems. Studying persistent conditions provides information that may only be relevant to the maintenance of the problems, while examining the development of new episodes might shed light on the development of the conditions. A final problem is related to the definitions of anxiety, depression, and insomnia. Instruments that are applicable in the general population and measurements that do not include sleep difficulties as part of the definitions of anxiety and depression are needed. The present study will thus untangle the bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia using a prospective design in the general population, the occurrence of preexisting problems, the etiology of new problem episodes, and adequate psychometric instruments.

Aim of this study

The purpose of the current investigation was to investigate whether there is a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia over the course of a year.

Method

Overview of the design

This prospective study was carried out in the general population. On cross-sectional analyses, bivariate correla-

Table 1
Demographic parameters at baseline for the 1498 study participants

Parameter	Values
Age in years [mean (S.D.)]	42 (12)
Gender: female (%)	55
Civil status: married or cohabiting (%)	72
Occupational status (%)	
Employed	80
Unemployed	6
Students	8
On sick leave or pension	6
Highest education (%)	
Compulsory school	22
High school	44
College or university	30
Other	4

tions between anxiety, depression, and insomnia were examined. In addition, prospective analyses of bidirectional interrelationships were performed over the course of a year. The Örebro Hospital's Board on Research Ethics approved this study.

Participants

The study is a population-based investigation of a random sample of 3000 residents aged 20–60 years from Örebro County, Sweden. The broader aim of the investigation was to examine burnout and its risk factors, cross-sectionally and prospectively, with a 1-year follow-up [15]. At the time of the data collection for this study, Örebro County had roughly 270,000 residents, and the sample consisting of 3000 individuals thus constituted slightly more than 1% of the county's population. The sample was obtained from the county's public register via simple random sampling. In these registers, all individuals registered in Sweden at a given point in time are listed. The age range used in this study, 20–60 years, was chosen to represent the adult population.

The inclusion criterion for this study was the return of both the baseline questionnaire and the 1-year follow-up questionnaire. Of the 3000 participants who were eligible for this study, 1812 (60%) participants returned the baseline questionnaire. The attrition analysis of 1188 baseline nonresponders (based on age and gender) that was carried out in the project is described in detail elsewhere [15]. In sum, the analysis showed that increasing age and more women were associated with completion of the questionnaires, thus indicating a response bias. While the responders' mean age was 41.3 years (S.D.=11.7) and 53% were women, the nonresponders' mean age was 38.8 years (S.D.=11.8) and 43% were women. Of the 1812 individuals who returned the baseline questionnaire, 1498 (83%) also returned the follow-up questionnaire. Thus, 1498 individuals fulfilled the criterion for this study. The descriptive statistics for the study participants are presented in Table 1.

The study participants resembled relatively well the 20- to 60-year-olds in the general population in Örebro County. For

the entire population of 20- to 60-year-olds in Örebro County consisting of approximately 150,000 individuals, the mean age was 42 years, 52% were women, and 69% reported being married or cohabiting. Of all 20- to 60-year-olds in the county, occupational status was as follows: 82% were employed, 4% were unemployed, 7% were students, and 7% were on sick leave or pension. Finally, 19% reported compulsory school as their highest level of education, 47% reported high school as their highest level of education, 28% reported college or university as their highest level of education, and 6% reported other education as their highest level of education.

Procedure

A questionnaire, along with a letter of introduction, information about the project, and a stamped return envelope, was mailed to the random sample. If a response was not received within 2 weeks, a reminder was sent. If an additional 2 weeks elapsed without a response, a second reminder, together with a new questionnaire, was mailed. Individuals who had returned the baseline questionnaire were also sent a follow-up questionnaire 1 year after the mailing of the baseline questionnaire. Again, reminders were sent if a response was not obtained after 2 weeks.

Measures

The questionnaire was based on existing and validated surveys, and was constructed to assess a number of factors, including demographic variables, anxiety, depression, and sleep. The following demographic parameters were assessed: age, gender, civil status (married or cohabiting, living alone), level of education (compulsory school, high school, college or university), and occupational status (employed, unemployed, student, on sick leave or pension).

To assess anxiety and depression, the Hospital Anxiety and Depression Scale (HADS) was used [16,17]. HADS is a self-rating scale with 14 questions in which the severity of anxiety and depression is rated on 4-point scales (score range, 0–21). To detect a possible case of anxiety or depression, dichotomization, a procedure often used in research, was performed: a score of ≤7 indicates a noncase, and a score of ≥8 indicates a definite case [16]. This cutoff was determined based on a review concluding that, when comparisons were made with a structured or a semistructured diagnostic interview, an optimal balance between sensitivity and specificity was achieved with caseness defined by a score of ≥8 on both subscales, resulting in sensitivities and specificities of approximately 0.80 for both subscales [18].

Items concerning sleep were taken from the Basic Nordic Sleep Questionnaire [19] and the Uppsala Sleep Inventory [20,21]. The items assessed the perception of sleep difficulty for three nights or more per week during the past 3 months, difficulty initiating sleep, and difficulty maintaining sleep. The question "Have you had problems sleeping during the past 3 months?" was used, with a "no–yes" response alternative. If a "yes" response was reported, the participant was asked to assess how many nights per week this had occurred during the past 3 months. Furthermore, these two questions were used: "On average, how many minutes are you awake before you fall asleep?" and "On average, if you wake up at night, how many minutes are you awake?" The measures employ a definition of insomnia that is appropriate for epidemiological studies and considered to be psychometrically sound [21]. Given that there is yet no consensus on how to define insomnia, the definition of insomnia in this study was based on several diagnostic systems (e.g., *Diagnostic and Statistical Manual of Mental Disorders* and *International Classification of Sleep Disorders*). In this study, insomnia was thus defined as reporting a sleep problem for three nights or more per week during the past 3 months and difficulty initiating or maintaining sleep (≥30 min on sleep-initiation difficulties or sleep-maintenance difficulties).

Statistical analysis

The data were first summarized to provide descriptive statistics. The following variables were categorized: anxiety (low–high), depression (low–high), and insomnia (no–yes). To investigate the bivariate relationships between anxiety (low–high) and depression (low–high), and insomnia (no–yes) at baseline and at 1-year follow-up, correlational analyses (ϕ) were used. To explore the bidirectional relationships between, on one hand, anxiety and depression and, on the other hand, insomnia over the course of a year, four stepwise logistic regression analyses were executed. Odds ratios (ORs) are presented with 95% confidence intervals (95% CIs). Wald statistic and Nagelkerke R^2 are also reported for the stepwise logistic regression analysis. A P level of .05 was employed for two-tailed tests.

Results

Anxiety, depression, and insomnia: descriptive statistics at baseline and on follow-up

The descriptive statistics at baseline and at 1-year follow-up concerning the number and percentage of participants fulfilling the criteria for anxiety (low–high), depression (low–high), and insomnia (no–yes) are presented in Table 2. Among 873 participants reporting low anxiety at baseline, the mean age was 41.9 years and 51% were women. In the group consisting of 625 individuals fulfilling the criteria for high anxiety at baseline, the mean age was 42.1 years and 62% were women. Among 1082 participants reporting low depression at baseline, the mean age was 41.2 years and 54% were women. In the group consisting of 416 individuals fulfilling the criteria for high depression at baseline, the mean age was 44.0 years and 60% were women. At baseline, 798 individuals (53%) fulfilled the criteria for both low

Table 2
Descriptive statistics at baseline and at 1-year follow-up for the 1498 study participants: number and percentage of participants fulfilling the criteria for anxiety (low–high), depression (low–high), and insomnia (no–yes)

		Baseline		1-year follow-up	
		n	*%*	*n*	*%*
Anxiety [a]	Low	873	58	936	62
	High	625	42	562	38
Depression [b]	Low	1082	72	1093	73
	High	416	28	405	27
Insomnia [c]	No	1273	85	1281	86
	Yes	225	15	217	14

[a] Low anxiety: score of ≤ 7 on the HADS anxiety subscale; high anxiety: score of ≥ 8 on the HADS anxiety subscale.

[b] Low depression: score of ≤ 7 on the HADS depression subscale; high depression: score of ≥ 8 on the HADS depression subscale.

[c] Sleep problem for three nights or more per week during the past 3 months and difficulty initiating or maintaining sleep (≥ 30 min on sleep-initiation difficulties or sleep-maintenance difficulties).

anxiety and low depression, and 341 (23%) fulfilled the criteria for both high anxiety and high depression.

Among the 936 participants reporting low anxiety at 1-year follow-up, the mean age was 42.1 years and 53% were women. In the group consisting of 562 individuals fulfilling the criteria for high anxiety on follow-up, the mean age was 41.9 years and 60% were women. Among the 1093 participants reporting low depression on follow-up, the mean age was 41.2 years and 55% were women. In the group consisting of 405 individuals fulfilling the criteria for high depression on follow-up, the mean age was 44.2 years and 58% were women. On follow-up, 857 individuals (57%) fulfilled the criteria for both low anxiety and low depression, and 326 (22%) fulfilled the criteria for both high anxiety and high depression.

Among 1273 participants reporting no insomnia at baseline, the mean age was 41.6 years and 54% were women. In the group consisting of 225 individuals fulfilling the criteria for insomnia at baseline, the mean age was

Table 3
Bivariate relationships for the 1498 study participants between anxiety (low–high), depression (low–high), and insomnia (no–yes) at baseline (below the diagonal) and at 1-year follow-up (above the diagonal): phi correlational analyses

	Anxiety [a]	Depression [b]	Insomnia [c]
Anxiety [a]		.54 *	.35 *
Depression [b]	.51 *		.32 *
Insomnia [c]	.33 *	.32 *	

[a] Low anxiety: score of ≤ 7 on the HADS anxiety subscale; high anxiety: score of ≥ 8 on the HADS anxiety subscale.

[b] Low depression: score of ≤ 7 on the HADS depression subscale; high depression: score of ≥ 8 on the HADS depression subscale.

[c] Sleep problem for three nights or more per week during the past 3 months and difficulty initiating or maintaining sleep (≥ 30 min on sleep-initiation difficulties or sleep-maintenance difficulties).

∗ Significant at the .01 level.

43.5 years and 67% were women. Among the 1281 participants reporting no insomnia at 1-year follow-up, the mean age was 41.5 years and 54% were women. In the group consisting of 217 individuals fulfilling the criteria for insomnia on follow-up, the mean age was 44.3 years and 65% were women.

Anxiety, depression, and insomnia: bivariate correlations at baseline and on follow-up

The bivariate relationships between anxiety (low–high) and depression (low–high), and insomnia (no–yes) at baseline and at 1-year follow-up are shown in Table 3. The table depicts that anxiety, depression, and insomnia were significantly intercorrelated. In addition, when comparing the baseline and follow-up correlations, the strength of the relationships was found to be consistent over time.

Bidirectional relationships between anxiety and depression, and insomnia: prospective analyses

The results of four stepwise logistic regression analyses concerning the bidirectional relationships between anxiety and depression, and insomnia are displayed in Table 4. In the first analysis, anxiety at baseline (low–high), age, and gender were used as predictor variables, and insomnia on follow-up (new case–no new case) was used as outcome variable. The analysis employing the 1273 individuals who had no insomnia at baseline showed that only high anxiety at baseline was significantly associated with insomnia on follow-up. In the second analysis ($n=1273$), depression at baseline (low–high), age, and gender were used as the

Table 4
Prospective analyses of the bidirectional relationships between anxiety and depression, and insomnia over the course of a year: stepwise logistic regression analyses

		OR	95% CI	Wald	R^2
Outcome variable: insomnia [a] on follow-up (no: $n=1194$; yes: $n=79$)					
Anxiety [b]	Low ($n=873$)	1.00			.08
	High ($n=625$)	4.27	2.63–6.94 *	34.42	
Outcome variable: insomnia [a] on follow-up (no: $n=1194$; yes: $n=79$)					
Depression [c]	Low ($n=1082$)	1.00			.02
	High ($n=416$)	2.28	1.41–3.68 *	11.35	
Outcome variable: anxiety [b] on follow-up (low: $n=767$; high: $n=106$)					
Insomnia [a]	No ($n=1273$)	1.00			.02
	Yes ($n=225$)	2.30	1.10–4.82 *	4.86	
Outcome variable: depression [c] on follow-up (low: $n=951$; high: $n=131$)					
Insomnia [a]	No ($n=1273$)	1.00			.04
	Yes ($n=225$)	3.51	2.11–5.83 *	23.40	

The final solutions and significant variables are presented.

[a] Sleep problem for three nights or more per week during the past 3 months and difficulty initiating or maintaining sleep (≥ 30 min on sleep-initiation difficulties or sleep-maintenance difficulties).

[b] Low anxiety: score of ≤ 7 on the HADS anxiety subscale; high anxiety: score of ≥ 8 on the HADS anxiety subscale.

[c] Low depression: score of ≤ 7 on the HADS depression subscale; high depression: score of ≥ 8 on the HADS depression subscale.

∗ Significant at the .01 level.

predictor variables, and insomnia on follow-up (new case–no new case) was used as the outcome variable. High depression at baseline was the only factor that was significantly associated with insomnia on follow-up.

In the third analysis, insomnia at baseline (no–yes), age, and gender were employed as the predictor variables, and anxiety on follow-up was employed as the outcome variable. The analysis using the 873 participants with low anxiety at baseline demonstrated that only insomnia at baseline (yes) was significantly associated with high anxiety on follow-up. In the fourth analysis, insomnia at baseline (no–yes), age, and gender were used as the predictor variables, and depression on follow-up was used as the outcome variable. The results of the analysis employing the 1082 participants with low depression at baseline showed that only insomnia at baseline (yes) was significantly associated with high depression on follow-up.

Discussion

The results of this study suggest that there is a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia over the course of a year. Both anxiety and depression were related to future insomnia, and insomnia was related to future high anxiety and future high depression. Of anxiety and depression, anxiety was the most prominent mechanism in explaining future insomnia [OR=4.27 (8% of variance)], and the results showed also that insomnia had a stronger predictive power in relation to future depression [OR=3.51 (4% of variance)] compared to future anxiety [OR=2.30 (2% of variance)]. Anxiety and depression, and insomnia are thus bidirectionally related over time, which may ultimately have theoretical and clinical implications.

The unique features of the present study were that the nature of the bidirectional relationship was examined using a prospective design in the general population and the etiology of new episodes of high anxiety, high depression, and insomnia. One advantage with a prospective design is that it is possible to draw stronger conclusions about the relationship compared with cross-sectional investigations and retrospective reports. Since associations between, on one hand, anxiety and depression and, on the other hand, insomnia could be biased towards stronger relationships in patient samples, which may not be representative of the population as a whole, a general population sample is a methodological strength. In addition, use of retrospective reports to examine the bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia is not optimal for several reasons (e.g., recall bias). Previous research has almost exclusively focused on persistent conditions (i.e., anxiety, depression, and insomnia) rather than on the development of a new episode of such problems. One advantage with exploring the onset of new problem episodes is that it provides information on the development of the conditions.

The findings of this study are in parallel with and extend previous research on the bidirectional relationship between anxiety and depression, and insomnia. Two retrospective investigations [8,9] and two prospective studies [7,10] have previously investigated the direction of risk between, on one hand, anxiety and depression and, on the other hand, insomnia. The results from this study, in combination with evidence from previous research, suggest clearly that anxiety may be a risk factor for future insomnia, but also that insomnia may increase the risk for future anxiety [7–10,14]. Findings are also consistent as to whether insomnia may be a risk factor for future depression [12–14]; congruous results show that insomnia increases the risk of developing depression. Earlier studies on the direction of risk between depression and insomnia are somewhat more conflicting. While this study and two previous prospective studies [7,10] suggest that depression may act as a risk factor for future insomnia, two retrospective studies [8,9] indicate that depression is not associated with the risk of developing insomnia in the future. Overall, evidence on whether depression is a risk factor for future insomnia is thus not clear. The discrepancy across studies on the association between depression and future insomnia may possibly be a result of differences in the measures employed or in the use of insomnia criteria in different studies. Although data from psychobiological studies suggest a strong bidirectional relationship between sleep, sleep alterations, and depression [22], further longitudinal research is warranted to provide clarity. Overall, continued research is needed to improve the theoretical understanding of the bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia.

Given that anxiety, depression, and insomnia seem to be intertwined over time, this has implications for theoretical conceptualizations of the problems at hand. On a conceptual level, several cognitive–behavioral models of the maintenance of insomnia emphasize that anxiety, depression, and insomnia are indeed related over time [23–25]. The findings of this study offer empirical support for extant models of insomnia, since a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia was demonstrated. It is also important to underscore that the results indicated that the association does not seem to be a simple cause–effect relationship where anxiety and depression influence insomnia or vice versa, but is instead a complex bidirectional association where anxiety and depression may have an effect on insomnia or vice versa. The data would thus be congruent with the idea that both anxiety and depression or insomnia could start a negative spiral where one enhances the other.

Since the findings of this study and of previous investigations suggest that the nature of the relationship between, on one hand, anxiety and depression and, on the other hand, insomnia is bidirectional, this also has implications for clinical interventions. If the directional associations found here and elsewhere represent some aspect of the

etiology of the onset of future problems with anxiety, depression, or insomnia, interventions may prevent the development of such future conditions. Of note, estimations show that 47% of the incidences of depression at 1-year follow-up could have been prevented had sleep problems at baseline been eliminated [26]. Although there is a clear need for future testing, effective treatment for anxiety and depression might well hamper the onset of insomnia and vice versa. The development of such interventions is vital not only because it may be possible to prevent future conditions but also because comorbid problems are often much more difficult to treat and indicate poorer prognosis [27].

The current investigation has some methodological disadvantages. Although it is common to employ self-report measures in epidemiological research, it does introduce the possibility of reporting bias. However, this problem was minimized in this investigation, as the participants' baseline ratings were determined a year before anxiety, depression, and insomnia were assessed on follow-up. A second problem in this study was the 60% participation rate in the sample. Although this is not uncommon, it may restrict the generalizability of the findings. A related disadvantage was that the attrition analysis showed that increasing age and more women were associated with completion of the questionnaires, thus indicating a response bias. A third potential problem was the robustness of the definitions of anxiety, depression, and insomnia used in this study. Standardized and validated instruments were used in determining the conditions [16,18,21]. These questionnaires not only are appropriate for epidemiological studies but also have been shown to be psychometrically sound. Although it is important to underscore that the instruments used do not provide a diagnosis of anxiety or depressive disorders or insomnia, they are nevertheless relatively reliable and valid instruments [21]. For example, when compared with the diagnostic interview, the cutoff (≥ 8) for HADS was demonstrated to result in sensitivities and specificities of approximately 0.80 for both subscales [18]. However, future research may well employ assessments of anxiety, depression, and insomnia that are fully based on diagnostic systems. The final potential problem are the inclusion criteria used for insomnia. Since full information about co-occurring disorders (e.g., psychological, sleep, or medical) was not assessed in this study, it is likely that the sample consisted of participants with both primary insomnia and comorbid insomnia. It is therefore possible to generalize the findings to insomnia at a symptomatic level.

As a whole, this investigation in the general population demonstrated that there is a bidirectional relationship between, on one hand, anxiety and depression and, on the other hand, insomnia over the course of a year. This has theoretical implications not only on how to view the interrelated course of anxiety, depression, and insomnia and vice versa but also on how to test different interventions in research settings and to implement treatment in clinical contexts.

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