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Prospective Longitudinal Associations Between Persistent Sleep Problems in Childhood and Anxiety and Depression Disorders in Adulthood

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The objective of this study was to examine the associations between persistent childhood sleep problems and adulthood anxiety and depression. Parents of 943 children (52% male) participating in the Dunedin Multidisciplinary Health and Development Study provided information on their children's sleep and internalizing problems at ages 5, 7, and 9 years. When the participants were 21 and 26 years, adult anxiety and depression were diagnosed using a standardized diagnostic interview. After controlling for childhood internalizing problems, sex, and socioeconomic status, persistent sleep problems in childhood predicted adulthood anxiety disorders (*OR* (95% *CI*) = 1.60 (1.05– 2.45), p = .030) but not depressive disorders (*OR* (95% *CI*) = .99 (.63–1.56), p = .959). Persistent sleep problems in childhood may be an early risk indicator of anxiety in adulthood.

Keywords: sleep problems; anxiety; depression.

Introduction

Recent research suggests that childhood sleep problems may predict the development of subsequent internalizing problems in adolescence (Gregory & O'Connor, 2002). Despite growing support for this proposition, the longitudinal significance of childhood sleep problems for mental health remains unclear because studies to date have used relatively short follow-up periods. Furthermore, the possibility that sleep problems predict certain internalizing disorders and not others has not been fully investigated as existing studies tend to examine variation in *general* outcomes, rather than in *specific* psychiatric outcomes. This study seeks to clarify the longitudinal significance and specificity of persistent sleep problems in *childhood* on anxiety and depression diagnosed in *adulthood*.

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Predictive Associations Between Sleep Problems and Internalizing Problems

Research examining predictive associations between sleep problems and internalizing problems has focused on adults. Such work has typically examined the association between insomnia and depression, and suggests that adults' sleep problems forecast depression (e.g. Breslau, Roth,Rosenthal,&Andreski, 1996; Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997; Ford & Kamerow, 1989; Livingston, Blizard, & Mann, 1993; Weissman, Greenwald, Nino-Murcia, & Dement, 1997; for a review seeRiemann&Voderholzer, 2003). Longitudinal research linking sleep problems and *anxiety* in adults also suggests a connection (e.g. Breslau et al., 1996; Ford & Kamerow, 1989). The biological mechanisms underlying these associations have yet to be fully elucidated.

Childhood risk indicators, such as parental loss, family conflict, and physical and sexual abuse, have been identified for the development of later internalizing problems (e.g. Birmaher et al., 1996; Fergusson, Horwood, & Lynskey, 1996). Less attention, however, has been paid to assessing the predictive associations between sleep problems and internalizing problems in children. One prospective longitudinal study of 490 children found that a composite measure of commonly reported sleep problems (e.g. nightmares, sleep-talking/walking, atypical sleep duration) at 4 years was associated with an increase in internalizing problems in mid-adolescence, after controlling for early symptoms of internalizing problems (Gregory & O'Connor, 2002). Other studies using different definitions of sleep problems and different age groups have found parallel associations (Gregory, Eley, O'Connor, & Plomin, 2004; Wong, Brower, Fitzgerald, & Zucker, 2004). Further studies examining clinically significant levels of internalizing problems have not found a longitudinal link (Johnson, Chilcoat, & Breslau, 2000; Stoleru, Nottelmann, Belmont, & Ronsaville, 1997). It is noteworthy that the prediction of later internalizing problems from sleep problems is more robust in adults than in children, suggesting that sleep problems may be a better predictor of internalizing problems in older than in younger participants. What no research has yet investigated is whether sleep problems in childhood predict *adult* outcomes. The hypothesis that sleep problems in childhood forecast internalizing psychopathology in adulthood is suggested by research demonstrating persistence and co-occurrence of sleep and internalizing problems over long time-frames (e.g. Gregory & O'Connor, 2002; Pine, Cohen, Gurley, Brook, & Ma, 1998).

Predictive Associations Between Sleep Problems and Internalizing Problems: Methodological and Conceptual Refinements

In contrast to the adult literature, which typically focuses on sleep problems predicting anxiety and depression *disorders* (e.g. Ford & Kamerow, 1989), much of the child literature focuses instead on individual differences incorporating both normal and pathological levels of disturbance. In particular, some of the strongest evidence to date for a link between sleep and later internalizing problems is based on nonclinical samples and variation within the normal range rather than on outcomes with obvious clinical relevance. Accordingly, in the current study we examine the extent to which early sleep problems in childhood predict clinically significant levels of disturbance in adulthood, namely, disorder.

A further problem in much of the previous research on children is the reliance on parent reports of *both* sleep problems and internalizing problems. This creates the possibility of rater bias artificially inflating the association between sleep and internalizing problems. The current study overcomes this limitation by directly assessing anxiety and depression according to standard clinical interview techniques.

Adult studies examining different types of internalizing problems have found sleep problems to forecast both anxiety and depression (e.g. Breslau et al., 1996; Ford & Kamerow, 1989). Child research tends not to examine different types of internalizing problems, and often examines combined anxiety-depression phenotypes, partly reflecting parents' difficulty in differentiating between symptoms of anxiety and of depression in their children (Achenbach, 1991). Hence, the possibility that childhood sleep problems predict certain internalizing problems and not others needs to be further explored.

Hypotheses

In summary, three hypotheses were tested. First, we tested the hypothesis that there is a predictive association between sleep problems and internalizing problems *from childhood to adulthood*. Second, we tested the hypothesis that childhood sleep problems predict adult internalizing *disorders*. Third,we tested the exploratory hypothesis that sleep problems constitute a nonspecific risk factor for internalizing disorders in adulthood. These hypotheses were examined in an entire birth cohort of 1,037 children born in Dunedin, New Zealand in 1972–1973.

Method

Participants

Participants are members of the Dunedin Multidisciplinary Health and Development Study, a longitudinal investigation of the health and behavior of a complete birth cohort. 1,037 children born between April 1, 1972 and March 31, 1973 in Dunedin, New Zealand (91% of eligible births; 52% male) participated at age 3 years. Cohort families are primarily White and represent the full range of socioeconomic status in the general population of New Zealand's South Island. Follow-ups have been carried out at ages 5, 7, 9, 11, 13, 15, 18, and 21, and most recently at 26 years (*N* = 980: 96% of the living cohort members). At each assessment, participants (including overseas emigrants) are brought back to the research unit within 60 days of their birthday for a full day of data collection. All examiners are unaware of responses given in previous assessments. Participants are fully reimbursed for any costs (e.g., travel; lost wages; child care). At each assessment, the study protocol is approved by the Otago Ethics Committee. Study members give informed consent before participating. In this article we report data on sleep problems and covarying anxiety/depression from the 5-, 7-, and 9-year-old assessments; and on anxiety and depressive disorders at 21 and 26 years.

Measures

Socioeconomic status (SES) of the study members' familieswas measured on a 6-point scale that assessed parents' self-reported occupational status. The scale allocates each occupation to one of six categories (6 = *unskilled laborer*, 1 = *professional*) on the basis of the educational levels and income associated with that occupation in data from the New Zealand census. The variable used in our analyses, childhood SES, is the average of the highest SES level of either parent, assessed repeatedly during the study member's first 15 years. The variable of childhood SES thus reflects the socioeconomic conditions experienced by the study members as they grew up.

Given that previous research has highlighted the importance of unresolved sleep problems in predicting emotional problems (e.g., Ford&Kamerow, 1989), a measure of persistent sleep problems was developed. Parents reported on their children's sleep problems at the 5-, 7- , and 9-year assessments. At both 5 and 7 years, three questions explored sleep problems ("Sleep problems last night?", "Typically has sleep problems?", "Does child have sleep problems?"). At the 9-year-old assessment, six items addressed sleep problems ("Sleep problems last night?", "Sleeping difficulties?", "Child has trouble falling asleep?", "Child awakens at night and can't return to sleep?", "Child slept much more recently?", "Child wakens very early?"). Although these items were originally coded on different scales, each item was recoded on a binary scale (0 = *no sign of a problem*; 1 = *sign of a problem*). In order to focus on sleep problems that did not desist, a binary "persistent sleep problem" variable was developed, with children scoring 1 if they showed signs of a sleep problem at the latest (9-year-old) assessment (i.e., scored 1 point on at least 1 item) *and* at one or more other times, and 0 otherwise. Although the reliability of the persistent sleep problem scale might have been improved by increasing the number of affirmative responses necessary for group-membership, this would have reduced the number of participants in the persistent sleep problem group (and hence power to detect effects). Juvenile internalizing problems were assessed by parent report using the Rutter Child Behaviour Scales (Rutter, Tizard, & Whitmore, 1970) at 5, 7, and 9 years. Items include: "Often worried, worries about many things" and "often appears miserable, unhappy, tearful, or distressed." Each item was scored on a 3-point scale (0 = *does not apply*; 1 = *applies somewhat*; 2 = *certainly applies*). Scores for these items were summed separately at each age and then averaged across the three time-points. This measure was used to control for childhood internalizing symptoms while testing for a connection between childhood sleep and adult disorders. The reliability and validity of the Rutter Child Behaviour Scale is demonstrated elsewhere (Sclare, 1997).

Anxiety and depression were examined in private standardized interviews at 21 and 26 years by means of the Diagnostic Interview Schedule (Robins, Cottler, Bucholz, & Compton, 1995; Robins,

Helzer, Croughan, & Ratcliff, 1981), administered by interviewers unaware of cohort members' previous data, including their mental health status. Modifications, procedures, reliability, validity, prevalence, and evidence of impairment have been described in detail at 21 years of age (Newman, Moffitt, Silva, & Stanton, 1996). At age 26, diagnoses were made following the *Diagnostic and Statistical Manual of Mental Disorders, Version 4* (*DSM-IV*: American Psychiatric Association, 1994) criteria, and at 21 years disorders were diagnosed according to the then-current *DSM-IIIR* (American Psychiatric Association, 1987) criteria. The reporting periodwas 12 months before interview. Dunedin cohort prevalence rates in young adulthood match closely those from the U.S. National Comorbidity Survey (Kessler et al., 1994; Newman et al., 1996). Here we focus on study members who met criteria for any anxiety disorder or any depressive disorder at either time-point. The seven anxiety disorders examined were Generalized Anxiety Disorder, Obsessive-Compulsive Disorder, Posttraumatic Stress Disorder (data only available at 26 years), Panic Disorder, Agoraphobia, Simple Phobia, and Social Phobia. The depressive disorders examined were Major Depressive Episode (MDE) and Dysthymia.

Statistical Analyses

Differences between children with and without persistent sleep problems were examined using two-tailed tests. The associations between childhood sleep problems and adulthood anxiety and depression were examined using chi-squared tests. The prediction of anxiety in adulthood from persistent sleep problems up to age 9 years was established by means of two-tailed logistic regression. Two different models examined the prediction of each phenotype. Model 1 examines the unadjusted odds ratio for persistent sleep problems predicting the outcome variable (anxiety or depression). Model 2 examines the odds ratio for sleep problems predicting the outcome variable, after controlling for the effects of sex, SES, and childhood internalizing problems. Childhood internalizing problems were controlled to demonstrate whether childhood sleep problems, apart from those secondary to childhood anxiety and depression, predicted adult disorder, over and above the known continuity from childhood internalizing symptoms to adult disorders. Incidentally, controlling for childhood anxiety and depression also accounted for the contemporary effects of risk factors associated with these problems.

Results

Data on sleep problems were available for 943 children (52% male); 12.4% (n = 117) of the children had a persistent sleep problem. Children with and those without persistent sleep problems did not differ significantly on SES or sex. Children with persistent sleep problems, however, had more internalizing childhood problems (mean= 2.76, *SD* = 1.55) than those without persistent sleep problems (mean=2.09, *SD*=1.44; t (940)=4.66,p < .001). Of those children providing data on sleep problems at 9 years old, 912 (97%) also provided data on anxiety and depression in adulthood (at 21 and/or 26 years old). Of these adults, 34% and 28% were considered to have any anxiety and depression disorders, respectively. Figure 1 shows the proportion of children with and those without persistent sleep problems who have anxiety and depression disorders in adulthood. Forty-six per cent of children *with* persistent sleep problems had anxiety in adulthood, compared to 33% of children without persistent sleep problems at 9 ($\div_2$ = 6.74, df = 1, p = .014). In contrast, there were no differences in the proportion of participants with and those without persistent sleep problems who manifested depression in adulthood (both = 28%; $\div_2$ = 0, df = 1, p = 1.000). The results of the logistic regression analyses are presented in Table I. Even after controlling for child sex, SES, and childhood internalizing problems, persistent sleep problems predicted adulthood anxiety (*OR* (95% *CI*) = 1.60 (1.05–2.45), p = .030), but not depression (*OR*(95% *CI*) = 1.04 (.63–1.56), p = .959).

Discussion

Findings from this prospective longitudinal cohort study of nearly 1,000 individuals support a link between persistent sleep problems in childhood and diagnosed anxiety in adulthood, after controlling for sex, SES, and childhood internalizing symptoms. Although childhood internalizing problems were controlled in the analyses, these results do not necessarily imply that early

sleep problems predict an *increase* in later anxiety, as different measures were used to examine anxiety at the different ages. Furthermore, it is possible that anxiety in adulthood is qualitatively different from that experienced in childhood. Nevertheless, these data provide the strongest evidence to date of the association between sleep problems in childhood and psychiatric disorders in adulthood. The association between childhood sleep problems with diagnosed depression in adulthood was nonsignificant.

Childhood Sleep Problems Predict Anxiety in Adulthood

One possible mechanism underlying the association of sleep problems with anxiety is that both have *similar underlying risk factors*. Certain environmental risk factors, such as difficult peer relations and stressful life events, may influence both sleep problems and anxiety (Eley & Stevenson, 2000; Kumpulainen et al., 1998; Sadeh, 1996;

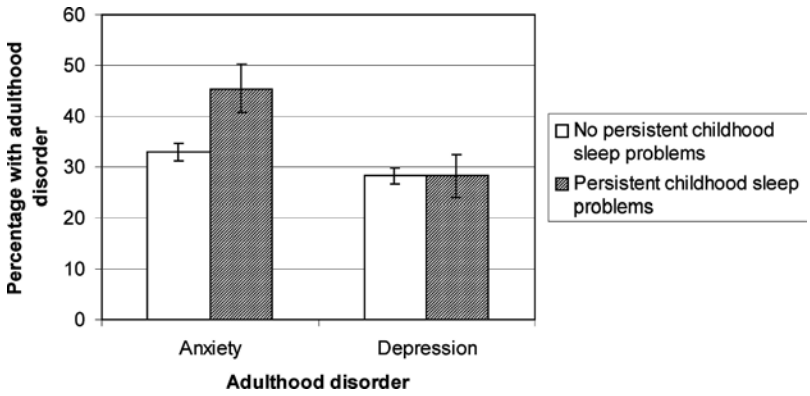

Fig. 1. Percentage of study members with and without persistent childhood sleep problems who develop anxiety and depressive disorders in adulthood (with standard error bar).

Table I. Predicting Anxiety and Depressive Disorders in Adulthood From Persistent Sleep Problems in Childhood

Model number	Variable	*B*	*SE*	p	*OR*	95% *CI* for *OR*
Predicting anxiety disorders at 21/26						
Model 1	Sleep problems	.53	.21	.010	1.70	1.14–2.54
Model 2	Anxiety/depression at 5, 7, and 9	.16	.05	.001	1.17	1.07–1.29
	Sex	-.80	.15	.000	.45*a*	.34–.60
	SES	-.21	.07	.002	.81	.71–.93
	Sleep problems	.47	.22	.030	1.60	1.05–2.45
Predicting depression disorders at 21/26						
Model 1	Sleep problems	.00	.23	1.000	1.00	.64–1.56
Model 2	Anxiety/depression at 5, 7, and 9	.07	.05	.175	1.07	.97–1.19
	Sex	-.81	.15	.000	.45	.33–.60
	SES	.02	.07	.781	1.02	.89–1.16
	Sleep problems	-.01	.23	.959	.988	.63–1.56

Note. Models 1 provide the unadjusted odds ratio for sleep problems predicting later anxiety and depressive disorders. Models 2 provide the odds ratios after controlling for covarying factors. *B* = coefficient; *SE* = Standard Error of *B*; *p* = significance level; *OR* = odds ratio; *CI* = confidence intervals.
*a*Coded as: 1 = female; 2 = male.

Williams, Chambers, Logan, & Robinson, 1996). Recent research also suggests that genetic influences may play a part in the association between anxiety and sleep problems (Gregory et al., 2004). Candidate genes playing a role in the association between sleep problems and anxiety include those involved in the serotonin system, which contributes to variation in many physiological functions, including sleep and anxiety (Adrien, 2002; Eley, Collier, & McGuffin, 2002). Additionally, cognitive biases such as anxiety sensitivity and depressogenic attributional style are associated with both sleep problems and anxiety, and may act as risk factors for both (see Gregory & Eley, in press).

A second possible mechanism for the association between persistent sleep problems and anxiety is *causal*. Longitudinal research comparing the psychiatric status of adults successfully treated for childhood sleep problems with that of those untreated for childhood sleep problems could provide a means of testing this hypothesis.

A third explanation for the association between sleep problems and anxiety is that the former are a *subclinical prodrome* of the latter. Sleep problems may represent subclinical anxiety symptoms that parents did not pick up or report. These anxiety symptoms may develop to become clinically significant, as the result of a more stressful developmental era (i.e., adolescence), or may be identified in adulthood by the employment of more sensitive measurement made directly of the affected individual. Explanations for the longitudinal association between sleep problems and anxiety need to be further developed in order to account for the nonassociation between sleep and depression.

Childhood Sleep Problems Do Not Predict Depression in Adulthood

The finding that childhood sleep problems predict *anxiety but not depression* was unexpected. Although fewer adults were considered depressed than anxious, differences in power to detect associations cannot explain the specificity reported in this study, as there was no sign of a trend for persistent childhood sleep problems predicting adulthood depression. Furthermore, the possibility that the association between early sleep problems and later depression was not found because confounding variables were overcontrolled cannot explain the results reported here; for removing childhood internalizing problems, sex, and SES from the analyses (models 1) resulted in substantially identical results. Instead, the findings reported here suggest that there may be etiological differences between anxiety and depression. However, it is somewhat puzzling that sleep problems predict anxiety and not depression, given high levels of comorbidity between anxiety and depression (Kovacs & Devlin, 1998). Hence, a replication of this finding would be valuable.

Limitations

Despite the many strengths of this study—including the use of an entire birth cohort, the longitudinal nature of the study, low attrition rates and diagnostic data—its limitations must be acknowledged. One limitation concerns the measure used to examine sleep problems. As is common in epidemiological samples, this study did not include a detailed assessment of sleep problems. Instead, a measure was developed from available items for the purposes of this report. Themeasure used provides subjective information about the persistence of commonly-reported childhood sleep problems, in contrast to polysomnographic data on sleep disorders. The general nature of the questions used to examine sleep problems (e.g. “Does child have sleep problems?”) means that parents may have reported upon a wide range of sleep problems, such as insomnia, nightmares, and sleepwalking, and may have included problems of varying severity. Hence, these findings should not be extrapolated to clinically significant specific sleep disorders such as insomnia, which may have different associations with anxiety and depression. A further consideration with regard to the interpretations of the results concerns the method used to categorize sleep problems. For *a priori* reasons specified above, the focus of this report was sleep problems that did not desist by the age of 9 years. However, when other sleep problem scales were examined, significant results were not always obtained. For example, when persistence was defined as a sleep problem at any two or more time points, there was a nonsignificant trend for sleep problems to predict anxiety (*OR* (95% *CI*) = 1.35 (.92–2.00), p = .13) but not depression (*OR* (95% *CI*) = .89 (.58–1.35), p = .57). However, by taking the mean of all 12 dichotomous sleep problem items and standardizing the scale, sleep problems predicted anxiety (*OR* (95% *CI*) = 1.15 (1.00–1.32), p = .05) but not depression (*OR* (95% *CI*) = 1.02 (.89– 1.18), p = .75). These results need to be considered when interpreting the results of this study.

A further limitation is that the sleep measure used in this study relied on parent-reports. Although parentreports are useful in the assessment of child sleep problems, additional self-

reports would have been informative (especially in later childhood assessments). Despite the shortcomings of our sleep-measure we found a specific association with adulthood anxiety disorders. It is therefore possible that using an improved sleep-measure we would have found an even stronger effect.

An additional limitation concerns the absence of sleep data from the adulthood assessment. This means that alternative hypotheses concerning the direction of effects between sleep and co-occurring problems could not be examined. Finally, associations between persistent sleep problems and different types of anxiety disorders are not presented here. Unreported analyses indicated trends for children with persistent sleep problems to be more likely to have each type of anxiety disorder (with the exception of agoraphobia). Only the associations between persistent sleep problems and social phobia and generalized anxiety disorder reached significance. For clarity of presentation, and because groups having specific anxiety disorders tended to be small, co-morbid with other anxiety disorders, or both, these analyses are not reported. Although MDE and dysthymia were also grouped, analyses (unreported) showed that MDE examined separately showed similar null associations with sleep problems.

Clinical Implications

The possibility that sleep problems are a sign of concurrent anxiety tendencies that parent reports do not identify, suggests that it may be beneficial to obtain detailed examinations of anxiety symptoms in children presenting with sleep problems. Furthermore, the finding that persistent sleep problems in childhood predict adulthood anxiety *disorders* suggests that persistent childhood sleep problems should not be ignored as some cases may represent an *early indicator* that subsequent anxiety may develop. Once individuals at risk of later anxiety disorders are identified, the likelihood of an anxiety disorder developing may be reduced by employing preventive programs (Rapee, 2002). As there was also a high rate of anxiety disorders in adults who did not have persistent sleep problems as children, other risk factors for the development of adulthood anxiety need to be considered. Finally, if it were found that sleep problems were themselves a *risk factor* for the development of anxiety, then the early identification and treatment of sleep problems in children might prevent the development of later anxiety disorders.

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