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Increased sleep predicts annual decreases in psychological distress: Results from a 6-year longitudinal panel sample

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ABSTRACT

Objective: To investigate the annual temporal ordering of sleep quantity and psychological distress, separating between-person stability from within-person change.
Design: Random-intercepts cross-lagged panel model using 6 annual waves of longitudinal data from the New Zealand Attitudes Values Study postal questionnaire.
Participants: New Zealand Attitudes Values Study respondents in 2013, 2014, 2015, 2016, 2017, and 2018 (*Ns* = 17,890; 15,757; 13,904; 21,849; 17,031; and 47,462).
Measurements: Participants were asked, "During the past month, on average, how many hours of actual sleep did you get per night?" and responded to the K6 psychological distress scale each year. They also reported their demographic characteristics.
Results: Identified longitudinal associations between sleep duration and psychological distress in a traditional cross-lagged panel model were mostly attributable to the stability of the between-person differences in sleep duration and psychological distress. We provide evidence to suggest that increased sleep duration as indicated over a short period of time (ie, 1 month) predicted lower within-person levels of psychological distress the following year. Psychological distress did not predict sleep duration, in contrast.
Conclusions: Our analyses suggest that sleep duration in this sample of New Zealanders precedes psychological distress. This is significant given the propensity for short sleep in this sample and issues of poor mental health and short sleep among low SES indigenous members of this community. The promotion of adequate sleep duration may yield positive gains in psychological well-being.

Introduction

Sleep disturbances such as insomnia, sleep apnea, and narcolepsy are related with the incidence of mood disorder diagnoses (eg, major depression, bipolar disorders, and cyclothymic disorder).[1] Emerging evidence from large community prospective investigations reveal relationships between short sleep duration with self-reported psychological distress[2] and psychological distress with short sleep duration.[3] Meta analyses[4] from other prospective studies confirmed associations of both insufficient[5-10] and long sleep[7-10] duration with negative affect (ie, frequency of depressive and anxious emotions). While these large data sets have been useful, differences in study design, measurement of sleep and negative affect, quantification of "long" and "insufficient" sleep, and statistical approach, have hindered conclusions about the direction of association between sleep duration and negative affect. Given the costs to both the individual and society associated with these conditions, an understanding of the temporal order of the sleep duration-negative affect pathway is required to identify individuals "at risk" and to inform public health campaigns and evidence-based intervention.

A systematic review[1] of 9 studies (8 prospective, *N* = 7336) reported a bidirectional relationship between sleep disturbance and mood disorders in 4 studies, a unidirectional relationship between sleep disturbance and depression in 3 studies and no relationship between both variables in one study. The authors concluded there is a bidirectional relationship between insomnia and depression. While there is evidence of an association between sleep disorders and mood disorders, there is a dearth of research that has assessed the directional pathway between sleep duration and nonclinical levels of negative affect in community samples. A measure of nonspecific psychological distress such as the Kessler psychological distress scale (K6) is frequently used in community-based epidemiological research as it is a measure that captures elements of primarily depressive and anxiety-

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related negative affect that is strongly associated with current and future mood and anxiety disorder diagnoses.[11-13]

Highlighting the benefits of assessing psychological distress, a large prospective New Zealand study reports that insufficient sleep was not related to depression incidence but was associated with increased psychological distress at each time-point.[2] However, this study only assessed the unidirectional pathway between variables, and this approach aligns with research in a recent meta-analysis[4] of prospective studies (K = 7, N = 25,271) in which all studies proposed and only assessed the sleep to depression disorder relationship. Similarly, this trend of unidirectional hypothesis testing continues with significant associations in studies of sleep duration to distress[14] and distress to sleep duration[3] pathways.

In a cross-sectional study of elderly Japanese individuals (M = 74 years), short sleep duration was associated with higher psychological distress on the K6,[14] and this aligns with similar findings in a 1-year prospective study with children where short sleep was associated with higher psychological distress.[15] In a related large cross-sectional study (N = 36,859), severe psychological distress (>13 on K6) was related with both short (≤6 hours) and long (≥9 hours) sleep durations, and when psychological distress was assessed continuously, higher distress was associated with short, but not long, sleep duration.

Although there is literature that suggests that poor sleep *quality* is associated with health states such as coronary heart disease, diabetes, depression, and anxiety,[16] less is known about the contribution of short or long sleep on mental health. This lack of evidence is likely due to the smaller literature that has focussed on assessing unidirectional pathways and employed disparate research methods.

A meta-analysis[4] reveals that most researchers used differing metrics to categorize "insufficient" (range <5-≤7 hours) and "long" (range >8-≥9 hours) sleep durations.[4] Similarly, different measures of negative affect (with different covariates) and sleep measurement (eg, actigraphy Vs self-report) compromise the ability to merge the small data and assess the direction of association between variables. In the present study, we can overcome these issues by using a longitudinal data set of adults from a national probability study that is larger than the total sample included in recent systematic[1] and meta-analyses[4] and a statistical design using 6 annual waves of panel data to assess the temporal associations between sleep quantity and psychological distress. Such data provide an avenue to determine if the focus of intervention should on improving sleep practices or reducing distress.

In preference to arbitrarily defining regions of long or insufficient sleep, the present study will illustrate the best overall direction of relationship between variables and determine if the relationship is unidirectional (sleep duration → distress, or distress → sleep duration) or bidirectional (sleep duration → distress, and distress → sleep duration). For example, a recent study of children found support for a unidirectional effect of depressive symptoms at baseline on decreased sleep duration 1 year later but not between baseline sleep duration and depressive symptoms.[15] While traditional cross-lagged panel models (CLPMs) are often used to examine the temporal ordering of constructs, recent critiques have been raised that this approach confounds within-person change with between-person stability.[17] Here, we present analyses comparing traditional CLPMs with random-intercepts CLPMs (RI-CLPMs)—an analytic approach that properly separates between-person stability from within-person change.[17] Given the data and this method of focusing on within-person change, it does not require the use of covariates, sleep classifications, or subgroup analyses in order to establish the directionality of relationships in this large adult population. Due to the mixed findings of the reviewed literature, it is premature to offer a directional hypothesis. Our aim is therefore to assess the temporal ordering of sleep duration and psychological distress as understanding this pathway is not only of scientific value but can assist in identifying those at risk of developing a mood or sleep disorder and provide the first step toward evidence-based intervention.

Participants and methods

Participants and procedure

The New Zealand Attitudes and Values Study (NZAVS) is longitudinal panel study of personality, social attitudes, and health outcomes using a national probability sample of New Zealand adults. The University of Auckland Human Participants Ethics Committee approved all procedures, and participants gave informed consent. The present study uses data collected at Time 5 (2013, N = 17,890), Time 6 (2014, N = 15,757), Time 7 (2015, N = 13,904), Time 8 which included a booster sample (2016, N = 21,849), Time 9 (2017, N = 17,031), and Time 10 which included a booster sample (2018, N = 47,462).[1] We focus on participants between ages 15 and 94 (M_{age} at time 5 = 47.64, SD = 14.09; 62.75% women) who provided partial (N = 58,347) or complete responses (N = 5763) to our variables of interest. Key demographics by year, including an index of decile-ranked deprivation (1 = *least deprived*, 10 = *most deprived*),[18] are provided in Table 1. Additional details about the sample, procedure, and retention of participants, are available on the NZAVS website.[19]

Measures

Sleep duration was assessed using a single item derived from the Pittsburgh Sleep Quality Index (PSQI)[20]: "During the past month, on average, how many hours of actual sleep did you get per night?" This measure has been used in other studies investigating psychological wellbeing[2] and was the only PSQI item measured in the NZAVS omnibus survey.

Psychological distress was assessed using the K6 psychological distress scale.[11] Using a 5-point scale (0 = none of the time, 1 = a little of the time, 2 = some of the time, 3 = most of the time, 4 = all of the time) participants reported "during the last 30 days, how often did you": (a) "feel hopeless?," (b) "feel so depressed that nothing could cheer you up?," (c) "feel restless or fidgety?," (d) "feel that everything was an effort?," (e) "feel worthless?," (f) "feel nervous?" Items were averaged to create a scale, and reliability coefficients are reported in Table 2. It is a useful brief scale used in epidemiological studies to explore anxiety, depression, and other aspects of negative affect.[21] The K6 is strongly associated with present and prospective mood and anxiety disorders[11-13] and outperforms the General health questionnaire in screening for anxiety or mood disorders with both the Composite International Diagnostic Interview or the Diagnostic and Statistical Manual.[21] It has a standard cut-off of ≥13 (scaled average ≥2.617), used to identify individuals with a high likelihood of having a diagnosable illness severe enough to cause functional limitations requiring treatment.[21-23] The proportion of individuals meeting this cut-off by year are reported in Table 1.

Statistical analyses

All CLPMs were run using maximum likelihood estimation with robust standard errors to account for any skewness in the data.[24] Full information maximum likelihood (FIML) was used to impute missing

[1] Sample size, response rates, booster samples, and retention information are included in Supplementary Table S1. Times 1-4 are not included in this study as these data collections did not assess sleep duration. Participants who had completed the previous time-point were contacted to respond approximately 1 year after they last completed the questionnaire, while data for each time-point were collected over a span of several months.

Table 1
Sample demographic characteristics over 6 annual waves

	T5	T6	T7	T8	T9	T10
Age	47.64 (14.09) [a]	49.32 (14.05) [f]	50.80 (13.91) [k]	49.61 (13.94) [p]	51.32 (13.78) [u]	48.59 (13.86) [z]
Gender (Female)	62.75% [b]	63.31% [g]	62.71% [l]	62.69% [q]	63.41% [v]	62.76% [aa]
Ethnicity						
NZ Euro/Pakeha	79.29%	80.52%	81.54%	81.74%	82.34%	82.84%
Maori	13.35%	12.64%	12.26%	11.61%	11.90%	10.10%
Pacific	2.97%	2.78%	2.58%	2.31%	1.90%	1.87%
Asian	4.38% [c]	4.06% [h]	3.62% [m]	4.34% [r]	3.86% [w]	5.19% [ab]
Deprivation Score	4.81 (2.79) [d]	4.71 (2.76) [i]	4.70 (2.78) [n]	4.67 (2.75) [s]	4.59 (2.72) [x]	4.62 (2.71) [ac]
K6 score ≥ 13	5.61% [e]	5.31% [j]	4.90% [o]	6.06% [t]	5.37% [y]	6.67% [ad]

Notes. [a]n = 18253, [b]n = 18258, [c]n = 17428, [d]n = 18066, [e]n = 17890, [f]n = 15820, [g]n = 15767, [h]n = 15629, [i]n = 15569, [j]n = 15757, [k]n = 13942, [l]n = 13892, [m]n = 13637, [n]n = 13616,[o]n = 13904, [p]n = 21933, [q]n = 21861, [r]n = 21305, [s]n = 21624, [t]n = 21849, [u]n = 17071, [v]n = 17014, [w]n = 16863, [x]n = 16781, [y]n = 17031, [z]n = 47949, [aa]n = 47832, [ab]n = 46427, [ac]n = 47450, [ad]n = 47462, 2013 Percentile Dep Score. High = More deprived on a scale from 1 to 10.

Table 2
Summary of intercorrelations, means, and standard deviations for random intercepts cross-lagged panel model for Times 5, 6, 7, 8, 9, and 10 of sleep duration and psychological distress

	M	*(SD)*	*N*	*α*	1	2	3	4	5	6	7	8	9	10	11
1. Sleep duration T5	6.981	(1.190)	17,227	-	1										
2. Sleep duration T6	6.896	(1.215)	14,143	-	0.601	1									
3. Sleep duration T7	6.877	(1.164)	13,330	-	0.567	0.611	1								
4. Sleep duration T8	6.892	(1.171)	20,816	-	0.546	0.567	0.628	1							
5. Sleep duration T9	6.900	(1.177)	16,418	-	0.510	0.541	0.600	0.619	1						
6. Sleep duration T10	6.943	(1.134)	45,469	-	0.517	0.531	0.600	0.609	0.656	1					
7. Kessler6 T5	0.856	(0.666)	17,890	0.841	−0.113	−0.111	−0.106	−0.109	−0.121	−0.119	1				
8. Kessler6 T6	0.828	(0.650)	15,757	0.846	−0.093	−0.130	−0.112	−0.106	−0.131	−0.124	0.710	1			
9. Kessler6 T7	0.826	(0.648)	13,904	0.848	−0.097	−0.127	−0.147	−0.120	−0.139	−0.128	0.693	0.737	1		
10. Kessler6 T8	0.878	(0.679)	21,849	0.850	−0.079	−0.110	−0.117	−0.139	−0.134	−0.126	0.672	0.710	0.735	1	
11. Kessler6 T9	0.842	(0.654)	17,031	0.850	−0.097	−0.114	−0.123	−0.135	−0.169	−0.137	0.666	0.700	0.709	0.738	1
12. Kessler6 T10	0.900	(0.691)	47,462	0.852	−0.089	−0.114	−0.111	−0.127	−0.141	−0.158	0.652	0.683	0.700	0.722	0.758

Notes. All correlations are significant at $P < .001$.
Sleep duration is average number of hours per night over the last month. Kessler is psychological distress using a 5-point scale (0 = none of the time, 1 = a little of the time, 2 = some of the time, 3 = most of the time, 4 = all of the time).

data given the inevitability of missing data in longitudinal research. This approach to handle missing data has several strengths. First, FIML neither imputes missing values nor requires data to be missing completely at random.[25] Second, FIML is an efficient way to utilize all available data without discarding responses as would be the case in list-wise or case-wise deletion and outperforms both of these methods in producing unbiased and efficient parameter estimates while managing Type 1 errors.[26] Therefore, we used FIML to estimate the CLPMs and RI-CLPMs presented below.

In order to assess whether sleep duration predicts changes in psychological distress over time (and vice-versa), we conducted 2 separate sets of analyses. The first analysis estimated a traditional CLPM in which sleep duration hours and the mean-scaled score for psychological distress measure at T-1 were used to predict both measures the following year across all 6 annual waves. These associations were modeled as a stationary process, where all congeneric paths were constrained to equality (eg, the autoregressive association between psychological distress at Time 1 and Time 2 was constrained to be equal to the same autoregressive association at Time 2 and Time 3, and so on).

Although traditional CLPMs allow for the modeling of change over time in order to examine causal relationships, this approach can lead to inaccurate conclusions about the temporal ordering of variables as it confounds within-person change with between-person stability.[17,27] Recent advances in multilevel models have led to the development of the RI-CLPM which uses a random intercept to account for stable trait-like differences in constructs while simultaneously modeling within-person change using an intuitive framework.[17] Here we estimate an RI-CLPM in a second set of analyses (see Fig. 1 for a conceptual overview). We first estimated a random intercept for both sleep duration and psychological distress by fixing the factor loadings of each variable at each measurement occasion to 1 and by allowing the 2 random intercepts to correlate. Thus, these random intercepts reflect the sample means of each participant's average levels of sleep duration and psychological distress across all 6 annual assessments.

To model within-person deviations from a participant's expected mean score on each sleep duration and psychological distress over time, we simultaneously estimated a latent variable for each construct at each time-point by constraining the factor loading and the residual variance for each manifest indicator at each time-point to 1 and 0, respectively. The within-person components of our model then estimate a stationary cross-lagged model where the within-person latent variables at Time 6 were regressed onto the within-person latent variables at Time 5 (and so on). We estimated the covariances between the within-person latent variables at Time 1, as well as the contemporaneous residual variances at Times 2-6, to account for time-specific sources of systematic variance (eg, participants' mood while completing the survey in a given year). The correlations between both random intercepts and the within-person measures of sleep duration and psychological distress at Time 1 were constrained to 0. Finally, we estimated bias-corrected (BC) 95% confidence intervals (CIs) using 1000 bootstrapped resamples (with replacement). Syntax for all models is available on the NZAVS website (www.nzavs.auckland.ac.nz).

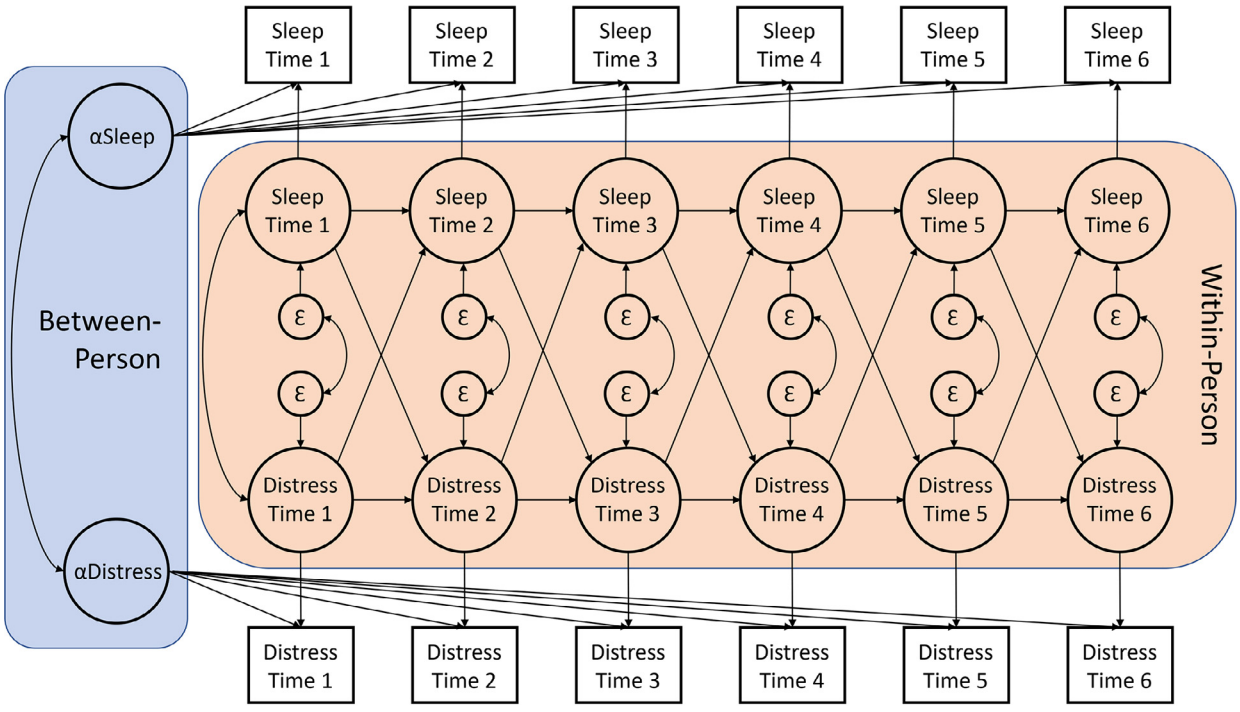

Fig. 1. Conceptual random intercepts cross-lagged panel model of the associations between sleep duration and psychological distress.

Results

Analytic strategy

Descriptive statistics and bivariate correlations for sleep duration and psychological distress are presented in Table 2. Both sleep duration (r = 0.52, $P < .001$) and psychological distress (r = 0.65, $P < .001$) showed high levels of rank-order stability over 6 years (ie, between the annual assessments at the first and last time-point). Transformations to Fisher z-scores and subsequent transformations back to Pearson correlation coefficients indicated that the average wave-to-wave correlations for sleep duration ($\bar{r}$ = 0.62, $P < .001$) and psychological distress ($\bar{r}$ = 0.74, $P < .001$) were also high. Overall, these results show that people's relative positions on both sleep duration and psychological distress were stable over time.

Main results

The chi-square (χ^2) test and fit indices affected by model complexity for the traditional CLPM, as seen in Table 3, suggested a null hypothesis that this model fits perfectly in the population could be rejected, χ^2 (56) = 16,457.234, $P < .001$, comparative fit index (CFI) = 0.841. Given the large sample size, obtaining a nonsignificant χ^2 would be very unlikely. However, indices less influenced by complexity still suggested an inadequate fit of the model to the observed covariance matrix (ie, root mean square error of approximation [RMSEA] >0.06, standardized root mean square residual [SRMR] >0.08), SRMR = 0.132, RMSEA = 0.071 (CI_{90} = [0.071, 0.072]). Although model fit was poor, the autoregressive paths reveal that both sleep duration (B = 0.631, BC CI_{95} = [0.627, 0.636]; $P < .001$) and psychological distress (B = 0.751, BC CI_{95} = [0.747, 0.755]; $P < .001$) were stable over time.

Table 3
Path coefficients of the associations between sleep duration and psychological distress

		Traditional cross-lagged		Random intercepts cross-lagged	
		Panel model		Panel model	
Outcome	Predictor $_{T-1}$	*B (SE)*	95% CI	*B (SE)*	95% CI
Sleep duration					
	Sleep duration	0.631 (0.002)*	(0.627, 0.636)	0.146 (0.006)*	(0.134, 0.158)
	Psychological distress	−0.062 (0.004)*	(−0.070, −0.053)	−0.005 (0.011)	(−0.027, 0.017)
Psychological distress					
	Psychological distress	0.751 (0.002)*	(0.747, 0.755)	0.127 (0.006)*	(0.115, 0.138)
	Sleep duration	−0.012 (0.001)*	(−0.014, −0.009)	−0.009 (0.003)*	(−0.014, −0.004)
Slope contrast		0.050 (0.005)*	(0.040, 0.059)	0.004 (0.011)	(−0.017, 0.025)
Model fit					
χ^2			16457.234		526.573
df			56		53
P			<.0001		<.0001
CFI			0.841		0.995
SRMR			0.132		0.022
RMSEA			0.071 (0.070, 0.072)		0.012 (0.011, 0.013)

Notes. Slope contrast refers to difference between cross-lagged effects in the given model.
*$P < .001$.

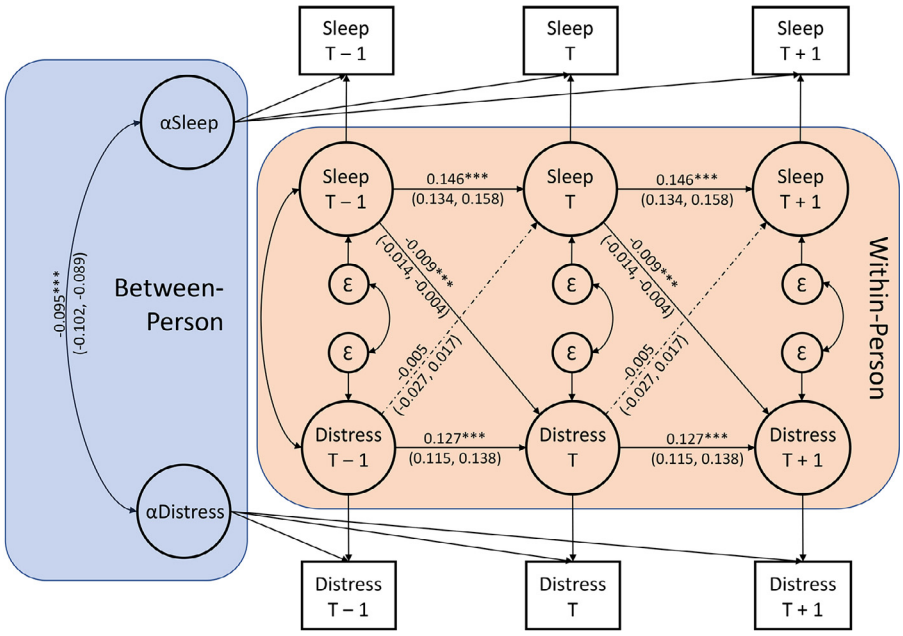

Fig. 2. Random intercepts cross-lagged panel model of the associations between sleep duration and psychological distress. Coefficients are unstandardized (with bias-corrected 95% confidence intervals). Gray dotted lines reflect nonsignificant paths. ***$P < .001$.

Most relevant to our aims, however, are the cross-lagged associations between sleep duration and psychological distress. Specifically, sleep duration$_{T-1}$ predicted decreases in psychological distress ($B = -0.012$, BC CI$_{95}$ = [−0.014, −0.009]; $P < .001$), and psychological distress$_{T-1}$ predicted decreases in sleep duration ($B = -0.062$, BC CI$_{95}$ = [−0.070, −0.053]; $P < .001$), over time. The latter association was significantly larger than the former association ($B_{Difference} = 0.050$, BC CI$_{95}$ = [0.040, 0.059]; $P < 0.001$), suggesting that, although the relationship between psychological distress and sleep duration appears to be bidirectional, it is psychological distress that decreases sleep duration more than sleep duration decreases psychological distress.

When properly partitioning the between-person stability from the within-person change, inspection of the RI-CLPM as shown in Fig. 2 (with details in Table 3) tells a more complete story. This model was an excellent fit with the data, χ^2 (53) = 526.573, $P < .001$, CFI = 0.995, SRMR = 0.022, RMSEA = 0.012 (CI$_{90}$ = 0.011, 0.013). The between-person components of sleep duration and psychological distress showed a small negative correlation, ($B = -0.095$, BC CI$_{95}$ = [−0.102, −0.089]; $P < .001$), suggesting that on average, those who reported more sleep hours per night during the past month reported lower levels of psychological distress. Within-person deviations from these trait-level means (ie, the autoregressive associations) correlated positively over time for both sleep duration ($B = 0.146$, BC CI$_{95}$ = [0.134, 0.158]; $P < .001$) and psychological distress ($B = 0.127$, BC CI$_{95}$ = [0.115, 0.138]; $P < .001$).

While autoregressive effects in a traditional CLPM represent rank-order stability across assessment waves, these coefficients in an RI-CLPM represent the persistence of a one-point deviation from a person's trait-level mean at one assessment to the following assessment. That is, autoregressive effects in RI-CLPMs denote the degree to which a variable continues to increase (or decrease) within people over time after correcting for the rank-order stability of the construct (ie, the random intercept). In our model, a 1-point deviation above (below) participants' mean level of psychological distress persisted as a 0.127-point positive (negative) deviation from their trait-level mean the following year.

Most relevant for the current study are the associations that model the within-person dynamics between sleep duration and psychological distress. The within-person cross-lagged effect of psychological distress$_{T-1}$ on sleep duration was nonsignificant ($B = -0.005$, BC CI$_{95}$ = [−0.027, 0.017]; $P = .657$), whereas the effect of sleep duration$_{T-1}$ on psychological distress was ($B = -0.009$, BC CI$_{95}$ = [−0.014, −0.004]; $P < .001$); these associations were not significantly different from each other ($B_{Difference} = 0.004$, BC CI$_{95}$ = [−0.017, 0.025]; $P = .706$). However, we provide some evidence to suggest that sleep duration as indicated over a short period of time (ie, 1 month) leads to psychological distress 1 year later, and it is not psychological distress that precedes changes in sleep duration. This also does not preclude the existence of these effects in another direction at shorter time periods. Therefore, after appropriately partitioning the variance of these cross-lagged associations into their between-person and within-person components, the previously identified longitudinal associations between sleep duration and psychological distress in a traditional CLPM are mostly attributable to the stability of the between-person differences in sleep duration and psychological distress.

Discussion

The primary aim of the present investigation was to determine whether sleep duration preceded or followed psychological distress in a large prospective sample of adults over 6 annual waves using a RI-CLPM. The findings reveal strong evidence that shorter sleep durations precede higher levels of psychological distress, and the inverse that longer sleep durations precede lower levels of psychological distress. These findings, however, need to be considered against several important factors, namely, the complexities of assessing the potential pathways between sleep duration with psychological distress, the biological factors that may underpin the association, and contextualizing the findings with the demographic composition of the current sample.

Complex association

Beyond the complexity of defining the directional pathways in the study of the sleep duration with negative affect relationship, further complications persist.[1,4] In particular, given that some have proposed

a U-shaped association between sleep duration and risk of negative affect,[4] potentially, subgroup analysis of short, normal, and long sleepers may be required to assess this theory. However, inconsistent classifications of these sleep duration categories, coupled with individual differences in sleep requirements, compromise this line of enquiry. A prospective study lends partial support to our findings that short sleep was associated with psychological distress and other measures of poor well-being; however, the same prospective study also reports that long sleep duration, but not short sleep, was associated with depression diagnoses in the preceding 5 years.[2] Additionally, in a sample of persons with clinical depression, both short and long sleep durations were related to poorer treatment outcomes.[28] Potentially, a subgroup analysis of clinical Vs nonclinical negative affect states may provide an explanation for the disparate findings within the literature. Similarly, while prospective designs are preferred to cross-sectional studies, the waxing and waning nature of negative affect across time may not directly correspond with the discrete assessment times for all people at all time-points.[4] Considered collectively, there are several factors that likely contribute to the "noise" in the data collected to assess the relationship between sleep duration and negative affect.

With the above adequately borne in mind, we strategically chose to use the sample in its entirety to assess the primary research question concerning the direction of relationship between constructs. Specifically, the RI-CLPM procedure is designed for this purpose.[17] Additional sensitivity analyses excluding adolescents (ie, <18 years of age) and those who reported long-sleep duration (ie, ≥9 hours) are reported in the Supplementary Materials. These results suggest that our findings persist with the exclusion of adolescents and omitting those with long sleep results in a similar pattern of findings to those reported here in the main text with the addition of a significant within-person cross-lagged effect of psychological distress$_{T-1}$ on sleep duration. This is interesting to note, but it is also possible that longer sleep duration could be related to or confounded with poorer psychological and physical health. With regards to psychological health, it is worth noting that our sample, similar to other large samples (4%),[3] comprised a substantial proportion of approximately 5%-7% of individuals with nonspecific serious psychological distress according to K6 standard cut-offs, and this speaks to the clinical significance of the findings. Although our statistical approach, design, and sample size are strengths, the dynamics of the factors under consideration suggest that more work is required to substantiate our claims.

Biological explanations

The claim that shorter sleep precedes psychological distress is supported not only by similar findings[2] but also by theory and empirical evidence of the interplay of neuronal changes related with short sleep and ensuing depression.[1] Specifically, changes in the prefrontal cortex have been targeted given its integral role with emotion regulation and sensitivity to sleep loss.[29] While a compelling biological explanation remains elusive,[29] several lines of experimental evidence have linked sleep deprivation with reductions in the functional connectivity between the medial prefrontal cortex and amygdala[30] and heightened autonomic activation.[31] The research highlighted that both neuronal[30] and physiological[31] changes elicited by sleep deprivation were associated with amplified reactivity to negative emotional stimuli. However, sleep deprivation studies are extreme examples of short sleep durations and more meaningful findings may emanate from prospective studies of enduring short sleep durations.

Recent prospective (1-year follow-up) research with children employed a two-wave CLPM (N = 11,067 time 1, N = 4696 at follow-up) to assess the association of sleep duration with depression scores.[15] The findings reveal a pathway from increased depression score to shorter sleep duration, but the reverse pathway was not found. Further, higher depressive problem scores mediated the relationship between lower cortical area volume (orbitofrontal cortex, superior, middle and medial superior frontal gyrus, inferior and middle temporal gyrus, precuneus, and posterior cingulate cortex) and shorter sleep duration. These findings support the reverse pathway identified in the present study, but this may be due to differing statistical procedures, the young sample, and/or the 1-year follow-up. It is also noteworthy that short sleep duration mediated the relationship between the cortical area volume and cognitive performance in this sample, and potentially, whether the measure of affect included items of cognition/concentration may explain disparate findings in the literature. Differing measures of negative affect may also alter the temporal association with sleep duration, with some evidence that higher anxiety symptoms precede shorter sleep and that shorter sleep precedes depression symptoms.[1] The Kessler measure of distress[11] used in the current study captures elements of both anxiety and depression symptoms.

Demographic specific implications

Past research indicates that Māori (the indigenous people of New Zealand) and Pacific peoples and those of lower socioeconomic status report higher rates of short sleep duration and/or sleep problems.[2,32,33] A range of factors can be linked to their greater lack of sleep. This includes their higher likelihood of shift or night work, neighborhood context, and poorer health status.[33,34] Importantly, these groups also persistently exhibit higher rates of psychological distress and mental health problems.[34-36] Addressing factors that lead to shorter sleep among these groups may thus help improve their psychological well-being over time.

Strengths and limitations

The research design in the present investigation did not consider important covariates. However, the primary aim was to use a statistical technique to overcome the limitations of previous approaches to assess temporal associations between constructs.[3,27] Nevertheless, the very large sample taken across several waves of data collection minimizes the influence that covariates can exert in smaller cross-sectional samples. Additionally, our single-item measure of sleep duration from the widely used and validated PSQI[20] does not consider the impact of sleep quality and may lack reliability as multiple item measures can provide a better estimate of the consistency of response to construct-related items. Finally, the Kessler measure of distress[11] while often used to assess negative affect, does not provide a separate index score for anxiety and depression symptoms, and research has suggested that these symptoms may occupy different temporal locations in the association of short sleep with negative affect.[1] These limitations are balanced, however, by several strengths including the large, potentially "at-risk" sample, the 6 annual waves of data collection, and the novel statistical approach that was designed to overcome the limitations of traditional CLPM[3,27] that have previously been used to assess the relationship between sleep duration and negative affect.

Conclusion

Our findings add to the mixed literature that has assessed the temporal association between sleep duration and negative affect. That our analysis shows that short sleep precedes psychological distress is significant given the propensity for short sleep in this sample of New Zealanders. Given the reports of short sleep and poor mental health among low socioeconomic status indigenous members of this community,[2] our findings provide an evidence-base for policy makers and public health initiatives to prioritize efforts to improve sleep

practices. While the impact of sleep duration is often overlooked, promoting adequate sleep duration may prevent the exacerbation of negative mental health outcomes.

Declaration of conflicts of interest

The authors have declared no conflicts of interest.

Disclosures

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sleh.2020.12.005.

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