Perceived financial hardship and sleep in an adult population-based cohort: The mediating role of psychosocial and lifestyle-related factors

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ABSTRACT

Background: Social inequalities in sleep have been reported, but there is less research on the mechanisms underlying this association. This study investigates the relationship between financial hardship and sleep within the general adult population, focusing on the mediating effects of psychosocial and lifestyle-related factors.
Methods: We used data from the Specchio cohort, a population-based study in Geneva, Switzerland, initiated in December 2020. Perceived financial hardship and sleep outcomes (insomnia, sleep quality, and sleep duration) were assessed by questionnaire in 2020 to 2021. Counterfactual mediation analysis was conducted to examine the extent to which perceived financial hardship impacts sleep through psychosocial (psychological distress and loneliness) and lifestyle-related (weight, smoking, and physical inactivity) pathways. Models were adjusted for age, sex, education, living alone, and chronic disease.
Results: Among 4388 participants, those experiencing financial hardship had a greater risk of insomnia (odds ratio: 2.11; 95% confidence interval: 1.70-2.61), poor sleep quality (odds ratio: 1.69; 95% confidence interval: 1.41-2.02), and not meeting sleep duration guidelines (odds ratio: 1.40; 95% confidence interval: 1.18-1.66) compared to those without financial difficulties. Psychosocial factors explained 40% of the relationship of financial hardship with insomnia, 35% of the relationship with poor sleep quality, and 10% of the association with suboptimal sleep duration. The contribution of lifestyle-related factors was 8%, 12%, and 17%, respectively.
Conclusion: Perceived financial hardship is a significant predictor of poor sleep, and this association is mediated by psychosocial and, to a lesser extent, lifestyle-related factors. These findings highlight the need for integrative approaches addressing social inequalities in sleep.
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Introduction

Sleep is a public health concern, with as much as half of the population in high-income countries experiencing short sleep duration, insomnia, and other sleep disturbances.[1] Sleep is pivotal to human health and well-being, serving as an essential biological mechanism for physical and cognitive rejuvenation.[2] Insufficient and poor quality sleep are associated with premature mortality, increased risk of accidents, and various health conditions,[3] including

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depression, Alzheimer's disease, addiction-related disorders,[2] and 7 leading causes of death: cardiovascular disease, malignant neoplasm, cerebrovascular disease, accidents, diabetes, septicemia, and hypertension.[4] Understanding the determinants of sleep is paramount to improving the health of the general population, and ultimately reducing costs to society.

Research into the social and environmental determinants of sleep has increased in recent years,[5] as they offer a potential explanation for disparities in health and well-being, and represent modifiable factors that could be targeted in interventions.[6] Most of the existing research has shown that there is a social gradient in sleep health, such that socioeconomic disadvantage – defined by conventional indicators such as low education level, occupational position, or income – is associated with various sleep outcomes including shorter sleep duration, poor sleep quality, and insomnia.[1,7,8] Subjective socioeconomic measures (self-rated measures of social class, financial difficulties, and food security) have been examined to a lesser extent than conventional indicators in relation to sleep, but seem to be more consistently associated with sleep duration than conventional indicators, perhaps because they better reflect an individual's social structure and class,[9] and because they reflect the individual's perception that might have a more direct impact on sleep than conventional measures.

Perceived financial hardship, which is the focus of this study, is considered a distinct aspect of socioeconomic circumstances, contributing to health outcomes along with conventional indicators. Specifically, it signifies current material challenges, such as difficulties in bill payments and purchasing necessities.[8,10] Financial hardship as a socioeconomic determinant has already been linked to adverse health outcomes, including obesity, mental health conditions,[11] decreased cognitive functions, and cardiovascular diseases,[12] as well as sleep outcomes including poor sleep quality, shorter sleep duration,[13] and other sleep disturbances.[8] Previous studies examining the relationship between perceived financial hardship and sleep have focused on specific population subgroups such as women from ethnic minority groups,[13] men who have sex with men,[14] students,[15] and public sector employees.[8]

Few studies have formally tested pathways mediating the association between socioeconomic disadvantage and sleep; although several studies have shown that the associations between conventional socioeconomic indicators and sleep are attenuated after adjustment for lifestyle, behavioral, and health factors (including smoking, alcohol consumption, physical activity, body mass index [BMI], depression, and perceived stress).[9] Among the few studies assessing mediating pathways, one population-based study of 2162 adults from Lausanne (Switzerland) found that BMI partly mediated the association between a lower occupational position/education level and sleep-disordered breathing.[16] Another cross-sectional study of 785 adults from the US general population found that psychological distress partly mediated the association between food insecurity and subjective sleep quality.[17] Several other studies testing mediating pathways linking socioeconomic disadvantage and sleep outcomes in children have focused on environmental factors, such as exposure to noise and a chaotic home environment.[18] To our knowledge, no studies have examined psychosocial and lifestyle-related mediators of the association between perceived financial hardship and sleep outcomes. Understanding the pathways linking social inequalities and sleep is needed to inform public health promotion strategies.

The counterfactual approach to mediation analysis overcomes several limitations of traditional approaches, such as the difference-of-coefficients method. Advantages include estimation of natural direct and indirect effects,[19] the ability to handle nonlinear models (such as when the outcome is dichotomous),[20] and estimation of joint indirect effects (e.g., effect of exposure on an outcome mediated simultaneously by a block of mediators) as well as fine-grained decompositions (path-specific indirect effects).[21] Using counterfactual mediation analysis, we aim to extend the existing research by formally testing psychosocial and lifestyle-related factors as pathways mediating associations between perceived financial hardship and various sleep outcomes, including insomnia, sleep quality, and sleep duration, in a population-based sample.

Material and methods

Participants and study design

Data were obtained from the Specchio cohort, a population-based digital study launched in December 2020 to follow up participants in a COVID-19 serosurvey, in Geneva, Switzerland.[22] Upon registration, participants completed a baseline questionnaire on sociodemographic information, including perceived financial hardship, and lifestyle-related factors. Sleep outcomes and psychosocial factors were separately assessed in two subsequent questionnaires (general health and mental health questionnaires) in June 2021. For the present study, we included participants who had completed the baseline questionnaire, and the follow-up questionnaire including the sleep measures. The Specchio study was approved by the Cantonal Research Ethics Commission of Geneva, Switzerland (Project ID 2020-00881) and informed consent was obtained from all participants.

Conceptual approach

A scoping literature review was conducted to establish hypothesized relationships between financial hardship, psychosocial and behavioral mediators, sleep outcomes, and their covariates. A directed acyclic graph (Fig. 1) was constructed to inform decisions regarding variable selection and modeling strategies.

Measures

Perceived financial hardship

Financial hardship was assessed using the following question: "Currently, would you say that financially… (I am comfortable, money is not a source of worry and it's easy to save; My income is sufficient to cover my expenses and to deal with minor unforeseen events; I have to watch my spending and unforeseen events could put me in financial difficulty; I cannot cover my needs with my income and I need external support to function (debt, credit, various forms of financial aid); I do not wish to reply)." Responses were dichotomized to reflect financial hardship (financial strain and reliance on external support during unexpected expenses) and no financial hardship (easy savings and expense management). Perceived financial hardship was moderately correlated with gross household income (Pearson's r = 0.28, $p < .001$), as in previous research.

Sleep outcomes

Insomnia was measured using the Insomnia Severity Index (ISI), which consists of seven items rated on a 5-point scale.[23] Internal consistency of the ISI scale was high in the study sample (α = 0.88). A cutoff score of ≥8 was used to identify insomnia or sleep disturbance.[24] Sleep duration was assessed by asking how many hours on average participants slept at night during week and weekend days. The average sleep duration per night was calculated as: (week time × 5 + weekend time × 2) / 7. Responses were dichotomized to identify those who met the National Sleep Foundation guidelines for sleep duration (7-9 hours; "optimal sleep duration"), and those who did not meet the guidelines (< 7 or > 9 hours; "suboptimal sleep duration").[25] We did not distinguish between short and long sleep duration as only 1% of the sample had a long sleep duration (> 9 hours), meaning that those who did not meet the guidelines
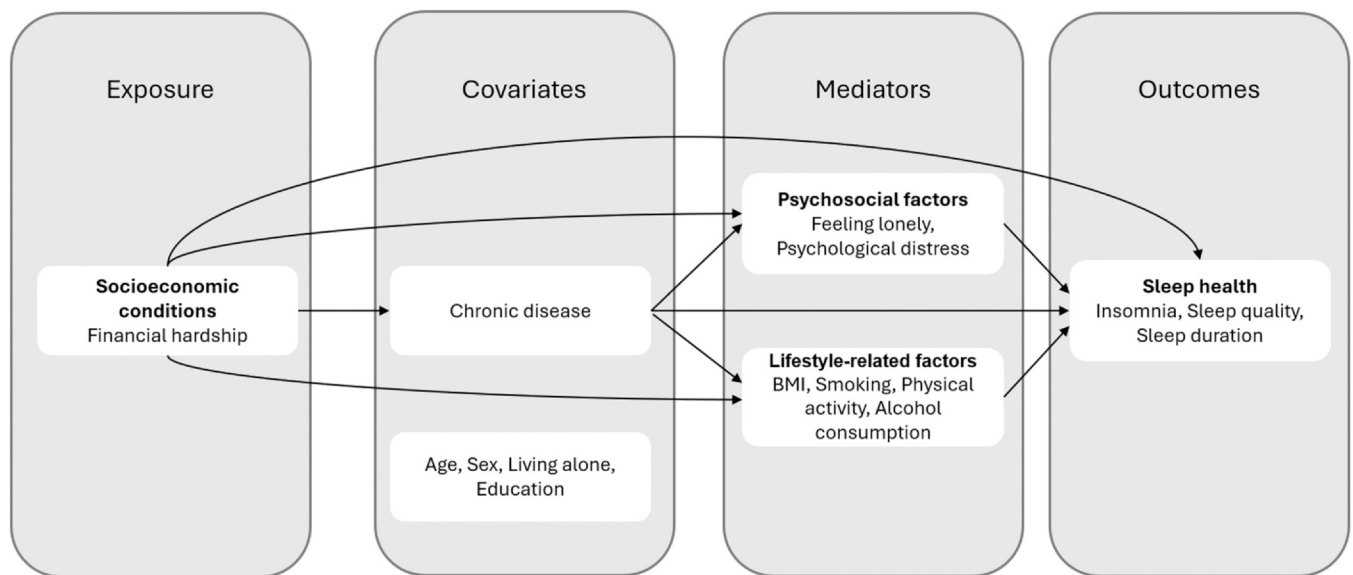
Fig. 1. Directed acyclic graph of the association between financial hardship, psychosocial factors, lifestyle-related factors and sleep outcomes. Chronic disease is considered as a confounder of the mediator-outcome association influenced by the exposure. Age, sex, living alone, and education are considered covariates of the exposure – outcome, exposure – mediator, and mediator – outcome associations. Arrows are not drawn for readability

were primarily short sleepers. Sleep quality was assessed using the following question from the Pittsburgh Sleep Quality Index[26]: "Overall, how would you rate the quality of your sleep during the past month?" (very good, quite good, quite poor, very poor). Responses were dichotomized to reflect good or poor sleep quality as less than 2% of the sample reported very bad sleep quality. The sleep outcomes were inter-correlated as expected: poorer sleep quality was strongly associated with higher ISI scores (Pearson's $r = -0.76$, $p < .001$); shorter sleep duration was moderately associated with poorer sleep quality (Pearson's $r = 0.14$, $p < .001$) and higher ISI scores (Pearson's $r = -0.15$, $p < .001$).

Psychosocial mediators

Psychological distress was measured using the Kessler Psychological Distress (K6) Scale, which comprises 6 questions about emotional states each with a 5-point response scale. Internal consistency of the K6 scale was high in the study sample ($\alpha = 0.89$). A cutoff score of ≥14 was used to identify individuals likely to be affected by a mental illness.[27] Loneliness was measured using the 3-item version of the UCLA Loneliness scale, designed to measure subjective feelings of loneliness and social isolation. Internal consistency of the UCLA Loneliness scale was high in the study sample ($\alpha = 0.84$). Based on previous research,[28] a score of 6 or more was used to identify lonely (vs. not lonely) individuals. Psychological distress and loneliness were strongly inter-correlated (Pearson's $r = 0.60$, $p < .001$).

Lifestyle-related mediators

Participants were asked how frequently they participated in vigorous physical activity, defined as activities requiring a great deal of effort, resulting in shortened breathing, and accelerated heart rate (e.g., jogging, sports cycling, tennis, swimming, gymnastics).[29] Responses were dichotomized to identify active participants (those who engaged in vigorous physical activity at least once a week) and inactive participants (those who never or occasionally engaged in vigorous physical activity). Smoking status was categorized as current smoking and nonsmoking, the latter included former smoking. Alcohol consumption was based on the reported frequency of alcoholic beverage intake and was categorized as mild (less than once a day) or heavy (once a day or more). Participants' BMI was calculated

with self-reported height and weight and categorized into healthy weight, underweight, overweight, and obesity, using the World Health Organization (WHO) criteria.[30] As expected, active individuals were less likely to smoke (OR [95% CI] = 0.66 [0.57, 0.77], $p < .001$), less likely to be heavy drinkers (OR [95% CI] = 0.80 [0.67, 0.96], $p = .014$), and less likely to have overweight or obesity (OR [95% CI] = 0.53 [0.47, 0.60], $p < .001$).

Covariates

Covariates that were hypothesized to influence the associations under study were age (in years), sex, living situation (living alone or with others), and education. Education was the highest level of educational qualification obtained by the time of the study and categorized as tertiary (including doctoral, university, and advanced professional training), secondary (secondary school education), or primary (apprenticeships, compulsory education, or no formal education). Chronic disease (yes, no) was the self-reported presence or absence of any long-term health conditions, defined as those necessitating treatment for over 6 months. The latter was considered as a covariate of the mediator-outcome association influenced by the exposure. Correlations between the covariates were small to moderate (Pearson's $r = 0$-0.2).

Statistical analyses

In the initial step, we used a series of generalized linear models following a binomial distribution to examine the following: (1) associations between the exposure (financial hardship) and each sleep outcome (insomnia, sleep duration, sleep quality), (2) associations between financial hardship and each mediating factor, and (3) associations between each of the mediating factors and each sleep outcome. Following the directed acyclic graph (Fig. 1), all models were adjusted for age, sex, living situation and education; associations between mediating factors and sleep outcomes were further controlled for chronic conditions.

Counterfactual mediation analysis of the relationship between financial hardship and sleep was then performed for each group of mediating factors (psychosocial factors, lifestyle-related factors, all) and each sleep outcome (insomnia, sleep quality, and sleep duration). Mediation analysis uses a set of regression models to decompose the total effect of an exposure on an outcome into a natural

direct effect (effect of exposure on the outcome via pathways that do not involve the mediator) and a natural indirect effect (effect of exposure on the outcome operating through the mediator). The proportion mediated corresponds to the proportion of the total effect that is explained by the mediators.

Mediation effects were estimated with marginal structural models using the CMAverse package.

Confidence intervals were computed through bootstrapping (random sample with replacement—1000 simulations). All analyses were performed with R version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was defined with a 95% confidence level.

For all the statistical analyses (initial step and counterfactual mediation analysis described above), we run two sets of models, one using categorical variables and one using continuous variables when possible.

Results

Sample characteristics

A total of 4729 participants completed both the baseline questionnaire and the follow-up questionnaire including sleep measures. Of these participants, 314 did not want to disclose their financial situation and 27 had missing information on sleep outcomes, lifestyle-related factors, or covariates, resulting in an analysis sample of 4388 participants. Analyses of psychosocial factors were restricted to the 3596 participants who additionally completed the mental health questionnaire.

Compared to the total eligible sample (N = 4729; Supplementary Table 1), participants in the analytic sample were older, had a higher education level, and had lower psychological distress, although these differences were small (within approximately 1%). In the analysis sample for psychosocial mediators, there was a smaller proportion of people without financial hardship than in the total eligible sample, but this difference was largely due to the inability to include participants who did not report this information. In the analysis sample (see Table 1), mean age was 51.4 years (standard deviation: 14.5 years), and 56.7% of participants were women. Most of the sample had a tertiary education level (66.3%), and 83.2% reported no financial hardship. The overall prevalence of insomnia was 12.5%, 24.5% reported poor sleep quality, and 30.0% of participants did not meet sleep duration guidelines.

Associations between financial hardship and sleep outcomes

Compared with those not experiencing financial hardship, individuals experiencing financial hardship had a greater risk of insomnia (aOR: 2.11; 95% CI: 1.70-2.61), poor sleep quality (1.69; 1.41-2.02), and suboptimal sleep duration (1.40; 1.18-1.66). These associations were also evident when modeling the continuous sleep outcomes (β: 1.65; 95% CI: 1.21-2.09) for ISI scores; − 0.12 (− 0.21 to − 0.03) for sleep duration (hours).

Associations between financial hardship and the mediating factors

Individuals experiencing financial hardship had a greater risk of having overweight (aOR: 1.45; 95% CI: 1.22-1.72) or obesity (aOR: 1.70; 95% CI: 1.32-2.19), smoking (aOR: 1.91; 95% CI: 1.57-2.31) and being physically inactive (aOR: 1.71; 95% CI: 1.45-2.02). There was no significant association between financial hardship and heavy alcohol consumption (*p*-value >.1). In terms of psychosocial factors, individuals experiencing financial hardship were more likely to feel psychologically distressed (aOR: 2.51; 95% CI: 1.74-3.61) and lonely (aOR: 1.90; 95% CI: 1.49-2.42) than their more advantaged counterparts. These associations were replicated when testing associations

Table 1

Characteristics of the total analysis sample, and by sleep outcomes (n (%))

	Total	Insomnia	Poor sleep quality	Suboptimal sleep duration
	N = 4388	N = 550	N = 1077	N = 1316
Age (y)				
18-34	583 (13.3)	88 (16.0)	185 (17.2)	132 (10.0)
35-49	1385 (31.6)	215 (39.1)	401 (37.2)	399 (30.3)
50-64	1494 (34.0)	188 (34.2)	370 (34.4)	490 (37.2)
65 or older	926 (21.1)	59 (10.7)	121 (11.2)	295 (22.4)
Sex				
Female	2487 (56.7)	352 (64.0)	667 (61.9)	686 (52.1)
Male	1901 (43.3)	198 (36.0)	410 (38.1)	630 (47.9)
Chronic disease				
No	3265 (74.4)	381 (69.3)	773 (71.8)	922 (70.1)
Yes	1123 (25.6)	169 (30.7)	304 (28.2)	394 (29.9)
Living alone				
No	3741 (85.3)	478 (86.9)	932 (86.5)	1081 (82.1)
Yes	647 (14.7)	72 (13.1)	145 (13.5)	235 (17.9)
Education				
Primary	146 (3.3)	20 (3.6)	33 (3.1)	50 (3.8)
Secondary	1331 (30.3)	168 (30.5)	317 (29.4)	457 (34.7)
Tertiary	2911 (66.3)	362 (65.8)	727 (67.5)	809 (61.5)
Financial hardship				
No	3652 (83.2)	396 (72.0)	828 (76.9)	1046 (79.5)
Yes	736 (16.8)	154 (28.0)	249 (23.1)	270 (20.5)
Weight status				
Healthy	2659 (60.6)	320 (58.2)	654 (60.7)	709 (53.9)
Underweight	146 (3.3)	23 (4.2)	34 (3.2)	38 (2.9)
Overweight	1201 (27.4)	150 (27.3)	279 (25.9)	416 (31.6)
Obesity	382 (8.7)	57 (10.4)	110 (10.2)	153 (11.6)
Current smoking				
No	3674 (83.7)	436 (79.3)	865 (80.3)	1057 (80.3)
Yes	714 (16.3)	114 (20.7)	212 (19.7)	259 (19.7)
Physical activity				
Active	2323 (52.9)	272 (49.5)	533 (49.5)	648 (49.2)
Inactive	2065 (47.1)	278 (50.5)	544 (50.5)	668 (50.8)
Alcohol consumption				
Mild	3858 (87.9)	496 (90.2)	959(89)	1157 (87.9)
Heavy	530 (12.1)	54 (9.8)	118 (11)	159 (12.1)
Psychological distress[a]				
No	3449 (95.9)	345 (62.7)	729 (67.7)	1019 (77.4)
Yes	147 (4.1)	91 (16.5)	102 (9.5)	60 (4.6)
Loneliness[b]				
Not lonely	3146 (87.5)	283 (51.5)	620 (57.6)	931 (70.7)
Lonely	450 (12.5)	153 (27.8)	211 (19.6)	148 (11.2)

[a] Measured using the 6-item Kessler scale. Individuals with a score of 14 or more were identified as being psychologically distressed (n = 3596).
[b] Measured using the 3-item UCLA loneliness scale. Individuals with a score of 6 or more were identified as being lonely (n = 3596).

between financial hardship and continuous mediators. For BMI (kg/m²), β: 0.91; 95% CI: 0.55-1.27; for physical activity (times per week), β: − 0.23; 95% CI: − 0.36 to − 0.11; for alcohol consumption (times per week), *p*-value >.05; for psychological distress (K6 score), β: 1.54; 95% CI: 1.18-1.90; for loneliness (UCLA score), β: 0.38; 95% CI: 0.26-0.51.

Associations between the mediating factors and sleep outcomes

Obesity was associated with a greater risk of suboptimal sleep duration and poor sleep quality, while current smoking and not engaging in vigorous activity were additionally associated with insomnia (Table 2a). Participants feeling psychologically distressed and lonely were also more likely to have poor sleep outcomes, especially insomnia and poor sleep quality. These associations were also seen for the continuous mediators and sleep outcomes (Table 2b).

Table 2a
Associations between mediating factors and sleep outcomes (n = 4388)

	Insomnia	Poor sleep quality	Suboptimal sleep duration
	aOR (95% CI; *p*-value)	aOR (95% CI; *p*-value)	aOR (95% CI; *p*-value)
Weight status			
Normal	Ref.	Ref.	Ref.
Underweight	1.20 (0.75-1.91; .445)	0.82 (0.55-1.22; .326)	1.01 (0.68-1.47; .979)
Overweight	1.17 (0.94-1.45; .153)	1.06 (0.89-1.25; .519)	1.30 (1.11-1.51; <.001)
Obesity	1.29 (0.94-1.77; .108)	1.30 (1.01-1.66; .038)	1.63 (1.30-2.04; <.001)
Current smoking			
No	Ref.	Ref.	Ref.
Yes	1.34 (1.07-1.69; .011)	1.30 (1.08-1.56; .005)	1.39 (1.17-1.66; <.001)
Regular physical activity			
Yes	Ref.	Ref.	Ref.
No	1.18 (0.98-1.42; .079)	1.26 (1.09-1.45; .002)	1.16 (1.02-1.33; .025)
Alcohol consumption			
Mild	Ref.	Ref.	Ref.
Heavy	0.96 (0.71-1.31; .806)	1.12 (0.90-1.41; .312)	0.89 (0.73-1.10; .283)
Psychological distress[a]			
No	Ref.	Ref.	Ref.
Yes	12.73 (8.90-18.21; <.001)	7.32 (5.07-10.57; <.001)	1.69 (1.20-2.38; .003)
Loneliness[b]			
No	Ref.	Ref.	Ref.
Yes	4.73 (3.74-5.98; <.001)	3.20 (2.59-3.94; <.001)	1.21 (0.98-1.51; .080)

Results are adjusted odds ratios (aOR) and 95% confidence intervals (CI) from logistic regressions adjusted for age, sex, living alone, education and chronic condition.
[a] Measured using the 6-item Kessler scale. Individuals with a score of 14 or more were identified as being psychologically distressed (n = 3596).
[b] Measured using the 3-item UCLA loneliness scale. Individuals with a score of 6 or more were identified as being lonely (n = 3596).

Table 2b
Associations between continuous mediating factors and sleep outcomes (n = 4388)

	Insomnia score[a]	Poor sleep quality	Sleep duration, h
	β (95% CI; *p*-value)	aOR (95% CI; *p*-value)	β (95% CI; *p*-value)
Body mass index (kg/m^2)	0.05 (0.01-0.08; .014)	1.02 (1.01-1.04; .006)	−0.01 (−0.02 to −0.01; <.001)
Current smoking			
No	Ref.	Ref.	Ref.
Yes	0.61 (0.18-1.05; .006)	1.30 (1.08-1.56; .005)	−0.16 (−0.25 to −0.07; <.001)
Physical activity (times/wk)	−0.23 (−0.33 to −0.12; <.001)	0.92 (0.88-0.97; .002)	0.02 (0.00-0.04; .031)
Alcohol consumption (times/wk)	0.03 (−0.04 to 0.09; .428)	1.01 (0.98-1.04; .433)	0.01 (0.00-0.03; .054)
Psychological distress score[b]	0.72 (0.68-0.76; <.001)	1.25 (1.22-1.28; <.001)	−0.01 (−0.02 to −0.01; .001)
Loneliness score[c]	1.39 (1.26-1.51; <.001)	1.43 (1.35-1.51; <.001)	−0.02 (−0.04 to 0.01; .264)

For insomnia score and sleep duration (continuous outcomes), results are adjusted β and 95% confidence intervals (CI) from linear regressions adjusted for age, sex, living alone, education and chronic condition. For poor sleep quality (dichotomous outcome), results are adjusted odds ratios (aOR) and 95% CI from logistic regressions adjusted for age, sex, living alone, education, and chronic condition.
[a] Measured using the Insomnia Severity Index.
[b] Measured using the 6-item Kessler scale (n = 3596).
[c] Measured using the 3-item UCLA loneliness scale (n = 3596).

The consistent associations found between financial hardship, sleep outcomes, psychosocial and lifestyle-related factors provided the rationale for the formal mediation analysis hereafter. The only exception was alcohol consumption, which was not related to financial hardship and sleep, and was thus not included in the mediation models.

Mediating pathways

The counterfactual mediation analysis revealed that psychosocial factors (categorical) explained 40% of the association between financial hardship and insomnia (proportion mediated [pm]: 0.40; 95% CI: 0.25-0.61), 35% of the association with poor sleep quality (pm: 0.35; 95% CI: 0.20-0.64), and 10% of the association with suboptimal sleep duration (pm: 0.10; 95% CI: 0.01-0.34). Lifestyle-related factors (categorical) explained 8% of the association between financial hardship and insomnia (proportion mediated [pm]: 0.08; 95% CI: 0.00-0.15), 12% of the association with poor sleep quality (pm: 0.12; 95% CI: 0.05-0.21), and 17% of the association with suboptimal sleep duration (pm: 0.17; 95% CI: 0.08-0.41). Together, psychosocial and lifestyle-related factors (categorical) explained 42% of the association with insomnia (pm: 0.42; 95% CI: 0.27-0.67), 43% of the association with poor sleep quality (pm: 0.43; 95% CI: 0.27-0.71),

and 33% of the association with suboptimal sleep duration (pm: 0.33; 95% CI: 0.13-0.92).

In the analysis using continuous variables, psychosocial factors explained up to 80% of the association between financial hardship and insomnia score (proportion mediated [pm]: 0.80; 95% CI: 0.59-1.23), and 83% of the association with poor sleep quality (pm: 0.83; 95% CI: 0.58-1.37) but did not significantly mediate the association between financial hardship and hours of sleep duration. Lifestyle-related factors did not significantly mediate the association of financial hardship with insomnia score, poor sleep quality, or hours of sleep duration (*p*-value >.05); although the latter was borderline statistically significant (*p* = .06). Together, psychosocial and lifestyle-related factors explained 83% of the association with insomnia score (pm: 0.83; 95% CI: 0.61-1.29), 85% of the association with poor sleep quality (pm: 0.85; 95% CI: 0.59-1.45), and 56% of the association with hours of sleep duration (pm: 0.56; 95% CI: 0.11-2.21). All results are shown in Table 3.

Discussion

In this population-based study, individuals experiencing financial hardship had a greater risk of insomnia, poor sleep quality, and

Table 3
Counterfactual mediation analysis of the psychosocial and lifestyle-related pathways linking financial hardship and sleep outcomes (n = 4388)

Mediator[a]	Estimate	Insomnia	Poor sleep quality	Suboptimal sleep duration
		aOR (95% CI; *p*-value)	aOR (95% CI; *p*-value)	aOR (95% CI; *p*-value)
Psychosocial[1]	Natural direct effect	1.59 (1.23-2.02; .002)	1.38 (1.11-1.70; .004)	1.32 (1.08-1.62; .014)
	Natural indirect effect	1.25 (1.14-1.38; <.001)	1.15 (1.09-1.26; <.001)	1.03 (1.00-1.07; .024)
	Total effect	2.04 (1.54-2.63; <.001)	1.61 (1.29-2.00; <.001)	1.35 (1.11-1.65; .006)
	Proportion mediated	0.40 (0.25-0.61; <.001)	0.35 (0.20-0.64; <.001)	0.10 (0.01-0.34; .030)
Lifestyle-related[2]	Natural direct effect	2.13 (1.66-2.67; <.001)	1.65 (1.37-1.97; <.001)	1.37 (1.10-1.66; .004)
	Natural indirect effect	1.04 (1.00-1.08; .028)	1.05 (1.02-1.09; .002)	1.06 (1.03-1.09; <.001)
	Total effect	2.22 (1.73-2.79; <.001)	1.74 (1.44-2.09; <.001)	1.45 (1.16-1.76; <.001)
	Proportion mediated	0.08 (0.00-0.15; .028)	0.12 (0.05-0.21; .002)	0.17 (0.08-0.41; <.001)
All[1]	Natural direct effect	1.58 (1.20-2.04; .002)	1.38 (1.11-1.72; .012)	1.25 (1.00-1.59; .044)
	Natural indirect effect	1.28 (1.16-1.46; <.001)	1.22 (1.13-1.31; <.001)	1.10 (1.05-1.15; <.001)
	Total effect	2.09 (1.58-2.75; <.001)	1.70 (1.34-2.12; <.001)	1.37 (1.09-1.73; .008)
	Proportion mediated	0.42 (0.27-0.67; <.001)	0.43 (0.27-0.71; <.001)	0.33 (0.13-0.92; .008)
Mediator[b]	Estimate	Insomnia score	Sleep quality	Sleep duration, h
		β (95% CI; *p*-value)	aOR (95% CI; *p*-value)	β (95% CI; *p*-value)
Psychosocial[1]	Natural direct effect	0.41 (−0.07 to 0.88; .084)	1.15 (0.94-1.41; .176)	−0.10 (−0.21 to 0.01; .082)
	Natural indirect effect	1.08 (0.71-1.43; <.001)	1.41 (1.25-1.57; <.001)	−0.04 (−0.09 to 0.01; .088)
	Total effect	1.36 (0.77-1.91; <.001)	1.55 (1.23-1.92; <.001)	−0.11 (−0.23 to −0.01; .042)
	Proportion mediated	0.80 (0.59-1.23; <.001)	0.83 (0.58-1.37; <.001)	0.35 (−0.53 to 1.50; .122)
Lifestyle-related[2]	Natural direct effect	1.50 (0.93-2.01; <.001)	1.58 (1.32-1.89; <.001)	−0.10 (−0.20 to 0.00; .044)
	Natural indirect effect	0.11 (−0.08 to 0.31; .258)	1.06 (0.98-1.14; .158)	−0.04 (−0.08 to 0.00; .060)
	Total effect	1.57 (1.02-2.07; <.001)	1.64 (1.37-1.98; <.001)	−0.12 (−0.23 to −0.03; .016)
	Proportion mediated	0.07 (−0.06 to 0.19; .258)	0.14 (−0.05 to 0.30; .158)	0.31 (−0.03 to 0.95; .068)
All[1]	Natural direct effect	0.37 (−0.15 to 0.83; .156)	1.14 (0.93-1.38; .188)	−0.07 (−0.19 to 0.03; .152)
	Natural indirect effect	1.12 (0.78-1.50; <.001)	1.43 (1.27-1.61; <.001)	−0.06 (−0.11 to −0.01; .002)
	Total effect	1.36 (0.77-1.95; <.001)	1.55 (1.23-1.91; .002)	−0.11 (−0.23 to −0.01; .024)
	Proportion mediated	0.83 (0.61-1.29; <.001)	0.85 (0.59-1.45; .002)	0.56 (0.11-2.21; .026)

Results are adjusted odds ratios (aOR) from marginal structural models for categorical sleep outcomes or β estimated with the weighting-based approach for continuous sleep outcomes, proportions, and 95% confidence intervals (CI). Psychosocial mediators include psychological distress and loneliness; lifestyle-related mediators include overweight, smoking and physical activity. Total effect = total effect of financial hardship on the sleep outcome; Natural direct effect = effect of financial hardship on the sleep outcome via pathways that do not involve the mediator; Natural indirect effect = effect of financial hardship on the sleep outcome operating through the mediator; Proportion mediated = proportion of the total effect that is explained by the mediators.
[a]Categorical mediators. [b]Continuous mediators. 1n = 3596. 2n = 4388.

suboptimal sleep duration than their more advantaged counterparts. These findings concur with previous studies focusing on perceived financial hardship within specific population subgroups,[8,14,13,15] and with studies focusing on more conventional measures of socio-economic status.[1,7,8,31,32] Furthermore, this study extends previous research by formally testing hypothesized mediation pathways and showing that more than half of financial disparities in sleep health can be explained by psychosocial and lifestyle-related factors.

We theorized that experiencing financial difficulties might increase feelings of loneliness and/or psychological distress, leading to poor sleep – a model our findings support. The associations between financial hardship and psychological distress, as well as between psychological distress and sleep disturbances are well-established.[8,11,13] Our study further demonstrates the pivotal role of mental wellbeing in sleep disparities as an important mediator. Worries and feelings of shame due to financial difficulties can adversely impact mental health, and these factors may contribute to the differences in sleep seen in the present study. Previous research has also shown that financial strain is a strong predictor of social loneliness, the perceived absence of a broader, engaging social network.[33] Loneliness may manifest as sleep inefficiency, fragmentation, and reduced sleep quality as it induces hypervigilance for social threats, resulting in sustained neural alertness during sleep attempts.[34] While our study focused on loneliness, which pertains to the subjective feelings of isolation, other research has shown that financial stress can lead individuals to become more isolated, engage in fewer social activities, and maintain lower-quality relationships.[35] Given that social isolation and loneliness tend to co-occur, but they can also be experienced independently of one another[36] further research is needed to determine the extent to which these constructs independently explain the association between financial hardship and sleep.

As previously observed, financial hardship was related to lifestyle-related factors such as excess weight, smoking, and decreased physical activity,[37] which in turn explained poorer sleep outcomes. Indeed, excess weight is a strong predictor of sleep apnea,[16] affecting sleep length and quality; smoking can disrupt sleep initiation and maintenance[38]; and lack of exercise may decrease sleep efficiency and duration.[39] In our study, financial hardship was not associated with alcohol consumption. It might be because we could not distinguish between acute and chronic financial hardship in our study, while some research indicates that only the former is related to heavy drinking,[40] and the latter is associated with abstinence.[41] It is also possible that we did not see an association due to our measure of alcohol consumption, which captured frequency but not quantity of alcohol consumption.

In our study, psychosocial mediators had a seemingly smaller impact on sleep duration than lifestyle-related factors did, while the inverse was true for insomnia and sleep quality. This suggests that sleep duration is more affected by lifestyle choices and modifiable habits, whereas psychosocial factors may exert a greater influence on the cognitive and emotional processes associated with sleep quality and the onset of insomnia. Stress, anxiety, and rumination, for instance, can disrupt one's capacity to initiate or maintain sleep, thus affecting sleep quality and leading to insomnia. Yet, these factors may not invariably shorten the overall duration of sleep. For example, someone with a consistent sleep schedule may still face frequent disturbances, affecting sleep quality.

Between 20% and 50% of the association between financial hardship and sleep remained unexplained by the examined pathways, suggesting that other factors contribute to financial disparities in sleep health. Environmental factors likely contribute to the observed associations and should be investigated in future research. Socioeconomic disadvantage is associated with living in smaller, more crowded, and poorer quality housing, as well as living in disadvantaged neighborhoods where there are greater problems of noise, pollution, crime, and security, which may impact sleep directly. In terms of other health behaviors, future research should

consider the role of dietary factors and cannabis use, as these have been shown to contribute to socioeconomic inequalities in health[42] and sleep outcomes. Other psychosocial factors, such as job strain, cognitive coping strategies, and adverse life experiences may also play a role.

Taken together, our findings are in line with the social-ecological model of sleep health[43] according to which sleep is influenced by individual-level factors (behavior, psychology, health), and these are embedded in the context of social factors (work, neighborhood). At the individual level, socially disadvantaged individuals are more likely to engage in unhealthy behaviors, including those that relate to sleep health, due to being less educated, having higher stress levels in the context of financial or employment insecurity, and having limited access to health resources.[44] Consequently, socially disadvantaged individuals have poorer physical and mental health than that of socially advantaged individuals, which is also reflected in sleep.

Implications

While the promotion of proper sleep hygiene remains vital, our findings offer insights for public health practitioners and policy-makers, suggesting that interventions to improve sleep health must transcend clinical settings and encompass socioeconomic policies. Initiatives could include income support programs, access to affordable housing, and job security measures, which have the potential to mitigate the stressors contributing to poor sleep health. Addressing financial hardship and associated concerns may in turn impact individual health behaviors due to improved access to resources and reduced stress. Indeed, previous research has shown that policies that improve social security benefit eligibility/generosity are associated with improvements in mental health,[45] while income maintenance and health insurance interventions have been associated with significant improvements in self-rated health[46] and health behaviors.[47] Targeting attitudes and beliefs about healthy lifestyles may also improve sleep outcomes in socioeconomically disadvantaged groups. Additionally, our findings suggest that targeted interventions to address loneliness and social isolation could be beneficial. Community-based programs that facilitate social connection and provide mental health support can mitigate the psychosocial factors contributing to poor sleep. Integrating loneliness assessment into routine health screenings can ensure early identification and intervention, potentially mitigating sleep disorders and other related health issues.

Strengths and limitations

Strengths of the study include the population-based design, the formal mediation analysis testing psychosocial and lifestyle-related pathways, and the assessment of various sleep outcomes using validated measures. While we considered both lifestyle-related and psychosocial pathways linking financial hardship and sleep, we did not assess other potentially important mediators. As the sample was predominantly white European, we could not examine the role of ethnicity, which may contribute to the reported associations. We conducted a thorough literature review and considered common confounders, such as education and chronic diseases, which are relevant to our conceptual model. However, we acknowledge that residual confounding may still be present. Compared to the general Swiss population, the Specchio cohort is older, more educated, and potentially healthier, which could lead to an underestimation of the observed effects. Recruitment and retention of disadvantaged groups in epidemiological research is an ongoing challenge, and further research should try to replicate these findings in more diverse samples and different socioeconomic contexts. It is also important to note that the data were collected during the COVID-19 pandemic, which impacted financial circumstances, health behaviors, and

psychosocial stress in the general population. Associations between financial hardship and the variables included in this study have been demonstrated prior to the pandemic. However, it is possible that the effects in this study could be stronger than prepandemic effects. We used a relatively simple measure of perceived financial hardship, although it correlated as expected with other socioeconomic constructs, as well as the mediators and outcomes of interest, providing some evidence of convergent and predictive validity. Subjective socioeconomic measures such as perceived financial hardship capture the individual's perspective and can provide information beyond conventional measures. However, as with all self-report measures, there is a risk of bias. Certain aspects of the study design, such as the use of an online questionnaire, the assurance of anonymity, and option to refrain from answering, helped reduce, but may not have eliminated, the likelihood of bias. We used established, validated self-report measures of sleep, but the use of objective sleep and lifestyle-related parameters would provide further insights. Although we assessed sleep outcomes after the measurement of financial hardship, prolonged sleep difficulties could influence a person's psychosocial well-being, lifestyle, and financial situation. We suggest that future research incorporate repeat measures of sleep and the mediating factors in their models to test for potential bidirectional associations.

Conclusion

Sleep disturbances are common in the general adult population and increase the risk of morbidity and premature mortality. Our population-based study identified a strong connection between financial hardship and sleep outcomes, as well as psychosocial and lifestyle-related pathways through which financial hardship impacts sleep. These findings suggest that an integrative approach is needed to address social inequalities in sleep. Future research should focus on longitudinal studies to establish causal relationships and assess the effectiveness of targeted interventions.

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Author contributions

Ambra Chessa: Conceptualization, Formal analysis, Methodology, Visualization, Writing - original draft preparation. **Stephanie Schrempft**: Conceptualization, Methodology, Formal analysis, Writing - original draft preparation, Writing - reviewing and editing. **Viviane Richard**: Methodology, Formal analysis, Visualization, Writing - reviewing and editing. **Hélène Baysson**: Project administration. **Nick Pullen**: Data curation. **María-Eugenia Zaballa**: Project administration. **Elsa Lorthe**: Writing - reviewing and editing. **Mayssam Nehme**: Writing - reviewing and editing. **Idris Guessous**: Funding acquisition, Supervision. **Silvia Stringhini**: Conceptualization, Funding acquisition, Supervision.

Declaration of conflicts of interest

Nothing to declare.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.sleh.2024.12.006.

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