

Sexual harassment and assault predict sleep disturbances and is partly mediated by nightmares: findings from national survey of all university students in Norway.

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Conflict of interest

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Iris M. Steine reports no conflicts of interest or financial disclosures.

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Author contributorship

IMS, JCS and BS came up with the basic idea for the study, and developed the analytical strategy together. JCS carried out the data analysis in collaboration with IMS and BS. IMS, BS and JCS drafted the manuscript. All of the authors contributed with comments and amendments to drafts of the manuscript. The submitted version is approved by all authors.

Summary

Sexual harassment and assault is common in most domains of society, and has been linked to several adverse outcomes, including reduced sleep quality. However, less is known about the possible impact of sexual harassment and assault on various sleep problems among university students. In a sample of 49,051 students in Norway (69.2% women), we examined 1) the associations of varying extents of sexual harassment (unwanted sexual comments, looks or gestures, photographs, indecent exposure, and physical harassment) and sexual assault (attempted or completed rape), with meeting DSM-5 diagnostic criteria of insomnia and with sleep duration, 2) the association of cumulative exposure to sexual harassment/assault with insomnia and sleep duration, and 3) to what extent nightmares could explain the association between sexual harassment and insomnia and sleep duration. For both genders, all forms of harassments with the exception of 'indecent exposure', and 'unwanted sexual photographs' for men, were negatively associated with sleep duration, with the strongest associations being found for 'rape' and 'attempted rape'. For both genders, the odds of insomnia increased as a function of cumulative harassment exposure. Similarly, a graded, negative association was found between cumulative harassment and sleep duration for both genders. Mediation analyses showed that 28% of the observed association between cumulative harassment and insomnia, and 15% of the association between cumulative harassment and sleep duration, was mediated by frequency of nightmares.

Keywords: Insomnia; Sleep duration; Sexual abuse victims; Student sample; Dose-response association, Mediation, Nightmare.

Introduction

Reports following the #MeToo movement has documented that sexual harassment and assault is a widespread challenge for university students, as it is in other domains of society. In a recent national survey of all students pursuing higher education in Norway, we found that almost one in four students reported lifetime sexual harassment of some form, while one in six students reported being sexually harassed during the past year ¹. In that study, sexual *harassment* was defined broadly, encompassing a wide range of unwanted sex-related behaviors appraised as offensive by the recipient, including both verbal and nonverbal harassment, as well as sexual assault (rape attempt, and rape).²

Several studies have shown that victims of sexual assault experience more mental and somatic health problems,³ and a systematic review also linked sexual abuse victimization to increased risk of different sleep problems, including short sleep duration, insomnia, as well as nightmares ⁴. However, most previous studies in this field have been conducted on small and/or clinical samples, and relatively few studies have examined sleep outcomes associated with other forms of sexual harassment beyond sexual assault. To the best of our knowledge, no population-based studies have examined to what extent different forms of sexual harassment among university students is associated with specific sleep problems. Although sexual harassment may lead to impaired sleep in general, potential associations may also differ across specific sleep problems, for example subjective symptoms of insomnia or reduced sleep duration, and it is therefore important to include a detailed and validated assessment of sleep.

Although previous studies have shown that the extent of sleep problems may vary as a function of the severity of adversity exposure (*cumulative exposure*) in a ‘dose-response’ manner ⁵, no previous studies have examined whether such graded associations exist between cumulative exposure to different types of sexual harassment/assault and levels of sleep problems, with the exception of one recent study reporting higher odds of poor sleep among women reporting sexual assault as compared to sexual harassment ⁶. That study, however, utilized a relatively small sample and included women only, limiting the generalizability of the findings

Indeed, as for sexual harassment and assault, there are clear gender specific patterns across different sleep problems, with higher rates of insomnia among women, while men typically have

higher risk of short sleep duration ⁷. Still, less is known about how gender may be related to the *magnitude* of associations between sexual harassment/assault and health outcomes, emphasizing the need for new studies to explore such associations separately for men and women.

Another sleep disturbance that may be relevant in this context is nightmares, which is a commonly reported consequence of sexual assault ^{4,8}. Nightmares also frequently co-occur with insomnia ^{9,10}, highlighting nightmares as one plausible pathway underlying the sexual assault/harassment-sleep link. Previous studies have suggested that nightmares may partly mediate the association between bully victimization and depression in adolescents ¹¹, but to our knowledge no previous studies have examined the indirect effect of sexual harassment/assault on insomnia or short sleep duration through reports of nightmares.

To address these literature gaps, the aim of the current study was threefold. Firstly, we examined whether varying types of sexual harassment/assault representing different levels of severity and invasiveness were associated with insomnia and sleep duration. Based on previous studies, we hypothesized that sexual harassment/assault would be positively associated with fulfilling insomnia diagnostic criteria and negatively associated with sleep duration, and that the effects would be stronger with increasing harassment/assault severity ⁶. Secondly, we examined the association of cumulative exposure to different sexual harassment/assault forms with insomnia and sleep duration. We hypothesized that the likelihood of fulfilling diagnostic criteria of insomnia would increase, and sleep duration decrease, as a function of cumulative exposure to sexual harassment/assault, informed by previous studies reporting ‘dose-response’ associations of cumulative exposure to other types of adverse events with sleep disturbances ⁵. Thirdly, we examined the potential indirect effect of sexual harassment/assault on insomnia and sleep duration through nightmares. Finally, taking advantage of the large sample size of a national survey of all students taking higher education in Norway (n=50,054), we investigated possible gender specific patterns by conducting all statistical analysis separately for male and female students.

Methods

Sample

The study sample came from the Students' Health and Wellbeing Study (SHoT2018), a national survey among full-time Norwegian students pursuing higher education (both in Norway and abroad), initiated by the three largest welfare organizations in Norway. The SHoT2018 study was completed electronically via a web-based platform from February to March 2018. All full-time Norwegian students aged between 18 and 35 taking higher education were invited to participate via email and text messages. In total, 162 512 students fulfilled the inclusion criteria, of whom 50 054 students agreed to participate, yielding a response rate of 30.8%. For a detailed description of the study, see ¹²

The SHoT2018 study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway (no. 2017/1176). An electronic informed consent was obtained after the participants had received a detailed introduction to the study.

Measures

Demographic information. All participants indicated their age and gender.

Sleep measures

Insomnia. The participants indicated the number of nights per week they experienced difficulties initiating sleep (DIS), difficulties maintaining sleep (DMS) and early morning awakenings (EMA), as well as daytime sleepiness and tiredness. Those suffering from sleep problems were asked about duration of the problems. The following three criteria were used as an operationalization for insomnia disorder, in line with the DSM-5 criteria: (a) the presence of either DIS, DMS or EMA for at least 3 nights per week; (b) the presence of daytime sleepiness or tiredness for at least 3 days per week; and (c) a duration of the sleep problems for at least 3 months. Thus, insomnia was coded a binary variable in the present study ("No" coded as "0", "Yes" coded as "1").

Sleep duration. The participants' self-reported usual bedtime and rise time were indicated in hours and minutes, and data were reported separately for weekdays and weekends. Time in bed (TIB) was calculated as the difference between bedtime and rise time. Sleep-onset latency (SOL) and wake after sleep onset (WASO) were also indicated separately for weekdays and weekends in hours and minutes. Sleep duration was defined as TIB minus SOL and WASO. For the purpose of the present study, sleep duration was also used as a continuous variable indicating hours, and only weekday sleep duration was included in the analysis.

Frequency of nightmares. The frequency of nightmares was assessed using one item from the Nightmare Frequency Questionnaire (NFQ):⁸ “Based on the last three months, how often would you say that you experience nightmares/bad dreams?”. Response categories were “Never”, “Yearly”, “Monthly”, and “Weekly”.

Sexual harassment and assault. Sexual harassment and assault was assessed using a seven-item self-report instrument covering three categories harassment, ranging from milder forms of non-contact sexual harassment to severe forms of sexual assault, corresponding to the legal definition of sexual harassment in Norway¹³. The three categories were: 1) *Verbal harassment* (sexual expressions and suggestions, comments about one's body, appearance or private life), 2) *Non-verbal harassment* (close eye or body movements, being shown sexual images, including digital images, and indecent exposure), and 3) *Physical harassment* (unwanted touching, hugging or kissing, rape attempt, or rape). As a preamble to these questions, the participants were given the following definition of sexual harassment: “*unwanted sex-related behaviors that are appraised by the recipient as offensive or bothersome*”.

In the present study, these seven items were transformed into binary variables (“No” coded as “0”, “Yes” coded as “1”) to indicate whether they had experienced any of the following types of sexual harassment and assault: 1) Comments, 2) Looks or gestures, 3) Photographs, 4) Indecent exposure, 5), Unwanted physical harassment (not including rape attempt or rape), 6) Attempted rape, and 7) Rape. For each of these seven forms of harassment/assault, the respondents indicated when the harassment/assault was experienced, with response categories being “past month”, “past year”, “more

than a year ago, but after entering college/university”, and “before entering college/university”.

Everyone reporting exposure to harassment/assault were included in the present study, independent of when the harassment/assault happened. Details on the prevalence rates of sexual harassment/assault in the same dataset has been published elsewhere.¹

Cumulative measures of harassment. In order to assess the cumulative association of sexual harassment/assault with insomnia and sleep duration, a count variable was created indicating how many types of these seven harassment categories the participants had experienced (ranging from “1 experience” to “4 or more experiences”).

Statistical analysis

Sleep variables were checked for validity of answers based on preliminary data analysis, resulting in n=111 subjects being omitted due to obvious invalid responses (e.g. negative sleep duration). The eligible sample for this study was defined as those with valid responses on sleep variables, age and gender (N=49,051). We employed list-wise deletion to handle missing responses on the variables of interest, leaving a final study sample of N=47,152 (96.1%). Table 1 contains descriptive analysis of the included variables across gender. Independent two-sample t-tests were employed for continuous variables (age and sleep duration) and χ^2 -tests were employed for binary variables to indicate gender differences. For insomnia as dependent variable, separate gender stratified logistic regression models were computed with each of the harassment variables as independent variables while controlling for age (figure 1). Similarly, for sleep duration as dependent variable, separate gender stratified linear regression models were computed with each of the harassment variables as independent variables while controlling for age (figure 2). In order to not confound the effect estimates of more common types of harassment (“comments”, “looks or gestures”, “photographs”, “indecent exposure”, “unwanted physical harassment”) with more adverse and less prevalent types of sexual assault (“attempted rape”, “rape”), we recoded six of the seven harassment/assault variables for these regression analyses. Specifically, the sexual harassment variables of “comments”, “looks or gestures”, “photographs”, “indecent exposure” “unwanted physical harassment” were coded as missing (to avoid misclassification) if the participant also reported the

sexual assault variables of “attempted rape” and/or “rape”. Also, “attempted rape” was coded as missing if the participant also reported “rape”. We also tested for interactions between each harassment/assault variable and gender on the relationship with insomnia and sleep duration, respectively, using likelihood ratio tests. Furthermore, we used the cumulative harassment/assault variable as an independent factor variable in gender-stratified logistic (insomnia) and linear (sleep duration) regression models while adjusting for age to estimate the relationship of level of harassment/assault exposure with insomnia and sleep duration (figure 3 and 4). For these regressions, we tested for interactions between cumulative harassment/assault and gender on the relationship with insomnia and sleep duration, respectively, using likelihood ratio tests. We also investigated the association between different types of sexual harassment and frequency of nightmares using multinomial logistic regression, using the same operationalization of sexual harassment as described above (table 2). Finally, we estimated two indirect models examining the effect of cumulative harassment/assault (independent variable) on insomnia and sleep duration (dependent variables) through nightmare frequency (figure 5). All analyses were carried out using STATA version 15.0 and R.

Results

Descriptive statistics of sample and main variables

In the study sample, a total of N=32,631 (69.2%) participants were women. The mean age was 23.3 years (standard deviation (SD): 3.3 years), and men were slightly older than women ($p < 0.001$). The mean sleep duration was 7.42 hours (SD: 1.39 hours), and no gender difference was observed ($p = 0.256$). For insomnia and nightmares, a higher proportion was observed among women compared to men ($p < 0.001$). The most commonly reported type of sexual harassment were “comments” and “unwanted physical harassment” (both $\approx 15.4\%$), and the least common was “attempted rape” (2.1%). For all harassment/assault variables, women reported a higher proportion of exposure compared to men (all p -values < 0.001).

Harassment and association with insomnia and sleep duration.

In relation to insomnia, all harassment/assault variables except “indecent exposure” was associated with increased odds of having insomnia for both genders (p-values ranging from 0.015 to <0.001). For both genders, the highest odds were reported for “rape” (OR, men: 3.99 and OR, women: 2.48), and “attempted rape” (odds ratio (OR), men: 2.53 and OR, women: 2.27). Due to lower numbers of men reporting exposure to the different types of harassment/assault, the confidence intervals were considerably larger compared to women. However, the odds of insomnia were significantly higher for men exposed to “looks or gestures” (likelihood ratio test (LRT), $p < 0.001$) and “photographs” (LRT, $p = 0.023$) compared to women. No other significant gender differences were observed in the association between harassment and insomnia.

For sleep duration, negative statistically significant associations were observed for both genders for “comments”, “looks or gestures”, “unwanted physical harassment”, “attempted rape” and “rape” (p-values ranging from 0.007 to <0.001). For women, a statistically significant association between “photographs” and shorter sleep duration was also observed ($p < 0.001$). For both genders the strongest association with sleep duration was observed for “rape” (B, men=-0.88 and B, women=-0.46), and “attempted rape” (B, men=-0.68 and B, women=-0.46). As noted above, the confidence intervals were considerably larger for men than women. The negative association with sleep duration was, however, stronger for men than women for comments (LRT, $p = 0.024$) and rape (LRT, $p = 0.029$). No other significant gender differences were observed in the association between harassment and sleep duration.

Cumulative harassment/assault and association with insomnia and sleep duration

For the association between cumulative harassment/assault and insomnia, the odds of fulfilling diagnostic criteria for insomnia increased as a function of cumulative harassment/assault for both genders (both p-values for trend <0.001). For men, the point estimates (odds ratio) were consistently higher compared to women, with a larger average increase across number of exposures (average odds ratio 1.47 vs 1.28, LRT: $p < 0.001$). A similar relationship was observed for the association between cumulative harassment/assault and sleep duration. A graded negative relationship was observed for

both genders (both p-values for trend <0.001), but with a larger average increase for men compared to women (average B -0.18 vs 0.11, LRT: p=0.031).

Mediation by nightmares

All types of sexual harassment was associated with increased frequency of nightmares, and the association was monotonous across frequency categories (table 2). The strength of the association was more pronounced for more severe forms of sexual harassment, especially for the highest frequency of nightmares (weekly). For both insomnia and sleep duration, mediation analyses were estimated using cumulative harassment/assault as the independent variable and frequency of nightmares as a potential mediator. In both mediation analyses, all of the estimated path coefficients were significant at $p < 0.001$. For insomnia, 28% of the observed association with cumulative harassment/assault was mediated by through frequency of nightmares, with an indirect/direct effect ratio of 0.39. The corresponding number for sleep duration, was 15% for mediation through nightmares, while the indirect/direct effect ratio was 0.17.

Discussion

In this large national survey inviting all Norwegian university students, sexual harassment and assault was associated with an increased risk of insomnia and short sleep duration, with the strongest associations for completed and attempted rape. Cumulative harassment/assault showed a positive 'dose-response' association with the likelihood of insomnia, and a negative 'dose-response' association with sleep duration; both of which were partly mediated by the frequency of nightmares. The association with sleep duration and insomnia was stronger for men than women for women.

Sexual harassment/assault, with the exception of indecent exposure, was associated with insomnia, with the odds of insomnia increasing as a function of the severity of harassment and assault. Similarly, with the exception of indecent exposure for both genders, and of harassing sexual photographs for men, all the sexual harassment/assault variables negatively predicted total sleep duration with effect sizes increasing with the severity of harassment and abuse. These findings are in line with the only previous comparable study we identified that examined associations of both sexual

abuse and sexual harassment with sleep disturbances, which reported larger effect sizes for more severe forms of abuse compared to less severe forms of harassment in a sample of 304 women ⁶. A parsimonious interpretation of these findings is that the severity of sexual abuse and harassment is linked to the severity of sleep disturbances in a systematic way. Such interpretation is further supported by the finding that cumulative harassment/assault was associated with both insomnia and sleep duration in a ‘dose-dependent’ way, which aligns with a large broader literature documenting such ‘dose-response’ relation between cumulative adversity and the likelihood and severity of health outcomes in general ¹⁴, and sleep disturbances specifically ⁵.

The same pattern was, however, not found for the ‘indecent exposure’ variable, which was associated with neither insomnia nor sleep duration. This finding is non-intuitive as one would expect an association also for this kind of sexual harassment based on the other findings in the present paper. Due to the lack of comparison studies, this finding is difficult to interpret. However, it may reflect that indecent exposure is a less severe type of harassment, and consequently not predictive of sleep disturbances in and of itself. The same interpretation may also be applicable to the lack of association between harassing sexual photographs and sleep duration for men, although harassing sexual photographs did predict insomnia for both genders. Also, indecent exposure was the least common sexual harassment type (reported by 2.2% of females and 0.3% of males), and harassing sexual photographs was only reported by 1.1% of males in the present study. This leads to lack of statistical precision, and this may in part explain these specific findings. Based on these considerations, we believe that replications of these findings are warranted before adequate interpretations can be made.

The associations of rape with sleep duration, and of cumulative harassment with both sleep duration and insomnia, were stronger for men than women in the present study. This result seems inconsistent with findings from a study of more than 150,000 young students in China, in which sexually assaulted girls had a higher likelihood of sleep disturbances compared to boys ¹⁵, and those from a study of more than 8000 adults, which found no gender differences in insomnia symptoms among sexual assault victims ¹⁶. However, differences in analytic approaches, sample characteristics, sleep outcome measures, as well as sexual abuse assessment and timing, preclude direct comparisons

with these studies. The overall literature on gender differences in sleep disturbances among sexual assault victims is inconclusive, with the majority of studies reporting no gender differences or more sleep disturbances among women compared to men ^{4,15,16}. To avoid premature interpretations, therefore, our finding should be replicated in other samples before any conclusions regarding gender differences can be drawn.

The present study also showed that nightmares partly mediated the association of sexual harassment/assault with insomnia and sleep duration, indicating that nightmares are an important component of sleep disturbances among sexual harassment/assault victims. Both sexual abuse and sexual harassment predict posttraumatic stress symptoms (PTSS) ^{17,18}, which has sleep disturbances and nightmares among its core symptoms ¹⁹, raising the possibility that nightmares as measured in the present study may have captured PTSS. Since the present study assessed neither PTSS nor nightmare content, we do not know if the reported nightmares were related to PTSS, however. Still, the present finding further underscores the importance of a broad assessment of sleep, including sleep patterns, insomnia and nightmares, among students reporting sexual abuse or assault, and calls for interventions that target all of these symptom domains (see for example ²⁰).

The associations of sexual abuse and harassment with insomnia and sleep duration has clinical implications, as they highlight the importance of assessing sleep disturbances among students reporting sexual abuse or harassment. This is particularly imperative in light of the many negative consequences of short sleep duration and insomnia, including for learning capacity and academic performance specifically ^{21,22}, as well as the recognized role of sleep disturbances in the etiology and maintenance of several other disorders ²³⁻²⁶.

From a wider perspective, the current results stress the importance of placing sexual harassment and assault of University students on the agenda, given what we know about how sexual harassment may also impact victims' later academic future and career promotion ²⁷⁻²⁹, in addition to causing both short- and long-term health problems.

Study limitations and strengths

The present study has several limitations and strengths. The most important limitation is the response rate of 30.8%, which may limit the generalizability of the findings to the overall student population, as we cannot rule out that there may have been biases in who responded to the survey versus not. Another limitation is that the study did not specifically assess sexual abuse or harassment taking place during childhood; the developmentally sensitive time period during which exposure to severe stressors produce particularly pervasive effects on development and health³⁰. While sexual harassment/assault in childhood was most likely captured in the response category “before entering college/university” to the question about when the sexual harassment/assault had happened, the lack of a response category capturing childhood specifically prohibited an examination of whether the associations with the sleep outcome variables varied based on the timing of the harassment/assault. We did, however, perform sensitivity analyses where we reiterated all of our analyses using only pre-college/university harassment/assaults as the exposure variable. The results were similar to the results presented here, with no impact on the overall interpretation and conclusions of the present study. On a similar note, another limitation is that the present study did not assess exposure to other types of potentially traumatic events in childhood, nor adulthood, which prohibited examining associations of a wider range of adverse events with the sleep outcome measures, which again may have attenuated the ‘dose-response’ pattern obtained in the present study. Thus, future studies should assess a broader range of adversity variables, including childhood adversities specifically. Last, the study is cross-sectional, thus cause and effect cannot be established. Additional confounding may also have impacted on the results. For instance, mental health problems such as PTSD and depression are both related to trauma experience and sleep duration and insomnia. Relatedly, the mediation analyses must be interpreted with caution as all variables were reported at the same time. Important strengths of the present study include the unique and very large sample enabling gender-specific analyses, the broad assessment of sexual harassment/assault using specific, behavioral descriptions rather than subjective general categories (e.g., “were you ever sexually abused or harassed”), and a detailed sleep assessment battery, including an approximation of the DSM-5 criteria to operationalize insomnia.

Conclusions

In a sample of 49,051 higher education students in Norway, the present study showed that sexual abuse and sexual harassment was associated with an increased risk of insomnia and shorter sleep duration for both women and men, in a 'dose-dependent' way, and that these associations were partly mediated by the frequency of nightmares. Results call for assessments and interventions targeting sleep disturbances among students reporting sexually abusive and harassing experiences.

Tables and figures

Table 1: Descriptive statistics of included variables across gender. N=47,152.

	Female (N=32631)	Male (N=14521)	P-values	Overall (N=47152)
Age			<0.001 ^a	
Mean (SD)	23.1 (3.27)	23.5 (3.31)		23.3 (3.29)
Sleep duration (hrs)			=0.256 ^a	
Mean (SD)	7.43 (1.40)	7.41 (1.37)		7.42 (1.39)
DSM-5 Insomnia			<0.001 ^b	
Insomnia	11202 (34.3%)	3218 (22.2%)		14420 (30.6%)
Weekly nightmares			<0.001 ^b	
Less than weekly	26967 (82.6%)	13424 (92.4%)		40391 (85.7%)
Weekly	5664 (17.4%)	1097 (7.6%)		6761 (14.3%)
Comments			<0.001 ^b	
Yes	6688 (20.5%)	552 (3.8%)		7240 (15.4%)
Looks or gestures			<0.001 ^b	
Yes	5093 (15.6%)	306 (2.1%)		5399 (11.5%)
Photographs			<0.001 ^b	
Yes	1583 (4.9%)	156 (1.1%)		1739 (3.7%)
Indecent exposure			<0.001 ^b	
Yes	733 (2.2%)	46 (0.3%)		779 (1.7%)
Unwanted physical			<0.001 ^b	
Yes	6531 (20.0%)	731 (5.0%)		7262 (15.4%)
Attempted rape			<0.001 ^b	
Yes	932 (2.9%)	36 (0.2%)		968 (2.1%)
Rape			<0.001 ^b	
Yes	1524 (4.7%)	54 (0.4%)		1578 (3.3%)

^aIndependent two-samples t-test; ^b χ^2 -test

Table 2: Crude association between exposure to different types of sexual harassment and self-reported frequency of nightmares. Multinomial logistic regression. Relative risk ratios (95%CI).

Type of sexual harassment ^a	Frequency of nightmares			
	Never	Yearly RRR 95%CI	Monthly RRR 95%CI	Weekly RRR 95%CI
Comments	1.00 (ref)	1.73 (1.52-1.96)	2.28 (2.02-2.57)	2.76 (2.40-3.17)
Looks or gestures	1.00 (ref)	1.78 (1.52-2.10)	2.33 (2.00-2.72)	2.98 (2.50-3.54)
Photographs	1.00 (ref)	1.50 (1.13-1.98)	2.10 (1.62-2.72)	2.23 (1.64-3.04)
Indecent exposure	1.00 (ref)	1.14 (0.69-1.88)	2.23 (1.45-3.45)	2.62 (1.60-4.33)
Unwanted physical	1.00 (ref)	1.78 (1.64-1.93)	2.54 (2.35-2.74)	3.18 (2.91-3.48)
Attempted rape	1.00 (ref)	1.70 (1.29-2.25)	3.15 (2.45-4.04)	5.38 (4.15-6.96)
Rape	1.00 (ref)	1.56 (1.30-1.88)	2.91 (2.47-3.43)	6.12 (5.18-7.22)

^a“Comments”, “looks or gestures”, “photographs”, “indecent exposure” and “unwanted physical harassment” were coded as missing (to avoid misclassification) if the participant

also reported the sexual assault variables of “attempted rape” and/or “rape”. Also, “attempted rape” was coded as missing if the participant also reported “rape”. Abbreviations: 95% CI: 95% confidence interval, RRR: Relative risk ratio.

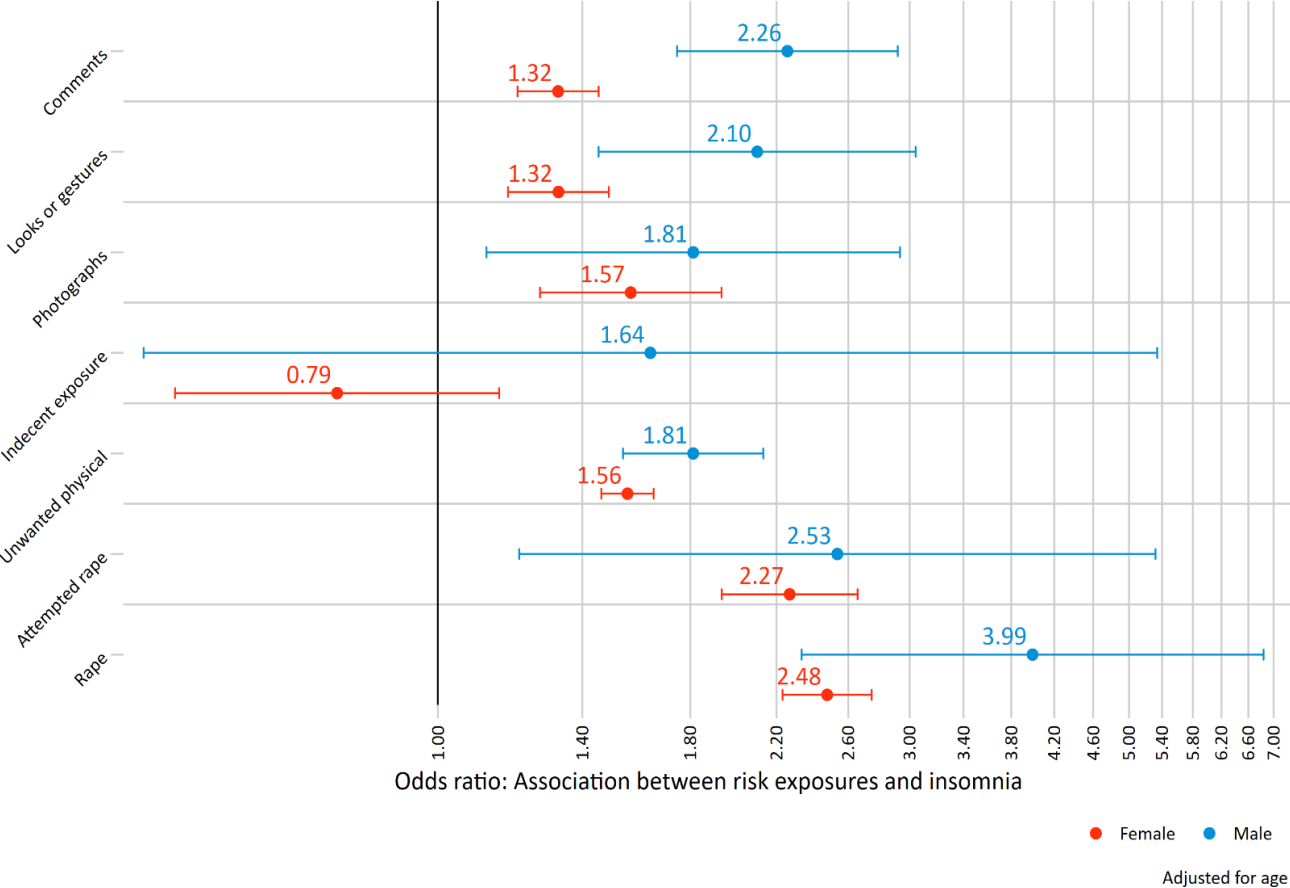


Figure 1: Association between separate risk factors and insomnia. Logistic regression models (Bars denote CI95%). N=47,152.

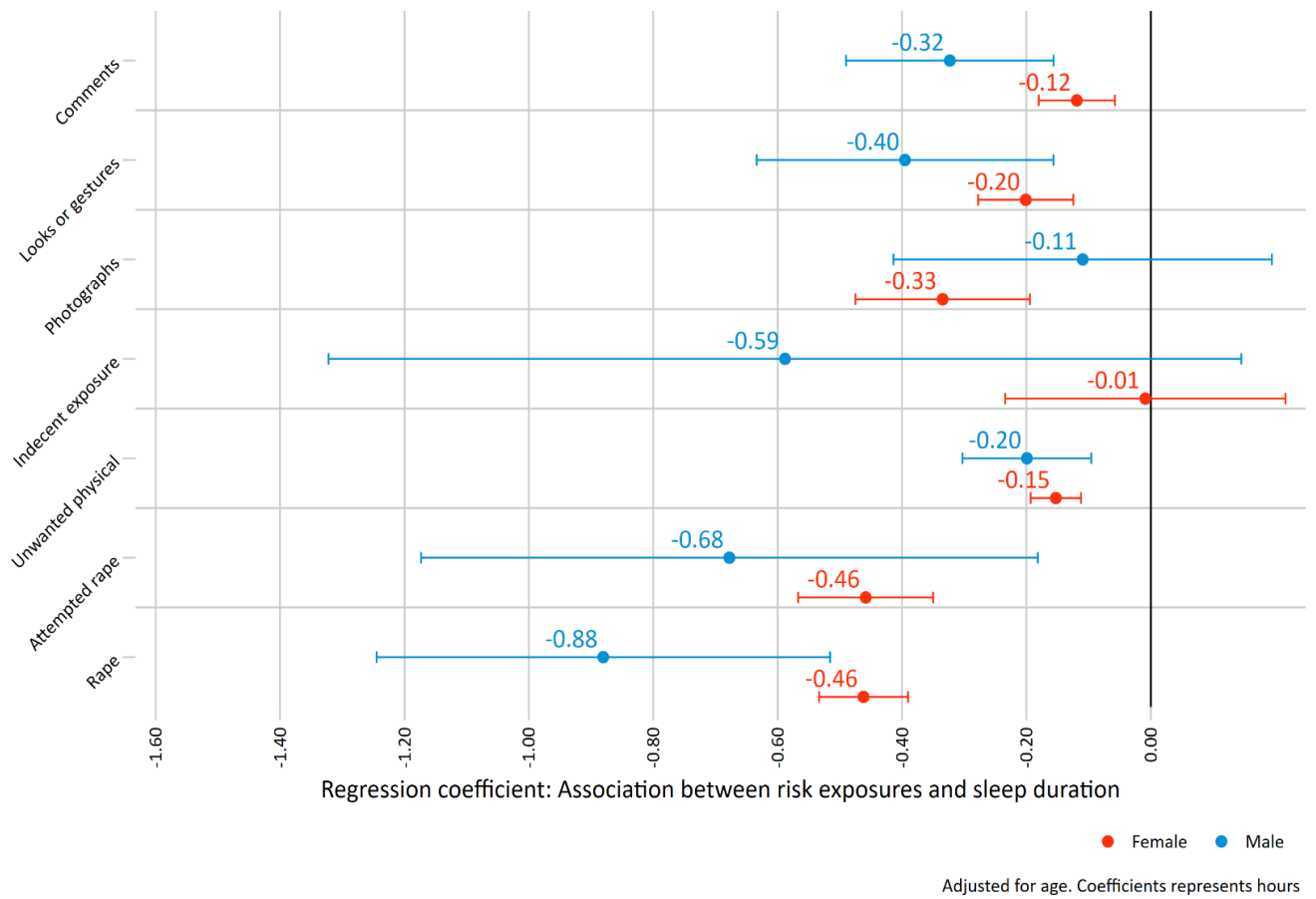


Figure 2: Association between separate risk factors and sleep duration. Linear regression models (Bars denote CI95%). N=47,152. Unstandardized coefficient (B) represents hours.

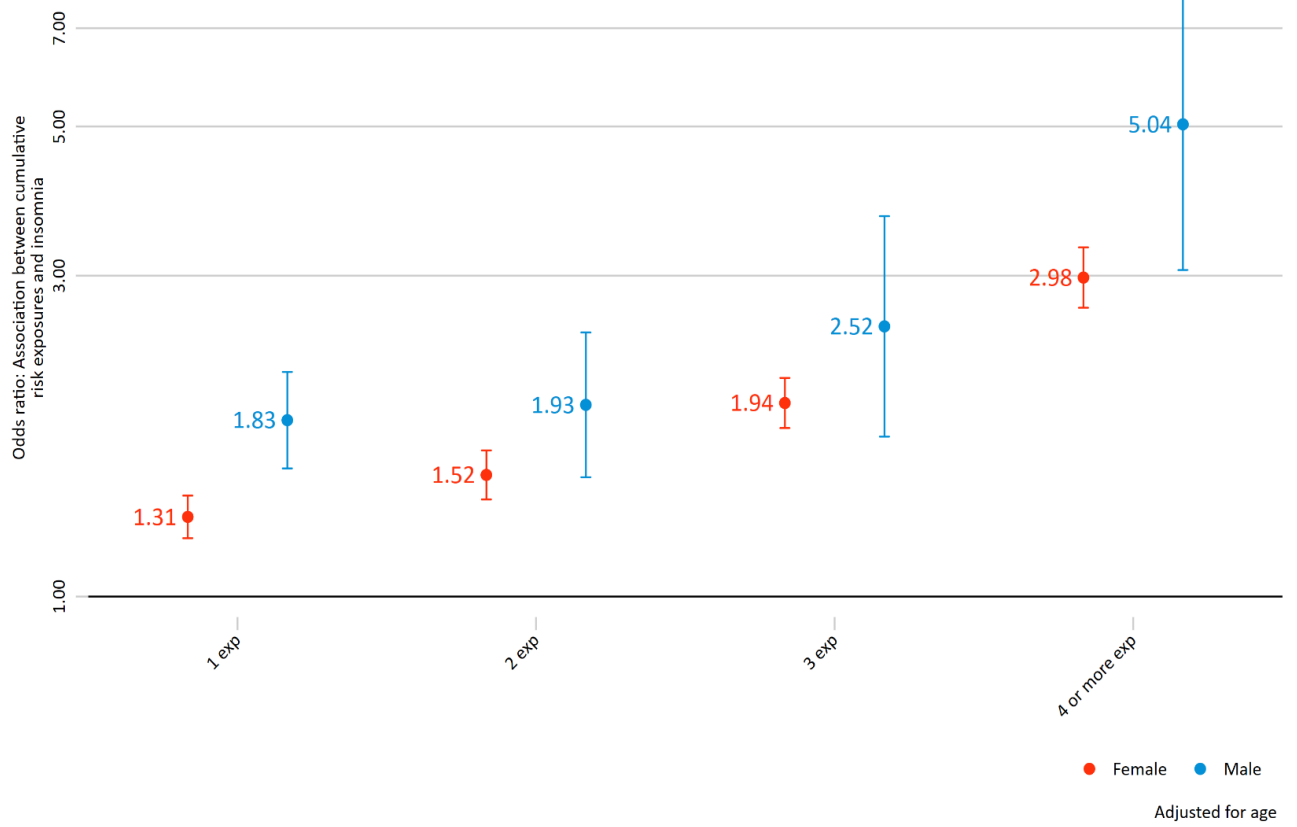


Figure 3: Association between cumulative risk factors and insomnia. Logistic regression models (Bars denote CI95%). N=47,152.

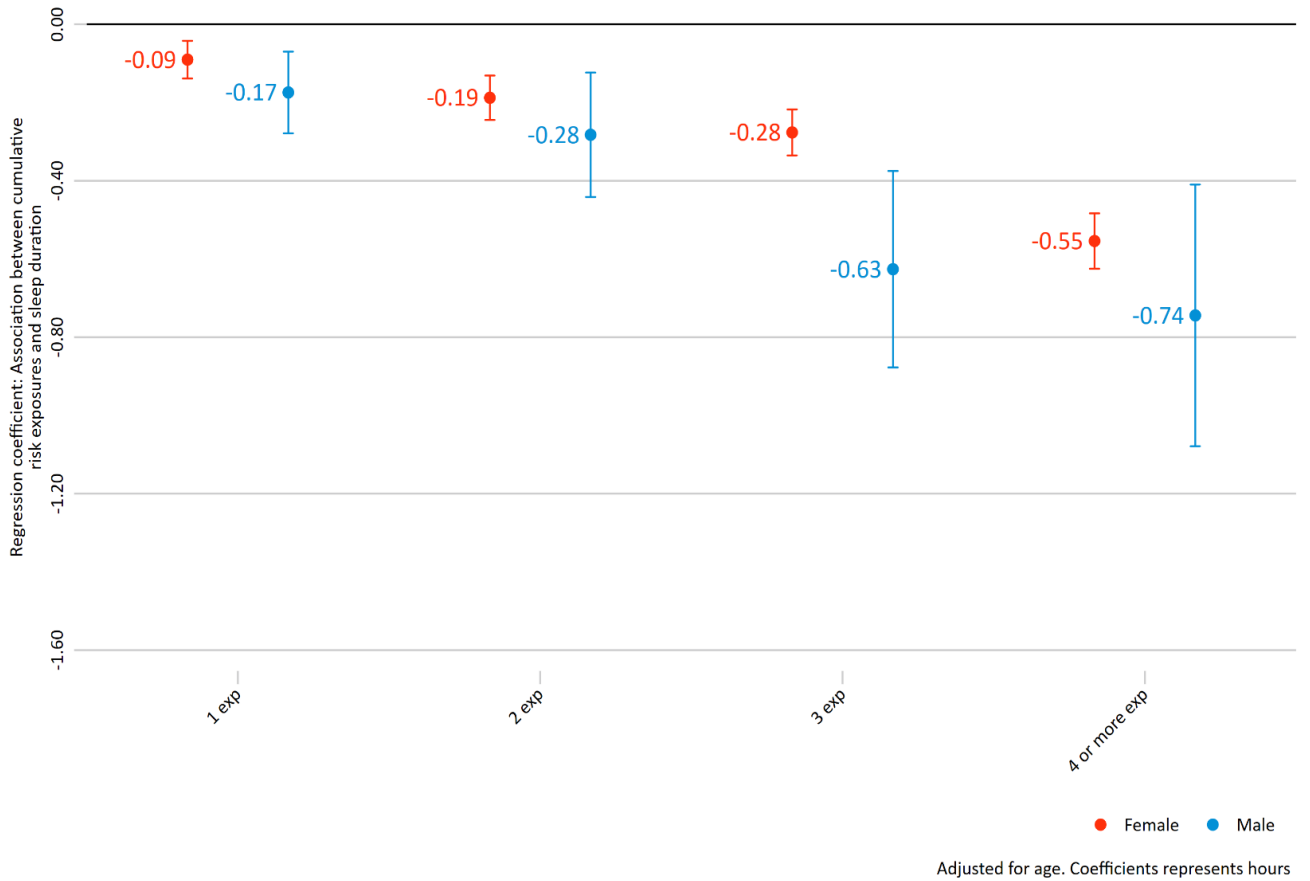
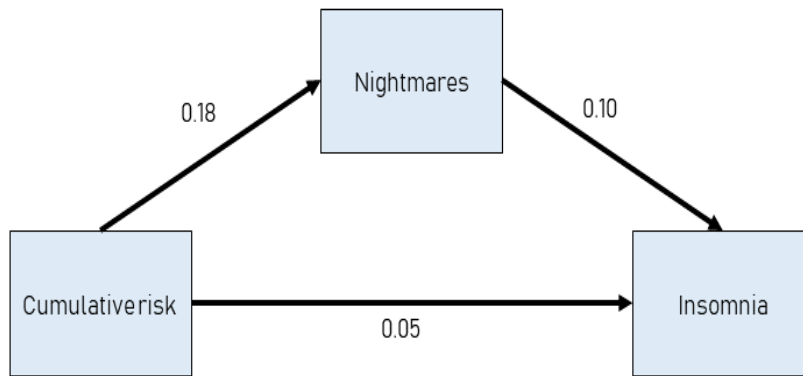
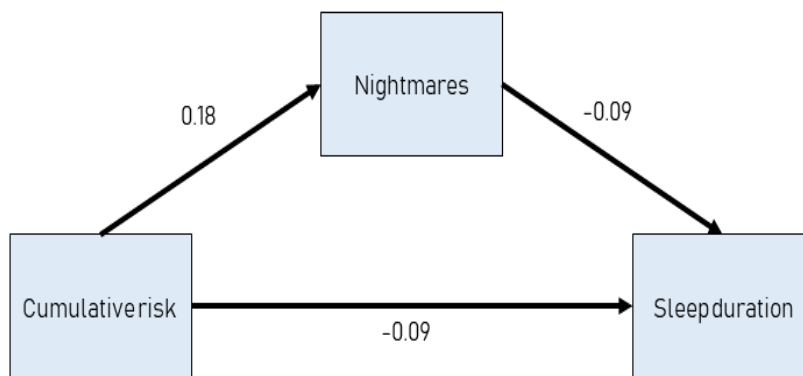


Figure 4: Association between cumulative risk factors and sleep duration. Linear regression models (Bars denote CI95%). N=47,152. Unstandardized coefficient (B) represents hours.



- Indirect/total effect ratio: 0.28
- Indirect/direct effect ratio: 0.39
- About 28% the association between cumulative risk and insomnia is mediated through nightmares.



- Indirect/total effect ratio: 0.15
- Indirect/direct effect ratio: 0.17
- About 15% the association between cumulative risk and sleep duration is mediated through nightmares.

Standardized path coefficients. All of the path coefficients of both models are significant at $p < 0.001$

Figure 5: Mediation analyses of cumulative risk factors, insomnia and sleep duration. Nightmares as mediator. Structural equation models, maximum likelihood estimation. N=47,152.

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