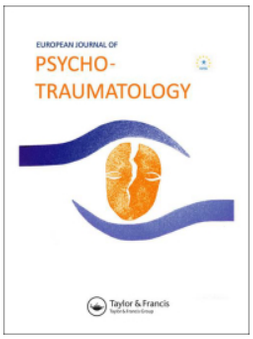

European Journal of Psychotraumatology

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/zept20

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To cite this article: Kate Porcheret, Synne Øien Stensland, Tore Wentzel-Larsen & Grete Dyb (2022) Insomnia in survivors 8.5 years after the Utøya Island terrorist attack: transition from late adolescence to early adulthood - the Utøya study, European Journal of Psychotraumatology, 13:1, 2020472, DOI: 10.1080/20008198.2021.2020472

To link to this article: https://doi.org/10.1080/20008198.2021.2020472

Published online: 26 Jan 2022.

EUROPEAN JOURNAL OF PSYCHOTRAUMATOLOGY
2022, VOL. 13, 2020472
https://doi.org/10.1080/20008198.2021.2020472

CLINICAL RESEARCH ARTICLE

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Insomnia in survivors 8.5 years after the Utøya Island terrorist attack: transition from late adolescence to early adulthood - the Utøya study

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ABSTRACT

Background: Insomnia is a global health concern, associated with many mental and physical health conditions. Prevalence of insomnia is reported to increase during adolescence and early adulthood. High levels of insomnia are also reported in adolescents up to 2.5 years after a traumatic event. What is less well understood is the prevalence of insomnia in a trauma exposed population transitioning from adolescence to adulthood.

Objective: To assess insomnia in the survivors in the 2011 Utøya Island terrorist attack, 2.5 years and 8.5 years after the attack when the majority of survivors were transitioning from late adolescence to early adulthood.

Method: Participants were 336 survivors of the Utøya Island attack who completed the Utøya Study 2.5 years (T3) and 8.5 years (T4) after the attack. Participants completed a face-to-face interview including the Bergen Insomnia Scale (BIS), which was used to assess insomnia symptoms and prevalence of meeting diagnostic criteria for insomnia.

Results: Insomnia was indicated in 47.7% of survivors 8.5 years after the attack. Insomnia prevalence did not significantly change from 2.5 to 8.5 years after the attack, though insomnia symptoms (BIS sum score) were found to increase. Age was negatively associated with insomnia at T4, with older age being associated with less insomnia. No significant sex difference was found in insomnia prevalence at T4.

Conclusion: Almost a decade after the Utøya Island terrorist attack, nearly a half of the young survivors in our study reported insomnia and typical age- and sex-related differences in sleep were not always seen. This rate is almost double what is reported in the general population (20–30%) indicating a high level of unmet need in this population. The implications of such sleep disruption during a critical time for physical, mental, social and cognitive development are far reaching.

Insomnio en sobrevivientes 8,5 años después del ataque terrorista en la isla de Utøya: transición de la adolescencia tardía a la adultez temprana - El estudio de Utøya

Antecedentes: el insomnio es un problema de salud mundial, asociado con muchas afecciones de salud mental y física. Se reporta que la prevalencia del insomnio aumenta durante la adolescencia y la edad adulta temprana. También se reportan niveles elevados de insomnio en adolescentes hasta 2,5 años después de un evento traumático. Lo que es menos comprendido es la prevalencia del insomnio en una población expuesta al trauma que pasa de la adolescencia a la edad adulta.

Objetivo: Evaluar el insomnio en los sobrevivientes del ataque terrorista de la isla de Utøya en 2011, 2.5 años y 8.5 años después del ataque, cuando la mayoría de los sobrevivientes pasaban de la adolescencia tardía a la adultez temprana.

Método: Los participantes fueron 336 supervivientes del ataque de la isla de Utøya que completaron el estudio de Utøya 2,5 años (T3) y 8,5 años (T4) después del ataque. Los participantes completaron una entrevista cara a cara que incluía la Escala de insomnio de Bergen (BIS), que se utilizó para evaluar los síntomas de insomnio y la prevalencia de cumplir con los criterios de diagnóstico para el insomnio.

Resultados: Se descubrió insomnio en el 47,7% de los supervivientes 8,5 años después del ataque. La prevalencia del insomnio no cambió significativamente de 2,5 a 8,5 años después del ataque, aunque se encontró que los síntomas de insomnio (puntuación suma BIS) aumentaron. La edad se asoció negativamente con el insomnio en T4, y la edad avanzada se asoció con menos insomnio. No se encontraron diferencias de sexo significativas en la prevalencia de insomnio en T4.

Conclusión: Casi una década después del ataque terrorista en la isla de Utøya, casi la mitad de los jóvenes supervivientes de nuestro estudio reportaron insomnio y no siempre se observaron

ARTICLE HISTORY

Received 26 October 2021
Revised 10 December 2021
Accepted 10 December 2021

KEYWORDS

Insomnia; adolescence; trauma; terrorism; young adulthood; sleep; Utøya study

PALABRAS CLAVE

Insomnio; Adolescencia; Trauma; Terrorismo; Adultez joven; Sueño; Estudio Utøya

关键词

失眠; 青春期; 创伤; 恐怖主义; 青年期; 睡眠; 于特岛研究

HIGHLIGHTS

- Almost a decade after the Utøya Island terrorist attack, nearly half of the survivors reported insomnia.
- Such high levels of insomnia, in mainly adolescents transitioning to early adulthood, have implications for normal development during this period.

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diferencias típicas en el sueño relacionadas con la edad y el sexo. Esta tasa es casi el doble de lo que se informa en la población general (20–30%), lo que indica un alto nivel de necesidad insatisfecha en esta población. Las implicaciones de tal interrupción del sueño durante un momento crítico para el desarrollo físico, mental, social y cognitivo son de gran alcance.

于特岛恐怖袭击事件发生 8.5 年后幸存者失眠:从青春期晚期到成年早期的过渡——于特岛研究

背景: 失眠是一个全球性的健康问题, 与许多精神和身体健康状况有关。据报道, 失眠的流行率在青春期和成年早期会增加。青少年在创伤事件后长达 2.5 年中也报告了很高程度的失眠。不太清楚的是, 从青春期过渡到成年期的创伤暴露人群中失眠的流行率。
目的: 评估 2011 年特岛恐怖袭击中幸存者在袭击发生后 2.5 年和 8.5 年的失眠情况, 当时大多数幸存者正从青春期晚期过渡到成年早期。
方法: 参与者是 336 名于特岛袭击事件的幸存者, 在袭击发生后 2.5 年 (T3) 和 8.5 年 (T4) 完成了于特岛研究。参与者完成了包括用于评估失眠症状和符合失眠诊断标准流行率的卑尔根失眠量表 (BIS) 在内的面对面访谈。
结果: 在袭击后 8.5 年, 47.7% 的幸存者表示失眠。尽管发现失眠症状 (BIS 总分) 有所增加, 但失眠流行率在发作后 2.5 至 8.5 年间没有显著变化。年龄与 T4 的失眠呈负相关, 年龄越大失眠越少。在 T4 时, 未发现失眠流行率的显著性别差异。
结论: 在于特岛恐怖袭击事件发生近十年后, 我们研究中近一半的年轻幸存者报告了失眠, 并不总是看到典型的年龄和性别相关的睡眠差异。这一比率几乎是一般人群 (20–30%) 报告的两倍, 表明该人群的需求未得到满足。在身体, 心理, 社交和认知发展的关键时期, 这种睡眠中断的影响是深远的。

1. Introduction

The disruption of normal sleeping patterns can impact on everyday functioning as well as impair physical and mental health (de Zambotti, Goldstone, Colrain, & Baker, 2018; Sivertsen et al., 2014). Adolescence and early adulthood is a particularly vulnerable time for sleep disruption. Sleep architecture, timing and duration all show developmental changes during adolescence and early adulthood: slow wave sleep decreases, sleep timings tend to get later and sleep duration gets shorter (Colrain & Baker, 2011; Keyes, Maslowsky, Hamilton, & Schulenberg, 2015). These changes stem from biological changes including delaying of the circadian clock (Roenneberg et al., 2004) and slowing of the homoeostatic sleep pressure (Jenni, Achermann, & Carskadon, 2005), as well as psychosocial factors such as more bedtime autonomy, access to technology in the evenings and continued early school start times (Carskadon, 2011; Crowley, Wolfson, Tarokh, & Carskadon, 2018). In the general population, 30.5% of late adolescents and young adults (18–25 years) were recently reported to meet criteria for insomnia (chronic sleep disruption) (Sivertsen et al., 2019), compared to 20% reported in middle to older adults (Sivertsen et al., 2021). However, lower rates have been reported in a younger age group: 18.5% of 16–18 year olds (Hysing, Pallesen, Stormark, Lundervold, & Sivertsen, 2013). Longitudinal assessment of sleep disturbance from the Bergen Child Study found rates of difficulties initiating or maintaining sleep (DIMS) increased from 8.5% in 7–9 year olds (parental report), 12.7% in 11–13 year olds (parental report) to 32.8% in 16–19 year olds (self-report) (Sivertsen, Harvey, Pallesen, & Hysing, 2017). Moreover, Hysing et al. (2020) found that insomnia increased from adolescence (20.2% at age 16–18 years) to early adulthood (28.0% at age 22–25 years). The stability of insomnia was also found to be high with 50% of individuals who had insomnia in adolescence continuing to do so in early adulthood. Although the rates of insomnia vary between these studies (likely due to different criteria for defining insomnia), they suggest not only high rates of insomnia but also an increase in prevalence during adolescence and into early adulthood. Furthermore, in all these studies, females were found to have a higher prevalence of insomnia than males (Hysing et al., 2020, 2013; Keyes et al., 2015; Sivertsen et al., 2017).

The impact of insomnia during adolescence and early adulthood is far reaching. As reported in adults, insomnia is associated with an increased risk of mental health problems, including: a reciprocal relationship with depression (Alvaro, Roberts, Harris, & Bruni, 2017; Roberts & Duong, 2013; Sivertsen, Harvey, Lundervold, & Hysing, 2014); an increased risk of suicidality, even after controlling for depression (Wong, Brower, & Craun, 2016); and increased substance use (Roane & Taylor, 2008; Sivertsen, Skogen, Jakobsen, & Hysing, 2015). Impaired cognitive functioning and academic performance have been associated with insomnia, with increased insomnia symptoms being associated with poorer executive functioning (Kuula et al., 2015) and memory performance (Schmidt, Richter, Gendolla, & Van der Linden, 2010), which are criterial during this intense learning period. Although not addressing insomnia per se, a meta-analysis has shown academic performance to be associated with both sleepiness, sleep quality and sleep duration (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). Insomnia is also associated with increased risk taking in adolescents (Catrett &

Gaultney, 2009; O'Brien & Mindell, 2005; Thomas, Monahan, Lukowski, & Cauffman, 2015). Although, it is currently not possible to determine the direction of this association, that is, if insomnia increases risk taking, or risk taking increases due to lack of sleep, this is especially concerning in terms of potential trauma exposure such as car accidents. Somatic health is also associated with insomnia, with higher somatic complaints being reported concurrently with insomnia (Zhang et al., 2012) as well as insomnia increasing the risk for future somatic complaints (Roberts, Roberts, & Duong, 2008). The long-term impact of insomnia during adolescence is less clear. Adolescent insomnia has been found to predict depression in early adulthood (Roane & Taylor, 2008) and impaired academic performance is likely to have an impact on future studies and work prospects.

Adolescence and early adulthood, is also a period of increased trauma exposure as a result of increasing independence (Meyer & Lee, 2019; Spear, 2000). Exposure to a traumatic event is a further trigger for the development of sleep disruptions. In the first months and years post-trauma, high rates of sleep disturbance have been reported in children and adolescents: for example, 77% of school children (n = 159) reported sleep disturbances 1 month (Pynoos, Nader, Frederick, Gonda, & Stuber, 1987) and 58% 14 months after witnessing a sniper attack (Nader et al., 1990). In a small sample (n = 42) of survivors of the 2011 Utøya Island terrorist attack, sleep disturbance was been reported by 52.3% of the adolescent survivors compared to 13.6% in matched controls, two years following the attack (Grønli et al., 2017). Longitudinal assessment of sleep disturbance in adolescents post-trauma have largely followed survivors of natural disasters. Generally, rates of insomnia are somewhat lower than following acts of mass violence, as previously reported, and remain relatively stable or decrease over time post-trauma. Three months following the 2013 Lushan earthquake, China, 52% of survivors reported sleep disturbance, which decreased to 40% at 6 months (Zhang, Zhang, Ren, & Tang, 2020). Geng et al. (2019) reported rates of sleep disturbance decreasing slightly 12 to 18 months after the 2008 Wenchuan earthquake (29.4% and 23.5% respectively), then remaining stable 24 months post-trauma (23.5%). While Fan and colleagues reported only a very slight decrease following the same earthquake: 38.3% at 12 months and 37.5% at 24 months (Fan, Zhou, & Liu, 2017). Finally, a recent trajectory analysis assessing sleep disturbance 1, 1.5, 2 and 2.5 years after the Wenchuan earthquake identified five trajectories in a trauma exposed adolescent population (Zhou, Zhen, & Wu, 2019). The majority of survivors showed stable sleep disturbance over this 2.5 year span, with 68% having little sleep disturbance throughout and 10.8% consistently high levels of sleep disturbance. Of the remaining participants, 8.7% showed a decrease, 8.7% showed an increase and 3.8% a U-shaped pattern. Within these studies, sex differences were only assessed by Zheng and colleagues, but again a higher prevalence was found in girls than boys (Zhang et al., 2020). In all studies where the association between sleep and posttraumatic symptomatology was directly assessed, insomnia or sleep disturbance was associated with higher rates of posttraumatic stress disorder (PTSD) or PTSD symptomatology (Fan et al., 2017; Geng et al., 2019; Grønli et al., 2017). In most cases of longitudinal analysis, insomnia predicted later PTSD (Fan et al., 2017; Geng et al., 2019; Zhang et al., 2020).

What remains to be explored is what happens during the transition to early adulthood. The aim of this study was to assess the long-term impact of trauma exposure on insomnia in the survivors of the 2011 terrorist attack on Utøya Island, Norway. The survivors of the attack were largely adolescents at the time of the attack and have been followed over 8.5 years as they have transitioned into early adulthood. Specifically, we aimed to: 1) investigate insomnia in survivors 2.5 and 8.5 years following the Utøya Island attack; 2) explore sex differences in insomnia in this population and 3) investigate the change in insomnia from 2.5 years to 8.5 years since the attack relating to both age and time since the attack.

2. Method

2.1. Participants

Participants were survivors who participated in the Utøya Study: an ongoing longitudinal study following the survivors of the 2011 mass shooting terrorist attack on Utøya Island, Norway (Glad, Stensland, & Dyb, 2021). On 22 July 2011, 564 people were present on Utøya Island during a mass shooting, 69 people were killed and 33 people were severely wounded. In addition, 7 participants who were returning to the island, and witnessed the attack from the mainland, were also invited to join the Utøya Study. All survivors of the attack were highly exposed to the attack, and most lost friends, family or a partner (Dyb et al., 2014; Glad et al., 2021). At the time of the attack, participants were mainly adolescents and young adults (range 13 to 57 years, mean = 19.2, SD = 4.3) and have previously been shown to be socio-demographically comparable to age-matched controls taken from the Young HUNT3 study (https://www.ntnu.edu/hunt), a Norwegian population-based general health study (Stensland, Zwart, Wentzel-Larsen, & Dyb, 2018). In this study survivors who were adolescents or young adults (≤30 years of age) at the time of the attack were included in the analysis.

2.2. Procedure

All survivors who remained in Norway following the attack were invited to join the Utøya Study (n = 502) 4–5 months (T1) and 14–15 months (T2) after the attack. All participants from T1 and T2 (n = 362) were invited to participate 31–32 months after the attack (T3, n = 266, 53% of original population of survivors). The full cohort

(n = 502) was then re-invited to participate 8.5 years after the attack (T4, n = 289, 58%). At each time point participants were interviewed face to face by trained personnel. Participants at T3 or T4, who were assessed for insomnia symptoms using the Bergen Insomnia Scale (Pallesen et al., 2008), were included in the analysis for this study. Ten participants were excluded from the analysis as they were over 30 years of age at the time of the attack. Two additional participants were excluded as they sustained mild traumatic brain injury (TBI) during the attack, which is associated with an increased risk of insomnia (Zhou & Greenwald, 2018). Thus, 336 participants were included in the analysis of present study.

The study was approved by the Norwegian Regional Committee for Medical and Health Research Ethics in Norway (document 551224, 2011/1625, 2014/246). Written informed consent was obtained at each time point, with parents providing consent for participants aged under 16 years old. At the end of each interview, the survivor's current needs for health services were assessed and interviewers provided help in contacting the appropriated resources if required.

2.3. Measures

Bergen Insomnia Scale (BIS) (Pallesen et al., 2008) was used to assess insomnia symptoms at T3 and T4. The BIS has been validated against subjective and polysomnographic data and shows good psychometric properties. In this study the BIS showed good internal consistency with Cronbach alphas of 0.82 and 0.84 for T3 and T4 respectively, which are consistent with those previously reported (Pallesen et al., 2008). The BIS consists of six items assessing DSM-IV (American Psychiatric Association [APA], 1994) criteria for insomnia disorder: 4 items assess criterion A (item 1) prolonged sleep onset, 2) difficulties maintaining sleep, 3) early morning awakening and 4) non-restorative sleep and 2 items assess criterion B 5) daytime sleepiness and 6) dissatisfaction with sleep. Participants were asked to report the number of days per week (0–7) they experienced each sleep problem for the past month. An additional item was included at T4 assessing the duration of symptoms in coherence with the added DSM-5 (APA, 2013) minimum requirement of insomnia symptoms to be present for at least 3 months (Sivertsen et al., 2021).

BIS sum score was calculated of items 1 to 6, range 0–42. The duration of symptoms item was not included. The half rule was applied to missing data where at least half the items must be present for the score to be calculated. In our sample the majority of participants had no missing data, with only 6 participants having one item missing.

Insomnia was defined as being present if participants reported: i) one or more criteria A symptom at least 3 nights per week, and ii) one or both criteria B symptom at least 3 nights per week during the past month. *Insomnia of at least 1 month* was defined as the presence of insomnia for at least one month and was measured at T3 and T4. *Insomnia of at least 3 months* was defined as meeting these criteria for 3 months or more and was only measured at T4.

2.3.1. Demographics and background measures

Age and sex at the time of the attack were determined from social security numbers. Non-Norwegian immigration background was defined as having both parents born outside of Norway. Low economic status at the time of the attack was based on self-reported family economy being below average (compared to average or above average) in the first 4–15 months after the attack (i.e. at T1 and T2). At T2 and T3 participants were asked to self-report on physical and sexual abuse prior to the terror attack. For participants who completed T1, T2 and T3, severe injury during the attack was defined as requiring hospitalization which was determined by access to hospital records from Vestre Viken and Oslo University hospitals, the two hospitals survivors were taken to after the attack (Bugge et al., 2017; Gaarder et al., 2012; Jorgensen, Naess, & Gaarder, 2016).

2.4. Data analysis

Group comparisons were performed using ANOVA or Chi-square tests. Linear mixed-effects models were used to assess differences in BIS sum score over time and between sexes. Linear regression models were used to assess the association between BIS sum score and age. Prevalence of participants meeting criteria for insomnia were analysed using Chi-squared tests: Pearson's Chi-squared was used for sex comparisons; McNemar's Chi-squared for change over time from T3 to T4. Since the McNemar test only included participants who completed both T3 and T4, this subgroup was compared on socio-demographic background variables to the rest of the population. The prevalence of insomnia in the present sample was compared with the prevalence of 30.5% in the general population reported in Sivertsen et al. (2019) by inverting Blaker confidence intervals (Blaker, 2000). Comparisons were performed both at T3 and T4 for for insomnia of at least 1 month and 3 months duration at T4. Blaker confidence intervals are more reliable than confidence intervals from a normal approximation for high degrees of confidence in samples of small or moderate sizes. Logistic regression models were used to assess the association between insomnia prevalence and age. Descriptive data are presented as mean and standard deviation or count and percentage unless stated. Statistical analysis was performed using R (version 3.4.4), with the R package nlme for mixed-effects models and BlakerCI for Blaker confidence intervals, and SPSS (version 27) for Chi-squared tests.

3. Results

3.1. Sample characteristics

The sample included in the present study comprised 336 individuals, which represented 67% of the survivors who were invited to join the Utøya study and 85% of the survivors who took part in at least one time point. Two hundred individuals completed both T3 and T4 and 136 completed one study wave (only T3 n = 56, only T4 n = 80). At the time of the attack the survivors where on average 19 years old (Table 1; min = 13.32 yrs, max = 29.61 yrs; 75.0% 19 yrs or younger; 20.5% 20 to 24 yrs; 4.5% 25 to 29 yrs). At T3, the survivors were on average 22 years old (min = 16.03 yrs, max = 32.26 yrs; 32.4% 19 yrs or younger; 55.9% 20 to 24 yrs; 9.4% 25 to 29 yrs; 2.3% 30–34 yrs) and 27 years old at T4 (min = 21.66 yrs, max = 38.01 yrs; 17.1% 20 to 24 yrs; 68.9% 25 to 29 yrs; 11.4% 30 to 34 yrs; 2.5% 35 yrs and older). Approximately half the participants were female (47–51%). The majority of participants were of Norwegian origin, with 5–8% of participants having both parents born outside of Norway. Approximately a fifth of participants (18–19%) had a below average family economic status at the time of the attack. Exposure to physical violence prior to the attack was reported by 14–19% of participants and 4–7% reported prior exposure to sexual violence. Following the attack 5–6% of the participants sustained injuries requiring hospitalization.

Participants who completed both T3 and T4 (n = 200) were compared on sociodemographic background variables to the rest of the survivors who completed only T3 or T4. Only immigration background differed significantly between the groups: more participants had both parents born outside of Norway, who did not complete both T3 and T4 (Only T3 or T4: n = 17, 12.7%; Both T3 and T4: n = 10, 5.0%; Pearson Chi-Square p = .014).

3.2. Prevalence of insomnia symptoms

A higher BIS sum score was reported by participants at T4 (mean = 15.95, SD = 9.95) compared to T3 (mean = 13.99, SD = 9.11). Higher levels were also reported by females compared to males at both T3 and T4 (Figure 1(a) and Table 2). A linear mixed-effects model showed these differences in BIS sum score to be statistically significant for time (time difference estimate = 1.36, CI = 0.19–2.53, p = .023) and sex (sex difference estimate = 3.08, CI = 1.21–4.96, p = .001). A time, sex interaction was included in an additional linear mixed effects model, but was not found to be statistically significant (p = .254).

Overall 53.9% (n = 137) of participants at T3 and 59.9% (n = 167) at T4 met criteria for insomnia of at least 1 month duration (Figure 1(b) and Table 2). A McNemar test showed no significant difference in insomnia prevalence between T3 and T4 for participants who completed both T3 and T4 (p = .222). At T4 47.7% (n = 133) of the 167 participants reported insomnia of at least 3 months duration. Of these participants the majority reported having symptoms for 1 year or more (91.0%, n = 121) and 71.4% (n = 95) for 6 years or more. For participants who completed both T3 and T4, 38.7% (n = 77) met criteria for insomnia of at least 1 month at both T3 and T4, 19.6% (n = 39) only met criteria at T4 and 14.1% (n = 28) only at T3. About one in four participants (27.6%, n = 55) did not meet insomnia criteria at either time point (Figure 1(c)).

Prevalence of meeting insomnia of at least 1 month criteria was higher for females than males at T3 and T4 (Figure 1(b) and Table 2): Pearson Chi-square T3 p = .043, OR for sex = 1.71, CI = 1.04–2.82; T4 p = .028, OR for sex = 1.76, CI = 1.09–2.85. However, prevalence of insomnia of at least 3 months duration at T4 was not significantly different between females and males (Pearson Chi-square p = .281, OR for sex = 1.32, CI = 0.83–2.12).

To allow a more direct comparison to the prevalence of insomnia reported in 18–25 year olds in the general population by Sivertsen et al. (2019), prevalences of insomnia were calculated for 18–25 year olds within this study along with Blaker confidence intervals (Blaker, 2000). The prevalence of insomnia for 18–25 year olds was 54.3% at T3 (99.9% confidence interval 43.2% to 65.0%), and at T4 66.5% for insomnia of at least 1 month duration (99.9% confidence interval 50.9% to 79.6%), and 53.1% for insomnia of at least 3 months duration (99.9% confidence interval 37.7% to 68.2%). Since the population prevalence of 30.5% reported by Sivertsen et al. (2019) was outside all these confidence

Table 1. Sample characteristics.

	Participants taking part at T3 (n = 256)			Participants taking part at T4 (n = 280)			Participants taking part in T3 and T4 (n = 200)		
	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*	*n*
Age at time of attack	18.8	2.9	256	18.8	2.8	280	19.0	3.0	200
Age at time of data collection	21.6	2.9	256	27.2	2.8	280			
	Count	%	*n*	Count	%	*n*	Count	%	*n*
Sex: female	120	46.9	256	143	51.1	280	101	50.5	200
Immigration background: both parents born abroad	21	8.3	254	16	5.7	280	10	5.0	200
Economy at the time of the attack: below average	49	19.6	250	44	18.6	237	35	18.0	194
Exposure to physical violence prior to the attack	47	18.8	250	36	14.1	256	33	16.8	197
Exposure to sexual violence prior to the attack	16	6.5	247	11	4.2	261	11	5.7	193
Injury during attack requiring hospitalization	14	5.5	256	13	4.6	280	9	4.5	200

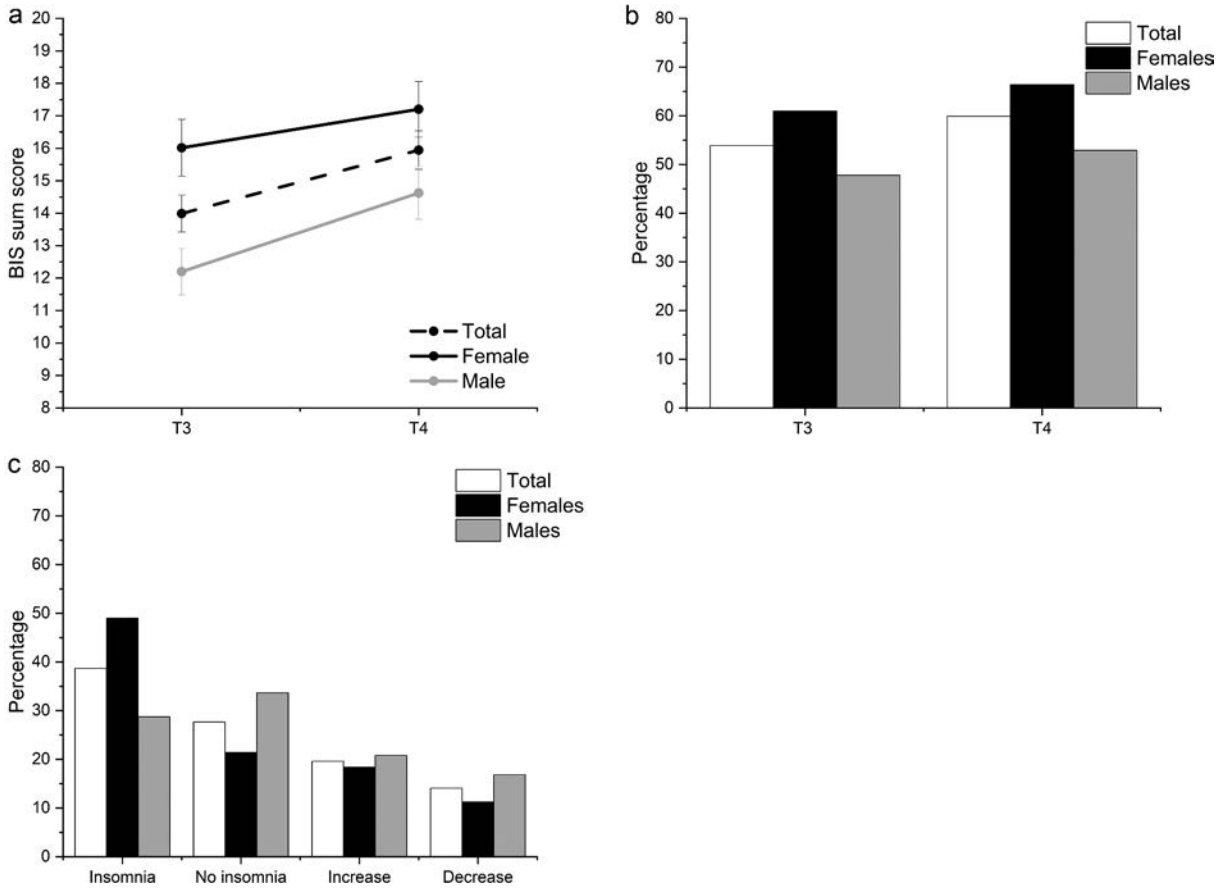

Figure 1. Insomnia symptoms and prevalence. (a) Insomnia symptoms (BIS sum score) reported by all participants who participated (total – dashed black), females (solid black) and males (solid grey) at T3 and T4. Data represent mean scores and error bars represent standard error of the mean. (b) Percentage of participants who met criteria for insomnia for at least one month duration at T3 and T4. Data is reported for total population (white), females (black) and males (grey). (c) Stability of insomnia of at least one month duration prevalence. Insomnia: percentage of participants who had met criteria for insomnia at T3 and T4. No insomnia: percentage of participants whodid not meet insomnia criteria at T3 and T4. Increase: percentage of participants who did not meet insomnia criteria at T3, but did at T4. Decrease: percentage of participants who met insomnia criteria at T3, but not at T4. Data is reported for total population (white), females (black) and males (grey).

Table 2. Insomnia symptoms and prevalence.

							Females						Males					
	T3			T4			T3			T4			T3			T4		
	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*	*n*	Mean	*SD*	*n*
BIS sum score	14.0	9.1	256	16.0	10.0	279	16.0	9.6	120	17.2	10.2	143	12.2	8.3	136	14.6	9.5	136
	Count	%		Count	%		Count	%		Count	%		Count	%		Count	%	
No insomnia diagnosis	117	46.1		112	40.1		46	39.0		48	33.6		71	52.2		64	47.1	
Probable insomnia	137	53.9		167	59.9		72	61.0		95	66.4		65	47.8		72	52.9	
Insomnia of 1 to 3 months				*34*	*12.2*					*22*	*15.4*					*12*	*8.8*	
Insomnia of at least 3 months				*133*	*47.7*					*73*	*51.0*					*60*	*44.1*	

intervals, prevalences in the present sample were considered as significantly higher ($p < .001$).

3.3. Insomnia symptoms with age

Linear regression models showed age was not significantly associated with the BIS sum score at T3 (Coefficient estimate = −0.21, CI = −0.60–0.18, p = .289). Results from logistic regression models also showed age was not significantly associated with the prevalence of insomnia of at least 1 month (OR = 0.93, CI = 0.85–1.01, p = .092) at this time point. However, at T4 contrary to what has been reported in the general population, a significant negative association was found (Coefficient estimate = −0.44, CI = −0.85–0.02, p = .038): the older a participant the lower the BIS sum score. This finding was supported by results from logistic regression analyses at T4 where higher age was significantly related to lower risk estimate of both insomnia of at least 1 month duration (OR = 0.89, CI = 0.81–0.97, p = .008) and at least 3 months (OR = 0.89, CI = 0.81–0.97, p = .008).

4. Discussion

Almost a decade after the Utøya Island terrorist attack nearly half of the young survivors in our study reported insomnia and a third reported having a problem with their sleep for at least 6 years. This study extends previous research by following survivors of trauma from primarily late adolescence to young adulthood over an 8.5 year time span. Results indicate that the typical patterns of insomnia related to age and sex during this transition period reported in the general population seem to be disturbed. Overall, these findings indicate that exposure to a single traumatic event at early age can have a long lasting impact on sleep, during a critical time for physical, mental, social and cognitive development.

In our population 47.7–59.8% of participants reported insomnia up to 8.5 years after attack. Rates varied depending on the criteria being used and the time since trauma: with insomnia of at least a 3 month duration being lower and the highest rate being 8.5 years after attack for insomnia of at least 1 month. Even considering the lowest rate reported, these rates are much higher than those reported in the general population. Using the same scale as the present study (the Bergen Insomnia Scale) and the same definition of insomnia of at least a 3 month duration as used at T4, Sivertsen et al. (2021) reported 20% of a middle to older adult population met criteria for insomnia. In adolescents, insomnia has been reported in 18.5–32.8% of the population (Hysing et al., 2020, 2013; Sivertsen et al., 2017) and in young adults (25 yrs or under) 28.0–30.5% (Hysing et al., 2020; Sivertsen et al., 2019). Methodologically these studies differ from the present study by using different scales. However, Sivertsen et al. (2017, 2019) used the same definition of insomnia of at least a 3 month duration in both of their studies and Hysing et al. (2020, 2013) used a similar definition but only included night time symptoms and not daytime symptoms. Moreover, we found the prevalence of 30.5% reported in the general population by Sivertsen et al. (2019) was outside the Blaker confidence intervals for participants within the same age range in our study. Thus, we can be reasonably confident that the prevalences of insomnia reported by the survivors of the Utøya Island attack are higher than would be expected in the general population. Future research should nevertheless aim to directly compare between different populations.

Compared to other trauma exposed adolescent populations, these rates are also on the higher side which range from 18.0% to 56.3% (Fan et al., 2017; Geng et al., 2019; Grønli et al., 2017; Nader et al., 1990; Zhang et al., 2020), which is particularly troubling since previous studies have assessed insomnia in only the first year or two post-trauma. In the most comparable study assessing sleep in a small sample (n = 42) of the survivors of the Utøya Island attack, insomnia was again assessed using the Bergen Insomnia Scale and was reported in 56.3% of the survivors 2 years after the attack (Grønli et al., 2017). It is therefore concerning that in our population, these high rates of insomnia are still being reported 8.5 years after the attack.

Previous studies have reported that in trauma-exposed adolescent populations, rates of insomnia tend to remain constant or decline over time (Fan et al., 2017; Geng et al., 2019; Nader et al., 1990; Zhang et al., 2020). However, in the general population rates of insomnia have been found to increase during adolescence and into early adulthood. Within the current study, our population is subject to both the passage of time since the trauma and increasing age from adolescence to early adulthood. In terms of time since trauma, we found that rates of insomnia remained high over the 6 year period studied and suggest that levels of insomnia symptoms may even have increased with a higher BIS sum score seen at T4 compared to T3. Moreover at T4, 34% of participants met criteria for insomnia and reported having symptoms for 6 years or more. These findings suggest that within this population a process of recovery is not being seen and to the contrary indicates the persistence of insomnia and possibly even an increase of symptom burden. To date only one study has reported the levels of insomnia symptoms in adolescents over time post trauma. Zhou et al. (2019) reported mean scores on three items from the Pittsburgh Sleep Quality Index (PSQI) 1, 1.5, 2 and 2.5 years in adolescents exposed to the Wenchuan earthquake. Mean scores were found to fluctuate over time but an overall decrease was seen from 1 year to 2.5 years after the earthquake, however, this change was not statistically tested. The increase in insomnia symptoms in the current study is a worrying trend.

As for the influence of age in our population, we found that age was not significantly associated with insomnia at T3, while at T4 age was associated with a decrease in insomnia: the older a participant the lower the odds of meeting criteria for insomnia and the less insomnia symptoms (lower BIS sum score). This is the opposite of what has previously been shown in the general population, where rates of insomnia have been found to be higher in early adulthood compared to late adolescence (Hysing 20). Although it is not possible to fully disentangle the effects of time since trauma and age in our study, age does not appear to be having the same influence on rates of insomnia as in the general population. Thus, the sustained high rates of insomnia reported by this population are unlikely to be driven by the increasing age of the population. The negative association with age at T4, however could indicate that survivors who were younger at the time of the attack were more susceptible to long-term sleep disturbance. Alternatively, this association at T4, could reflect that our population at this time point is beginning to transition out of early adulthood. Future research is needed to investigate the predictive factors for long-term insomnia post trauma.

Higher levels of insomnia have been consistently reported in females, after pubertal onset (Hysing et al.,

2020, 2013; Sivertsen et al., 2017, 2021). In the current study, we also found that females had more insomnia symptoms (higher BIS sum score) and a higher prevalence of insomnia of one month duration at T3 and T4. However, we found no statistically significant difference between the sexes in prevalence of insomnia, lasting for three months or more at T4. Since defining insomnia with a duration of at least three months is more in line with the most up-to-date definition of insomnia, we take this to be a more reliable marker of insomnia prevalence, which unfortunately cannot be determined at T3. Our findings of no significant difference in insomnia prevalence between males and females at T4, initially appears contrary to what is seen in both the general population and in trauma-exposed populations. However, we need to treat this finding with caution since the odds ratios and confidence intervals for the sex differences between insomnia of at least one month and of at least three months at T4 overlap considerably. Nevertheless, sex differences in insomnia prevalence post trauma should continue to be explored in future research. Sex differences in the general population have been linked to hormonal differences, with higher rates of insomnia in females seen particularly during puberty, pregnancy, and menopause, and could also be related to the way men and women report symptoms (Mallampalli & Carter, 2014). There is a possibility that neither of these factors are as influential in our trauma-exposed population. Another explanation could be that our population have a particularly chronic form of insomnia, which could be less influenced by sex differences. At T4, of the individuals meeting criteria for insomnia of at least three months duration in our population, 75% reported experiencing symptoms for over 6 years, suggesting a large proportion of the survivors could be experiencing recurring episodes of insomnia. Findings from the general population are limited and mixed. Recurring insomnia has been reported to be higher in adolescent (Luo, Zhang, & Pan, 2013) and older adult (Suh et al., 2013) females, however Ellis, Perlis, Neale, Espie, and Bastien (2012) found males to have a slightly higher prevalence of recurrent insomnia in a broader adult population. Thus, the chronicity of the insomnia experienced by this population could dampen the generally reported sex differences seen in the general population. Moreover, it is possible that other factors known be associated with insomnia, such as depression and other sleep disorders, could underlie the higher than expected levels of persistent insomnia in males in this population at T4, which again should be explored in future studies.

4.1. Methodological considerations

The strengths of the present study include the homogeneity of the population relating to the level of trauma exposure and the good retention rate of participants over 8.5 years. However, the generalizability of some findings could also be affected by the homogeneity of the population. The sample that completed both T3 and T4 were under represented by survivors with both parents born outside Norway. However, only the comparison of insomnia prevalence between T3 and T4 was assessed using this subgroup, so it is unlikely to have much bearing on most of the findings of this study. Previous studies have shown this is common within this population, where survivors of first generation immigrants to Norway are less likely to remain in the study (Stene & Dyb, 2015). The lack of a direct control group within this study is a limitation. However, we have compared our key findings relating to the prevalence of insomnia to primarily very large population based studies using the same or very similar methodologies for assessing insomnia, and compared prevalences with participants within the same age range. Another consideration is the use of the Bergen Insomnia Scale for the assessment of insomnia. The Bergen Insomnia Scale is well validated with good psychometric properties, however it was originally constructed based on the DSM-IV diagnostic criteria for insomnia which placed less emphasis on dissatisfaction with sleep quantity or quality. It therefore could be expected that the rates of insomnia reported in this study are higher than those assessed with the fully revised DSM-5 criteria. However, within this study comparisons to the general population where made primarily to studies also using the Bergen Insomnia Scale, making these comparisons still valid and the rates of insomnia reported still much higher relatively than those reported in the general population based on this scale. The prevalence of insomnia in this study could also be influenced by other factors or conditions which could preclude a diagnosis of insomnia, such as another sleep disorder, medication or co-morbid mental health symptoms, which were not addressed here. Future studies should aim to investigate associations between these factors and rates of insomnia in such populations.

4.2. Clinical importance

The high rates of insomnia reported in this population indicate a considerable level of unmet need. The importance of good sleep in the aftermath of a traumatic event is vital not only for day to day functioning but also for the potential amelioration of long-term consequences. This is compounded in an adolescent and young adult population where the impact of poor sleep can be felt during such a critical period for physical, mental, social and cognitive development. Thus, targeting poor sleep may importantly reduce long-term symptom burden, yet to date, there are no clinical trials for the use of sleep interventions in trauma-exposed populations. In addition, sleep targeted interventions are increasingly being shown to improve other symptoms such as depression (Taylor & Pruiksma,

2014) and PTSD (Ho, Chan, & Tang, 2016), providing a potentially added benefit to improving sleep post trauma. Considering the need for evidence-based interventions post-trauma, sleep could offer a much needed target for the wellbeing of individuals post-trauma.

Acknowledgments

We wish to thank all the participants for taking part in the study. We also thank Ingebjørg Lingaas, Andrea Undset and Hilde Michelsen for their coordination of the Utøya study at T4.

Data availability statement

The data that support the findings of this study can be available on request from the corresponding author, [Kate Porcheret]. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Norwegian Centre for Violence and Traumatic Stress Studies, the Norwegian Directorate of Health; and Kate Porcheret is supported by the European Union's Horizon 2020 research and innovation programme under the [Marie Skłodowska-Curie grant agreement No. 801133].

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