

Parental separation and parental mental health in childhood and risk of insomnia in adulthood among patients with tinnitus

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Short title

Parental mental health and insomnia in tinnitus

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Abbreviations

BSA	British Society of Audiology
CBT	Cognitive behavioral therapy
CI	Confidence interval
ISI	Insomnia severity index
OR	Odds ratio
NHS	National Health Service
RRR	Relative risk ratio
SD	Standard deviation
ULLmin	Average ULL over 0.25, 0.5, 1, 2, 4 and 8 kHz for the ear with the lower average ULL

Abstract

Objectives: To explore whether parental separation and parental mental health during childhood are related to the severity of insomnia among patients with tinnitus and/or hyperacusis seen in an Audiology clinic.

Design: This was a retrospective cross-sectional study.

Study Sample: One hundred and seventy four consecutive patients who attended a tinnitus/hyperacusis clinic in the UK were included.

Results: Sixteen percent of patients (27/174) reported that during the first 18 years of life their parents were separated or divorced and 41% (72/174) reported that their parent(s) suffered from a mental illness. The mean score for the insomnia severity index (ISI) was not significantly affected by parental separation or divorce. However, the mean ISI score was significantly worse for patients whose parents had a mental illness. A multinomial logistic regression model, adjusted for the presence of hyperacusis, hearing loss, age and gender, indicated that, for individuals experiencing tinnitus, a history of parental mental illness during their childhood increased the chance of severe insomnia by a factor of 3.4 (95% confidence interval: 1.1 to 10.8, $p = 0.04$). The risk of having severe insomnia was 3.8 times greater for patients with hyperacusis than for those without.

Conclusions: Among patients seeking help for tinnitus/hyperacusis, poor parental mental health was associated with severe insomnia.

Key Words: tinnitus, insomnia, mental health, childhood experience

Introduction

Tinnitus is the sensation of sound without any external sound source. The relationship between the severity of tinnitus and sleep disturbances has been highlighted by several authors (Meikle et al. 1984; Tyler & Baker 1983; Folmer & Griest 2000; Cronlein et al. 2016; Schecklmann et al. 2015). Recent studies suggest that over 70% of patients seeking help for tinnitus from a specialized audiology clinic within the UK National Health Service (NHS) also had insomnia (Aazh et al. 2017; Aazh & Moore 2017a; Aazh et al. 2016; Aazh & Moore 2019). It has been reported that the emotional and cognitive distress caused by tinnitus has a significant relationship with the severity of sleep disturbances (Cronlein et al. 2016). It also has been reported that among patients seeking help for tinnitus, depressive symptoms are significantly associated with the severity of insomnia (Aazh et al. 2017; Aazh & Moore 2019).

Research studies in the field of psychiatry suggest that adverse childhood experiences influence the way that individuals respond to stress later in life (Anda et al. 2010; Anda et al. 2008a; Anda et al. 2007; Anda et al. 2008b; Anda et al. 1999). Parental separation and parental poor mental health are important forms of adverse childhood experiences, with prevalence rates of 23% and 19%, respectively (Anda et al. 2006). Adverse childhood experiences are known to be associated with an increased risk of poor physical and mental health in adulthood (Iniguez & Stankowski 2016). Also, there is a growing body of evidence suggesting an association between childhood adversities and sleep disorders in adulthood (Bader et al. 2007; Chapman et al. 2013; Chapman et al. 2011; Kajeepeta et al. 2015; Ramsawh et al. 2011). Previous studies showed that poor parental mental health in childhood was associated with an increased the risk of hyperacusis and depression in adulthood among help-seeking tinnitus patients (Aazh et al. 2018a; Aazh et al. 2018b). However, no study to date has assessed whether individuals with a history of parental separation and/or poor parental mental health in their childhood are at greater risk of developing insomnia if they experience tinnitus in adulthood.

The aim of this study was to explore whether parental separation and parental mental health during childhood are related to the severity of insomnia among patients seeking help for tinnitus, as seen in an Audiology clinic.

Methods

Study design and patients

This was a retrospective cross-sectional study conducted at the Tinnitus and Hyperacusis Therapy Specialist Clinic, Royal Surrey County Hospital, Guildford, UK. Data were included for all patients who attended the clinic between April and November 2017 and for whom the self-report questionnaire assessing insomnia had been completed ($n = 174$). Demographic data for the patients and responses to the self-report questionnaires were imported from records held at the Audiology department.

Parental separation and parental mental health

In order to assess parental separation and parental mental health, two questions from the questionnaire for Adverse Childhood Experiences (Anda et al. 2006; Felitti et al. 1998) were used. The questions were introduced by the phrase “While you were growing up during the first 18 years of life...” (p.247; Felitti et al. 1998). The questions were: (1) were your parents separated or divorced? (2) did your parent(s) have depression or mental illness? The responses were “yes” or “no”. The test-retest reliability of responses to these questions is in the range good to excellent (Cohen’s kappa: 0.46-0.86) (Dube et al. 2004). For convenience, the period of life up to 18 years of age is referred to hereafter as childhood.

Insomnia Severity Index

The Insomnia Severity Index (ISI) was used to assess the severity of sleep difficulties and their effect on the patient’s life. The ISI comprises seven items, each of which is rated on a scale from 0 to 4. The total score ranges from 0 to 28. Scores from 0-7 indicate no clinically significant insomnia, scores from 8-14 indicate slight insomnia, scores from 15-21 indicate moderate insomnia, and scores from 22-28 indicate severe insomnia (Bastien et al. 2001).

Assessment of hearing thresholds

Pure-tone audiograms were measured using the procedure recommended by the British Society of Audiology (BSA 2011a). All audiometric equipment had been calibrated within the past year. The severity of hearing loss was categorized based on the values of the pure-tone average (PTA) at the frequencies 0.25, 0.5, 1, 2, and 4 kHz, as recommended by the British Society of Audiology (BSA 2011a): Mild (20 – 40 dB HL), Moderate (41 – 70 dB

HL), Severe (71 – 95 dB HL) and Profound (over 95 dB HL). Audiograms were available only for 162 of the 174 patients.

Assessment of hyperacusis

Hyperacusis is intolerance of everyday sounds that causes significant distress and impairment in social, occupational, recreational, and other day-to-day activities (Aazh et al. 2016). The sounds may be perceived as uncomfortably loud, unpleasant, frightening, or painful (Tyler et al. 2014). Uncomfortable Loudness Levels (ULLs) were measured following the BSA recommended procedure (BSA 2011b). The diagnosis of hyperacusis was based on the average ULL over 0.25, 0.5, 1, 2, 4 and 8 kHz for the ear with the lower average ULL, which is called ULL_{min}. Hyperacusis was considered as present if ULL_{min} was ≤ 77 dB HL (Aazh & Moore 2017b).

Ethical approval

This study was approved by the South West-Cornwall and Plymouth Research Ethics Committee and the Research and Development department at the Royal Surrey County Hospital.

Data analysis

The data were anonymized prior to statistical analysis. Descriptive statistics (means and standard deviations, SDs) for the characteristics of the patients and scores for the self-report questionnaires were calculated. The Wilcoxon rank-sum test was used to compare the mean of ISI scores for patients grouped based on the presence/absence of parental separation and based on the presence/absence of parental mental illness. The p -value required for statistical significance was set at $p < 0.05$. The significant difference in ISI scores found for the presence/absence of parental mental illness was explored using multinomial logistic regression to assess the relative risk ratio (RRR) of having different degrees of insomnia based on the presence/absence of parental mental illness. **The RRR is defined as the ratio of the probability of an outcome in an exposed group (with parental mental illness in this case) to the probability of an outcome in an unexposed group (without parental mental illness).** The values of the RRR and their 95% confidence intervals (CI) were calculated both unadjusted and adjusted for the presence of hyperacusis, hearing loss, age and gender. The STATA program (version 13) was used for statistical analyses.

Results

Characteristic of the study population

The average age of the patients was 52 years (SD = 15.5 years, range 18 to 84 years). **Forty seven percent** (81/174) of the patients were male. The mean PTA across ears was 21 dB HL (SD = 13 dB). The mean value of ULLmin was 76 dB HL (SD = 11). The means and SDs of the hearing thresholds and ULLs for each ear and each frequency are shown in Table 1.

Based on the PTA for the better ear, 63% of patients (102 out of 162 with audiograms) had no hearing loss, 33% (53/162) had mild hearing loss, and 4% (7/162) had moderate hearing loss. None of the patients had severe or profound hearing loss. The mean ISI score was 13 (SD = 7.7). Based on the values of ULLmin, 33% of patients (41/124) had ULLs of 77 dB HL or below, which indicates hyperacusis.

Based on scores for the ISI, 29% (51/174) of the patients did not have insomnia, 28% (49/174) had mild insomnia, 25% (44/174) had moderate insomnia, and 17% (30/174) had severe insomnia.

Parental separation and its relationship with insomnia

Sixteen percent of patients (27/174) reported that their parents were separated or divorced during the patient's childhood. The mean ISI score was 13.0 (SD = 7.8) for patients whose parents remained together and 12.6 (SD = 8) for patients whose parents were separated or divorced. The difference was not statistically significant ($p = 0.8$).

Parental mental health and its relationship with insomnia

Forty two percent of patients (72/174) reported that one or both of their parents suffered from a mental illness during the patient's childhood. The mean ISI score was 14.6 (SD = 7.8) for patients whose parents had a mental illness and 11.9 (SD = 7.5) for patients whose parents did not have a mental illness. This difference was statistically significant ($p = 0.029$).

The presence or absence of parental mental illness was used in multinomial logistic regression analyses to assess its influence on the RRR of having a specific category of insomnia (relative to the category of no insomnia). Columns 3 and 4 of Table 2 show the relationship between insomnia categories as measured via the ISI (dependent variable) and (1) parental mental health, (2) presence of hyperacusis and (3) hearing loss, treating each

measure separately as an independent variable. Different numbers of patients (n) were included in each model as complete data on all measures were not available for all patients. Columns 5 and 6 of Table 2 show the outcomes of a model including all three independent variables, adjusted for age and gender. This model assessed the relationship between parental mental health and insomnia taking into account the effect of other variables. For patients seeking help for tinnitus, the presence of parental mental illness during the patients' childhood increased the chance of having severe insomnia (the RRR) by a factor of 3.3 unadjusted (95% CI: 1.3 to 8.4, $p = 0.013$). This remained significant when adjusting the RRR for the effect of the presence of hyperacusis, hearing impairment, age and gender (95% CI: 1.1 to 10.8, $p = 0.04$). In addition, the presence of hyperacusis increased the chance of having severe insomnia by a factor of 3.98 unadjusted (95% CI: 1.3 to 12.3, $p = 0.016$). The effect of the presence of hyperacusis remained significant when the model was adjusted for the effect of parental mental illness, hearing impairment, age and gender. Finally the presence of mild hearing loss in the better ear compared to no hearing loss did not significantly increase the risk of having insomnia. There were only seven patients with moderate hearing loss in the better ear, so this category could not be included in the regression model.

Discussion

The results showed that, for patients seeking help for tinnitus, the risk of developing severe insomnia in adulthood was 3.4 times greater if their parents had mental illness during the patients' childhood than if they did not, i.e. the RRR was 3.4. These RRRs can be compared with the odds ratios (OR) reported by Chapman et al. (2013) in an epidemiological study of the general population ($n = 25810$). They assessed the prevalence of "frequent insufficient sleep", which was defined as present if the individual gave a response " ≥ 14 days" in response to a question asking about the number of days in the past 30 days when they did not get enough sleep. Chapman et al. (2013) found that the OR of frequent insufficient sleep was 1.68 (95% CI 1.47 - 1.92) when mental illness in the whole family (siblings and parents) was taken into account, which is smaller than the RRR found in our study based on mental illness in the parents alone. Chapman et al. (2013) found that the OR of frequent insufficient sleep was 1.23 (95% CI 1.08-1.40) for individuals whose parents were separated or divorced during childhood relative to individuals whose parents remained together. The significant effect of parental separation found by them contrasts with the lack of significant effect found in this study. This is probably a consequence of the lower statistical power of the present study

resulting from the smaller number of participants, which increased the likelihood of a type II error.

In another survey of the general population ($n = 17337$) Chapman et al. (2011) assessed sleep disturbances by asking two questions: (1) Have you ever had or do you now have trouble falling asleep or staying asleep? (2) Have you ever had or do you now feel tired even after a good night's sleep? They also asked about various types of childhood adverse events. The ORs for having trouble falling asleep/staying asleep were 1.6 (95% CI = 1.5-1.8) for mental illness in the household and 1.2 (95% CI = 1.1-1.3) for parental separation/divorce. The ORs of feeling tired after a good sleep were 1.6 (95% CI = 1.5-1.8) for mental illness in the family and 1.3 (95% CI = 1.2-1.4) for parental separation/divorce. Thus, the ORs for parental mental illness were greater than the ORs for parental separation, as found in the present study.

The lower ORs for the effects of family mental illness on insomnia found by Chapman et al. (2013) and Chapman et al. (2011) relative to the RRR found here probably reflect the fact that we studied people seeking help for tinnitus, whereas they examined the general population. Tinnitus itself is a risk factor for insomnia (Cronlein et al. 2007), and the combination of tinnitus and a parental history of mental illness may pose a greater risk than parental mental illness alone. However, the differences across studies may also be partly a consequence of differences in the ways that sleep problems were assessed.

Parental mental illness can be considered as part of a larger class of adverse childhood experiences, which are defined as stressful or traumatic life events during the first 18 years of life, including exposures to different form of abuse (physical, emotional and sexual) and family dysfunction (substance abuse, mental illness, mother treated violently, incarcerated household member and parental separation) (Felitti et al. 1998). An epidemiological study, based on the same participants as for the study of Chapman et al. (2011) ($n = 17337$), reported that the risk of sleep disturbances was increased 2.1-fold for individuals with four or more adverse childhood experiences (Anda et al. 2006). In the study of Chapman et al. (2011), the OR for the association between mental illness in the family as a whole and trouble falling asleep (OR = 1.6) was comparable to the ORs for both emotional and physical abuse [OR = 1.7 (95% CI = 1.5-1.9)]. The ORs were smaller for sexual abuse, witnessing domestic violence, and household substance abuse [OR = 1.3 (95% CI = 1.2-1.4)], and household member imprisoned [OR = 1.1 (95% CI = 1.0-1.3)]. The OR for the association between

mental illness in the family as a whole and feeling tired after a good sleep (OR = 1.6) was larger than the ORs for emotional and physical abuse [OR = 1.4 (95% CI = 1.2-1.5), for witnessing domestic violence and household substance abuse [OR = 1.3 (95% CI = 1.2-1.4)], for sexual abuse [OR = 1.2 (95% CI = 1.0-1.3), and for household member imprisoned [OR=1.4 (95% CI=1.2-1.6)].

In the study of Chapman et al. (2013), the OR for the association between mental illness in the family as a whole and frequent insufficient sleep was 1.68 (95% CI = 1.47-1.92) which is comparable to the ORs for physical abuse [OR = 1.71 (95% CI = 1.50-1.97)], verbal abuse [OR = 1.59 (95% CI = 1.42-1.79)], sexual abuse [OR = 1.66 (95% CI = 1.44-1.93)], substance abusing household member [OR = 1.47 (95% CI = 1.03-1.65)], witnessing domestic violence [OR = 1.58 (95% CI = 1.37-1.82), and incarcerated household member [OR = 1.54 (95% CI = 1.21-1.95).

Overall, it seems that, in the general population, a history of family mental health problems during childhood is a risk factor for sleep problems and this risk is comparable to or greater than the risk associated with other adverse childhood experiences. Our study shows that a parental history of mental illness is an even greater risk factor for insomnia among those seeking help for tinnitus.

To sum up, poor parental mental health in childhood is associated with a markedly higher risk of developing severe insomnia for patients who seek help for tinnitus in their adulthood. To the authors' knowledge this finding is new and it may have implications for clinical practice. In the UK, the main intervention offered to patients who experience tinnitus is cognitive behavioral therapy (CBT), which is typically delivered by specialized audiologists (Aazh et al. 2016). The CBT is mainly aimed at reducing the severity of side effects of the tinnitus, including insomnia, rather than reducing the tinnitus itself. Based on this study, it might be beneficial for any therapy to address adverse childhood experiences as well as current circumstances and/or to involve appropriate mental health professionals with expertise in traumatic stress in the rehabilitation team when treating patients with tinnitus, severe insomnia and a history of adverse childhood experiences. Further research is needed to clarify these issues.

Our study was limited to information that was gathered in day-to-day clinics. We only

enquired about the presence or absence of parental separation and parental mental illness.

Note that this information takes very little time to obtain, and we think that it would be sensible to include questions of this type while taking a routine case history for patients seeking help for tinnitus or hyperacusis. Future research should systematically examine the relationship between the whole range of possible adverse childhood experiences and insomnia in tinnitus patients.

Our results did not show any significant relationship between hearing loss and insomnia. However some authors have suggested that poorer hearing is associated with poorer sleep (Lim et al. 2017; Test et al. 2011). The discrepancy could be related to the small variation in hearing loss categories among patients included in our study; the majority of our sample had either normal hearing or mild hearing loss. Further work is needed in this regard.

Our results showed that the presence of hyperacusis is significantly associated with severe insomnia. It is possible that this relationship is mediated by a higher prevalence of psychiatric illnesses, mainly depression, among patients with hyperacusis combined with tinnitus compared to tinnitus only (Aazh & Moore 2017c; Aazh & Moore 2017a). The link between insomnia and depressive symptoms in patients with tinnitus has been reported by several authors (Cronlein et al. 2016; Xu et al. 2016; Aazh et al. 2017).

Conclusions

Parental separation and parental mental illness among patients seeking help for their tinnitus and/or hyperacusis had a prevalence of 15.5% and 41.5%, respectively. There were no significant differences in ISI scores between patients with and without a history of parental separation. However, ISI scores were significantly higher (worse) for patients whose parents had a history of mental illness than for those who did not. A regression model showed that the risk of having severe insomnia was 3.4 times greater for patients whose parents had a history of mental illness than for those whose parents did not. Also, the risk of having severe insomnia was 3.8 times greater for patients with hyperacusis than for those without. It may be important to involve mental health professionals with expertise in psychological trauma in the rehabilitation team when treating patients with tinnitus, hyperacusis, severe insomnia and a history of parental mental illness.

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TABLE 1. Means (and standard deviations) of hearing thresholds (HTs) and uncomfortable loudness levels (ULLs), both in dB HL, for each ear of the study population. The number of patients included at each frequency is indicated by *n*.

	Frequency, kHz							
	0.25	0.5	1	2	3	4	6	8
HT Right	19 (13) <i>n</i> = 162	18 (13) <i>n</i> = 162	17 (14) <i>n</i> = 162	19 (16) <i>n</i> = 161	26 (20) <i>n</i> = 123	30.5 (21) <i>n</i> = 162	37 (24) <i>n</i> = 125	38 (27) <i>n</i> = 161
HT Left	19 (14) <i>n</i> = 161	19 (15) <i>n</i> = 161	18 (17) <i>n</i> = 161	21 (18) <i>n</i> = 160	28 (23) <i>n</i> = 123	32 (23) <i>n</i> = 60	40 (25) <i>n</i> = 123	40 (27) <i>n</i> = 160
ULL Right	77 (11) <i>n</i> = 124	76 (12) <i>n</i> = 136	78 (10) <i>n</i> = 136	77 (11) <i>n</i> = 136	80 (8) <i>n</i> = 89	78 (11) <i>n</i> = 136	80 (9) <i>n</i> = 90	75 (14) <i>n</i> = 124
ULL Left	77 (12) <i>n</i> = 124	77.5 (11) <i>n</i> = 135	77 (12) <i>n</i> = 136	77 (13) <i>n</i> = 135	81 (8) <i>n</i> = 88	78 (12) <i>n</i> = 135	80 (10) <i>n</i> = 91	76 (14) <i>n</i> = 123

TABLE 2. Outcomes of a multinomial logistic regression model assessing the relative risk ratio (RRR) of having various different severities of insomnia based on the presence/absence of parental mental illness in childhood, hyperacusis (ULLmin ≤ 77 dB HL), and mild hearing loss (PTA 20-40 dB HL) in the better ear. The table shows both the unadjusted RRR values and the RRR values adjusted for all variables in the model as well as age and gender, together with 95% confidence intervals (CI). Significant *p* values are indicated in bold font. The number of patients included in each analysis is indicated by *n*.

Severity of insomnia		Non- Adjusted RRR (95% CI)	<i>p</i> value	Adjusted RRR (95% CI)	<i>p</i> value
No insomnia	Parental mental health	1		1	
Slight insomnia	illness present	1.6 (0.72 to 3.7)	0.23	1.2 (0.42 to 3.3)	0.75
Moderate insomnia		1.4 (0.59 to 3.2)	0.45	1.4 (0.48 to 3.9)	0.55
Severe insomnia		3.3 (1.3 to 8.4)	0.013	3.4 (1.1 to 10.8)	0.04
		<i>n</i> =174		<i>n</i> =124	
No insomnia	Hyperacusis present	1		1	
Slight insomnia	(ULLmin ≤ 77 dB HL)	1.3 (0.4 to 3.8)	0.67	1.3 (0.4 to 4.1)	0.66
Moderate insomnia		1.8 (0.6 to 5.2)	0.29	1.8 (0.6 to 5.5)	0.32
Severe insomnia		3.98 (1.3 to 12.3)	0.016	3.8 (1.1 to 12.8)	0.034
		<i>n</i> =124		<i>n</i> =124	
No insomnia	Mild hearing loss (PTA of 20 to 40 dB HL)	1		1	
Slight insomnia		0.6 (0.23 to 1.3)	0.19	0.5 (0.16 to 1.4)	0.17
Moderate insomnia		0.5 (0.20 to 1.2)	0.12	0.7 (0.22 to 2.1)	0.51
Severe insomnia		0.7 (0.25 to 1.8)	0.46	0.98 (0.3 to 3.4)	0.98
		<i>n</i> =162		<i>n</i> =124	