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Which tinnitus-related characteristics affect current health-related quality of life and depression? A cross-sectional cohort study



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ABSTRACT

Tinnitus is sometimes associated with lower health-related quality of life (HRQoL) and depressive symptoms. However, only limited evidence exists identifying which tinnitus characteristics are responsible for these associations. The aim of this cross-sectional study was to assess associations between tinnitus, HRQoL, depressive symptoms, subjective tinnitus loudness and audiometrically assessed tinnitus characteristics (e.g., hearing threshold). Two hundred and eight outpatients reporting tinnitus completed questionnaires on tinnitus (Tinnitus Handicap Inventory, THI), HRQoL (World-Health-Organisation Quality of Life Short Form Survey, WHOQOL-BREF), and depressive symptoms (Beck Depression Inventory, BDI), and underwent audiometry. Patients with higher THI scores exhibited significantly lower HRQoL, and higher depression scores. THI total-score, THI subscales, and subjective tinnitus loudness explained significant variance of WHOQOL-BREF and BDI. Audiometrically measured features were not associated with WHOQOL-BREF or BDI. Overall, we confirmed findings that different features of tinnitus are associated with HRQoL and depressive symptoms but not with audiometrically assessed tinnitus characteristics. Consequently, physicians should evaluate THI total score, its sub-scores, and subjective tinnitus loudness to reliably and quickly identify patients who potentially suffer from depressive symptoms or significantly lower HRQoL. Supporting these patients early might help to prevent the development of reactive depressive symptoms and impairment of HRQoL.

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1. Introduction

Tinnitus is the auditory perception of sound in the absence of any external or internal acoustic stimulus (e.g., (Lockwood et al., 2002; Tunkel et al., 2014; Zeman et al., 2014)). It affects 7–19% of the population (Coles, 1984; Axelsson and Ringdahl, 1989; Sharгородsky et al., 2010) and can be associated with lower health-related quality of life (HRQoL) (Nondahl et al., 2007; Prestes and Daniela, 2009) and depressive symptoms (Folmer et al., 1999; Dobie, 2003). Nevertheless, not all individuals suffering from tinnitus develop significant problems that interfere with their daily living (e.g., interference with social interaction, work hindrance), HRQoL, or mood (e.g., depressive symptoms) (Coles, 1984; Davis and Rafai, 2000; Nondahl et al., 2002; Turner et al., 2007; Ooms et al., 2011). Between 30% and 60% of tinnitus patients report significant depressive symptoms (e.g., (Folmer et al., 1999; Dobie,

2003)). Furthermore, tinnitus severity has consistently been found to correlate with depressive symptoms (e.g., (Kuk et al., 1990; Newman et al., 1996; Ooms et al., 2011)). Overall, depressive symptoms are the most common psychiatric problem in tinnitus patients (Folmer et al., 1999). As for depressive symptoms, HRQoL is negatively associated with tinnitus severity (Nondahl et al., 2007). For this reason, recognizing those components of tinnitus experience associated with lower HRQoL and depressive symptoms could help to identify which patients are at risk for developing increased emotional and mental distress and mental disorders

In a recent attempt to shed light on the associations between various subjective characteristics of tinnitus, HRQoL, and depressive symptoms (Zeman et al., 2014), tinnitus severity was found to be inversely associated with physical and psychological HRQoL and directly associated with depressive symptoms. It also was less strongly but still significantly associated with poorer social relationship-related and environment-related HRQoL. On the Tinnitus Handicap Inventory (THI, (Kuk et al., 1990; Newman et al.,

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1996)) the items *feeling confused from tinnitus, trouble falling asleep, interference with job or household responsibilities, getting upset from tinnitus, and feelings of being depressed* were those with the strongest inverse association with HRQoL. All of those items were also significantly and directly correlated with depressive symptoms, with high item ratings portending more severe depressive symptoms.

However, despite its clinical relevance, there is still limited evidence regarding which tinnitus features potentially predict low HRQoL and depressive symptoms. Furthermore, these previous findings (Zeman et al., 2014) have not yet been replicated. In addition it is a crucial point for the clinical relevance whether or not tinnitus patients have clinically relevant symptoms. If the tinnitus patients only had minor tinnitus symptoms and a relatively good quality of life, this could indicate less clinical relevance.

Therefore, our first aim was to compare the level of tinnitus severity and HRQoL in tinnitus patients with the general population. Our second aim was to determine associations between tinnitus severity, depression and HRQoL. To extent the current knowledge, our third and final main objective was to examine objective measures of tinnitus symptomatology (e.g., audiometrically assessed tinnitus pitch and hearing threshold), that have been found to be partially but inconsistently linked to tinnitus severity (Hiller and Goebel, 1999; Mazurek et al., 2010; Wallhaeusser Franke et al., 2012; Hoekstra et al., 2014) but have rarely been investigated with regards to quality of life (Prestes and Daniela, 2009; Dallan et al., 2014) or depressive symptoms (Figueiredo et al., 2010; Karatas and Deniz, 2012; Chen et al., 2013; Gomaa et al., 2014) in patients with tinnitus.

In terms of *a priori* hypotheses, we expected to find significant lower HRQoL in our clinical sample versus the general population. We also hypothesized that tinnitus severity (measured using the THI) would be inversely associated with psychological and physical HRQoL (measured with WHOQOL-BREF). To a lesser extent, we expected to discover an inverse relationship between tinnitus severity and social relationship-related, environment-related, and global HRQoL. In terms of any association between tinnitus and depressive symptoms, we expected to identify an association, with worsening in one linked to worsening in the other. Analysing individual items on the THI, we expected to find the same items to be associated with HRQoL as before (Zeman et al.). Finally, we hypothesized that audiometrically assessed tinnitus characteristics (tinnitus pitch, hearing threshold, and minimal masking level) would be associated with specific aspects of HRQoL and/or depressive symptoms. In addition, higher subjective loudness of tinnitus was expected to be associated with lower HRQoL, and with more severe depressive symptoms.

2. Methods

2.1. Participants

The study was approved by the ethics committee of the Canton of Zurich and all participants gave their written (electronic) consent. Two hundred eighty patients referred to the tinnitus outpatient service at University Hospital Zurich and seen between 12/2012 and 05/2014 were asked to participate in the study. From these patients, 72 fulfilled all inclusion criteria but decided to not take part in the study. Two hundred and eight (74.3%) filled out the questionnaires and participated in the audiometric measurements.

Patients were asked to participate if they met the following inclusion criteria: 18 years old or older, fluent German or Swiss German, and reported tinnitus for at least one month. The tinnitus duration of at least one month was chosen to exclude people with temporary symptoms likely to remit and without a potential

reactive association with the HRQoL or depressive symptoms.

2.2. Measures

The *Tinnitus Handicap Inventory* (THI) was used to assess tinnitus-related handicap (Kuk et al., 1990). The beta version (25 questions), is easy to administer and interpret and psychometrically robust (Newman et al., 1996). It is the most standardized tinnitus handicap measuring tool in the literature (e.g., (Newman et al., 1996; Zeman et al., 2014)). A validated German version (Kleinjung et al., 2007) was used in this study that has demonstrated adequate reliability-validity and good internal consistency, and convergent and construct validity, current Cronbach's $\alpha=0.94$. Probability of occurrence is rated for each question/item (No=0, Sometimes=2, Yes=4). The THI total score ranges from zero to 100, with higher scores representing greater perceived handicap. This score can be categorized into five grades of tinnitus severity: slight (0–16), mild (18–36), moderate (38–56), severe (58–76), and catastrophic (78–100) (Zeman et al., 2014). Furthermore, the questionnaire can be grouped into three subscales according to the content of each item: functional, emotional and catastrophic responses.

The *Beck Depression Inventory* (BDI) (Beck and Steer, 1993) was used to assess depressive symptoms. The scale consists of 21 items each rated from 0 to 3, the total score ranging from 0 to 63. The German version of the questionnaire has shown good psychometric properties (Hautzinger et al., 1995), current Cronbach's $\alpha=0.86$.

The *World Health Organisation Quality of Life Short Form Survey* (WHOQOL-BREF), an internationally-used and well-validated instrument, was used to measure health-related quality of life (HRQoL) (WHO, 1998). The WHOQOL-BREF is comprised of 26 items that assess the following broad domains: physical health, psychological health, social relationships, environment, and global HRQoL. The WHOQOL-BREF has been validated in different representative samples; and for the German version, reference norms from the general population ($N=2055$) are available (Angermeyer et al., 2000), current Cronbach's $\alpha=0.92$.

Subjective tinnitus loudness was assessed with an eleven-point Likert scale, ranging from 0 to 10, with lower ratings indicating less subjective loudness and higher ratings more subjective loudness.

All *audiometric measurements* were performed in a sound proof listening booth with a standard audiometer (Interacoustics Equinox 2.0, Denmark) and standard supra-aural headphones (TDH 39, Telephonics Corporation, NY, USA). This booth and all audiometric procedures complied with the Swiss requirements regulated by the federal ordinance for audiometry. These regulations conform to international standards (e.g. ISO 8253). The annual periodic calibration of the audiometric equipment is performed according to the Federal Institute of Metrology (Switzerland).

For the assessment of *tinnitus pitch*, patients were presented with tones with different frequencies (e.g., 0.5 and 3 Hz) and asked which tonal pitch was most similar to their tinnitus. The frequency of presented tones was then narrowed down until the closest match was found. The *minimal masking level* (MML) of the tinnitus tone was assessed with white noise. The level at which the tinnitus was just ranked inaudible was recorded in dB SL and referred to as the MML. The stimulus was administered on the same side if the tinnitus was unilateral. For bilateral tinnitus, the stimulus was presented to the better-hearing ear. *Hearing threshold* was assessed by conventional pure tone audiometry (PTA, 125 Hz to 8 kHz). The hearing threshold for all frequencies was determined in dB HL by a standard Hughson-Westlake procedure (steps: 10 dB down, 5 dB up; 2 out of 3). The mean hearing level [dB HL] was calculated by averaging all thresholds for both ears measured by PTA from

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