

## **Examining the consequences of tinnitus using the multidimensional perspective**

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## **Abstract**

**Background:** Tinnitus is one of the most frequent chronic conditions in adults with wide range of consequences.

**Aims/Objectives:** The aim of the current study was to determine the problems and life effects reported by individuals with tinnitus using the International Classification of Functioning, Disability and Health (ICF) framework.

**Material and Methods:** The study used a cross-sectional survey design. 344 individuals with tinnitus completed a series of questionnaires. The responses to open-ended questions were linked to ICF categories.

**Results:** Activity limitations and participation restrictions were most dominant consequence of tinnitus followed by effect on the body function with limited emphasis on the contextual factors. Frequently reported responses to body function involved emotional functions (b152), attention function (b140), and sleep functions (b134). Commonly reported responses to activity limitations and participation restrictions were recreation and leisure (d920), conversation (d350), communicating with—receiving—spoken messages (d310), listening (d115), and remunerative employment (d850). Sound intensity (e2500) and sound quality (e2501) were the frequently reported responses to environmental factors. Coping styles, past and present experiences, and lifestyle were the most frequently occurring personal factors.

**Conclusions and Significance:** The study highlighted some key influencing factors of tinnitus in different ICF domains which can be helpful in rehabilitation planning.

**Key Words:** Tinnitus, ICF, Biopsychosocial perspective, Body function, Activity limitations, Participation restrictions, Open-ended questions

## Introduction

Tinnitus is a common condition affecting roughly 10-15% of adults. Of those with tinnitus, not all have severe tinnitus, however, for a proportion (estimated 2-10% in the general population) tinnitus interferes with daily life [1]. Tinnitus can affect various aspects of life including sleep, mood, concentration, and can lead to indirect psychological and psychosocial effects, such as depression and anxiety [2]. These effects negatively impact relationships and the ability to work effectively, which in turn has an impact on the health economy [3].

Considering the wide range of consequences experienced by individuals with tinnitus, applying the multidimensional perspective to examine the impact of tinnitus may help uncover the effects of this hidden disability. The World Health Organizations (WHO) - International Classification of Functioning, Disability and Health (ICF) is a framework and/or classification that is based on biopsychosocial models of disability and provides comprehensive framework to study and understand health and disability [4]. The ICF classification has been used to examine various forms of health conditions. It broadly includes two main parts: functioning and disability; and contextual factors. Functioning is an umbrella term and is described with the positive concepts such body structure (*s*), body function (*b*), and activity and participation (*d*), while the umbrella term disability is described with the negative terminology (i.e., impairment, activity limitation and participation restriction). The contextual factors include the components: environmental factors (*e*) and personal factors.

Only two previous studies have examined consequences of tinnitus using the International Classification of Functioning, Disability and Health (ICF) framework. Ramkumar and

Rangasayee [5] mapped the items of the Tinnitus Handicap Inventory (THI) framework and examined which aspects of tinnitus were more problematic using this structured questionnaire. Their study showed that body function was significantly more affected when compared to activity limitations and participation restrictions. In another study, Manchaiah et al. [6] examined responses to open-ended questions focusing on problems and life effects as a result of tinnitus in the UK population using the ICF classification. This study also showed that body function was more affected than the participation restrictions. The most frequent responses related to body function involved emotional functions (b152), sleep functions (b134), hearing functions (b230), and sustaining attention (b1400). Communicating with-receiving-spoken messages (d310), socialization (d9205), handling stress and other psychological demands (d240), and recreation and leisure (d920) were the commonly reported responses for activity limitations and participation restrictions. The study also highlighted various contextual factors such as environmental factors (i.e., sound intensity e2500; sound quality e2501; general products and technology for communication e1250) and personal factors (i.e., coping styles) which could mediate the experiences of tinnitus. These studies have identified some important consequences of tinnitus. Moreover, the ICF framework provides a culture neutral language to examine the consequences of health conditions and is easy to compare across populations. However, there could be differences in populations in the way in which they express their symptoms and consequences.

The aim of the current study was to identify key problems and life effects reported by individuals with tinnitus in the US. The response to open-ended questions were mapped to ICF classification. In addition, we compared the number of responses to both problem and life effects

questions as well as examined the association between number of responses to open-ended questions and tinnitus related variables. We also compared the current study results with similar study on the UK population to examine similarities and differences [6].

## **Method**

### **Study Design**

The study used a cross-sectional survey design. Study participants were seeking online psychological interventions for tinnitus (Clinical Trials.gov registration numbers NCT04004260, NCT04335812) and completed a series of pre-intervention measures [7-9].

### **Data Collection**

The data were collected using online questionnaire which included questions about (a) demographical factors (e.g., age, gender, education, work status), (b) tinnitus-related variables (e.g., duration of tinnitus) as well as standardized questionnaires, and (c) open-ended questions. The standardized questionnaires assessed the tinnitus severity using the Tinnitus Functional Index (TFI; [10]), anxiety using the Generalized Anxiety Disorder – 7 (GAD7), depression using the Patient Health Questionnaire – 9 (PHQ-9), insomnia using the Insomnia Severity Index (ISI), and the health-related quality of life (HRQoL) using the EQ-5D-5L VAS scale. The two open-ended questions focusing on problems and life effects associated with tinnitus and has been used in previous studies related to hearing loss and tinnitus [6,11,12]. The questions were worded as: (a) Problem question (PQ): “Make a list of difficulties, which you have as a result of your tinnitus. Write down as many as you can think of;” and (b) “Life effects question (LEQ): Make a list of the effects your tinnitus has on your life. Write down as many as you can think of.”

## Data Analysis

### *Quantitative Analysis*

The number of responses to PQ and LEQ by individual participant were determined.

The Shapiro–Wilk test suggested that the number of responses violated the assumption of normality. A Wilcoxon signed-rank test was therefore used to examine the differences in number of responses between the PQ and LEQ. The Spearman’s rho correlation was performed to examine the relationship between number of response and the tinnitus-related variables. A two-tailed significance of 0.05 was considered statistically significant, although a more stringent Bonferroni corrected significance level of 0.01 (i.e., 0.05/5 comparisons) were used to interpret the significance levels in multiple comparisons.

### *Qualitative Analysis and ICF Mapping*

The mapping of responses to open-ended questions to the ICF classification followed the procedure to manage qualitative data suggested by Granberg et al. [13] The procedure is based on qualitative content analysis and follows a procedure including meaningful concepts, latent interpretation and linking (mapping) data to the ICF. The ICF linking was performed using the well-established linking rules [14,15]. ICF classification does not provide a detailed classification for personal factors. For this reason, personal factors were classified using the classification proposed by audiology researchers [14,16,17]. According to the linking rules, any responses that was not possible to assign to ICF categories was labeled *nd* (not definable), *nc* (not covered by ICF), or *hc* (health condition). To increase the reliability of the procedure, the linking was conducted independently by two researchers (S.G. and E.K.). A third researcher (V.M.) was consulted to resolve any disagreements between the two independent coders.

**Table 1: Demographic information (n=344)**

Variable	N (%)	Mean (SD); Score range
Age (in yrs)	-	55.1 (13.2); 19 to 84
Gender		-
▪ Male	160 (46.5)	
▪ Female	184 (53.5)	
Race		-
▪ American Indian/Alaska Native	1 (0.3)	
▪ Asian	7 (2)	
▪ Native Hawaiian/Other Pacific Islander	0 (0)	
▪ Black or African American	9 (2.6)	
▪ White	313 (91)	
▪ More than One race	14 (4.1)	
Ethnicity		-
▪ Hispanic or Latino	36 (10.5)	
▪ Not-Hispanic or Latino	308 (89.5)	
Work		-
▪ Entry level or unskilled work,	8 (2.3)	
▪ Skilled or professional work	210 (61)	
▪ Retired	101 (29.4)	
▪ Not working	25 (7.3)	
Education		-
▪ Less than high school	0 (0)	
▪ High School	35 (10.2)	
▪ Some college but not degree	101 (29.4)	
▪ A university degree	208 (60.5)	
Tinnitus duration (in years)	-	12.4 (13.3); 0.17 to 70

Tinnitus severity (TFI)	-	53.4 (20.7); 6.4 to 100
Anxiety (GAD-7)	-	7.4 (5.8); 0 to 21
Depression (PHQ-9)	-	7.5 (5.9); 0 to 27
Insomnia (ISI)	-	11.5 (6.8); 0 to 28
Health-related quality of life (EQ-5D-5Q VAS)	-	74.8 (15.4); 9 to 100

## Results

Of the 440 people who enrolled for the online psychological interventions, 334 participants provided the response to open-ended questions (76% response rate). Of these, 53.5% of the participants (n=186) were females. Most of the participants were non-Hispanic and whites (nearly 90%). The mean tinnitus duration was 12.4 years and the mean TFI scores was 53.4 which suggested participants had severe tinnitus requiring interventions. Table 1 provides detailed demographic information including their work status, education, as well as scores for anxiety, depression, insomnia and quality of life measures.

### Number of Responses Open-ended Questions

The two open-ended questions generated 2,261 (i.e., 1,345 from the PQ and 885 from the LEQ). Of these, 32 responses were categorized as *nc* (n=25) or *hc* (n=7) as they could not be categorized using the ICF classification. The number of meaningful responses for PQ ranged from 0 to 16 and ranged from 0 to 10 for LEQ. The median responses for PQ and LEQ were 3 and 2, respectively. Table 2 provides the mean number of responses to PQ and LEQ in all the four ICF domains. The number of responses to PQ were significantly more when compared to LEQ in all the four ICF domains as shown in Table 2.



**Table 2: Number of responses in each of the ICF domains listed in the problem and life-effects questions**

Category	PQ Mean (SD)	LEQ Mean (SD)	Wilcoxon Z	P-value
All responses	3.9 (2.5)	2.6 (1.7)	-10.1	< .001
Functional impairment (body function)	1.2 (1.1)	1.4 (1.2)	-3.0	.003
Activity limitations and Participation restriction	1.8 (1.7)	0.88 (1.1)	-9.4	< .001
Environmental factors	0.64 (0.8)	0.27 (0.5)	-7.0	< .001
Personal factors	0.26 (0.5)	0.03 (0.2)	-7.9	< .001

### **Relationship Between Number of Responses to Open Questions and Tinnitus-related Variables**

Table 3 presents the results of Spearman's rho correlation between number of responses to PQ and LEQ and tinnitus-related variables. There was a statistically significant weak positive correlation between the variables tinnitus severity, anxiety, depression, and insomnia with number of responses to both PQ and LEQ. There was a weak negative correlation between age and number of responses to PQ, but not with number of responses to LEQ. The correlation between quality of life and number of responses was not statistically significant after applying the Bonferroni corrected significance level for interpretation. These results suggest that individuals with tinnitus report more problems and life effects when they have more severe tinnitus, anxiety, depression, and insomnia. Also, negative association between age and number of responses to open-ended questions suggest that younger participants reported more problems.

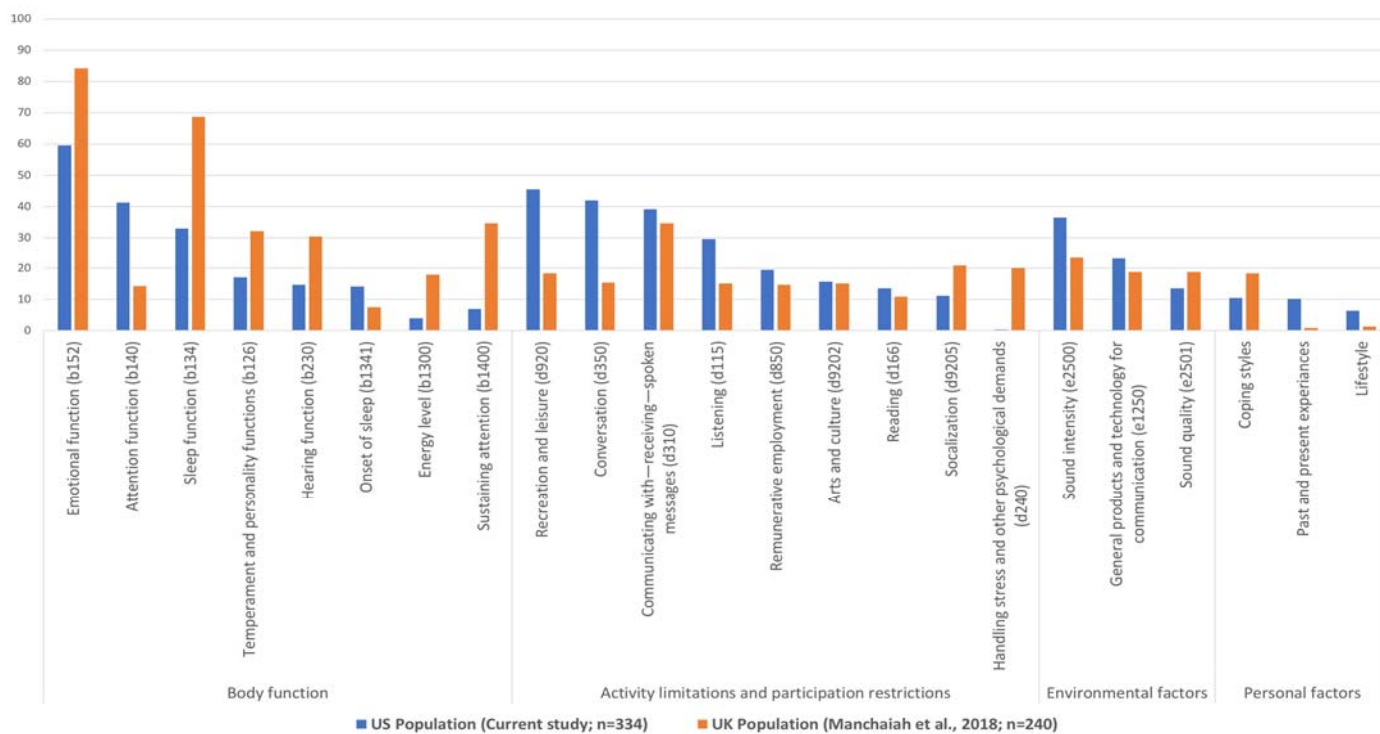
**Table 3: Relationship between number of responses to problem and life-effects question and the demographic and tinnitus-related variables**

<b>Variables</b>	<b>PQ (all)</b>	<b>LEQ (all)</b>
<b>Age</b>	-.15**	-.07
<b>Tinnitus duration</b>	-.05	-.07
<b>Tinnitus severity</b>	.28**	.23**
<b>Anxiety</b>	.25**	.28**
<b>Depression</b>	.24**	.27**
<b>Insomnia</b>	.2**	.24**
<b>Quality of life</b>	-.11*	-.09

Note: \*\*<0.01; \*<0.05

### **Understanding Consequences of Tinnitus Using the ICF Classification**

Figure 1 presents a summary of the consequences of tinnitus in the ICF domains in comparison with a UK population in percentages [6]. More detailed presentation of ICF codes for each of the domains is provided in supplementary tables. There was a total of 864 ICF codes (397 for PQ and 467 for LEQ), on body function, 950 codes (614 for PQ and 309 for LEQ) on activity limitations and participation restrictions, 314 codes (220 for PQ and 94 for LEQ), and 101 codes (90 for PQ and 11 for LEQ) from the open-ended responses. Activity limitations and participation restrictions seem to be most frequently affected followed by body function. Moreover, the study participants also reported various contextual factors (i.e., environmental and personal factors) influencing their tinnitus experience.



**Figure 1: The most frequently reported factors impacted due to tinnitus**

### *Tinnitus Impact on Bodily Aspects*

The most frequently occurring categories were emotional functions (b152) with 199 responses. Other frequently occurring categories included: attention function (b140) with 138 responses, sleep functions (b134) with 110 responses, temperament and personality function (b126) with 57 responses, hearing functions (b230) with 49 responses, and onset of sleep (b1341) with 47 responses. Sustaining attention (b1400) with 23 responses and energy level (b1300) with 13 responses were less frequently reported when compared to UK population [6].

### *Influence of Tinnitus on Activities and Participation*

The most frequently occurring ICF categories for activity limitations and participation restrictions were: recreation and leisure (d920) with 152 responses, conversation (d350) with 140

responses, communicating with—receiving—spoken messages (d310) with 131 responses, listening (d115) with 99 responses, remunerative employment (d850) with 65 responses, arts and culture (d9202) with 52 responses, and reading (d166) with 45 responses. Socialization (d9205) with 37 responses and also handling stress and other psychological demands (d240) with 1 response were less frequently reported when compared to UK population [6].

### ***The Impact of Environmental Factors***

Environmental factors are contextual factors that may influence an individual and the daily activities one might have. Sound intensity (e2500) with 122 responses, sound quality (e2501) with 21 responses, and general products and technology for communication (e1250) with 21 responses were the commonly reported responses about environmental factors.

### ***The Impact of Personal Factors***

Personal factors codes occurred least frequently when compared to other ICF domains. The frequently occurring personal factors included coping styles (35 responses), past and present experiences (34 responses), and lifestyle (21 responses). These factors are specific to an individual and could potentially mediate their tinnitus experiences positively or negatively.

## **Discussion**

The current study examined the impact of tinnitus by examining the responses to problem and life effects open-ended questions by linking the responses to ICF classification. The study used similar methodology as in the previous UK study [6]. Both studies also had similar population of

participants with bothersome tinnitus seeking psychological interventions who were comparable in terms of age and tinnitus severity.

Both problem and life effects question elicited a range of responses from study participants. However, number of responses to problem questionnaire were significantly higher when compared to life effects questionnaire. These findings are contrary to our previous study on tinnitus which showed no difference in number of responses elicited for problem and life effects questionnaire [6], although comparable to studies on hearing loss populations [11,12]. Moreover, the number of responses were associated with age, tinnitus severity, anxiety, depression, and insomnia. This was expected as tinnitus severity as well as its comorbidities show how significantly the participants were affected by their tinnitus. Overall, the findings suggest that responses to both open-ended and standardized outcome measures may provide insights into consequences of tinnitus.

In the current study, aspects of activities and participation were most commonly affected when compared to body function. This is contrary to previous studies which have shown that body function was most frequently affected by individuals with tinnitus [5,6]. This could potentially highlight differences in populations on how disease may impact different aspects of life.

Emotional function (b152) was the most frequently reported consequence of body function. This is understandable as stress, anxiety and depression associated with tinnitus is likely to negatively impact the thinking patterns [3]. Moreover, attention function (b140), sleep functions (b134), temperament and personality function (b126), and hearing functions (b230) were the other key body functions affected by tinnitus as noted in numerous qualitative studies on tinnitus [18].

Recreation and leisure (d920), conversation (d350), and communicating with—receiving—spoken messages (d310), listening (d115), and remunerative employment (d850) were the most frequently reported activity limitations and participation restriction items. Avoiding certain social situations as well as not being able to work as a result are more severe consequences of tinnitus [19]. It is noteworthy that participants also reported a series of contextual factors (i.e., environmental factors such as sound intensity [e2500], sound quality [e2501], general products and technology for communication [e1250] and also personal factors such as coping styles, past and present experiences, and lifestyle). These factors can mediate the tinnitus experience positively or negatively at an individual level and are important when considering the management strategies for tinnitus.

While the current study used a cross-sectional data of the clinical trials, a sub-sample of participants from the current study were included in two separate clinical trials who were all provided with the internet-based cognitive behavioral therapy intervention. The outcomes of these trials have been presented in our recent manuscripts [8,9]. Our recent studies from the UK sample have shown that the baseline tinnitus severity (i.e., TFI scores) and also education level was found to be the key prognostic factors of ICBT intervention [20].

### **Clinical Implications**

The study has direct clinical and practice implications. It highlights the impact of tinnitus with a multidimensional perspective and could be helpful when planning management strategies to address the consequences of tinnitus. Tinnitus management should be based on the key concerns of patients as well as considering the contextual modifying factors (i.e., environmental and

personal factors). For instance, if an individual with tinnitus report sleep functions (b134) as the main problem and if they were unable to cope. The management plan should focus on providing detailed information about sleep hygiene as well as suggestions about sleep aids (e.g., tinnitus relief pillow with masker). It is also important to consider the pathophysiology of tinnitus when developing the management plan, although the current study failed to examine the consequences of tinnitus based on the etiological as well as pathophysiological factors. Nevertheless, it is important for clinicians and researchers to consider the key outcome domains to be measured when performing clinical trials. The study could also contribute to the development of core outcome sets for tinnitus. Finally, as the ICF provides a culture neutral framework to capture the disease consequences and is easier to compare across countries and populations.

### **Study Limitations**

The study has three key limitations. First, the study included individuals with tinnitus seeking online psychological interventions and were of higher tinnitus severity. The study population was hence not representative of the general tinnitus population. Second, participants were self-selected and enrolled themselves for the intervention which may have caused sampling bias. For these reasons, the results should be viewed with caution and are most likely not generalizable to general tinnitus population. Third, the consequences reported by tinnitus patients could vary because of the etiological factors. However, we did not gather information about the possible etiological factors in the current study.

### **Conflict of Interest**

The authors have no conflict of interest.

## Ethical Approval

Ethical approval was obtained from the Institutional Review Board at Lamar University (IRB-FY17-209 and IRB-FY20-200).

## Data Availability

The data that support the findings of this study are openly available in Figshare at <http://doi.org/10.6084/m9.figshare.13681924>

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