

ORIGINAL ARTICLE

Assessment of Hyperacusis in Egyptian patients: Evaluation of the Arabic version of the Khalfa questionnaire

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Abstract

Objectives: Hyperacusis appears to be a subjective phenomenon, which is not easily defined or quantified by objective measurements. The primary aim of this work was to evaluate the Arabic version of the Khalfa questionnaire for hyperacusis on a sample of normal hearing Egyptians complaining of hyperacusis. The secondary aim was to compare the audiological criteria of this group of hyperacusis patients (with or without tinnitus) with a control group of similar age and gender. **Study design:** The study group comprised 60 adult patients (age range 19–45 years) having normal hearing and complaining of hyperacusis with or without tinnitus. The control group comprised 20 normal hearing age and gender-matched individuals. All patients were subjected to full history-taking, otological examination, pure tone audiometry, immittance audiometry, uncomfortable loudness levels (ULLs) assessment, a transient evoked otoacoustic emissions (TEOAEs) test and, in addition, to the Arabic version of the Khalfa hyperacusis questionnaire. **Results:** The uncomfortable loudness levels indicated a markedly contracted dynamic range in the hyperacusis group, with the majority of individuals showing ULLs less than 90dB HL. Hyperacusis patients with tinnitus showed significantly lower TEOAEs amplitudes, with overall echo level and reproducibility percent lower than for hyperacusis patients without tinnitus or for the control group. Hyperacusis patients had higher means of total, attentional, social, and emotional scores on the Khalfa questionnaire compared to the control group. The emotional parameter of the questionnaire had the highest score for the hyperacusis patients. Both the emotional and attentional dimension scores were higher in females, while attentional scores were higher for males. The total and social dimensions were affected by age. **Conclusions:** The emotional impact of noise exposure was more severe than the attentional and social impact in hyperacusis patients. There was a gender difference evident in the results of the Khalfa questionnaire in hyperacusis patients. The Arabic version of the Khalfa hyperacusis questionnaire seems to be a fairly effective tool for the assessment of hyperacusis patients.

Key words: hypersensitivity to sound, hyperacusis, questionnaire, noise exposure, hearing loss, tinnitus

Introduction

Several words have been used to describe oversensitivity of hearing. In the past, these have sometimes been used without care, and without clear definition, and this was unhelpful for patients, clinicians and researchers. The term ‘hyperacusis’ was first used in medical literature by Perlman (1); a later modification was ‘hyperacusis dolorosa’, which reflects the emotional impact, but this was not widely adopted (2). Clinical hyperacusis consists of marked intolerance to ordinary environmental sounds while hearing thresholds are quite often normal (3). It is commonly used to describe the situation of a patient who reports discomfort for sounds that would be acceptable to

most normal hearing people, e.g. the ringing of the telephone or traffic noise (4). The prevalence of hyperacusis in the general population is unknown, but is likely to be underestimated (5). A population study from the south of Sweden (6,7) estimated a point prevalence of 8–9% in this population. Considering that clinically significant tinnitus affects approximately 4–5% of the general population, and considering that 40% of the tinnitus patients have hyperacusis, at least 2% of the general population experiences hyperacusis to a varying degree (8). Patients with this condition experience severe discomfort when faced with everyday environmental sound levels (9). Hyperacusis leads to adaptive

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behaviours, including auditory deprivation and social withdrawal. These behaviours have sensory as well as cognitive consequences. Habituation to the effects of noise is often linked to exposure, therefore avoidance of ordinary sounds may increase hypersensitivity (10).

Hyperacusis appears to be a subjective phenomenon, which is not defined or quantified by objective measurements. Therefore, the assessment of this phenomenon presents some significant challenges. In order to form an initial judgment of the degree of severity the clinician must listen carefully to the patient's description of hyperacusis (7).

In order to normalise subjects' reports, and quantify and evaluate auditory hypersensitivity, the questionnaire developed by Khalifa et al. is a suitable tool (4). The Khalifa hyperacusis questionnaire was translated into the Arabic language by the researchers in this study (Appendix 1). Khalifa et al. (4) suggested that the wide distribution of total scores demonstrates that the hyperacusis questionnaire is highly sensitive in discriminating subjects in the general population.

The hyperacusis questionnaire has three dimensions: attentional, social, and emotional. Each dimension is considered individually. First, the attentional dimension includes items that explore attentional deficits due to noisy conditions. The questionnaire item asking whether people ever use earplugs or earmuffs to reduce noise appears to be associated with this attentional dimension. It is possible that since these forms of ear protection decrease the intensity of a sound, they result in an increase in subjects' available attentional resources. Thus, this attentional dimension may be useful in detecting attentional deficits due to noise disturbance (4).

The second dimension reflects the social behavioural consequences of hyperacusis, given that hyperacusis patients often report avoiding social interactions (11), and have altered life styles (12). Scores obtained along this social dimension will contribute to the understanding of the distress and isolation experienced by hyperacusis patients in social interactions.

The third dimension corresponds to questioning of items on the emotional aspect of hyperacusis. The emergence of this emotional dimension was expected, since loudness tolerance is known to correlate with the emotional state of anxiety. Moreover, hyperacusis has often been reported in pathologies including emotional disorders such as autism. The emotional dimension of this questionnaire is likely to be of particular use in studying patients with psychiatric disorders (4).

The primary aim of this study is to evaluate the use of a translated Arabic version of the Khalifa questionnaire on a sample of normal hearing Egyptian

patients complaining of hyperacusis. The secondary aim is to compare the audiological criteria of this group of hyperacusis patients (with or without tinnitus) to a control group of similar age and gender.

Subjects and methods

Subjects

The study group comprised 60 adult patients (age range 19–45 years) complaining of hyperacusis with or without tinnitus, and the control group comprised 20 normal hearing age and gender-matched individuals. Patients were attending the audiology clinic of Kasr Al-Eini Hospital, Cairo University, which is a tertiary referral centre for audiology, and the audiology clinic of Beni Suef University Hospital. In the selection of patients, we excluded patients with a history of head trauma and ear surgery, occupational exposure to excessive noise and sensorineural hearing loss. The latter was to avoid patients who may have been subject to recruitment. Only patients with type A tympanograms were included in this study. The study took place in the period between April 2009 and March 2010 and informed consent was obtained from the patients prior to enrolment.

Methods

All patients included in this study were submitted to full history-taking, otological examination, audiological evaluation in the form of pure tone audiometry, speech audiometry, uncomfortable loudness levels (ULLs) assessment, immittance audiometry including tympanometry, ipsi- and contra-lateral acoustic reflexes, and transient evoked otoacoustic emissions testing (TEOAE). The equipment used in these tests was a two-channel clinical audiometer Madsen Orbiter 922, immittance meter – Grason Stadler Middle Ear Analyzer (GSI 33 version II) calibrated according to ISO standards and an Otoacoustic Emission Otodynamics Analyzer mounted on a 'Track PC', software ILO 96.

The questionnaire

The Khalifa questionnaire (Appendix 1) was translated into the Arabic language, (Appendix 2). The questionnaire is divided into two parts, the first of which includes three binary questions on general information concerning auditory disorders and noise exposure. The second part comprises the items that were scored. Fourteen self-rating items were included. Answers to each question/item were rated on a

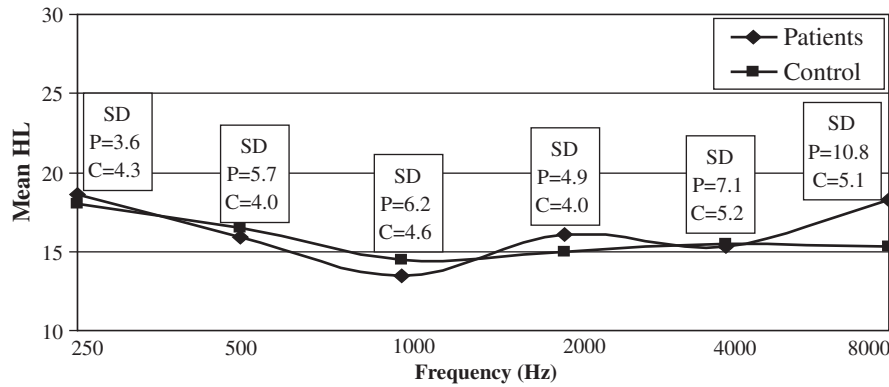


Figure 1. Comparison of the mean hearing level in dB HL at the main six frequencies (250–8000Hz) in the patient and control groups.

four-point scale, ranging from No (scoring 0 points); Yes, a little (scoring 1 point); Yes, quite a lot (scoring 2 points); to Yes, a lot (scoring 3 points). According to Khalfa et al. (4), a score of 28 is considered significant for the diagnosis of hyperacusis.

Statistical analysis

The data collected were entered into an Excel spreadsheet. Data were tabulated and statistically analyzed to evaluate the differences between the groups under study with regard to the various parameters. Calculations were made by means of Statistical Package for Social Science (SPSS), software version 15. The statistical analysis included the arithmetic mean and standard deviation for quantitative variables. Qualitative variables were expressed as numbers and percentages. Comparisons were made between different groups using the χ^2 test, and Pearson's correlation coefficient (r) was used between the essential studied parameters. Student's t -test was used for comparison between the means of two groups. A difference was considered statistically significant (S) when the probability (p)-value was <0.05 and highly significant (HS) when the probability (p)-value was <0.01 .

Table I. Comparison between all groups according to ULLs (dB HL) at frequencies (500–4000 Hz).

Group	Frequency (Hz)	<i>n</i>	Minimum	Maximum	Mean	SD
A	500	15	60	77.5	70	6.7
	1000	15	65	80	74	5.3
	2000	15	67.5	77.5	72	4.1
	4000	15	60	80	73	7.2
B	500	45	52.5	90	72.3	8.8
	1000	45	57.5	87.5	73.7	8.5
	2000	45	55	82.5	70.7	8.6
	4000	45	50	85	70.3	11.3
C	500	20	100	110	105.3	3.1
	1000	20	100	107.5	104.3	2.6
	2000	20	100	110	104.5	2.8
	4000	20	100	115	105.8	4.0

Results

The study group included 60 patients having normal peripheral hearing thresholds suffering from hyper-sensitivity to everyday environmental sounds: 15 patients without tinnitus (group A) with ages ranging from 23 to 40 years with a mean age of 29.1 ± 5.4 years, and 45 patients with tinnitus (group B) with ages ranging from 19 to 45 years with a mean age of 32.1 ± 5.5 years. Group A comprised seven (46.7%) males and eight (53.3%) females. Group B comprised 22 (48.9%) males and 23 (51.1%) females. The control group (group C) comprised 20 individuals with normal hearing sensitivity, not complaining of hypersensitivity to sound or tinnitus. Their ages ranged from 21 to 40 years with a mean age of 30.5 ± 5.6 years. The control group comprised eight (40%) females and 12 (60%) males.

The mean of the hearing thresholds (in dBHL) at the main six frequencies in the three groups was obtained. All subjects in this study had pure tone thresholds equal to or less than 25dB HL for all tested frequencies, as shown in Figure 1.

The uncomfortable loudness levels were markedly decreased in the hyperacusis groups A and B, mostly less than 90dB HL (Table I). However, no

Table II. Correlation between ULLs (dB HL) and the total, attentional, social and emotional scores on the Khalfa questionnaire.

Spearman's rho		ULLs (dB HL)	Sig.
Total score	R	-0.05	NS
	Sig.	0.970	
	N	60	
Attentional	R	0.125	NS
	Sig.	0.341	
	N	60	
Social	R	-0.56	NS
	Sig.	0.669	
	N	60	
Emotional	R	0.107	NS
	Sig.	0.418	
	N	60	

Table III. Comparison between groups A and B according to TEOAE response in dB SPL and reproducibility in percent.

	Group	n	Mean	SD	p-value	Sig.
Response (dB SPL)	A	15	14.8	4.5	0.009	HS
	B	45	10.7	6.4		
Reproducibility (%)	A	15	85.4	5.3	0.009	HS
	B	45	72.3	7.8		

statistically significant differences could be found between the scores of the individual scales on the Khalifa questionnaire and the ULL figures in the study group (Table II).

The mean TEOAE amplitude (dB SPL), overall response (dB SPL) and reproducibility (%) were compared between the hyperacusis patients without tinnitus (group A), hyperacusis patients with tinnitus (group B) and the control group (group C). This comparison revealed that hyperacusis patients with tinnitus had statistically lower TEOAE amplitudes at frequency bands 1, 2, and 3 kHz, overall response and reproducibility compared to hyperacusis patients without tinnitus as shown in Tables III and IV.

The TEOAE overall response (dB SPL) in group C (control group) was 17.3 ± 3.8 and reproducibility (%) was 93.1 ± 5.2 . Comparison between the TEOAEs results of groups B and C according to these two parameters revealed a highly significant difference ($p = 0.001$; $p = 0.002$, respectively). Hyperacusis patients with tinnitus (group B) had statistically lower TEOAE amplitudes at frequency bands 1, 2 and 3 kHz compared to the control group (group C) as shown in Table V.

The results of the Khalifa hyperacusis questionnaire revealed that the means of total, attentional, social and emotional scores on the questionnaire were higher in the hyperacusis groups than the control group (Tables VI and VII).

Table VI demonstrates a highly statistically significant difference between each two groups according to total score findings.

The emotional parameter of the questionnaire had the highest impact for hyperacusis patients (Table VII). Both the emotional and attentional

Table IV. Comparison of mean and standard deviation of TEOAE amplitudes (dB SPL) between groups A and B.

Frequency bands (kHz)	Group A		Group B		p-value	Sig.
	Mean	SD	Mean	SD		
1	9.8	2.7	6.2	4.0	0.002	HS
1.5	12.7	5.7	10.6	5.6	0.215	NS
2	11.6	3.4	8.5	4.9	0.027	S
3	11.6	5.7	6.6	2.3	0.001	HS
4	9	4.7	8.1	4.2	0.488	NS

Table V. Comparison of mean and standard deviation of TEOAE amplitude (dB SPL) between groups B and C.

Frequency bands in kHz	Group B		Group C		p-value	Sig.
	Mean	SD	Mean	SD		
	6.2	4.0	9.5	4.8	0.005	HS
1.5	10.6	5.6	10.4	5.6	0.894	NS
2	8.5	4.9	10.6	3.9	0.045	S
3	6.6	2.3	12.4	5.5	0.001	HS
4	8.1	4.2	9.4	4.5	0.264	NS

dimension scores were affected by gender; scores were higher in females than males on the emotional parameter, while males had higher values on the attentional parameter (Table VIII).

The social dimension of the Khalifa questionnaire was affected by age; it increases with age, and the same tendency was observed with the total score (Table IX).

Discussion

Clinical hyperacusis consists of a marked intolerance to environmental sounds, with hearing thresholds often normal (4), while the phenomenon of recruitment involves a more rapid than usual growth of loudness with increase in stimulus level. Recruitment is seen clinically in association with cochlear hearing loss, and has been specifically associated with outer hair cell dysfunction (7). For that reason, all subjects in this study had pure tone thresholds equal to or less than 25dB HL for all tested frequencies (Figure 1). A comparison of the mean uncomfortable loudness levels (ULLs) in dB HL between the hyperacusis groups (groups A and B) and control group (group C) was made (Table I). This study showed that patients with hyperacusis had significantly lower ULLs at all the indicated frequencies compared to the control group. These findings are in agreement with the results of Brandy and Lynn (12) and results of Marinus et al. (13). The mean of ULLs in dB HL in the hyperacusis groups was below 90dB HL, while the mean of ULLs in the control group was above

Table VI. Comparison between the two groups according to total score results on the Khalifa questionnaire.

Parameter	Group	N	Mean	SD	p-value	Sig.
Total score	Group A	15	20	7.9	0.001	HS
	Group B	45	28.9	5.3		
	Group A	15	20	7.9	0.003	HS
	Group C	20	9.6	6.3		
	Group B	45	28.9	5.3	0.001	HS
	Group C	20	9.6	6.3		

Table VII. Means and percentage of means of the attentional, social and emotional scores from the total score of the Khalfa questionnaire.

Parameter	Total score	Mean (%)		
		Attentional	Social	Emotional
Group A	20	4.2 (21)	6.2 (31)	9.6 (48)
Group B	28.9	6.9 (23.9)	12 (41.5)	10 (34.6)
Group C	9.6	2.9 (29.4)	2.3 (26.9)	4.4 (43.7)

100dB HL. These results are in agreement with those of Aazh (14), who reported that average ULLs were 90dB HL or lower in hyperacusis patients. However, there was no significant correlation between the ULLs and the total score and different scales of the Khalfa questionnaire used in our study (Table II).

TEOAE tests were performed in both the study group (groups A and B) and the control group (group C). The results were analyzed with respect to three parameters: the overall echo level, the whole reproducibility percent and amplitude across different frequency bands. A comparison of TEOAE results between the non-tinnitus affected group (group A) and tinnitus affected group (group B) was performed (Tables III, IV). It revealed that the non-tinnitus group had higher TEOAE amplitudes at different frequency bands (especially 1, 2, and 3 KHz) and higher overall response and reproducibility. This means outer hair cell damage according to some tinnitus theories. Mao et al. (15) also reported lower TEOAE amplitudes in tinnitus ears. Montoya et al. (16), on the other hand, reported an insignificant difference between tinnitus and non-tinnitus ears when comparing TEOAE amplitudes at different frequency bands.

The tinnitus group (group B) was compared with the control group (group C) (Table V). The results show higher TEOAE amplitudes in the control group, which were statistically significant at frequencies 1, 2 and 3 KHz. These findings are in agreement with the results of Hazell and Jastreboff (17) and Kamal et al. (18), who reported abnormal or reduced TEOAE amplitudes in tinnitus patients that hypothetically

Table VIII. Gender effect on the results of the total, attentional, social, and emotional scores on the Khalfa questionnaire.

	Gender	n	Mean	SD	p-value	Sig.
Total score	Male	29	27.8	6.7	0.274	NS
	Female	31	25.7	7.6		
Attentional	Male	29	6.6	3.8	0.034	S
	Female	31	4.9	2.4		
Social	Male	29	11.4	4	0.140	NS
	Female	31	9.8	4.3		
Emotional	Male	29	9.8	1.9	0.040	S
	Female	31	10.8	2.3		

Table IX. Correlation between age (years) and the total, attentional, social and emotional scores of the Khalfa questionnaire.

		Age (Years)	Sig.
Total score	R	0.49	S
	Sig.	0.043*	
	n	60	
Attentional	R	0.18	NS
	Sig.	0.169	
	n	60	
Social	R	0.67	HS
	Sig.	0.01**	
	n	60	
Emotional	R	0.08	NS
	Sig.	0.559	
	n	60	

R: Pearson correlation.

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).

could reflect minimal cochlear insult. In contrast, the study of Mor and Azevedo (18) reported no statistically significant difference when comparing TEOAE amplitudes between the study and control groups.

A comparison of the means of total, attentional, social and emotional scores between the study group and the control group was made (Tables VI, VII). This comparison showed that the study group had higher means of total, attentional, social, and emotional scores than the control group.

It is evident from Table VI that the emotional parameter had the highest impact for hyperacusis patients (highest mean values in groups A and B on this parameter compared to the other two parameters). Taking into consideration that the social parameter consists of six questions versus four for each of the other two parameters, the implication is that hyperacusis is associated with strong emotional distress and this may explain its association with many psychiatric disorders.

A comparison between males and females according to total, attentional, social, and emotional scores was performed. Both the emotional and attentional dimension scores were affected by gender. Scores were higher in females than males on the emotional parameter, while males had higher values on the attentional parameter (Table VIII). These findings are in agreement with the results of two studies indicating that 80% out of 30, and 65.4% out of 104 hyperacusis patients were females. This indicates that hyperacusis is either more prevalent in females or that females express their discomfort more readily than males (4). Males, on the other hand, might have more difficulty in concentrating or reading in noisy environments.

Our results revealed that the social dimension of the Khalfa questionnaire was affected by age. The social score increases with age, and the same tendency was observed with the total score (Table IX).

These findings are in agreement with the results of Anari et al. (20) who reported that such correlation may be explained by the fact that music or noise exposure is one of the possible causes of hyperacusis. Since older subjects are more likely to have been exposed to such acoustic stimuli, they are more susceptible to becoming hyperacusis. Therefore, a component of the questionnaire is sensitivity to age, suggesting that age is an important factor to take into account while assessing hyperacusis (4).

Conclusions and recommendations

We conclude from this study that hyperacusis patients had a significantly narrower dynamic range than the control group. Cochlear function as measured by TEOAE in hyperacusis patients with tinnitus was significantly lower than in hyperacusis patients without tinnitus. This difference was especially evident at 1, 2 and 3 KHz (mid frequencies). Results of the Khalfa questionnaire revealed that the emotional impact of noise exposure was more severe than the attentional and social impact in hyperacusis patients. There was a gender difference evident in the results of the different parameters of the Khalfa questionnaire in hyperacusis patients. The Arabic version of the Khalfa hyperacusis questionnaire seems to be a fairly effective tool for assessment of hyperacusis patients. We recommend the use of the Khalfa questionnaire for hyperacusis (Arabic version) on all patients complaining of intolerance to everyday environmental sounds (hyperacusis) and to introduce the Khalfa questionnaire in the assessment battery of patients complaining of tinnitus with normal hearing sensitivity. We believe that this will aid such patients in modifying their lifestyle to avoid the implications resulting from noise exposure.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Appendix 1. Khalfa hyperacusis questionnaire (4).

Preliminary questions:

1. Are you or have you been exposed to noise?
2. Do you tolerate noise less well as compared to a few years ago?
3. Have you ever had hearing problems? If so, of what kind?

	0	1	2	3
	No	Yes a little	Yes quite a lot	Yes quite a lot
1. Do you ever use ear plugs or earmuffs to reduce your noise perception? (Do not consider the use of hearing protection during abnormally high exposure situations).				
2. Do you find it harder to ignore sounds around you in everyday situations?				
3. Do you have trouble reading in a noisy or loud environment?				
4. Do you have trouble concentrating in a noisy or loud environment?				
5. Do you have difficulty listening to conversations in noisy places?				
6. Has anyone you know ever told you that you tolerate noise or certain kinds of sounds badly?				
7. Are you particularly sensitive to or bothered by street noise?				
8. Do you find the noise unpleasant in certain social situations (e.g. nightclubs, pubs, or bars, concerts, firework displays, cocktail receptions)?				
9. When someone suggests doing something (going out, to the cinema, to concert, etc.), do you immediately think about the noise you are going to have to put up with?				
10. Do you ever turn down an invitation or not go out because of the noise you have to face?				
11. Do noise or particular sounds bother you more in a quiet place than in a slightly noisy room?				
12. Do stress and tiredness reduce your ability to concentrate in noise?				
13. Are you less able to concentrate in noise toward the end of the day?				
14. Do noise and certain sounds cause you stress and irritation?				

استجاب خلفا الخاص بمرض فرط الحساسية للصوت

1. هل أنت تتعرض أو تعرضت للضوضاء ؟
2. هل تتأقلم مع الضوضاء بدرجة أقل من السنوات القليلة الماضية ؟
3. هل كان لديك يوما مشاكل في السمع ؟ إن وجد فمن أى نوع ؟

3	2	1	0	
نعم كثير	نعم كثير	نعم	لا	
جدا	نوعا ما	قليل		
				1. هل أنت دائما تستخدم واقيات الأذن لتقليل الإحساس بالضوضاء ؟ "لا تأخذ في الاعتبار استخدام واقيات السمع في حالات الضوضاء العاليه".
				2. هل تجد صعوبة في تجاهل الأصوات حولك في مواقف الحياة العاديه ؟
				3. هل تجد صعوبة في القراءة في الضوضاء ؟
				4. هل تجد صعوبة في التركيز في الضوضاء ؟
				5. هل تجد صعوبة في الاستماع للمحادثات في الضوضاء ؟
				6. هل هناك شخص أنت تعرفه أخبرك أنك تتأقلم مع الضوضاء او أصوات معينه بطريقه سيئه ؟
				7. هل أنت حساس أو تتضايق من ضوضاء الشارع ؟
				8. هل تجد الضوضاء تضايقتك في بعض المواقف الاجتماعيه ؟
				9. هل إذا اقترح شخص ما فعل شئ مثلا الذهاب للسينما تبادر بالتفكير سريعا في الضوضاء التي سوف تواجهها ؟
				10. هل ترفض دعوه أو ترفض الخروج بسبب الضوضاء التي سوف تواجهها ؟
				11. هل الضوضاء أو أصوات معينه تضايقتك في الأماكن الساكنة أكثر من الأماكن التي بها ضوضاء بسيطه ؟
				12. هل الضغط العصبي والتعب يقللان من قدرتك على التركيز في الضوضاء ؟
				13. هل تقل قدرتك على التركيز في الضوضاء في آخر اليوم ؟
				14. هل الضوضاء أو أصوات معينه تسبب لك ضغط نفسي أو تضايقتك ؟