The Cognitive Behaviour Therapist (2026), vol. 19, e20, page 1 of 10
doi:10.1017/S1754470X26100580

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ORIGINAL RESEARCH

Comparison of brief, self-administered exposure and sound therapy in the treatment of misophonia: an open-label, randomised study

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(Received 13 March 2025; revised 14 November 2025; accepted 25 February 2026)

Abstract

Misophonia is a condition characterised by intense emotional reactions to sounds that would not bother most people. Currently, there is no widely accepted and effective treatment for misophonia. Most published studies on treatment have used behavioural therapy, cognitive interventions, or audiological treatments; however, there is no comparison of the effectiveness of these approaches. This 6-week study aimed to compare the effects of brief, self-administered versions of exposure and tinnitus retraining therapy (TRT) in 58 adults with misophonia. The participants, randomly assigned to the two treatment groups and a wait-list group, were assessed at three time points (baseline, week 3, and week 6). The exposure group was given self-exposure homework assignments, where the patient was expected to self-expose to the live or recorded misophonic sound that was agreed upon during the week 0 assessment, for 20–40 minutes, three times a week. The patients in the TRT group were given a set of pre-recorded music pieces and asked to listen to any piece of their choosing for 20–40 minutes a day, three times a week. Self-report measures of misophonia severity (Misophonia Checklist), and interference due to symptoms were rated at each time point by the patients. The assessor also rated improvement at each time point. The study is registered in ClinicalTrials.gov (registration no. NCT05993286). The Intention to Treat (ITT) analyses revealed no difference between the three groups in terms of self-rated misophonia severity at week 6. The assessor-rated percentage of improvement favoured exposure, although the response rate was very low; only six out of 39 participants were rated as moderately or much improved, five of whom were in the exposure therapy group. The results underscore the need for finding ways to increase treatment response in misophonia.

Key learning aims

(1) To become familiar with the concept of misophonia; i.e. hatred of sounds.
(2) To evaluate the potential effectiveness of existing interventions for the treatment of misophonia.
(3) To gain insight into adapting established therapy methods to novel settings.

Keywords: exposure; misophonia; psychoeducation; sound therapy; treatment

Introduction

Background

Misophonia is defined as the condition where sounds that would not normally disturb most people arouse severe emotional reactions in the individual, such as anger, disgust, anxiety, or discomfort, upon exposure (Swedo *et al.*, 2022). The sounds, also called 'triggers', that people with misophonia are most disturbed by are human-induced, such as eating and smacking, swallowing, and snoring; or non-human sounds, such as clock ticking, dog barking, and water dripping. Misophonia can seriously affect patients' daily activities, social life and interpersonal relationships. Patients can try to cope with this situation in various ways; they use methods such as wearing earplugs, using earphones, not entering environments where sound may be encountered, leaving the environment when exposed to sound, suppressing the trigger sound with another sound (such as turning the television on), and even making the trigger sound themselves (Edelstein *et al.*, 2013). Misophonia is not yet included in psychiatric classification systems such as ICD (International Classification of Diseases and Related Health Problems) or DSM (The Diagnostic and Statistical Manual of Mental Disorders). In the audiology literature, it is defined as low sound tolerance (DST: decreased sound tolerance). Several research teams have attempted to define the misophonic syndrome, and some proposed diagnostic criteria for this condition (Dozier *et al.*, 2017; Jager *et al.*, 2020a; Kılıç *et al.*, 2021; Schröder *et al.*, 2013; Williams *et al.*, 2022). We have limited information on the prevalence of misophonia in the general population. General population studies conducted in the UK and Germany report probable misophonia rates to be between 5.9 and 18.4% (Jakubovski *et al.*, 2022; Vitoratou *et al.*, 2023). In a population-based epidemiological study conducted in Ankara, Turkey, the prevalence of misophonia was 12.8% (Kılıç *et al.*, 2021).

Treatment of misophonia

Currently, there is no evidence-based treatment for misophonia. Most reported studies on the treatment of misophonia are case reports and case series (Gregory and Foster, 2023; Gregory *et al.*, 2024; Mattson *et al.*, 2023). Comparative clinical studies are scarce (Ghorbani *et al.*, 2022; Jager *et al.*, 2020b; Jastreboff and Jastreboff, 2014; Schröder *et al.*, 2017). Based on the theory positing that the conditioned reflexes connecting the auditory system and the limbic and autonomic systems are similar in misophonia and tinnitus, Jastreboff and Jastreboff (2002) suggested that tinnitus retraining therapy (TRT), which takes 9–18 months to administer, can be used to treat misophonia (Jastreboff and Jastreboff, 2013). In their subsequent article, they reported a treatment success of 83% in the DST patient group of 167 patients with pure misophonia and 17 patients with combined hyperacusis and misophonia (Jastreboff and Jastreboff, 2014).

Apart from TRT, which is essentially a combination of cognitive education and desensitisation (Jastreboff and Jastreboff, 2023), cognitive behavioural therapy (CBT) is the most commonly reported type of treatment for treating misophonia. Due to the similarities of misophonia symptoms to obsessive-compulsive or phobic disorders, it is conceivable that exposing the misophonic person to the triggering sound in a controlled and gradual manner may lead to habituation or desensitisation to the trigger, as is the case for well-known exposure treatment of obsessions and phobias. Although Schröder *et al.* (2017) mention an unpublished pilot study that found exposure ineffective or even harmful, there are case reports showing its effectiveness (Altınöz *et al.*, 2018; Bernstein *et al.*, 2013; Hocaoğlu, 2018; Mattson *et al.*, 2023; McGuire *et al.*, 2015; Muller *et al.*, 2018, Singer, 2018). The only randomised controlled trial (Jager *et al.*, 2020b) on the subject showed significant improvement in the CBT group compared with controls in 54 patients (37% *vs* 0%).

As there is no established treatment method for misophonia, most of the interventions are experimental and researchers have modified conventional CBT to fit the needs of misophonic

https://doi.org/10.1017/S1754470X26100580 Published online by Cambridge University Press

patients (Altınöz *et al.*, 2018; Gregory and Foster, 2023; Gregory *et al.*, 2024). We have previously shown that a modified, short-term exposure therapy, relying mostly on homework assignments with minimal therapist contact, was effective in reducing misophonic symptoms in two of three female misophonic patients as early as at 4 weeks (Keskin Yıldız *et al.*, 2017).

In the current study, we aimed to compare the effectiveness of the above-cited short-term exposure homework (i.e. m-exposure) with modified music therapy (m-TRT) over the course of 6 weeks in people diagnosed with misophonia. We also had a control group that did not receive any active treatment. Our hypothesis was that the exposure group would show higher rates of improvement at the end of the treatment compared with m-TRT and the control group.

Method

The study design

This was a parallel-design, single blind, randomised study of misophonic out-patients. Misophonic patients were randomised to two treatment conditions and to a waiting-list control group. At the trial entry, all patients received a 30-minute psychoeducation session that provided basic information on the clinical features and known mechanisms of misophonic symptoms.

Sample

The sample was composed of participants over the age of 18 who were referred from Hacettepe University Hospital Psychiatry and Audiology Outpatient Clinics, or self-referrals who heard about the study through our posters or social media announcements. In order to be included in the study, the diagnosis of misophonia, based on the diagnostic criteria developed by our team (Kılıç *et al.*, 2021), and informed consent were required. In the two years (2019–2021) of data collection, 59 people out of 71 who volunteered for participation were eligible to be included in the study. People with current psychosis, intellectual disability or dementia, and those who had previously received exposure or TRT for misophonia symptoms were not included. Written informed consent was obtained from participants who were interviewed face-to-face. The participants, whose interviews had to be conducted by online video calls (due to the pandemic restrictions) gave verbal consent for participation.

Measures

The participants were evaluated using a battery consisting of both self-report questionnaires and clinical interviews conducted by the investigator (K.B.A.). Clinical interviews included the Misophonia Interview Scale (MIS) as well as a clinical psychiatric interview. The self-report measures included the Misophonia Total Score (MTS), and respondent-rated rating of interference with functioning due to symptoms. Other self-report measures of depression and OCD were also given, the findings of which will be reported elsewhere.

Misophonia Interview Scale

The MIS is an interview developed by researchers used in our previous study on the prevalence of misophonia (Kılıç *et al.*, 2021). It was administered by the investigator (K.B.A.). The MIS includes the Misophonia Checklist (MCL) that assesses 50 misophonic sounds that are read aloud to the patients one by one, and any degree of discomfort related to the sounds was coded on a 4-point Likert-type scale (0, none; 1, some; 2, moderate; 3, a lot). The rest of the MIS includes items required for a diagnosis of misophonia. The diagnostic criteria proposed by our team (Kılıç *et al.*, 2021) required the presence of one or more sounds coded as at least moderately disturbing, and

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the presence of severe emotional reactions (i.e. anger, disgust or distress coded as 'high') upon exposure to the misophonic sound. In addition, the symptoms must be severe enough to significantly affect daily functions. Misophonia Total Score (MTS), was also computed by summing up the 50 MCL items (range 0–150). The reliability for MCL in the current study was excellent (Cronbach's alpha = .96).

Treatment methods

Participants were randomly assigned either to a wait-list control group, or to either of the two active treatment groups: namely, the modified exposure therapy (m-exposure), and the modified tinnitus retraining therapy (m-TRT). All participants were assessed at baseline, and then at the end of third and sixth weeks. All participants randomised for inclusion received a 30-minute psychoeducation session at study intake. The wait-list control group received no further active treatment; the m-exposure group received a modified exposure protocol (see below), and the m-TRT group received a TRT protocol (see below) adapted for the current study aims. After the 6th week (endpoint), all patients were given the option of making an out-patient appointment to discuss the potential treatment options. The investigator was a psychiatrist experienced in administering m-exposure therapy in clinical practice; she carried out m-TRT under the supervision of an audiologist (S.A.) experienced in administering music therapy.

Modified exposure therapy

m-Exposure was based on our previous work with three misophonic cases who were treated with homework assignments of live exposure (Keskin Yıldız *et al.*, 2017). The main characteristics of m-exposure were: (1) short duration (endpoint at 6 weeks), (2) minimal therapist contact (therapist met with the patient at weeks 0, 3 and 6 only for target-setting and assessment of improvement/worsening), and (3) therapy consisted solely of homework exposure assignments; no therapist-assisted or in-session live-exposure was attempted. Each participant was asked to choose two misophonic sounds that they reported (in MCL) to be at least moderately disturbing. At the first treatment session [week 0 (W0)], the therapist reviewed the details about the sounds selected by the patient and their impact, confirmed that the selected sounds were actually misophonic, gave information about the basic principles of exposure therapy, and set homework assignments with mutual agreement. The homework assignment at the first treatment session (W0) was to expose oneself to these sounds for 20 minutes a day, 3 days a week, for 3 weeks. Two exposure options were presented to the participants: (1) making use of suitable real-life experiences or (2) listening to recorded trigger sounds (downloaded from the internet or recorded by the participant) for the required amount of time. At the second treatment session (W3), the investigator (K.B.A.) assessed the improvement, degree of adherence, deviations and the reasons for deviation from the protocol. The frequency and duration of homework assignments for the next 3 weeks were adjusted based on the degree of improvement in the symptoms and the person's adherence to the protocol. If the patient, despite adhering to the protocol, was rated as 'not improved or little improved' by the investigator, the instruction was modified (intensified) to listening to the same triggers for 40 minutes a day, 3 days a week. If the patient did improve, or did not/could not adhere to the protocol, the previous assignment was given again. At the end of the 6-week trial (W6), the patients were offered the option to make an out-patient appointment to discuss the available treatment options.

Modified tinnitus retraining therapy

m-TRT was adapted from the TRT protocol developed by Jastreboff and Jastreboff (2002) for treatment of misophonia. In accordance with the original protocol, the procedure was structured in 3-week cycles, with sessions lasting 20 minutes. To parallel the m-exposure therapy protocol,

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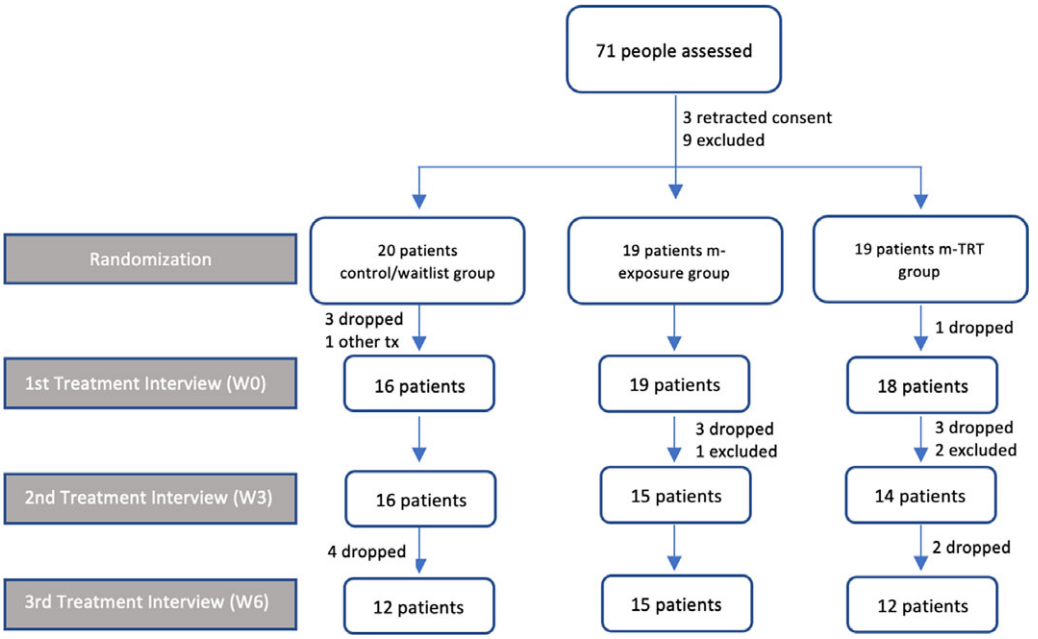

Figure 1. The recruitment of the participants.

the frequency was adjusted to 3 days a week rather than daily. Unlike TRT, which does not specify the type of music to be used in the protocol, we decided to use three groups of music, based on the clinical experience of our audiology department in the treatment of misophonic patients: white noise (equal volume in all octaves), pink noise (decreasing by 3 dB per octave towards high frequencies), and relaxing instrumental music. Forty music pieces (consisting of these three types of music) prepared for the study were given to the participants as audio files. They were advised to use earphones or headphones and were told they were free to choose which music piece they want to listen to. As m-TRT is one of the two active treatments, the instruction was modified to fit that of exposure instructions. At the first treatment session (W0), participants were instructed to listen to these music pieces for 20 minutes a day, 3 days a week, for the first 3 weeks. If, at the W3 assessment, despite adhering to the protocol, patients were rated as 'little or no improvement' by the investigator, the instruction was modified (intensified), requiring them to listen to the music for 40 minutes a day, 3 days a week. If the patient did improve, or did not/could not adhere to the protocol, the previous assignment was given again. At the end of the 6-week trial, the patients were offered the option to make an out-patient appointment to discuss the available treatment options.

Procedure

The recruitment of participants to the study is shown in Fig. 1. All patient recruitment was done by the investigator (K.B.A.).

Data collection started before the COVID pandemic (1 March 2019) and ended within the pandemic period (1 April 2021). During the pandemic, interviews (and assessments) were conducted through online video call. Although all participants were referred to the audiology department for an audiologic screening, due to the pandemic conditions, audiologic screening could be done for only 17 (29.3%) patients of the final sample. In order to reduce potential bias in patient selection, each eligible participant was randomly assigned to a treatment or control group by the study supervisor (C.K.), a senior psychiatrist (i.e. the allocation was concealed from the

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investigator until the start of treatment). The supervisor also held regular weekly sessions with the investigator (K.B.A.) to monitor treatment progress. Among the 71 that attended the screening session, nine were excluded as they did not qualify for a misophonia diagnosis, and three retracted their consent; the remaining 59 were randomised to either of the two treatment groups or to the wait-list control group. The data file of one participant was lost due to a technical error. The baseline analyses, therefore, were based on 58 people with full data at randomisation. After randomisation, four participants did not show up for the first treatment session (i.e. dropped out), and one was excluded because of having previously received treatment for misophonia.

The first treatment session (W0) was attended by 53 participants and all were given psychoeducation by the investigator (K.B.A.). At the same session, they were given either m-exposure or m-TRT instructions depending on which active treatment group they were in. Those in the wait-list control group were instructed to continue in the same way as they always dealt with their misophonia symptoms. The participants were not told what the treatments in the other groups were; they were only informed that there was no drug treatment in any of the groups. Treatment adherence was recorded (by K.B.A.) in the two treatment groups (0, not at all; 1, a little; 2, moderate; 3, much) at W3 and W6. Reasons for non-adherence, if present, were discussed and resolved at W3. There was no significant difference in terms of adherence to the protocol between the two treatment groups.

Statistical analyses

The sample size was not the same at each time point, due to drop-out between assessments. Consequently, we included all participants who were randomised at study intake ($n = 58$) in our analyses. We employed LOCF (last observation carried forward) method to account for the respondent attrition. Below are the variables we included in our analyses.

Demographic variables

These were age (18–60), education level (0, illiterate; 5, graduate education), monthly household income (1, 0–1000 TL; 6, more than 5000 TL), gender (1, male; 2, female), marital status (0, not married; 1, married), and occupational status (0, unemployed; 1, employed).

Outcome variables

Assessor-rated improvement variable. The investigator (K.B.A.) rated improvement at W3 and W6 based on her clinical judgement, taking into account the number of sounds that remained as triggers, the extent of emotional response to triggers, functional impairment, and the amount of avoidance. The 5-point Likert scale (0, some worsening; 1, no improvement 2, some improvement; 3, moderate improvement; 4, much improvement) was further recoded into a binary variable: the case was rated as 'improved' if there was a moderate to large improvement at either W3 or W6; the rest were rated as 'not improved'. The binary assessor-rated improvement variable was used in analyses.

Misophonia total score. This was filled in by the respondent at W0, W3, and W6.

Interference due to symptoms. This was rated by the respondent (0, no interference; to 3, much interference) at W0 and then at W3 and W6.

Analyses

SPSS v.25 program for Mac was used for statistical analyses. The relationship of the outcome variables in each of the three groups with variables such as age, gender, education, marital status and income was examined using ANOVA or chi-square tests.

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Table 1. Demographic characteristics of study participants at baseline ($n = 58$)

	Control (wait-list) mean (*SD*)	m-Exposure mean (*SD*)	m-TRT mean (*SD*)	Total mean (*SD*)	*F* (d.f.)	*p*	
Age	27.4 (9.1)	29.2 (9.9)	29.7 (8.7)	28.7 (9.1)	.36 (2)	0.7	
Education (0–5)	3.85 (.81)	3.68 (.82)	3.74 (.65)	3.76 (.75)	.24 (2)	0.79	
Monthly family income (1–6)	4.25 (1.37)	4.11 (1.48)	3.79 (1.78)	4.05 (1.53)	.45 (2)	0.64	
MTS total score	67.1 (27.5)	70.4 (28.4)	69.0 (31.7)	68.8 (28.8)	.63 (2)	0.94	
Interference due to symptoms	1.9 (.97)	1.74 (.87)	1.84 (1)	1.83 (.94)	.15 (2)	0.87	
	n (%)	*n* (%)	*n* (%)	*n* (%)	χ^2	*p*	Cramér's V
Single	15 (75)	14 (73.7)	14 (73.7)	43 (74.1)	2.4	0.88	.15
Employed	11 (55)	10 (52.6)	12 (63.2)	33 (56.9)	.11	0.95	.04

Results

The demographic variables of the study participants ($n = 58$) by treatment group are shown in Table 1. Mean age was 28.7 years (*SD* 9.4, range 18–60); 45 (84.9%) were female. Participants randomised to the three study groups did not differ in terms of demographic variables such as age, gender, educational status, monthly household income, and marital or occupational status. The groups were also similar at baseline in terms of disorder severity, as measured by the misophonia total score (MTS), and interference due to symptoms.

Table 2 shows the respondent-rated outcome variables at the last assessment (W6). The reductions in those variables throughout the study were small and similar across the three groups (not reported). There were no significant differences at the end of treatment (i.e. W6) between the groups regarding respondent-rated outcome variables (i.e. MTS, interference). The assessor-rated binary measure (i.e. 'improved/not improved'), on the other hand, favoured exposure; the exposure group had a small but significant superiority to other groups at the end of the study. The total number of 'improved' cases at W6 was 6; five of them were in the exposure group (data not reported).

Discussion

Misophonia is a disorder that causes severe disability, and its effective treatment is not yet known. While our findings can only be considered as preliminary, this is the first randomised study to compare the effectiveness of two different methods in the treatment of misophonia with each other and with a wait-list control group. During the 6-week treatment period, the respondent-rated severity measures showed only a slight reduction in all three groups. Similarly, although the percentage of improved cases at the end of the study, as rated by the assessor, was significantly higher in the m-exposure group than the other groups, overall rate of improvement was very low. Despite the fact that our study failed to replicate the positive treatment results reported in the literature, we nevertheless believe it is an important step in developing effective methods in treating this condition.

Our study has several limitations. First, neither of the active treatments was standard: they were both modified, brief and self-administered versions of established methods, necessitated mostly by constrained clinical conditions. The audiology literature suggests that TRT should be applied every day of the week for at least 9–18 months to be effective (Jastreboff and Jastreboff, 2013). Conducting such an intensive and long-range treatment regimen was not feasible in our clinical or research setting; it would also be very hard to devise a parallel comparison (i.e. exposure) group. As our main aim was to test the success of brief, self-administered exposure, we chose to follow the suggestions of 6-week cycles of music therapy (Jastreboff and Jastreboff , 2002). It is likely that this modification may be one of the reasons for lack of improvement in the m-TRT group, and adapting the suggested 9–18 month regimen may increase treatment response. Second, exposure is one of the most widely used psychotherapy methods, and its effectiveness in anxiety disorders, phobias and OCD is well-documented. Although established treatment manuals require

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Table 2. Outcome variables across study groups at the last assessment (W6)

	Control (wait-list) mean (*SD*)	m-Exposure mean (*SD*)	m-TRT mean (*SD*)	*F*	*p*	Partial η^2
Misophonia total score (MTS)	55.2 (24.4)	56.9 (34.72)	60.4 (36.89)	0.13 (2)	.88	.00
Interference due to symptoms	1.90 (0.97)	1.74 (0.93)	1.68 (0.89)	0.29 (2)	.75	.01

6–14 weekly therapy sessions (Beck and Wright, 1997), special circumstances may necessitate adaptations in technique. Ours was a brief, homework assignment-based exposure treatment with minimal therapist involvement. The patients in the m-exposure group were free to choose between real-life exposure or recorded trigger sounds. The lack of standardised homework assignments may have negatively affected the therapeutic success in that group. Using pre-recorded sounds (as we did in the m-TRT group) would have given the investigator more control over the administration of the treatment (i.e. which sounds the patients listened to, for how long, and how often). Third, we did not assess in detail behaviour that would violate the protocol. For example, we did not ask participants in the m-TRT group if they intentionally did exposure to misophonic sounds, or if those in the m-exposure group listened to modified music, or if those in the wait-list control group did exposure or listened to modified music.

Other limitations include the small and non-representative sample. The number of patients who completed treatment in each group was between 12 and 15. When comparing small numbers of patients, even small numbers of drop-outs can have a large effect on the outcome. As the sample size dropped from 58 at randomisation to 39 at W6, we used intent-to-treat (ITT) analysis to account for the missing observations. Our participants were younger, more educated, and had higher income than the general population. They had also more severe levels of misophonia than we found in the general population (Kılıç *et al.*, 2021). All of these may have affected our results and limit the generalisability of our findings. A potential source of bias was the absence of blinding: treatments and assessments were carried out by the same researcher (a psychiatrist). Ideally, in treatment studies, assessment and treatment should be done by different people to avoid bias (Pannucci and Wilkins, 2010). The investigator was a psychiatrist experienced in administering m-exposure therapy in clinical practice; she carried out m-TRT under the supervision of an audiologist (S.A.) experienced in administering music therapy. The qualifications of the therapist may have led her to favour the method she knows better (i.e. better manage problems or be more successful in suggesting appropriate homework assignments for patients in the m-exposure group).

Conclusions

The study highlights the fact that there is still a long way to go in effectively treating misophonia. Although the results showed some improvement in the m-exposure group, the rate of improvement was very small, and was only observed in the assessor-rated measure. Instead of implementing established protocols, we used our own treatment approaches that were based on our previous experience and were compatible with our resources. The success or lack of it therefore may not be attributed to the conventional therapeutic approaches, and choosing the conventional protocols may have resulted in better outcome for one or both of the active treatment groups. Future studies with larger samples, employing more frequent therapy sessions, and standardised homework, may address the limitations of the current study.

Key practice points

(1) There is no known/established treatment for misophonia.
(2) Best results so far have been obtained with therapies that are based on cognitive-behavioural principles.
(3) There is a need for exploring other potential treatments.

https://doi.org/10.1017/S1754470X26100580 Published online by Cambridge University Press

Further reading

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Data availability statement. The data that support the findings of this study are available upon reasonable request from the corresponding author, C.K., with the permission of Hacettepe University.

Acknowledgements. None.

Author contributions. All authors have made substantial contributions to the conception and design of the work; K.B.A. collected the data under the supervision of C.K. C.K. and K.B.A. ran the analyses, interpreted the data and wrote the first draft; S.A. and G.O. revised the first draft critically for important intellectual content. All authors gave final approval of the version to be published; and all agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Financial support. This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Competing interests. The authors declare none.

Ethical standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by Hacettepe University Ethics Board for non-interventional clinical research 18.9.2018; GO 18/878-09. The trial was registered on ClinicalTrials.gov (NCT05993286).

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Cite this article: Avanoğlu KB, Öz G, Aksoy S, and Kılıç C (2026). Comparison of brief, self-administered exposure and sound therapy in the treatment of misophonia: an open-label, randomised study. *The Cognitive Behaviour Therapist* 1–10. https://doi.org/10.1017/S1754470X26100580