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The effect of brown and black noise on persons suffering from a low frequency sound

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ABSTRACT

Some people suffer from hearing an often untraceable low-pitched sound. To help them two types of low frequency noise (brown and black noise) were put on CD. Sufferers could obtain this free CD on request. Over the course of more than 10 years about 200 CD's were sent out. In these 10 years 26 applicants have given a spontaneous reaction by e-mail after having used the CD for a shorter or longer period of time. Twenty three of these comments were (very) positive, two comments stated the CD did not help. In 2018 a retrospective survey was designed for those that had requested a CD before November 2018. The main goal of this study is to investigate how the complaints have changed over time in relation to the use of the CD. Further questions examine which other measures participants have taken and how they use(d) the CD in practical terms (brown and/or black noise, playing time, frequency of use, volume). The study started in February 2019 and a first analysis will be given in the paper. This may inspire others to help sufferers by using the same method. This could be an opportunity to include more participants in different areas.

Keywords: Low Frequency Sound, Hum

1. INTRODUCTION

Some people hear an intrusive, low pitched sound or 'hum' coming from an unidentified source. They may have serious health complaints, especially with respect to sleep. A lot of studies have been done on this topic (1). Nevertheless, no definite answer to the cause or source of such complaints have been found. Hypotheses range from a physical, external low frequency sound coming from a variety of sources to a neurological, internal cause. After about 10 years of research of this phenomenon we found that, at least in a number of cases, sound measurements did not help to determine the sound causing complaints nor its source. As a result, physical or technical solutions were not possible. Measurements had shown (2) that there was no clear difference of low frequency sounds in dwellings with or without complaints. Sound levels were on average as low as 25 dB(A) in daytime and 24 dB(A) at night, with a low frequency share (< 100 Hz) of 17 and 14 dB(A) respectively. This led to consider other types of help, based on the hypothesis that the relative absence of sound at night could be an important factor.

There is a practical reason and there are two considerations to think that adding sound to the dwelling (especially the sleeping room) could be beneficial for a complainant:

1- Many complainants told that added sound could help to cope with the intrusive sound. This could be from a ventilator or the ventilating system, music, radio, natural sounds and even a washing machine.
2- In a quiet environment soft sounds may be well audible, even though the level may be below any official limit. If such a sound has a negative association, it is likely to be a source of complaints.
3- In a quiet environment most elderly perceive tinnitus sounds, and in experiments most normal hearing persons hear sounds when put in a very quiet room (3). A possible explanation is that the absence of physical, external sound may result in picking up electrical noise in the brain which, in the audiocortex, is interpreted as sound.

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Thus, adding sound will either distract attention from a soft sound (point 2) or cause a signal in the audiocortex resulting from real sound (point 3). Both possibilities are supported by point 1. This led to the idea of producing a CD, in 2004 the most obvious generally available sound carrier, with a noisy sound at low frequencies. The choice was made for brown and black noise, because pink noise and certainly white noise to the ear are rather high pitched. In white noise sound energy per Hz is constant, in pink noise it falls with 1/f, in brown noise with $1/f^2$ and in black noise with $1/f^3$.

2. Study aim and method

2.1 Study aim

Since 2007, over 200 persons have requested the CD at the Beta Science Shop of the University of Groningen. Comments sent by 26 users showed that most of them (24) felt relief as a result of the black or brown noise on the CD. In 2018 it was decided to do a survey including all requesters to obtain a more objective view of the effect of the CD. The main study question was:

what is the effect of the use of the brown/black noise CD on complaints from the low pitched sound that troubles the complainant?

For people who had requested the CD in the past, the effect of the CD sound can only be determined from their (remembered) judgement. This is sufficient when considering satisfaction of the complainant with the CD. It is not suitable for determining the effect of the CD sound as such, as there is no objective factor on which to base this effect for this group. However, information about the development of complaints before and after use of the CD and a comparison with other mitigation measures may support the existence of the effect of the CD-noise as such.

2.2 Study method and material

The study is based on a survey of all those that requested the CD since 2007. For this period all requests with e-mail and postal addresses had been kept. It was expected that not all could be contacted because of a) changes in e-mail and/or postal addresses, b) some had requested the CD for someone else or for other purposes than self-help, and c) persons could be incapable of taking part in the survey or even be deceased (as it was expected that a significant part would be elderly persons).

The questionnaire was divided in four topics: 1) the development of complaints and the use of (other) measures to be less troubled by the intruding sound before the use of the CD; 2) the development of complaints after the use of the CD; 3) the actual use of the CD with respect to type of noise, volume, time and frequency of use; 4) general questions and possible remarks or questions from the respondent. The draft questionnaire was sent to four audiological specialists, two professionals from environmental health services and a team of four researchers in neuropsychology, all familiar with low frequency noise problems. The questionnaire was adapted according to their comments.

To determine whether respondents were self-selected (e.g. because of a positive effect of the CD) and not a random part of the study group, a non-response test was added. This test consisted of only two questions taken from the complete questionnaire: one about the period of use, the other about the perceived effect of the CD.

The questionnaire was made available online and on paper. As a first step all persons with an e-mail address would be requested to take part in the survey. Then those with no or an invalid e-mail address would be sent a request by post. Those not reacting to the first step were sent a reminder. As a last step all non-responders, i.e. those not having reacted at all, would be sent a second request, either by e-mail or post, to answer the two questions about the use and perceived effect of the CD.

2.3 New study

In a separate study that started in November 2018, we monitor the gravity and frequency of complaints of persons requesting the CD (or a digital file) at three points in time: before use of the CD, and one and three months after having started to use the CD. This will be done with three separate questionnaires that together are similar to the single questionnaire in the present study. Results will be available in 2020. If more researchers or institutions would like to distribute the CD (or digital sound files) and include the survey, the study group could be larger and include possible national differences.

3. RESULTS

3.1 Study group and respondents

As of November 2018 a total of 216 requests for the CD had been received and kept in archive. For all except 4 e-mail addresses were available, but 18 addresses did not exist anymore. These 22 persons were sent a postal request.

Table 1 gives an overview of reactions to the request to take part in the survey. For 5 persons there was no or no correct e-mail and postal address, so these were excluded. 89 persons did not react to the first request and they were sent the two questions from the non-response test. 39 responded to this second request with a reply to the two questions or even yet the completion of the full questionnaire, or they stated they had not used the CD (which was often why they had not reacted in the first stage). This leaves 50 persons who did not react at all. It was not possible to determine if these addresses were still in active use. Also, some could be unwilling to take part or could have moved or even died, so it is not clear how many of them do belong to the study group. If all would be potential respondents, there would be a 60% response, if none would be, the response would amount to 85% (see table 2).

Table 1 – Number of persons involved in the study and reaction to the first and second request to take part

Number of persons who ordered a CD		216		Number of persons in non-response test with two questions		89
Persons reacting to first request	questionnaire completed	100		Persons reacting to second request	two questions answered	15
	decline completion [1]	5			yet completed full questionnaire	3
	not applicable [2]	14			not applicable [2]	20
	deceased	3			deceased	1
	insufficient contact information	5				
	total	127			total	39
Persons not reacting to first request		89		Persons not reacting to second request		50

Notes: 1- because it was too long ago/did not remember (3), questionnaire too complicated, questions did not apply to complaints; 2 - CD not used

Table 2 – Number of persons and response in study group

	Including no reaction at all		excluding no reaction at all	
Total in study group [3]	173	100%	123	100%
respondents [4]	103	60%	103	85%
responding non-respondents [5]	20	12%	20	16%
no reaction at all	50	29%		

Notes: 3 - not included: not applicable, deceased, insufficient contact information; 4 - questionnaire completed; 5 - included: completion denied, non-response questions answered

Figure 1 shows the age and gender of the 103 respondents. The age was determined at the time of the request for the CD; the median value was 55 years. 33% of the respondents were male.

The number of respondents per question may be less than 103 as not all questions have been answered by all respondents. For some questions, answer categories were given but could include a category ‘other’ that is not included in the results.

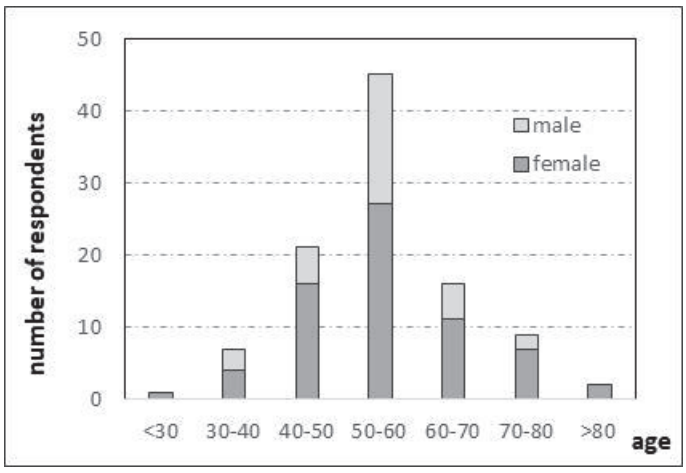

Figure 1 – respondents' distribution over age and gender (N=103)

3.2 Situation respondents *before* the use of brown/black CD- noise

In nearly all cases (100) the cause of complaints was a low pitched sound or hum. Almost one out of three respondents (29) were troubled by vibrations as well as a low pitched sound and just over one out of six (18) by pressure on the ears and a low pitched sound. 14 respondents were troubled by all three. As was indicated in the questionnaire, for convenience the term '(disturbing) sound' would be used, but it would include the other perceived causes. The same term and meaning will be used here.

When asked to rate the trouble or disturbance caused by the disturbing sound on a scale of 1 (no trouble at all) to 10 (very much trouble), 89 respondents gave a score of 8, 9 or 10 and only two less than 5.

Respondents have tried to be less troubled by the disturbing sound by taking measures at home. The question about mitigation measures had three answer categories: no, not tried; yes, but did not help; yes, and it helped. As figure 2 shows, some measures have been tried by most respondents, such as using earplugs, using other sound or trying to ignore the sound. Adding sound insulation was the least applied measure and only helped in two cases. The most effective measure, being effective for 26 out of 49 who tried it, was using a medicine (such as a sleeping drug) to lessen the effect of the disturbing sound. However, in practice using another sound was more efficient as its was tried by more persons which led to more positive results: out of 91 respondents who tried it, the use of a sound to lessen the effect of the disturbing sound helped 40 of them. It follows from figure 2 that respondents found other measures, if tried, not very effective. Another place to sleep, using earplugs or trying to ignore the sound only helped a small percentage.

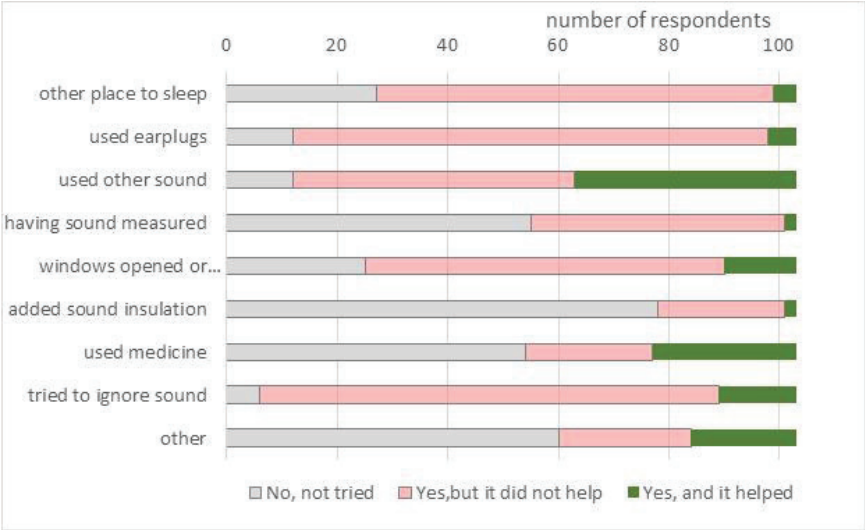

Figure 2 – possible mitigation measures that respondents have tried (or not) *before* use of the CD and respondents' judgment on their effect

3.3 Situation respondents *after* the use of brown/black CD-noise

The next subject in the questionnaire was about the situation after starting to use the CD. Again it was asked to rate the trouble caused by the sound (or other causes) on a scale of 1 to 10, but now for the present situation. In this situation the number of respondents was more or less the same for each score. This is shown in figure 3 together with the distribution of respondents over scores before CD use.

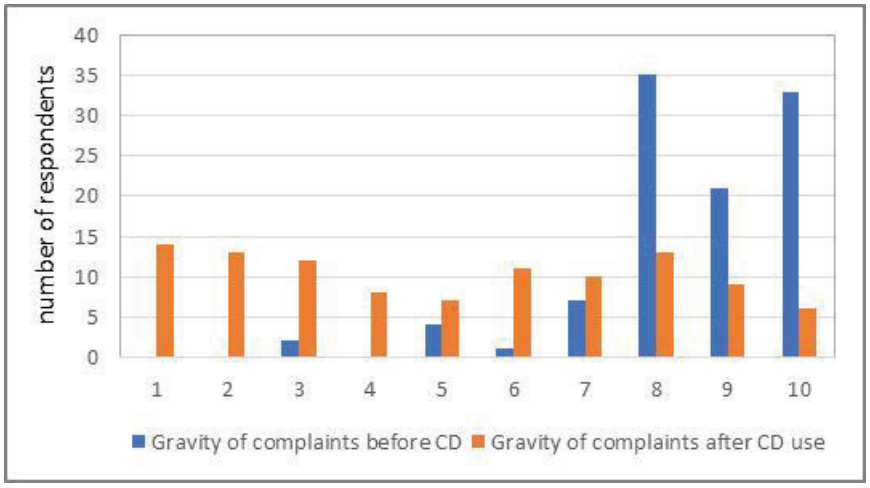

Figure 3 – scores for gravity of complaints before and after use of the CD

Do complaints fade out over time? We can find some information about this if we relate the answer to the question "How often does the sound trouble you now" to the date the CD was requested (which normally was close to the first use). In figure 7, with respondents divided in three periods with an approximately equal number of requests for the CD, the main difference between the three groups is that the number of respondents being troubled 'often' decreases over time, while at the same time the number of respondents being troubled 'sometimes' increases over time. The result (figure 4) shows that complaints of a low pitched sound persist over many years, though the frequency of being troubled by it decreases over time.

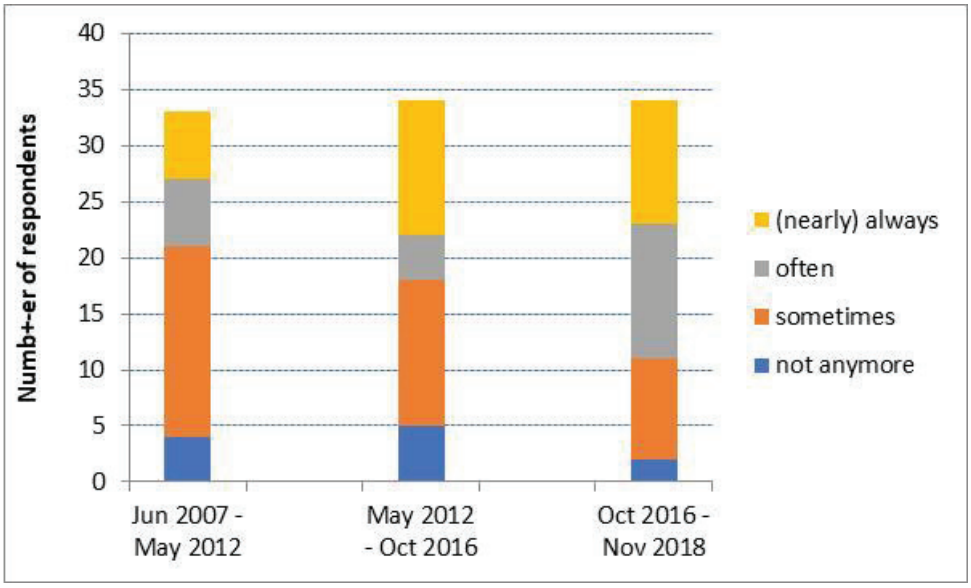

Figure 4 – frequency of being troubled by the disturbing sound

in relation to the time period the CD was first used

3.4 Effect of the CD with brown/black noise

After use of the CD 7 respondents were more troubled by the sound than before and 34 had not noticed a difference. In contrast, 32 respondents were somewhat less troubled and 30 were much less troubled. Could this be because of the CD? When asked if the CD had contributed to the change in

complaints, 23% thought it had contributed a lot and 29% thought it had contributed somewhat to reduce complaints. 33% thought the CD had not made a contribution, the remaining 12% respondents did not give a clear answer (table 3, one respondent missing with change in complaints unclear). Thus, the positive outcome is that after using the CD 60% of the respondents had less complaints. 52% attributed an improvement to a large or smaller degree to the CD.

Table 3 – Relation between change in complaints and contribution of CD to that change

Contribution of CD to change in complaints	less complaints		no change		more complaints		*sum*	
a lot	24	23%					*24*	*23%*
somewhat	25	24%	5	5%	2	2%	*32*	*31%*
none	6	6%	23	22%	5	5%	*34*	*33%*
no definite answer	7	7%	5	5%			*12*	*12%*
sum	*62*	*60%*	*33*	*32%*	*7*	*7%*	*102*	*99%*

Respondents who think the CD helps a lot have used the CD for at least 2 weeks, but most much longer (> year). On the other hand, just over half of those who think the CD did not help to reduce complaints have used the CD for no more than a few days, though some tried it for a month or longer.

Figure 5 shows two plots similar to figure 4, but here the four categories of respondents being troubled are given as percentages per time period. The two plots represent two groups of respondents: those who think that the CD had helped to reduce their complaints (at left) and those who did not think the CD had helped (right). The main difference between both plots is for those who requested the CD between 2.5 and 7 years ago. Respondents from this period and who think the CD helped, are far less troubled by the disturbing sound than respondents from the same period who did not think the CD helped: 80% of those who thought the CD helped are now sometimes or not at all troubled, in contrast to the 27% of those that thought the CD did not help. In the period after October 2016 there is no clear difference between the 'helpful' and 'not helpful' group in the percentage of respondents that are not or only sometimes troubled. However, there are relatively more respondents in the 'not helpful' group who are (nearly) always troubled when compared to the 'helpful' group.

The percentages for those first using the CD in 2007-2012 are rather similar for both groups. However, one must keep in mind that the number of respondents in a column can be quite small, so percentages can change considerably (5% to 12%) when only one person is in- or excluded. Also, 12 respondents are not include in figure 9 as they gave no clear answer whether the CD had helped.

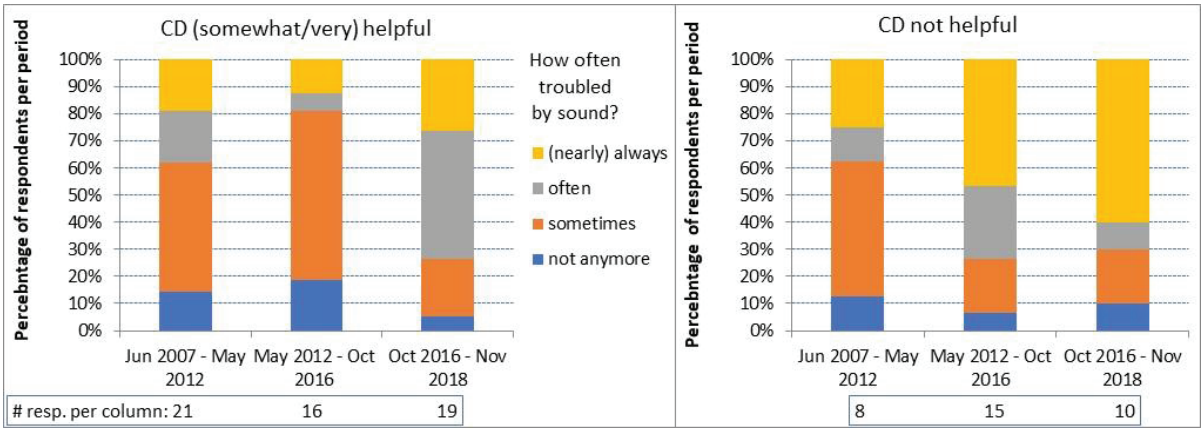

Figure 5 – frequency of being troubled by the disturbing sound in relation to the time period the CD was first used for two groups: those who think the CD contributed somewhat/a lot to reducing complaints (left) and those who do not think the CD contributed (right). Bottom row: total number of respondents per column.

3.5 Effect of other sounds

Respondents were asked if sound other than the CD-noise had helped reduce their complaints. One third reported they had used other sounds. Most mentioned noisy sounds (noise machine or app, ventilator, radio static), others nature sounds (rain, water sounds, trees and wind) and music or speech. 50% of them reported less complaints from the disturbing sound. Half of these respondents still contributed the improvement to the CD, perhaps because some of them used both the CD and another sound and some others used a noisy sound similar to the CD-noise. Perhaps some respondents interpreted the question whether the CD had helped in a broader sense, extending it to their helpful sound. Table 4 shows the relation between the change in complaints and the use of only the CD or another sound (possibly added to the brown/black noise-CD).

Table 4 – change in being troubled by disturbing sound in relation to use of brown/black noise CD or other sound (not or not only the CD)

			Have complaints changed over time?							
Sound used	number of respondents		decreased a lot		decreased somewhat		no change		increased somewhat	
CD	65	100%	21	32%	22	34%	18	28%	4	6%
Other sound [1]	36	100%	9	25%	10	28%	15	42%	0	0%
Total	*103*	*100%*	*30*	*29%*	*32*	*31%*	*34*	*33%*	*7*	*7%*

Note: 1 - possibly together with CD

3.6 Use of CD

At the time of the survey, 60% of the respondents had stopped using the CD, 18% of the respondents still used the CD and 11% more used it only occasionally (plus 11% unclear).

27% of the respondents only played the track with brown noise, 16% only black noise and 28% both; 26% did not know or remember. Most (52%) respondents heard the noise from small speakers of a computer or audio-set; 17% from separate, large speakers; 14% through earphones or a headset; the remaining 17% did otherwise. According to their own judgment, 5% played the sound at a very low volume, 37% at low volume, 21% soft nor loud, 24% loud and 12% very loud. 82% thought the sound quality was good, 9% thought it wasn't.

The CD was usually played in the evening (10% of respondents), when going to sleep (42%) or at night (33%); for some (15%) it could be any time of the day. When respondents started to use the CD, 56% played it (nearly) every day, 23% a few times a week and 19% a few times per month or less. After some time most used the CD a little less (14%) or far less (57%) and only 3% used it more often; for 25% there was no change. Initially, when using the CD, many played it for an hour or more (57%), 24% played it for less than an hour (but more than 10 minutes) and 19% played it less than 10 minutes. After the initial time, most (58%) continued this playing time, 11% played the CD for a longer time and 8% shorter. For 23% the playing time varied according to the needs per day.

3.7 Non-response test

After the initial request to take part in the survey and a reminder, 89 persons who had not reacted were asked to help us improve the survey quality by answering just two questions. Both questions were taken from the full questionnaire. One was about the length of time they had used the CD, the other whether the CD had helped in reducing complaints. 39 persons reacted to this non-response test, which showed that many of them never had used the CD (see table 1). The 15 persons that gave an answer to both questions can be compared to the respondents who had given an answer to the same questions. One conclusion is there are relatively more persons in the non-response group who have used the CD no more than a few days. The response to the second question shows that the effect of the CD as perceived by respondents and non-responders is very much the same. Thus, the non-response analysis shows that relatively more persons that used the CD for a very short time did not respond, but the perception of non-responders of the effect of the CD is similar to respondents.

4. CONCLUSION

In the past some 200 persons requested a CD with brown and black noise. They were asked to take part in a survey. We could not reach 50 of them and 38 had never used the CD or had died. 103 of the requesters completed a questionnaire. In the early phase, after starting to hear a low pitched sound or hum, it is a great or very great burden to complainants. Over the years this gets less, but about 10 years later still 38% are often or (nearly) always disturbed by the sound, regardless of whether they found the CD helpful or not.

Sufferers try to be less troubled, but most of what they try is not very effective. In practice the most helpful measures are playing another sound to lessen the effect of the disturbing sound and taking sleeping drugs. 88% used another sound and this helped 38%. 48% used sleeping drugs and this helped 28%.

54 respondents (52%) reported that the brown or black noise on the CD had helped them somewhat (29%) or a lot (23%) to be less troubled. 34% did not think the CD had helped to reduce complaints and 13% did not provide a clear answer.

Of the 54 respondents who were helped by the CD, 17 (17%) were in fact helped by a similar sound from another source or another sound (in some cases added to the CD). When considering respondents who requested the CD between about 2.5 and 7 years ago, amongst those who think the CD helped, at the time of the survey only 19% report to be often/always troubled, in contrast to the 73% amongst those who think the CD did not help.

The conclusion is that using sound to help relieve low frequency noise complaints helps just over half the respondents.

The results of this study have led to a better advice to sufferers. We still offer them the CD (or digital brown and black noise tracks). We now add that others sounds can be tried if the CD is not helpful or to find a sound that better suits the personal taste. Such other sounds are available on the internet or via apps.

ACKNOWLEDGEMENTS

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