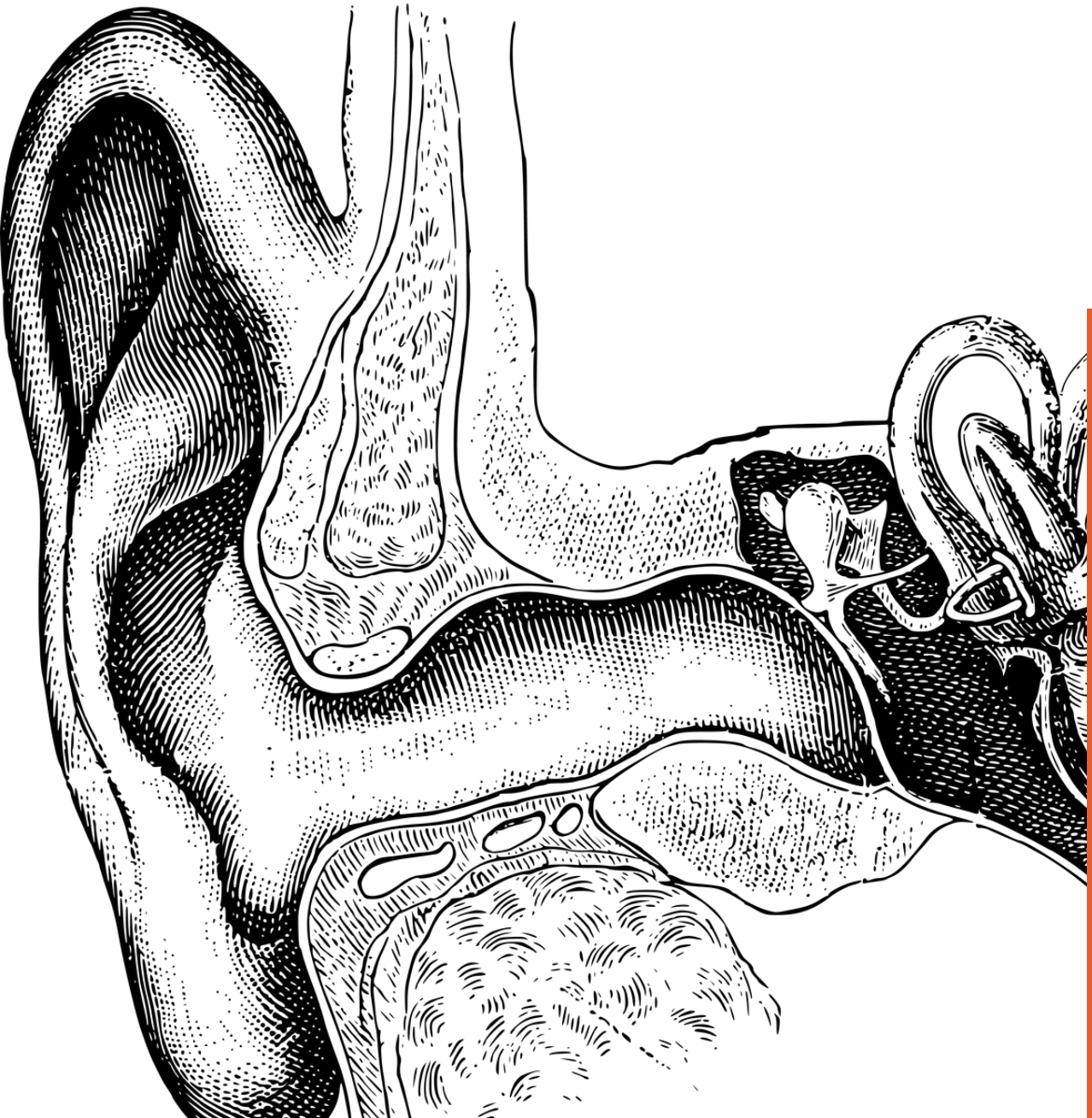
FREEQUENCY

WHITEPAPER 2026

User reported effects of Freequency, an immersive, augmented reality based app for tinnitus management

Combining therapeutic principles from exposure based tinnitus management, CBT and ACT

Editors of issue:
Cathelijne van der Zwan, BSc and Jan de Laat, PhD



SUMMARY

Freequency is an immersive, augmented reality based app. Freequency translates therapeutic principles form exposure based tinnitus therapy, Cognitive Behavioral Therapy (CBT) and Acceptance and Commitment Therapy (ACT) into interactive sessions. Repeated exposure in a supportive context can help reduce the emotional response to tinnitus and support long term habituation. This is complemented by daily content that helps users better understand their brain and tinnitus, as well as regular exercises to reduce stress and help retrain the brain. Freequency attracted over 20,000 subscription paying Dutch users in 2025 (on a population of 18 million people) after its launch in January 2025. To keep track of the clinical efficacy of the Freequency app, users are invited to go outside the app and fill in the TFI Questionnaire on a voluntary basis on baseline and after 30, 60 and 100 days use of the app. The data of users reporting on more than one moment, next to baseline, were analyzed on an anonymous basis.

MAJOR RESULTS

Users of the Freequency App (N=110, 2 or more reporting moments, TFI >= 18) experience a clinically significant improvement in approximately one-third of cases and a clinically relevant improvement measured on the TFI scale in over 40% of cases. These figures improve slightly when the population is limited to users with a TFI >=32 (N=85).

Among users who report more frequently (which could be interpreted as adherence) (N=36, 3 or more reporting moments, TFI >= 18), we see the figures rise toward nearly half of the users experiencing a clinically significant improvement and more than half of the users experiencing a clinically relevant improvement measured on the TFI scale. When the population is limited to users with a TFI >=32, the figures remain approximately the same (N=30).

We see statistically significant improvement in the areas of relaxation, auditory functioning, sense of control, emotional functioning, quality of life, intrusiveness and cognition. The sleep domain showed a slight (statistically non-significant) improvement.

Among the group of users who report 3 times or more and have a ‘big problem’ tinnitus experience (TFI score 54-72) at the start of using the app (N=6), there appears to be a clinically relevant and significant improvement in two-thirds of the users.

INTRODUCTION

Tinnitus
Tinnitus is the perception of sound without an external source and can be subjective or objective, pulsatile or non-pulsatile. This study focuses on chronic subjective non-pulsatile tinnitus, which affects a substantial share of the adult population, although only a smaller group experiences severe distress. Because tinnitus burden varies widely, it is influenced not only by auditory perception but also by comorbid conditions such as hearing loss, anxiety, and depression. Its impact is commonly measured with multi-item questionnaires, such as the Tinnitus Functional Index. The exact mechanism of tinnitus remains unclear, but leading models link it to reduced auditory input, increased central neural activity, and impaired filtering by limbic and prefrontal brain networks. These mechanisms may explain the strong association with emotional distress and reduced quality of life.

Current treatments
The most evidence-based way to get relief from tinnitus is usually not a 'cure', but reducing how much it bothers you: cognitive behavioral therapy (CBT) has the strongest support for lowering tinnitus-related distress. Hearing aids help when hearing loss is present and sound-based approaches or tinnitus retraining can also help some people. Bimodal neuromodulation devices are promising, but the evidence is still emerging and they are not as established as CBT and hearing rehabilitation. In practice, the best results usually come from combining a hearing evaluation, counseling or CBT, and sound enrichment rather than relying on medications, which generally have weak evidence for chronic tinnitus.

Freequency: extended tinnitus care at home
Freequency is an immersive, augmented reality based app. It helps people retrain how their brain responds to tinnitus through short, daily sessions on their phone. Using spatial audio, controlled sound exposure and evidence based gradual exposure techniques, Freequency supports the process of long term habituation. The app transforms the home environment into a safe training space where users can gradually engage with their tinnitus in a structured way. Through step by step guidance, daily insights and progress tracking, Freequency helps people feel less bothered by tinnitus over time. Freequency supports both self guided care and blended care, making it easier for clinicians to extend treatment beyond the clinic while keeping patients actively engaged in their progress.

Exposure based therapy in every day life
Freequency translates therapeutic principles from exposure based tinnitus therapy, cognitive behavioral therapy, acceptance and commitment therapy into interactive sessions.
Users first match their own tinnitus sound in the app and are guided through augmented reality to locate that sound in their surroundings. Visual feedback and calming game elements create a safe environment in which the brain learns that the sound is not a threat. Repeated exposure in a supportive context can help reduce the emotional response to tinnitus and support long term habituation. This is complemented by daily content that helps participants better understand their brain and tinnitus, as well as regular exercises to reduce stress and help retrain the brain. The app offers users a 100-day program as well as content to support users after the program. This is all developed and delivered by experts in tinnitus, CBT and ACT.

Real world traction
After strong early adoption in the Netherlands, Freequency is preparing to expand to the United States. Since its launch in January 2025, the app has been used by thousands of people with tinnitus and has shown promising results in supporting habituation and self management. These early insights are now helping shape the introduction of Freequency for patients and healthcare professionals in the US. Some results in 2025:

- Over 20,000 paying Dutch users in 2025 after launch in January 2025 (on a population of 18 million people in the Netherlands).
- High organic adoption without clinical referral.
- Winner Best Applied Game Award and National Healthcare Innovation Award in the Netherlands.

1 The TFI Questionnaire is integrated in the app itself to stimulate the response to fill in the TFI Questionnaire, still on a voluntary basis.
2 The paper 'Freequency's underlying principles of care', reference is made to several scientific publications regarding exposure therapy, CBT and ACT for tinnitus care.

TINNITUS FUNCTIONAL INDEX (TFI)

For analysis of the efficacy of the Freequency app through user feedback the TFI Questionnaire (Tinnitus Functional Index) is used [2]. The TFI Questionnaire is a validated questionnaire used to measure the severity and impact of tinnitus on daily functioning. The TFI was chosen because it was specifically developed to measure treatment-sensitive changes in tinnitus and is therefore better suited as an outcome measure in intervention research than the more general THI, THQ, and TQ [3].

TFI scoring classes

Based on the TFI score, the severity of tinnitus can be subdivided into five scoring classes (Table 1).

TFI total score	Qualitative class	Source/notes
0–17	Not a problem	Tinnitus has little or no practical impact.
18–31	Small problem	Symptoms are noticeable, but the burden is limited.
32–53	Moderate problem	Tinnitus begins to interfere more clearly with functioning.
54–72	Big problem	Tinnitus has a substantial negative effect.
73–100	Very big problem	Tinnitus is highly disruptive and strongly affects well-being.

Table 1 – TFI scoring classes

The TFI scoring classes indicate how much tinnitus is affecting daily life, from minimal to very severe impact. So, higher TFI scores mean greater tinnitus-related distress and functional impact.

8 domains of the TFI score

The TFI-score has 8 domains: intrusiveness, sense of control, cognition, sleep, auditory functioning, relaxation, quality of life, and emotional functioning.

Clinical relevant & clinical significant

Traditionally, an improvement in the TFI score of 13 points or more is considered a clinically significant improvement [1]. Recent psychometric research shows that an improvement in the TFI score of 9 points or more can be considered a clinically relevant improvement [4].

Inclusion

- The data were taken from a dataset covering the period from August 11, 2025, to April 1, 2026.
- The user sharing the TFI score must have given explicit consent to participate in the study at least once.
- Participants had to have completed at least two measurements, at baseline and at least once more.
- The baseline TFI score must be at least 18 or 32 points. This is used to analyze the difference in efficacy between a user group of >=18 and >=32.

Data gathering and processing

Regular users of Freequency (who pay a subscription) in the Netherlands are invited to go outside the app and report their TFI-score on a voluntary basis on baseline and after 30, 60 and 100 days use of the app. A separate consent question asks whether the data may be used for scientific research. Responses are linked over time using the user's email address, which is converted into a unique ID number before analysis. Email addresses are removed so the data can be processed anonymously.

1 The TFI Questionnaire is integrated in the app itself to stimulate the response to fill in the TFI Questionnaire, still on a voluntary basis.

RESULTS FOR USERS WITH TWO OR MORE REPORTING MOMENTS

Analysis and results for included users with two or more reporting moments, one at baseline and at least one more.

TFI 18

Descriptive statistics

Between 11 August 2025 and 1 April 2026, N = 110 participants with a baseline TFI score of at least 18 points used the tinnitus app.

Variable	Value
Age (years)	M = 59.49 (SD = 9.86)
Sex	
Male	73 (66.4%)
Female	37 (33.6%)
Duration of tinnitus	
< 12 months	17 (15.5%)
≥ 12 months	93 (84.5%)
TFI score at baseline	M = 48.14 (SD = 17.44)
TFI category at baseline	
Small problem (TFI 18–31)	25 (22.7%)
Moderate problem (TFI 32–53)	47 (42.7%)
Big problem (TFI 54–72)	30 (27.3%)
Very big problem (TFI 73–100)	8 (7.3%)

Table 2 - Baseline Characteristics of Participants

Effect on TFI score

The mean TFI score decreased from 48.1 (SD = 17.4) at the first measurement to 41.0 (SD = 19.1) at the last measurement. The mean reduction was 7.15 points (95% CI 4.77 to 9.52; $p < .001$, paired t-test), indicating that the probability of this reduction occurring by chance is less than 0.1%.

Reduction in TFI	Number (N)	Percentage
Reduction in TFI	Number (N)	Percentage
≥ 9 points (clinically relevant)	46	41.8%
≥ 13 points (clinically significant)	36	32.7%

Table 3 – Clinically relevant and significant improvement in TFI

Of the participants, 41.8% achieved a clinically relevant improvement (≥ 9 points) and 32.7% achieved a clinically significant improvement (≥ 13 points) (table 3).

Improvement per domain
Table 4 shows the mean scores per TFI domain at the first measurement (baseline) and the last measurement (follow-up), as well as the mean change. Domain scores were calculated as the mean of the items within each domain (scale 0–10).

The largest mean improvement was found in relaxation (Δ = −0.98), followed by auditory functioning (Δ = −0.92) and control (Δ = −0.81). A statistically significant improvement was found for seven of the eight domains ($p < 0.05$). Only the sleep domain did not show a statistically significant change ($p = .131$).

Domain	Mean baseline	Mean follow-up	Δ score	p
Relaxation	6.10	5.12	−0.98	< .001
Auditory functioning	5.04	4.12	−0.92	< .001
Sense of control	6.08	5.27	−0.81	< .001
Emotional functioning	4.09	3.33	−0.76	< .001
Quality of life	3.61	2.90	−0.70	< .001
Intrusiveness	5.98	5.32	−0.66	< .001
Cognition	4.22	3.76	−0.45	.008
Sleep	4.01	3.69	−0.32	.131

Table 4 - Change per TFI domain

Relationship between baseline
TFI and improvement A weak but statistically significant positive correlation was found between the baseline TFI score and the degree of improvement (Pearson $r = 0.22$, $p = .021$). This indicates that participants with higher tinnitus severity at baseline showed a greater reduction in TFI score on average. Figure 1 shows the relationship between the baseline TFI score and the change in TFI score.

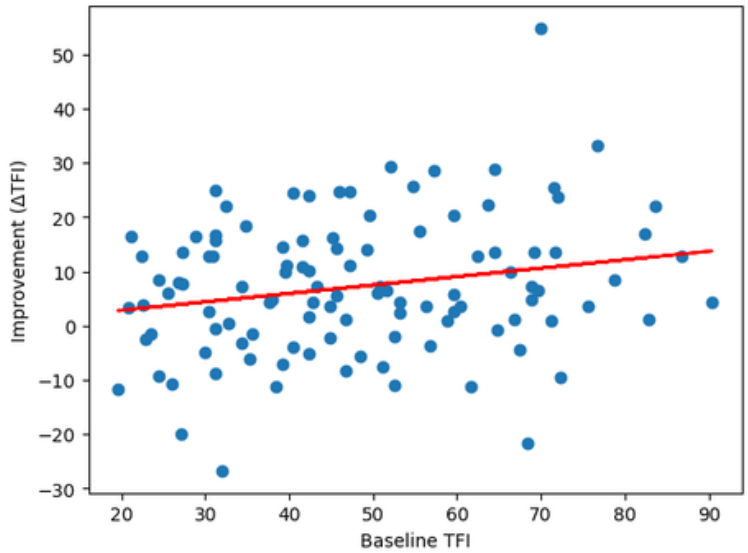


Figure 1. Association between baseline TFI score and improvement in TFI score (ΔTFI). The red line represents the linear regression fit (Pearson r = 0.22, p = .021).

TFI ≥ 32

Descriptive statistics

Between 11 August 2025 and 1 April 2026, N = 85 participants with a baseline TFI score of at least 32 points used the tinnitus app.

Variable	Value
Age (years)	M = 59.68 (SD = 9.65)
Sex	
Male	57 (67.1%)
Female	28 (32.9%)
Duration of tinnitus	
< 12 months	14 (16.5%)
≥ 12 months	71 (83.5%)
TFI score at baseline	M = 54.46 (SD = 14.59)
TFI category at baseline	
Moderate problem (TFI 32–53)	47 (55.3%)
Big problem (TFI 54–72)	30 (35.3%)
Very big problem (TFI 73–100)	8 (9.4%)

Table 5 - Baseline characteristics of the participants

Effect on TFI score

The mean TFI score decreased from 54.5 (SD = 14.6) at baseline to 46.5 (SD = 17.6) after using the app. The mean reduction was 8.00 points (95% CI 5.21 to 10.79; $p < .001$, paired t-test), indicating that the probability of this reduction occurring by chance is less than 0.1%.

	Number (N)	Percentage
≥ 9 points (clinically relevant)	37	43.5%
≥ 13 points (clinically significant)	29	34.1%

Table 6 - Clinically relevant and significant improvement in TFI

Of the participants, 42.4% achieved a clinically relevant improvement (≥ 9 points) and 32.9% achieved a clinically significant improvement (≥ 13 points) (table 6).

Clinically relevant improvement per TFI score category

Table 7 shows the percentage of participants who achieved a clinically relevant improvement in TFI score, broken down by tinnitus severity category at baseline. Improvement was defined as a reduction of at least 9 or 13 points on the TFI.

The largest proportion of participants with a clinically relevant improvement was found in the 'Very big problem' category. In this group, 50.0% of participants achieved an improvement of at least 9 points and 37.5% an improvement of at least 13 points. In the 'Big problem' category, 46.7% and 40.0% of participants reached these thresholds, respectively.

In the 'Moderate problem' and 'Small problem' categories, a clinically relevant improvement was observed less frequently (38.3% and 36.0% for ≥ 9 points; 27.7% and 24.0% for ≥ 13 points).

TFI category at baseline	**≥ 9 points**	**≥ 13 points**
Small problem (TFI 18–31)	9 (36.0%)	7 (28.0%)
Moderate problem (TFI 32–53)	18 (38.3%)	13 (27.7%)
Big problem (TFI 54–72)	14 (46.7%)	12 (40.0%)
Very big problem (TFI 73–100)	5 (62.5%)	4 (50.0%)

Table 7 - Clinically relevant improvement per severity category

RESULTS FOR USERS WITH THREE OR MORE REPORTING MOMENTS

Analysis and results for included users with two or more reporting moments, one at baseline and at least two more.

TFI 18

Descriptive statistics

Between 11 August 2025 and 1 April 2026, N = 36 participants with a baseline TFI score of at least 18 points and at least three TFI measurements used the tinnitus app.

Variable	Value
Age (years)	M = 60.22 (SD = 9.83)
Sex	
Male	24 (66.7%)
Female	12 (33.3%)
Duration of tinnitus	
< 12 months	7 (19.4%)
≥ 12 months	29 (80.6%)
TFI score at baseline	M = 51.1 (SD = 17.1)
TFI severity grade at baseline	
Small problem (TFI 18–31)	6 (16.7%)
Moderate problem (TFI 32–53)	17 (47.2%)
Big problem (TFI 54–72)	9 (25.0%)
Very big problem (TFI 73–100)	4 (11.1%)

Table 8. Baseline characteristics of the participants

Effect on TFI score

The mean TFI score decreased from 51.1 (SD = 17.1) at the first measurement to 40.5 (SD = 18.6) at the last measurement. The mean reduction was 10.58 points (95% CI 6.25 to 14.92; $p < .001$, paired t-test), indicating that the probability of this reduction occurring by chance is less than 0.1%.

Reduction in TFI	Number (N)	Percentage
Reduction in TFI	Number (N)	Percentage
≥ 9 points (clinically relevant)	19	52.8%
≥ 13 points (clinically significant)	17	47.2%

Table 9. Clinically relevant and significant improvement in TFI

Of the participants, 52.8% achieved a clinically relevant improvement (≥ 9 points) and 47.2% achieved a clinically significant improvement (≥ 13 points) (table 9).

TFI ≥ 32

Descriptive statistics Between 11 August 2025 and 1 April 2026, N = 30 participants with a baseline TFI score of at least 32 points and at least three TFI measurements used the tinnitus app.

The largest mean improvement was found in relaxation (Δ = −0.98), followed by auditory functioning (Δ = −0.92) and control (Δ = −0.81). A statistically significant improvement was found for seven of the eight domains ($p < 0.05$). Only the sleep domain did not show a statistically significant change ($p = .131$).

Variable	Value
Age (years)	M = 61.10 (SD = 8.28)
Sex	
Male	22 (73.3%)
Female	8 (26.7%)
Duration of tinnitus	
< 12 months	5 (16.7%)
≥ 12 months	25 (83.3%)
TFI score at baseline	M = 55.47 (SD = 15.29)
TFI severity grade at baseline	
Moderate problem (TFI 32–53)	17 (56.7%)
Big problem (TFI 54–72)	9 (30.0%)
Very big problem (TFI 73–100)	4 (13.3%)

Table 10. Baseline characteristics of the participants

Effects on TFI score

The mean TFI score decreased from 55.5 (SD = 15.3) at baseline to 44.5 (SD = 17.5) after using the app. The mean reduction was 10.97 points (95% CI 5.84 to 16.09; $p < .001$, paired t-test), indicating that the probability of this reduction occurring by chance is less than 0.1%.

	Number (N)	Percentage
≥ 9 points (clinically relevant)	16	53.3%
≥ 13 points (clinically significant)	14	46.7%

Table 11. Clinically relevant and significant improvement in TFI

Of the participants, 53.3% achieved a clinically relevant improvement (≥ 9 points) and 46.7% achieved a clinically significant improvement (≥ 13 points).

Clinically relevant improvement per TFI score category

Table 12 shows the percentage of participants who achieved a clinically relevant improvement in TFI score, broken down by tinnitus severity grade at baseline. Improvement was defined as a reduction of at least 9 or 13 points on the TFI.

The largest proportion of participants with a clinically relevant improvement was found in the 'Big problem' category. In this group, 66.7% of participants achieved both an improvement of at least 9 points and at least 13 points. In the 'Small problem' and 'Very big problem' categories, 50.0% of participants reached both the ≥ 9 point and ≥ 13 point thresholds, respectively.

In the 'Moderate problem' category, a clinically relevant improvement was observed less frequently (47.1% for ≥ 9 points and 35.3% for ≥ 13 points).

TFI category at baseline	**≥ 9 points**	**≥ 13 points**
Small problem (TFI 18–31)	3 (50.0%)	3 (50.0%)
Moderate problem (TFI 32–53)	8 (47.1%)	6 (35.3%)
Big problem (TFI 54–72)	6 (66.7%)	6 (66.7%)
Very big problem (TFI 73–100)	2 (50.0%)	2 (50.0%)

Table 12. Clinically relevant improvement per TFI severity grade

Conclusions and limitations

Conclusions

- Users (N=110, 2 or more reporting moments, TFI >= 18) experience a clinically significant improvement in approximately one-third of cases and a clinically relevant improvement measured on the TFI scale in over 40% of cases. These figures improve slightly when the population is limited to users with a TFI >=32 (N=85).
- Among users who report more frequently (which could be interpreted as adherence) (N=36, 3 or more reporting moments, TFI >= 18), we see the figures rise toward nearly half of the users experiencing a clinically significant improvement and more than half of the users experiencing a clinically relevant improvement measured on the TFI scale. When the population is limited to users with a TFI >=32, the figures remain approximately the same (N=30).
- We see statistically significant improvement in the areas of relaxation, auditory functioning, sense of control, emotional functioning, quality of life, intrusiveness and cognition. The sleep domain showed a slight (statistically non-significant) improvement.
- In the group of users who report 3 times or more and have a 'big problem' tinnitus experience (TFI score 54-72) at the start of using the app (N=6), there appears to be a clinically relevant and significant improvement in two-thirds of the users.

Limitations

Data from users who participated in the study on a voluntary basis were included. Therefore, this study does not provide a picture of usage and perceived effect across the entire user population during the study period.

Participants did not complete the questionnaires at a uniform time or after a uniform duration of app usage. As a result, the time between the first and last measurement varies per participant, which may influence the interpretation of changes in TFI scores.

In this analysis, the frequency or intensity of app usage was not taken into account. It is possible that participants who used the app more frequently or consistently experienced greater improvement. Future research should therefore include the app usage pattern (e.g., frequency and duration of use) in the analysis to gain a better understanding of the relationship between app usage and changes in tinnitus symptoms.

Future Research

To demonstrate the effectiveness of the Freequency app more convincingly, follow-up research with a larger sample of several hundred participants is desirable. A larger, preferably multicenter study, makes it possible not only to establish a significant improvement in the overall tinnitus experience but also to analyze changes within the individual TFI domains more accurately. Additionally, conducting the study in both the Netherlands and the USA would increase the generalizability of the findings and support the international applicability of the app. With a larger population, subgroup analyses can also be performed, for example, regarding tinnitus severity, duration of symptoms, age, or intensity of app usage. This allows one to determine for which groups the app is most effective, which is useful for both publication and implementation in clinical practice. Follow-up research in the Netherlands is underway, and initial discussions regarding follow-up research in the USA are currently taking place.

References

- Mary B Meikle, James A Henry, Susan E Griest, Barbara J Stewart, Harvey B Abrams, Rachel McArdle, Paula J Myers, Craig W Newman, Sharon Sandridge, Dennis C Turk, Robert L Folmer, Eric J Frederick, John W House, Gary P Jacobson, Sam E Kinney, William H Martin, Stephen M Nagler, Gloria E Reich, Grant Searchfield, Robert Sweetow, and Jack A Vernon. The tinnitus functional index. Ear Hear., 33(2):153–176, March 2012.
- Jacquemin L, Mertens G, Van de Heyning P, Vanderveken OM, Topsakal V, De Hertogh W, Michiels S, Van Rompaey V, Gilles A. Sensitivity to change and convergent validity of the Tinnitus Functional Index (TFI) and the Tinnitus Questionnaire (TQ): Clinical and research perspectives. Hear Res. 2019
- Milena Engelke, Laura Basso, Berthold Langguth, Florian Zeman, Winfried Schlee, Stefan Schoisswohl, Rilana Cima, Dimitris Kikidis, Jose Antonio Lopez-Escamez, Petra Bru¨ggemann, Birgit Mazurek, and Jorge Piano Simöes. Estimation of minimal clinically important difference for tinnitus handicap inventory and tinnitus functional index. Otolaryngol. Head Neck Surg., 173(1):69–79, July 2025.
- Malinvaud D, Londero A, Niarra R, Peignard P, Warusfel O, Viaud-Delmon I, Chatellier G, Bonfils P. Auditory and visual 3D virtual reality therapy as a new treatment for chronic subjective tinnitus: Results of a randomized controlled trial. Hear Res. 2016 Mar;333:127-135.
- Fackrell K, Hall DA, Barry JG, Hoare DJ. Psychometric properties of the Tinnitus Functional Index (TFI): Assessment in a UK research volunteer population. Hear Res. 2016 May;335:220-235
- Blakley BW, Carter JM, Granieri EC, Henry JA, Hollingsworth D, Khan FA, Mitchell S, Monfared A, Newman CW, Omole FS, Phillips CD, Robinson SK, Taw MB, Tyler RS, Waguespack R, Whamond EJ. Clinical practice guideline: tinnitus. Otolaryngol Head Neck Surg. 2014 Oct
- Sherlock LP, Ballard-Hernandez J, Boudin-George A, Clark K, Colandrea M, Edmonds C, Kelley C, Lovelace S, Mahmood S, Martinez I, Myers P, Pulliam S, Sall J, Spencer M, Theodoroff SM, Tolisano AM, Wayman LM, Zaugg T, Folmer RL. Clinical Practice Guideline for Management of Tinnitus: Recommendations From the US VA/DOD Clinical Practice Guideline Work Group. JAMA Otolaryngol Head Neck Surg. 2025 May 1;151(5):513-520
- Walter U, Pennig S, Bleckmann L, Röschmann-Doose K, Wittig T, Thomsen J, Schlee W. Continuous Improvement of Chronic Tinnitus Through a 9-Month Smartphone-Based Cognitive Behavioral Therapy: Randomized Controlled Trial. J Med Internet Res. 2025 Feb 18;27:e59575. doi: 10.2196/59575. PMID: 39965780; PMCID: PMC11888023.

Authors

Cathelijne van der Zwan

BSc, Department of Technical Medicine, Delft University of Technology, responsible for data analysis.

Jan de Laat

PhD, medical physicist - audiologist, Leiden University Medical Center, and clinical advisor to Freequency, corresponding author: japmdelaat@lumc.nl.