Original Paper

Real-World Use and Effectiveness of Internet-Based Vestibular Rehabilitation Following Nationwide Implementation: Prospective Observational Cohort Study

Hà TN Ngo[1,2], MD; Otto R Maarsingh[1,2], MD, PhD; Marco H Blanker[3], MD, PhD; Jettie Bont[1,2,4], MD, PhD; Vincent A van Vugt[1,2], MD, PhD

[1]Department of General Practice, Amsterdam UMC location Vrije Universiteit Amsterdam, Amsterdam, Noord-Holland, The Netherlands

[2]Amsterdam Public Health, Amsterdam, Noord-Holland, The Netherlands

[3]Department of Primary and Long-term care, Cure and Care in the Community Context (FOUR-C) research program, University Medical Center Groningen, Groningen, The Netherlands

[4]Department of General Practice, Amsterdam UMC location University of Amsterdam, Amsterdam, Noord-Holland, The Netherlands

Corresponding Author:
Hà TN Ngo, MD
Department of General Practice
Amsterdam UMC location Vrije Universiteit Amsterdam
Boelelaan 1117
Amsterdam, Noord-Holland, 1081 BT
The Netherlands
Phone: 31 637385774
Email: t.n.h.ngo@amsterdamumc.nl

Abstract

Background: Vestibular rehabilitation is a safe and effective exercise-based treatment for various vestibular disorders, yet it is underused by general practitioners. Following a randomized controlled trial demonstrating the effectiveness of Vertigo Training, an internet-based vestibular rehabilitation program, a nationwide implementation was initiated in the Netherlands.

Objective: This study aimed to evaluate the real-world use and effectiveness of Vertigo Training on vestibular symptoms.

Methods: We conducted a prospective observational cohort study by using anonymized data from Vertigo Training users (period 2023-2025). Individuals were eligible if they reported vestibular symptoms for at least 1 month, irrespective of the underlying cause. Main analyses focused on users who completed voluntary questionnaires, capturing demographic and clinical characteristics. We evaluated the effectiveness using the Vertigo Symptom Scale—Short Form (VSS-SF). Factors associated with treatment success (defined as ≥3-point reduction in VSS-SF score at 3 months) were analyzed using multivariable logistic regression. To contextualize these outcomes, we used program-level data and additional voluntary questionnaires to describe engagement and adherence.

Results: A total of 2156 users were included for the main analyses (median age 60, IQR 48-70 years; n=1427, 66% women). The most frequently self-reported diagnoses were benign paroxysmal positional vertigo and vestibular neuritis. Median VSS-SF scores improved from 17 (IQR 12-22) at baseline to 11 (IQR 6-18) at 3 months, with 63% (155/247) achieving treatment success. Higher baseline VSS-SF scores were associated with a greater likelihood of treatment success (odds ratio 1.1, 95% CI 1.0-1.1), as was a diagnosis of benign paroxysmal positional vertigo (risk ratio 1.7, 95% CI 1.1-2.0). These outcomes were observed in a context where engagement declined over time, with 43% (1442/3367) of users progressing to week 2, and adherence to the recommended exercise frequency averaged 13%.

Conclusions: In this real-world cohort, Vertigo Training was associated with meaningful reductions in vestibular symptoms following nationwide implementation. These findings confirm its effectiveness beyond the trial setting and support broader integration of internet-based vestibular rehabilitation into routine care. However, sustained engagement remains an important target for future research and optimization.

International Registered Report Identifier (IRRID): RR2-10.1186/s43058-023-00524-1

(JMIR Rehabil Assist Technol 2026;13:e106458) doi: 10.2196/106458

XSL•FO
RenderX

KEYWORDS

implementation; dizziness; vertigo; general practice; primary care; mobile health; mHealth; eHealth

Introduction

Patients with vestibular symptoms, such as dizziness and vertigo, are commonly seen in general practice. Approximately 1 in 4 adults experience these symptoms in their lives, and the prevalence increases with age [1]. A significant number of patients develop chronic symptoms. For example, 30% to 40% of patients with vestibular neuritis persistently experience vestibular symptoms after 6 months [2]. This can be caused by a failure of the vestibular compensation process, which encompasses an adaptation of the nervous system to vestibular damage [3]. It is difficult to estimate the prevalence of chronic vestibular symptoms due to varying definitions, but cross-sectional studies on the epidemiology report a prevalence of up to 4.8% in the adult population [4,5].

Vestibular symptoms are associated with a high physical, psychosocial, and economic burden. Anxiety and depression are common among patients with vestibular symptoms, as well as increased health care use and work absenteeism [4,6-8]. Adequate treatment is therefore essential, especially when these symptoms are chronic. Vestibular rehabilitation (VR), an exercise-based treatment that aims to stimulate vestibular compensation, has proven to be safe and effective for a variety of vestibular disorders, including chronic symptoms [9-11]. The majority of patients with vestibular symptoms are treated in primary care [12-15], but general practitioners (GPs) seem to lack knowledge about this treatment. Surveys among Dutch and British GPs report that only 6% to 7% of GPs apply this treatment [16,17]. This gap between evidence and practice highlights the need for scalable strategies to improve access to VR [18].

To address this, we developed Vertigo Training, an internet-based VR program designed for use in general practice [19]. In a randomized controlled trial (RCT), Vertigo Training was shown to be safe and effective in reducing vestibular symptoms, dizziness-related impairment, and anxiety for up to 36 months of follow-up [20,21]. However, evidence from controlled trials does not necessarily translate to effectiveness in routine care, where patient populations and context differ [22]. To bridge this gap, Vertigo Training was made available nationwide in the Netherlands, offering free and easily accessible VR to patients with chronic vestibular symptoms [23].

The objective of this study is to evaluate the real-world use and effectiveness of Vertigo Training in a nationwide user cohort. These findings will inform further optimization of Vertigo Training and support strategies to enhance its uptake and sustained use in general practice.

Methods

Study Design, Setting, and Participants

We conducted a prospective observational cohort study, following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement (Multimedia Appendix 1).

Vertigo Training was made available nationwide in the Netherlands in April 2023. For this study, we collected anonymized data for 2 years (April 2023 to April 2025) from Vertigo Training users who gave informed consent for the collection and analysis of their data. Users who did not give informed consent could still follow the treatment. Users were eligible for Vertigo Training if they were 18 years or older, had reported vestibular symptoms for at least 1 month on most days of the week (irrespective of the underlying cause), and experienced symptoms provoked or exacerbated by head movements or visual stimuli. Upon registration, all users were required to complete a questionnaire to assess their eligibility. Users who did not meet these criteria were not granted access to the intervention. Apart from these eligibility criteria, no other exclusion criteria were applied. More information on Vertigo Training can be found in Textbox 1.

Our study protocol contains specifics on the implementation and the multicomponent implementation strategy [23]. We used the RE-AIM (reach, effectiveness, adoption, implementation, and maintenance) framework, a widely used framework for planning and evaluating implementation, to guide the evaluation [24]. More detailed findings and reflections on the nationwide implementation process, including implementation outcomes and lessons learned, will be reported elsewhere.

Textbox 1. Information on Vertigo Training.

- Vertigo Training is a freely accessible online intervention that encompasses 6 vestibular rehabilitation exercises. These exercises include eye, head, and body movements that aim to stimulate vestibular recovery through 3 main principles: adaptation (using head movements to improve vestibulo-ocular reflex gain), habituation (using repeated provocative eye, head, and/or body movements to diminish responsiveness), and substitution (using alternative sensory inputs to substitute missing vestibular functions). Additionally, the intervention incorporates a form of exposure-based behavioral therapy by provoking vestibular symptoms in a controlled setting.
- The intervention prescribes a personal exercise program for a period of 6 weeks, based on the severity of symptoms while performing the exercises. Users are asked to perform the exercises twice a day for 10 minutes (total duration 20 minutes).
- Users may register for Vertigo Training on their own initiative or following a referral by a health care provider. They can perform the exercises independently or under the guidance of a health care provider, such as a physiotherapist. In the Netherlands, physiotherapy is accessible without a referral.

XSL•FO
RenderX

Ethical Considerations

The medical ethics committee of the VU University Medical Center approved the study protocol (2022.0569).

Data Collection and Outcome Measures

We collected baseline and follow-up data through online voluntary questionnaires that were integrated into the intervention. Main analyses focused on users who completed these questionnaires. Baseline data included user demographics; self-reported (vestibular) diagnoses and treatments; the source through which users became aware of Vertigo Training; and severity of vestibular symptoms according to the Vertigo Symptom Scale—Short Form (VSS-SF), a validated self-report instrument [25-27]. Follow-up VSS-SF measurements were obtained at 6 weeks, 3 months, and 6 months to evaluate changes in symptom severity over time. We chose the VSS-SF because this measure was used as the primary outcome in the RCT investigating the safety and effectiveness of Vertigo Training, allowing us to compare trial outcomes with the real-world outcomes of this study.

Outcomes were user characteristics, the effectiveness of Vertigo Training, and factors associated with treatment success. The effectiveness of Vertigo Training was assessed as the proportion of users with treatment success, which was defined as a clinically relevant improvement in vestibular symptoms (≥3-point reduction in VSS-SF score between baseline and 3 months) [28-31].

To contextualize these outcomes, we used data on program use to describe engagement (number of users over time) and adherence (exercise frequency). Exercise frequency was obtained weekly from week 2 through week 6 using a voluntary questionnaire administered to all users. Table S1 in Multimedia Appendix 2 [32-34] shows an overview of variables, including their definitions.

Statistical Analyses

We used descriptive statistics to assess user characteristics, program engagement and adherence, and the effectiveness of Vertigo Training. To further describe adherence, we compared exercise frequency between users who completed the baseline questionnaire and those who did not, as well as between users who completed all questionnaires (ie, baseline and follow-up at 6 weeks, 3 months, and 6 months) and those who did not. Furthermore, we described the exercise frequency of users who completed questionnaires at both baseline and 3 months. A Wilcoxon signed-rank test was performed to evaluate whether there was a significant difference in VSS-SF score between baseline and follow-up measurements. Finally, we performed univariable and multivariable logistic regression analyses to evaluate whether certain characteristics were associated with treatment success. Because the relatively favorable prognosis of benign paroxysmal positional vertigo (BPPV) could have influenced our findings, we performed an additional sensitivity analysis excluding these patients. Odds ratios (ORs) and 95% CIs were obtained from the regression analyses. For categorical variables, ORs were converted to risk ratios (RRs), including their 95% CIs. All variables with a P value <.05 were considered statistically significantly associated with treatment success. We used SPSS (version 28.0; IBM Corp) for the analyses.

Results

User Characteristics

During the 2-year observation period, a total of 2156 users completed the baseline questionnaire and were included in the cohort. The median age of users was 60 (IQR 48-70) years, and 66% (n=1427) were women. Most users (n=1489, 69%) lived in moderately to extremely urbanized areas, 57% (n=1223) had a high educational level, and 9% (n=192) reported a migration background. The most common self-reported diagnoses were BPPV, vestibular neuritis, persistent postural perceptive dizziness, and Ménière disease. Users also mentioned other vestibular and nonvestibular disorders, such as vestibular migraine, Mal de Débarquement syndrome, postconcussion syndrome, cerebrovascular accidents, and vestibular schwannomas. Concurrently, 47% (n=1025) of users reported having no diagnosis.

More than half of the users (n=1209, 56%) received treatment for their symptoms from a health care professional, mainly a physiotherapist and, to a lesser extent, a GP or medical specialist. Antivertigo drugs were used by 19% (n=416) of users. Most users were referred to Vertigo Training by their GP or found Vertigo Training online (eg, through search engines or social media). Table 1 shows all baseline user characteristics.

XSL•FO
RenderX

Table 1. Baseline characteristics of Vertigo Training users (N=2156).

Characteristics	Users
Demographic characteristics	
Age (y), median (IQR)	60 (48-70)
Gender, n (%)	
Women	1427 (66)
Men	718 (33)
Other	11 (1)
Degree of urbanization[a], n (%)	
Extremely urbanized	550 (26)
Strongly urbanized	585 (27)
Moderately urbanized	354 (16)
Hardly urbanized	377 (18)
Not urbanized	108 (5)
Missing	182 (8)
Education level[b], n (%)	
Low	897 (42)
High	1223 (57)
Missing	36 (1)
Migration background, n (%)	
Yes	192 (9)
No	1928 (89)
Missing	36 (2)
Clinical characteristics	
Received diagnosis, n (%)	
Yes	1120 (52)
No	1025 (47)
Missing	11 (1)
Self-reported diagnosis[c], n	
BPPV[d]	371
Vestibular neuritis	210
PPPD[e]	182
Ménière disease	146
Other or unknown	340
Received medical care, n (%)	
Yes	1209 (56)
No	931 (43)
Missing	16 (1)
Which health care provider[c] , n	
Physiotherapist	704
Medical specialist	595
General practitioner	574
Other	83

XSL•FO
RenderX

Characteristics	Users
Antivertigo drug use, n (%)	
Yes	416 (19)
No	1729 (80)
Missing	11 (1)
Awareness of Vertigo Training	
Source[c], n	
The internet	705
General practitioner	530
Media	337
Medical specialist	266
Friends or acquaintances	260
Patient association	132
Other	90

[a]On the basis of the municipality of residence: not or hardly urbanized (<1000 surrounding addresses), moderately urbanized (1000-1500 surrounding addresses), strongly urbanized (1500-2500 surrounding addresses), and extremely urbanized (>2500 surrounding addresses).

[b]Low=primary education, prevocational secondary education, senior general secondary education, preuniversity education, or senior secondary vocational education. High=higher vocational education or university education.

[c]Multiple answers possible.

[d]BPPV: benign paroxysmal positional vertigo.

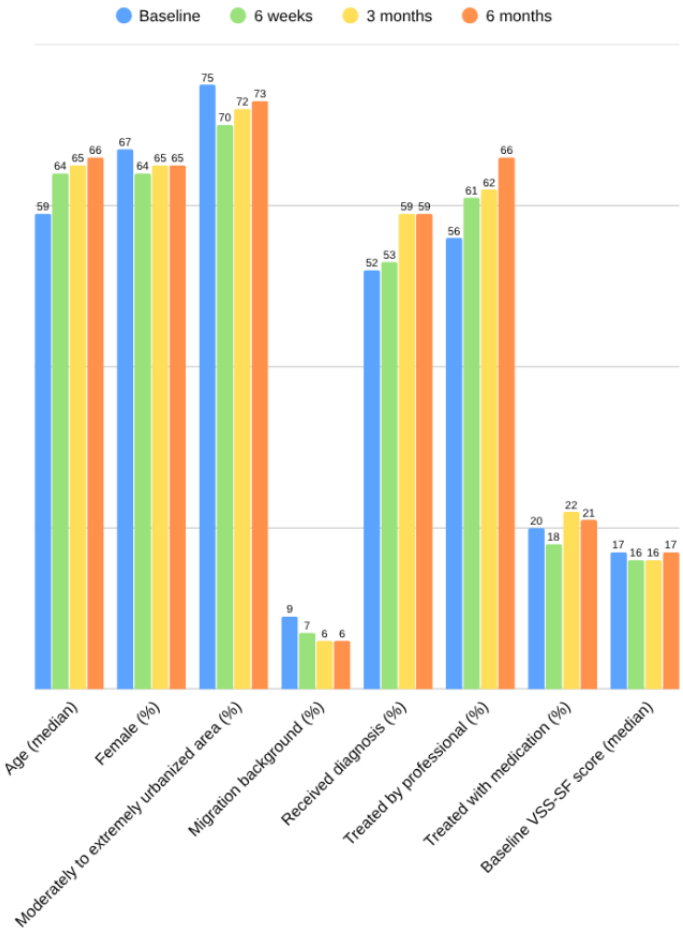
[e]PPPD: persistent postural perceptive dizziness.

Effectiveness

A total of 1905 users completed the questionnaire on the VSS-SF score at baseline. Follow-up data were available for 382 users (20%) at 6 weeks, 275 (14%) at 3 months, and 199 (10%) at 6 months; 88 users (5%) completed all measurements. Figure 1 depicts baseline user characteristics per VSS-SF measurement. The median VSS-SF score was 17 (IQR 12-22) at baseline, 13 (IQR 7-18) at 6 weeks, 11 (IQR 6-18) at 3 months, and 12 (IQR 7-17) at 6 months. Of 247 users with both baseline and 3-month data, 155 (63%) were treated successfully (≥3-point reduction). All follow-up VSS-SF measurements were significantly lower than baseline (P<.001).

XSL•FO
RenderX

Figure 1. Baseline characteristics of users who completed the Vertigo Symptom Scale–Short Form (VSS-SF) at each measurement point. For each characteristic, bars show the values at baseline, 6 weeks, 3 months, and 6 months. Continuous variables are shown as median and categorical variables as proportions.



Factors Associated With Treatment Success

The odds of treatment success increased by 10% with each point higher in VSS-SF score at baseline (OR 1.1, 95% CI 1.0-1.1). A self-reported diagnosis of BPPV also increased the likelihood of treatment success (RR 1.7, 95% CI 1.1-2.0). Table 2 shows the results from the univariable and multivariable regression analyses.

A sensitivity analysis, excluding users with BPPV as a self-reported diagnosis (n=55), yielded a similar proportion of treatment success (119/192, 62%) and similar regression results (Table S2 in Multimedia Appendix 2).

XSL•FO
RenderX

Table 2. Results of univariable and multivariable logistic regression analyses assessing factors associated with treatment success.

Characteristics	Successful treatment (n=155)	No successful treatment (n=92)	Univariable analysis, OR[a] (95% CI)	Univariable analysis, RR[b] (95% CI)	Multivariable analysis, OR[a] (95% CI)	Multivariable analysis, RR[b] (95% CI)
Demographic characteristics						
Age (y), median (IQR)	63 (53-70)	66 (56-72)	1.0 (1.0-1.0)	—[c]	1.0 (1.0-1.0)	—[c]
Gender, %						
Men	34	33	1.1 (0.6-1.8)	1.0 (0.8-1.2)	1.5 (0.8-2.9)	1.3 (0.9-1.5)
Education level [d], %						
High	60	60	1.1 (0.6-1.8)	1.0 (0.8-1.2)	1.0 (0.5-1.9)	1.0 (0.7-1.3)
Migration background, %						
Yes	7 7		1.0 (0.4-2.9)	1.0 (0.5-1.3)	0.9 (0.2-3.3)	0.9 (0.4-1.8)
Clinical characteristics						
Baseline VSS-SF[e] score, median (IQR)	17 (13-23)	15 (9-19)	1.1 (1.0-1.1)[f]	—[c]	1.1 (1.0-1.1)[f]	—[c]
Received diagnosis, %						
Yes	57	65	0.8 (0.5-1.3)	0.9 (0.7-1.1)	0.7 (0.3-1.5)	0.9 (0.6-1.1)
Self-reported diagnosis, %						
BPPV[g]	23	21	1.2 (0.6-2.3)	1.1 (0.8-1.3)	2.7 (1.2-6.3)[f]	1.7 (1.1-2.0)[f]
Vestibular neuritis	12	11	1.1 (0.5-2.4)	1.0 (0.7-1.3)	0.9 (0.3-2.5)	1.0 (0.5-1.3)
PPPD[h]	9	9	1.0 (0.4-2.6)	1.0 (0.6-1.3)	0.8 (0.3-2.3)	0.9 (0.5-1.3)
Ménière disease	8	11	0.7 (0.3-1.7)	0.9 (0.5-1.2)	0.7 (0.2-2.2)	0.9 (0.4-1.3)
Received medical care, %						
Yes	59	70	0.7 (0.4-1.1)	0.9 (0.7-1.0)	0.4 (0.2-1.1)	0.7 (0.4-1.0)
Which health care provider, %						
Physiotherapist	34	41	0.7 (0.4-1.3)	0.9 (0.7-1.1)	0.9 (0.4-2.0)	1.0 (0.7-1.2)
General practitioner	28	27	1.1 (0.6-1.9)	1.0 (0.8-1.2)	1.2 (0.6-2.5)	1.1 (0.8-1.3)
Medical specialist hospital	29	33	0.8 (0.5-1.5)	0.9 (0.7-1.1)	0.8 (0.4-1.8)	0.9 (0.6-1.2)
Medical specialist elsewhere	6	7	0.9 (0.3-2.6)	1.0 (0.5-1.3)	0.7 (0.2-2.5)	0.9 (0.4-1.3)
Antivertigo drug use, %						
Yes	23	25	0.9 (0.5-1.6)	1.0 (0.7-1.2)	1.3 (0.5-3.0)	1.1 (0.8-1.3)
Other characteristics						
Exercise frequency, %						
At least once daily	69	58	1.6 (0.9-2.7)	1.2 (1.0-1.4)	1.7 (0.9-3.3)	1.2 (1.0-1.4)

[a]OR: odds ratio.

[b]RR: risk ratio.

[c]Odds ratio not converted to risk ratio, because of continuous variable.

[d]Low=primary education, prevocational secondary education, senior general secondary education, preuniversity education, or senior secondary vocational education. High=higher vocational education or university education.

[e]VSS-SF: Vertigo Symptom Scale—Short Form.

[f]Significant association (P<.05).

XSL•FO
RenderX

[g]BPPV: benign paroxysmal positional vertigo.

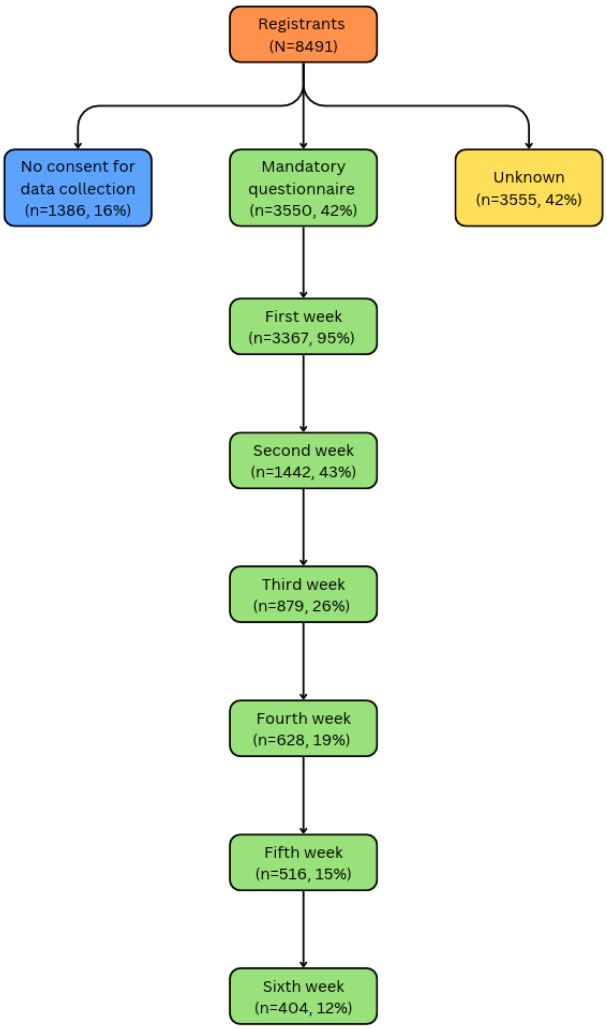
[h]PPPD: persistent postural perceptive dizziness.

Program Engagement and Adherence

During the 2-year observation period (2023-2025), a total of 8491 persons registered for Vertigo Training, of whom 3550 (42%) completed the mandatory questionnaire to assess their eligibility. Of these users, 3367 (95%) entered the first week of the program. Additionally, of 8491 persons who registered for Vertigo Training, 1386 (16%) gave no consent for data collection and analysis. This leaves 3555 (42%) registrants who did not engage with Vertigo Training. Engagement declined over time, with 43% (1442/3367) of users progressing to the second week and 12% (404/3367) of users completing the final week. Reasons for not engaging or discontinuation are unknown. Figure 2 illustrates user engagement from registration to week 6.

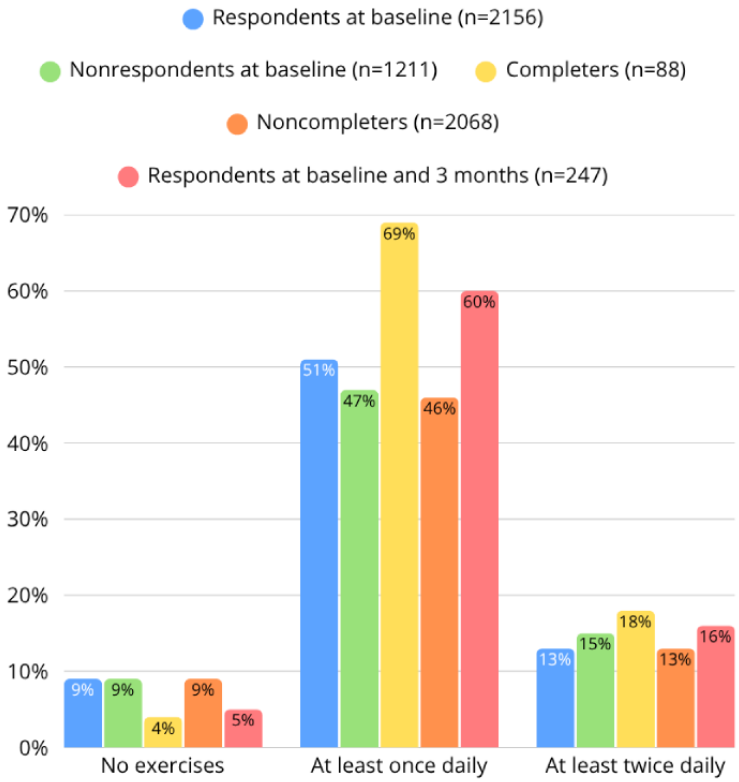
At the beginning of every new week of the program, all users were asked to report their exercise frequency. On average, 51% of users performed exercises at least once daily, 13% adhered to the recommended frequency of ≥14 times per week, and 9% did not perform any exercises. Among 2156 users who completed the baseline questionnaire, an average of 13% adhered to the recommended frequency, compared with 15% of users in the group who did not. Of the 88 users who completed all voluntary questionnaires (ie, baseline and follow-up at 6 weeks, 3 months, and 6 months), an average of 18% performed the exercises according to the recommended frequency, compared with 13% of users who completed the baseline questionnaire but not all follow-up questionnaires. Finally, 16% of users who completed the questionnaire at both baseline and 3 months adhered to the recommended frequency. Figure 3 shows adherence among respondents to the questionnaires compared with nonrespondents.

Figure 2. Flowchart illustrating user engagement from registration to week 6.



XSL•FO
RenderX

Figure 3. Adherence among respondents and nonrespondents to the baseline questionnaire, users who completed all questionnaires (completers), users who completed the baseline questionnaire but not all follow-up questionnaires (noncompleters), and users who completed the questionnaire at both baseline and 3 months.



Discussion

Principal Findings

In this real-world cohort of 2156 Vertigo Training users, we found clinically relevant improvement of vestibular symptoms, with 63% (155/247) of users achieving treatment success at 3 months. Median VSS-SF scores decreased from 17 (IQR 12-22) to 11 (IQR 6-18), indicating substantial symptom relief in routine care. Higher baseline symptom severity and a diagnosis of BPPV were associated with a greater likelihood of treatment success. These outcomes were observed in a context where engagement declined over time, with 43% (1442/3367) of users progressing to week 2, and adherence to the recommended exercise frequency averaged 13%. Our findings demonstrate that the effectiveness of Vertigo Training, previously established in an RCT, is maintained in a real-world setting following nationwide implementation. However, sustained engagement of digital interventions remains a challenge.

Strengths and Limitations

This study had several strengths and limitations. A key strength was the prospective evaluation of a large, real-world user cohort following nationwide implementation. This design enhances the generalizability of our findings and provides insight into how an evidence-based digital intervention performs outside a controlled trial setting. Additionally, the 2-year observation period led to a substantial number of users, which increased the accuracy of our evaluation of the effectiveness and factors associated with treatment success.

Several limitations should be considered. First, data collection relied mostly on voluntary questionnaires, introducing the possibility of selection and nonresponse bias. Respondents may have been more engaged or motivated, potentially leading to an overestimation of the effect of Vertigo Training. We addressed this potential bias in 2 ways. First, we compared user characteristics per VSS-SF measurement. Respondents to the baseline VSS-SF questionnaire were overall comparable to respondents to the follow-up measurements. At 3-month follow-up, respondents were slightly older (median age 65 [IQR 54-72] vs 59 years [IQR 47-69] at baseline), and a larger proportion was diagnosed (161/272, 59% vs 990/1900, 52%) and treated (171/274, 62% vs 1063/1895, 56%). However, research, including this study, has shown that age does not necessarily influence VR outcomes [35]. We expect that having a diagnosis will not significantly impact outcomes either, as VR is known to be effective for chronic vestibular symptoms irrespective of the original cause [11], which is the target population for Vertigo Training. Finally, prior treatment by a health care professional is more likely to be associated with worse VR outcomes, as patients may be less responsive to treatment. This would lead to an underestimation of the effect, rather than an overestimation. Second, we compared adherence between respondents and nonrespondents to the questionnaires. Users who completed all questionnaires performed the exercises more frequently, suggesting that more engaged users are overrepresented. However, adherence did not differ between respondents and nonrespondents to the baseline questionnaire, and the difference in exercise frequency was less pronounced in users who completed questionnaires at both baseline and 3

XSL•FO
RenderX

months. This suggests a limited impact of bias on our effect estimates.

Two other aspects were possibly affected by the voluntary nature of the questionnaires. First, we deliberately kept the questionnaires brief to limit the burden for users, but this restricted the depth of the information obtained. For example, antivertigo drug use was only assessed as "ever used," and it therefore remained unclear whether users were still treated with medication during the program. Second, almost all data, including exercise frequency and VSS-SF score, were self-reported. Exercise frequency may not accurately reflect actual exercise behavior due to overreporting. We collected program-level data as an objective measure, but this reflects progression through the program, rather than exercise performance: users may quickly learn the exercises and continue independently of the program. To our knowledge, there is no gold standard for the measurement of adherence, and future studies are needed on this topic. In our study, self-report was the most feasible method, as users should be able to follow Vertigo Training on their own initiative and independently at home. The VSS-SF is a validated instrument but also relies on self-report. Objective vestibular assessment was not feasible in this study and is not part of routine general practice care. Nevertheless, this limits the interpretation of the results from our analyses on the effectiveness.

Another limitation was the heterogeneity of our cohort: self-reported diagnoses included both vestibular and nonvestibular disorders, and 47% (1025/2156) of users reported no diagnosis at all. This composition reflects routine general practice, in which a substantial proportion receives no diagnosis [36] and, consequently, no appropriate treatment. Vertigo Training aims to address this gap. However, the heterogeneity prevented us from drawing conclusions on the diagnosis-specific effectiveness of Vertigo Training. A future study with a larger number of users with complete follow-up data would allow us to evaluate this reliably.

Our considerable loss to follow-up was also a possible limitation. This is common in digital health studies [37] and observational studies in general but may affect the precision of effect estimates. Despite this limitation, a Cochrane review from 2024 reported that effect estimates of observational studies differ little to not at all from those of RCTs [38].

The final limitation is that our design did not allow evaluation of users who registered but did not consent to data collection or did not engage with the program, limiting insight into barriers to uptake and adherence.

Comparison With Prior Work

The observed effect of Vertigo Training in this study is consistent with the effect reported in the earlier RCT from 2019. In this study, the median VSS-SF score decreased from 17 (IQR 12-22) at baseline to 11 (IQR 6-18) at 3 months. The RCT showed a similar reduction: in the group that only received Vertigo Training as an intervention, the mean baseline VSS-SF score was 14 and decreased to 8 at 3 months [20]. In both studies, the effect remained at 6 months (median VSS-SF score 12 in this study compared with 8 in the RCT). This suggests that treatment effects are preserved when moving from a controlled research setting to everyday practice.

In this study, 63% (155/247) of users who completed both baseline and 3-month VSS-SF measurements achieved treatment success. To our knowledge, only a few other studies have specifically reported the proportion of patients with clinical improvement, as measured by the VSS-SF. A secondary analysis of the RCT assessing Vertigo Training reported that 60% of participants receiving Vertigo Training, either as stand-alone treatment or in combination with physiotherapy support, showed improvement in VSS-SF score at 6 months [39]. A similar British RCT on internet-based VR for chronic vestibular symptoms reported that 62% of patients felt better at 3 months [31]. These proportions are similar to our findings.

Regarding factors for treatment success, we found that a higher baseline VSS-SF score and a self-reported diagnosis of BPPV were associated with a higher likelihood of treatment success. A prior study attempted to develop a prediction model for treatment success of Vertigo Training, but all models demonstrated poor discriminative ability [39]. No other studies have evaluated factors associated with treatment success of internet-based VR, but research has shown that many factors can influence the outcome of VR in general [35]. For example, patients with unilateral vestibular disorders respond well to VR, as reported by a Cochrane review in 2015 [9]. For patients with BPPV specifically, canalith repositioning maneuvers are first-line treatment, as these are more effective than VR in the short term. However, combining these maneuvers with VR is likely to improve longer-term recovery [9]. Vertigo Training users with BPPV represent a specific subgroup, that is, those with persistent symptoms, who may not have responded sufficiently to repositioning maneuvers. This could explain why a BPPV diagnosis was still associated with a higher likelihood of treatment success.

Finally, we observed that 13% of users adhered to the recommended exercise frequency of twice daily and that program engagement declined over time. The updated clinical practice guideline from the Academy of Neurologic Physical Therapy of the American Physical Therapy Association recommends gaze stabilization exercises 3 to 5 times per day, for a total of at least 20 minutes for patients with chronic unilateral and bilateral vestibular hypofunction [40]. Static and dynamic balance exercises are recommended for a minimum of 20 minutes daily. However, these recommendations are graded as weak, and evidence is based on extrapolation from available literature rather than direct evidence. In addition, most underlying studies were performed in the context of supervised VR, whereas Vertigo Training is primarily intended as an unsupervised program. The recommended exercise frequency in the guideline may therefore not be realistic for Vertigo Training users. Most users in our study performed the exercises once daily. Still, 63% (155/247) of users achieved treatment success. This suggests that a lower but sustainable exercise frequency may be sufficient in a real-world setting. It also highlights the need for more research on the minimal effective exercise dosage. The declining engagement in this study—43% (1442/3367) of users progressed to the second week, after which the number of users decreased with each week— is in line with

XSL•FO
RenderX

studies on digital interventions for other chronic conditions. Reasons for not engaging or discontinuation are unknown, but prior research has reported the following reasons that may apply to our study as well: unrelated health issues, finding the exercises too provocative, difficulty of the exercises, family or work conflicts, litigation, lack of time, loss of interest or motivation, or feeling better [40]. It should be noted that discontinuation of the Vertigo Training program does not necessarily imply discontinuation of the exercises, as users may continue doing them independently of the program. The majority of Vertigo Training content is given in the first week; this week provides information on vestibular symptoms, the rationale for VR, and both video and written instructions for the exercises [20,41]. However, our data do not allow us to determine whether users continued exercising after discontinuing the program or how early disengagement affected treatment benefit. Multiple studies report similar dropout or retention rates, including a systematic review and meta-analysis from 2020. This study, evaluating dropout in app-based interventions for chronic diseases, reported a pooled dropout rate of 49% for observational studies, compared with 42% (3555/8491) in our study [37]. A study from 2023 assessed a self-management application for individuals with type 2 diabetes and reported that 50% of users discontinued after registration, but the reasons are unknown [42]. Another study from 2022, which focused on the real-world implementation of a self-management application for bipolar disorder, also found decreasing retention rates over time [43]. They reported the following reasons for discontinuation: repetitiveness, technical issues, not finding it useful, and having an undesired daily reminder of their condition. Furthermore, a study from 2020 analyzed the reach, use, and retention of a mindfulness training application [44]. One week after downloading the application, 43% of users engaged with it, and this proportion decreased over time. The aforementioned studies, including this study, show that sustained engagement remains an important issue that should be addressed in implementation research.

Implications for Research and/or Practice

Our findings support the use of internet-based VR as an effective and scalable treatment option in general practice. The demonstrated effectiveness in a heterogeneous, real-world population strengthens the case for broader integration of Vertigo Training into primary care pathways.

At the same time, improving engagement of users should be a priority. Future research should focus on users who discontinued the app and individuals who are eligible for the app but do not use it. This includes exploring patient preferences, usability, and contextual factors influencing adherence. These findings would give more insight into possible targets for improvement of the implementation. Ongoing work will further evaluate the impact of Vertigo Training on general practice care, including its role in reducing unnecessary medication use and supporting more efficient care pathways in general practice.

Conclusions

In this real-world cohort study, Vertigo Training was associated with meaningful reductions in vestibular symptoms, confirming its effectiveness beyond the trial setting. Effects were most pronounced in users with higher baseline symptom severity and those with BPPV. However, sustained engagement remains an important target for future research and optimization.

Acknowledgments

The authors would like to thank Curavista for their continued effort and aid in making Vertigo Training available to patients with vestibular symptoms. The authors would also like to thank all Vertigo Training users for their contributions to this research.

Funding

This work was supported by ZonMw (grant 08391052110005).

Data Availability

The datasets generated or analyzed during this study are available from the corresponding author on reasonable request.

Generative AI Use

The authors declare that generative AI was used in the creation of this manuscript. Generative AI (ChatGPT, Claude) was used for proofreading, editing, or language polishing. The authors verified all outputs of the tool(s) used in the preparation of this manuscript and take full responsibility for the final content of the manuscript" should be changed into "The authors declare that generative AI was used in the creation of this manuscript. Generative AI (ChatGPT GPT-6, Claude Sonnet 5.5) was used for proofreading, editing, or language polishing. The authors verified all outputs of the tool(s) used in the preparation of this manuscript and take full responsibility for the final content of the manuscript.

Authors' Contributions

Conceptualization: VAvV (lead), HTNN (equal), ORM, (supporting), MHB (supporting), JB (supporting)
Data curation: HTNN
Formal analysis: HTNN
Funding acquisition: VAvV
Investigation: HTNN

XSL•FO
RenderX

Methodology: VAvV (lead), HTNN (equal), ORM (supporting), MHB (supporting), JB (supporting)
Project administration: VAvV (lead), HTNN (supporting)
Supervision: VAvV
Validation: VAvV
Visualization: HTNN
Writing—original draft: HTNN
Writing—review & editing: HTNN (lead), ORM, (supporting), MHB (supporting), JB (supporting), VAvV (supporting)

Conflicts of Interest

None declared.

Multimedia Appendix 1

STROBE statement.
[DOCX File , 41 KB-Multimedia Appendix 1]

Multimedia Appendix 2

An overview of the included variables and results from the sensitivity analysis.
[DOCX File , 32 KB-Multimedia Appendix 2]

References

1. Neuhauser HK. The epidemiology of dizziness and vertigo. Handb Clin Neurol. 2016;137:67-82. [doi: 10.1016/B978-0-444-63437-5.00005-4] [Medline: 27638063]
2. Neuhauser HK, Lempert T. Vertigo: epidemiologic aspects. Semin Neurol. Nov 2009;29(5):473-481. [doi: 10.1055/s-0029-1241043] [Medline: 19834858]
3. Lacour M, Helmchen C, Vidal PP. Vestibular compensation: the neuro-otologist's best friend. J Neurol. Apr 2016;263 Suppl 1:S54-S64. [FREE Full text] [doi: 10.1007/s00415-015-7903-4] [Medline: 27083885]
4. Neuhauser HK, Radtke A, von Brevern M, Lezius F, Feldmann M, Lempert T. Burden of dizziness and vertigo in the community. Arch Intern Med. Oct 27, 2008;168(19):2118-2124. [doi: 10.1001/archinte.168.19.2118] [Medline: 18955641]
5. Kim EJ, Song HJ, Lee HI, Kwon E, Jeong SH. One-year prevalence and clinical characteristics in chronic dizziness: the 2019–2020 Korean National Health and Nutrition Examination Survey. Front Neurol. Dec 01, 2022;13:1016718. [FREE Full text] [doi: 10.3389/fneur.2022.1016718] [Medline: 36530637]
6. Kovacs E, Wang X, Grill E. Economic burden of vertigo: a systematic review. Health Econ Rev. Dec 27, 2019;9(1):37. [FREE Full text] [doi: 10.1186/s13561-019-0258-2] [Medline: 31883042]
7. Ciorba A, Bianchini C, Scanelli G, Pala M, Zurlo A, Aimoni C. The impact of dizziness on quality-of-life in the elderly. Eur Arch Otorhinolaryngol. Mar 2017;274(3):1245-1250. [doi: 10.1007/s00405-016-4222-z] [Medline: 27450383]
8. Kim CH, McCray LR, Nguyen SA, Staab JP, Jafri S, Rizk H. Anxiety and depression in adults with vestibular disorders: a systematic review and meta-analysis. Laryngoscope. Feb 2026;136(2):535-546. [doi: 10.1002/lary.70055] [Medline: 40815545]
9. McDonnell MN, Hillier SL. Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. Cochrane Database Syst Rev. Jan 13, 2015;1(1):CD005397. [doi: 10.1002/14651858.CD005397.pub4] [Medline: 25581507]
10. Porciuncula F, Johnson CC, Glickman LB. The effect of vestibular rehabilitation on adults with bilateral vestibular hypofunction: a systematic review. J Vestib Res. 2012;22(5-6):283-298. [doi: 10.3233/VES-120464] [Medline: 23302709]
11. Kundakci B, Sultana A, Taylor AJ, Alshehri MA. The effectiveness of exercise-based vestibular rehabilitation in adult patients with chronic dizziness: a systematic review. F1000Res. Mar 05, 2018;7:276. [FREE Full text] [doi: 10.12688/f1000research.14089.1] [Medline: 29862019]
12. Grill E, Penger M, Kentala E. Health care utilization, prognosis and outcomes of vestibular disease in primary care settings: systematic review. J Neurol. Apr 2016;263 Suppl 1:S36-S44. [FREE Full text] [doi: 10.1007/s00415-015-7913-2] [Medline: 27083883]
13. Murphy C, Reinhardt C, Linehan D, Katiri R, O'Connor A. A review of primary care referrals for patients with dizziness and vertigo: prevalence and demographics. Ir J Med Sci. Feb 2022;191(1):385-389. [doi: 10.1007/s11845-021-02575-6] [Medline: 33675015]
14. Sloane PD, Dallara J, Roach C, Bailey KE, Mitchell M, McNutt R. Management of dizziness in primary care. J Am Board Fam Pract. 1994;7(1):1-8. [Medline: 8135132]
15. Stam H, Harting T, Sluijs MV, van Marum R, Horst HV, Wouden JC, et al. Usual care and management of fall risk increasing drugs in older dizzy patients in Dutch general practice. Scand J Prim Health Care. Jun 2016;34(2):165-171. [FREE Full text] [doi: 10.3109/02813432.2016.1160634] [Medline: 27049170]

XSL•FO
RenderX

16. van Vugt VA, Diaz Nerio PM, van der Wouden JC, van der Horst HE, Maarsingh O. Use of canalith repositioning manoeuvres and vestibular rehabilitation: a GP survey. Scand J Prim Health Care. Mar 2017;35(1):19-26. [FREE Full text] [doi: 10.1080/02813432.2017.1288683] [Medline: 28277043]
17. Jayarajan V, Rajenderkumar D. A survey of dizziness management in general practice. J Laryngol Otol. Aug 2003;117(8):599-604. [doi: 10.1258/002221503768199915] [Medline: 12956912]
18. van Vugt VA, van der Horst HE, Payne RA, Maarsingh OR. Chronic vertigo: treat with exercise, not drugs. BMJ. Aug 23, 2017;358:j3727. [doi: 10.1136/bmj.j3727] [Medline: 28835412]
19. van Vugt VA, van der Wouden JC, Bosmans JE, Smalbrugge M, van Diest W, Essery R, et al. Guided and unguided internet-based vestibular rehabilitation versus usual care for dizzy adults of 50 years and older: a protocol for a three-armed randomised trial. BMJ Open. Jan 20, 2017;7(1):e015479. [FREE Full text] [doi: 10.1136/bmjopen-2016-015479] [Medline: 28110290]
20. van Vugt VA, van der Wouden JC, Essery R, Yardley L, Twisk JW, van der Horst HE, et al. Internet based vestibular rehabilitation with and without physiotherapy support for adults aged 50 and older with a chronic vestibular syndrome in general practice: three armed randomised controlled trial. BMJ. Nov 05, 2019;367:l5922. [FREE Full text] [doi: 10.1136/bmj.l5922] [Medline: 31690561]
21. van Vugt VA, Ngo H, van der Wouden JC, Twisk JW, van der Horst HE, Maarsingh OR. Online vestibular rehabilitation for chronic vestibular syndrome: 36-month follow-up of a randomised controlled trial in general practice. Br J Gen Pract. Aug 31, 2023;73(734):e710-e719. [FREE Full text] [doi: 10.3399/BJGP.2022.0468] [Medline: 37487644]
22. Rothwell PM. External validity of randomised controlled trials: "to whom do the results of this trial apply?". Lancet. Jan 2005;365(9453):82-93. [doi: 10.1016/S0140-6736(04)17670-8] [Medline: 15639683]
23. Ngo HT, Maarsingh OR, van de Berg R, Blanker MH, Bruintjes TD, Castien R, et al. Study protocol for a nationwide implementation of internet-based vestibular rehabilitation for patients with chronic vestibular symptoms (I-RECOVER). Implement Sci Commun. Nov 22, 2023;4(1):147. [FREE Full text] [doi: 10.1186/s43058-023-00524-1] [Medline: 37993954]
24. Glasgow RE, Harden SM, Gaglio B, Rabin B, Smith ML, Porter GC, et al. RE-AIM planning and evaluation framework: adapting to new science and practice with a 20-year review. Front Public Health. Mar 29, 2019;7:64. [FREE Full text] [doi: 10.3389/fpubh.2019.00064] [Medline: 30984733]
25. Yardley L, Masson E, Verschuur C, Haacke N, Luxon L. Symptoms, anxiety and handicap in dizzy patients: development of the Vertigo Symptom Scale. J Psychosom Res. Dec 1992;36(8):731-741. [doi: 10.1016/0022-3999(92)90131-k] [Medline: 1432863]
26. Wilhelmsen K, Strand LI, Nordahl SH, Eide GE, Ljunggren AE. Psychometric properties of the Vertigo Symptom Scale - Short Form. BMC Ear Nose Throat Disord. Mar 27, 2008;8:2. [FREE Full text] [doi: 10.1186/1472-6815-8-2] [Medline: 18371190]
27. Noordzij AS, Terluin B, van der Wouden JC, van der Horst HE, Essery R, Yardley L, et al. Cross-cultural validation of the Dutch version of the Vertigo Symptom Scale – Short Form Questionnaire in general practice. Research Square. Preprint posted online on February 08, 2022. [doi: 10.21203/rs.3.rs-1325407/v1]
28. Yardley L, Barker F, Muller I, Turner D, Kirby S, Mullee M, et al. Clinical and cost effectiveness of booklet based vestibular rehabilitation for chronic dizziness in primary care: single blind, parallel group, pragmatic, randomised controlled trial. BMJ. Jun 06, 2012;344:e2237. [FREE Full text] [doi: 10.1136/bmj.e2237] [Medline: 22674920]
29. Yardley L, Kirby S. Evaluation of booklet-based self-management of symptoms in Ménière disease: a randomized controlled trial. Psychosom Med. 2006;68(5):762-769. [doi: 10.1097/01.psy.0000232269.17906.92] [Medline: 17012531]
30. Yardley L, Donovan-Hall M, Smith HE, Walsh BM, Mullee M, Bronstein AM. Effectiveness of primary care-based vestibular rehabilitation for chronic dizziness. Ann Intern Med. Oct 19, 2004;141(8):598-605. [doi: 10.7326/0003-4819-141-8-200410190-00007] [Medline: 15492339]
31. Geraghty AW, Essery R, Kirby S, Stuart B, Turner D, Little P, et al. Internet-based vestibular rehabilitation for older adults with chronic dizziness: a randomized controlled trial in primary care. Ann Fam Med. May 2017;15(3):209-216. [FREE Full text] [doi: 10.1370/afm.2070] [Medline: 28483885]
32. Degree of urbanisation. Centraal bureau voor statistiek. URL: https://www.cbs.nl/en-gb/our-services/methods/definitions/degree-of-urbanisation [accessed 2026-11-12]
33. Education level. Centraal bureau voor statistiek. URL: https://www.cbs.nl/en-gb/news/2023/48/satisfaction-high-in-caribbean-nl-in-spite-of-low-material-well-being/education-level [accessed 2026-11-12]
34. Migration background. Centraal bureau voor statistiek. URL: https://www.cbs.nl/en-gb/our-services/methods/definitions/migration-background [accessed 2026-11-12]
35. Whitney SL, Sparto PJ, Furman JM. Vestibular rehabilitation and factors that can affect outcome. Semin Neurol. Feb 2020;40(1):165-172. [doi: 10.1055/s-0039-3402062] [Medline: 31887754]
36. Bösner S, Schwarm S, Grevenrath P, Schmidt L, Hörner K, Beidatsch D, et al. Prevalence, aetiologies and prognosis of the symptom dizziness in primary care - a systematic review. BMC Fam Pract. Feb 20, 2018;19(1):33. [FREE Full text] [doi: 10.1186/s12875-017-0695-0] [Medline: 29458336]

XSL•FO
RenderX

37. Meyerowitz-Katz G, Ravi S, Arnolda L, Feng X, Maberly G, Astell-Burt T. Rates of attrition and dropout in app-based interventions for chronic disease: systematic review and meta-analysis. J Med Internet Res. Sep 29, 2020;22(9):e20283. [FREE Full text] [doi: 10.2196/20283] [Medline: 32990635]
38. Toews I, Anglemyer A, Nyirenda JL, Alsaid D, Balduzzi S, Grummich K, et al. Healthcare outcomes assessed with observational study designs compared with those assessed in randomized trials: a meta-epidemiological study. Cochrane Database Syst Rev. Jan 04, 2024;1(1):MR000034. [doi: 10.1002/14651858.MR000034.pub3] [Medline: 38174786]
39. van Vugt VA, Heymans MW, van der Wouden JC, van der Horst HE, Maarsingh OR. Treatment success of internet-based vestibular rehabilitation in general practice: development and internal validation of a prediction model. BMJ Open. Oct 16, 2020;10(10):e038649. [FREE Full text] [doi: 10.1136/bmjopen-2020-038649] [Medline: 33067287]
40. Hall CD, Herdman SJ, Whitney SL, Anson ER, Carender WJ, Hoppes CW, et al. Vestibular rehabilitation for peripheral vestibular hypofunction: an updated clinical practice guideline from the Academy of Neurologic Physical Therapy of the American Physical Therapy Association. J Neurol Phys Ther. Apr 01, 2022;46(2):118-177. [FREE Full text] [doi: 10.1097/NPT.0000000000000382] [Medline: 34864777]
41. Geraghty AW, Kirby S, Essery R, Little P, Bronstein A, Turner D, et al. Internet-based vestibular rehabilitation for adults aged 50 years and over: a protocol for a randomised controlled trial. BMJ Open. Jul 22, 2014;4(7):e005871. [FREE Full text] [doi: 10.1136/bmjopen-2014-005871] [Medline: 25052178]
42. Blythin AM, Elkes J, van Lindholm T, Bhogal A, Wilkinson TM, Saville C, et al. Can digital health apps provide patients with support to promote structured diabetes education and ongoing self-management? A real-world evaluation of myDiabetes usage. Digit Health. Mar 11, 2023;9:20552076221147109. [FREE Full text] [doi: 10.1177/20552076221147109] [Medline: 36923369]
43. García-Estela A, Cantillo J, Angarita-Osorio N, Mur-Milà E, Anmella G, Pérez V, et al. Real-world implementation of a smartphone-based psychoeducation program for bipolar disorder: observational ecological study. J Med Internet Res. Feb 02, 2022;24(2):e31565. [FREE Full text] [doi: 10.2196/31565] [Medline: 35107440]
44. Kozlov E, Bantum E, Pagano I, Walser R, Ramsey K, Taylor K, et al. The reach, use, and impact of a free mHealth mindfulness app in the general population: mobile data analysis. JMIR Ment Health. Nov 27, 2020;7(11):e23377. [FREE Full text] [doi: 10.2196/23377] [Medline: 33245289]

Abbreviations

BPPV: benign paroxysmal positional vertigo
GP: general practitioner
OR: odds ratio
RE-AIM: reach, effectiveness, adoption, implementation, and maintenance
RR: risk ratio
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology
VR: vestibular rehabilitation
VSS-SF: Vertigo Symptom Scale–Short Form

Edited by S Munce; submitted 10.Jul.2026; peer-reviewed by A Wolfovitz, T Ledin, D Meldrumd; comments to author 23.Sep.2026; revised version received 16.Oct.2026; accepted 29.Oct.2026; published 20.Nov.2026

Please cite as:
Ngo HTN, Maarsingh OR, Blanker MH, Bont J, van Vugt VA
Real-World Use and Effectiveness of Internet-Based Vestibular Rehabilitation Following Nationwide Implementation: Prospective Observational Cohort Study
JMIR Rehabil Assist Technol 2026;13:e106458
URL: https://rehab.jmir.org/2026/1/e106458
doi: 10.2196/106458
PMID:

©Hà TN Ngo, Otto R Maarsingh, Marco H Blanker, Jettie Bont, Vincent A van Vugt. Originally published in JMIR Rehabilitation and Assistive Technology (https://rehab.jmir.org), 20.Nov.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Rehabilitation and Assistive Technology, is properly cited. The complete bibliographic information, a link to the original publication on https://rehab.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX