Original Article

JHSMR Journal of Health Science and Medical Research

Effectiveness of Visual Vestibular Habituation versus Optokinetic Training for Chronic Motion Sensitivity

Brightlin Suresh, MPT (Neuro)[1], Rajalaxmi Visvanathan, MPT (Neuro), Ph.D.[2], Nandhini Dhanasekaran, MPT (Cardio)[1], Visali Chokkan Egambaram Jeevanantham, MPT (Ortho)[1]

[1]College of Physiotherapy, Sri Venkateswaraa University, Redhills, Chennai 600067, India.

[2]Faculty of Physiotherapy, Dr.MGR Educational and Research Institute, Chennai 600077, India.

Received 30 July 2025 ● Revised 14 September 2025 ● Accepted 15 September 2025 ● Published online 30 April 2026

Abstract:

Objective: To compare the effectiveness of visual vestibular habituation exercises and optokinetic training for subjects with chronic motion sensitivity.

Material and Methods: This comparative study of the pre-test and post-test type included 50 healthy women based on the inclusion criteria and then randomly divided into Group A and Group B, containing 25 subjects each. Group A performed visual vestibular habituation exercises, Group B performed optokinetic training, and both groups performed balance exercises for 6 weeks. The paired t-test was adopted to find the statistical difference within the groups, and the independent t-test (Student t-Test) was adopted to find the statistical difference between the groups. A p-value of ≤0.05 was considered statistically significant.

Results: Both visual vestibular habituation exercises (Group A) and optokinetic training (Group B) produced significant improvements in motion sensitivity symptoms, as measured by Motion Sickness Susceptibility Questionnaire (MSSQ), Motion Sensitivity Quotient (MSQ), State Trait Anxiety Inventory (STAI), and Video Induced Dizziness Time (VIDT) scores (p-value≤0.05). Group A showed lower post-intervention scores for MSSQ (56.67±6.21) and MSQ (11.92±3.17), lower anxiety levels on STAI (41.76±3.43), and higher tolerance to video-induced dizziness time (216.72±18.23) compared to Group B.

Conclusion: Visual vestibular habituation exercises are more effective than optokinetic training for alleviating the symptoms of motion sickness in individuals with chronic motion sensitivity.

Keywords: chronic motion sensitivity, optokinetic training, visual vestibular habituation

Contact: Brightlin Suresh, MPT (Neuro)
College of Physiotherapy, Sri Venkateswaraa University, Redhills, Chennai 600067, India.
E-mail: brightlinsuresh03@gmail.com

J Health Sci Med Res 2026;44(5):e20261356
doi: 10.31584/jhsmr.20261356
www.jhsmr.org

Introduction

Chronic motion sensitivity, commonly referred to as motion sickness, encompasses a collection of autonomic symptoms triggered by actual or imagined motion[1-3]. The autonomic responses during motion sickness vary widely among humans, including nausea, vomiting, headaches, dizziness, sweating, facial pallor (also known as cold sweating), increased salivation, lack of appetite, anxiety, blurry vision, and postural balance[4,5]. The incidence of motion sickness is approximately 30% in the general population, with a comparatively higher incidence in women than in men[6,7].

The ocular, vestibular, and proprioceptive systems are the three sources of motion detection, which usually agree with each other[8-10]. Motion sickness occurs when there is a mismatch between the sensory information transmitted by these three systems to the central nervous system[11-14].

The pharmacological management of motion sickness includes antimuscarinics, e.g., scopolamine. H1 Antihistamines, e.g., dimenhydrinate, sympathomimetic, e.g., amphetamine[14,16]. Various non-pharmacological managements of motion sickness include habituation, multisensory stimulation, gaze stabilization exercise, optokinetic training, and yoga[17].

Recent years have seen an increase in the awareness of motion sickness, which is primarily brought on by the stimulation of the visual system, frequently without any actual physical motion. Visually induced motion Sickness (VIMS) has become a widespread phenomenon because of recent advancements in the technology of visual displays and applications (such as surround-sound theatres, vehicle simulators, virtual reality, and augmented reality)[16]. Habituation training simulates the sensory conflict as closely as possible to the stimulating environment[18,19]. This study focused on two habituation programs that can help improve the symptoms of motion sickness.

Visual vestibular habituation exercises are a specialized form of exercise intended to relieve symptoms caused by chronic motion sickness, like dizziness due to repeated exposure to the particular movements or visual signals that provoke patients' dizziness[20]. The vestibulo-ocular reflex stabilises visual pictures on the retina despite variations in head position[21]. In visual vestibular rehabilitation, the retinal slip error signal is utilised to enhance the gain of the vestibular response. While keeping your eyes fixed on the subject, you can move your head in either a horizontal or vertical direction to cause a retinal slip[22,23]. Unlike optokinetic training, they produce a retinal slip by combining active head motions with stationary/moving visual objects, with the intended goal of enhancing Vestibular Occular Reflex (VOR) gain (adaptation process). These activities enhance gaze stability during normal head motion and directly retrain the vestibulo-ocular reflex, in contrast to optokinetic training[24].

Optokinetic training is the process of desensitizing patients through progressive exposure to motion sickness-provoking movements and situations. It also induces retinal slip[25-27]. Earlier studies have shown that a computer screen, a head-mounted display, or a Digital Versatile Disc (DVD) with visual stimulation might all provide similar or less severe stimulation, like high-tech optokinetic drums[27,28]. Unlike visual habituation training, optokinetic training creates visual-vestibular conflict and desensitises patients to visually caused dizziness by using moving visual surroundings (such as rotating drums, virtual reality, and screen-based stimuli). It is specifically useful for people with disorders where habituation alone does not produce results, such as visual dependency, Persistent Postural-Perceptual Dizziness (PPPD), or visually induced motion sickness[29].

Although several unique strategies have been researched with positive results, an effective method to minimize motion sickness has not yet been found. Research is needed to compare the various interventions to determine the techniques that provide better outcomes for subjects with motion sensitivity. This study aimed to compare the effects of visual vestibular habituation exercises and optokinetic training on individuals with motion sickness.

Material and Methods

Design and setting

The present study was an experimental study that compared the effectiveness of visual vestibular habituation exercises and optokinetic training for subjects with chronic motion sensitivity. The study was conducted at the Physiotherapy Outpatient Department of A.C.Shanmugam (ACS) Medical College and Hospital.

Ethical statement

This research was reviewed and approved by the institutional review board of Faculty of Physiotherapy, Dr.MGR Educational and Research Institute. The approval code is MPT (NEUROLOGY)-03/IRB/PHYSIO/2022-23. Study procedures were explained in full to all the subjects, who were then asked to sign the informed consent. Complete confidentiality was assured.

Inclusion and exclusion criteria

Subjects 20-40 years of age with experiences of motion sickness, a motion sensitivity quotient score (MSQ) of 0-30, and a normal cervical range of motion were included in the study. Subjects without the experience of motion sickness, pregnant women, a diagnosis of vestibular dysfunction, neurologic pathology, migraines, seizures, cervical spine orthopaedic impairments, and currently taking medications causing dizziness/imbalance were excluded from the study.

Procedure

Once the study was approved by the Institutional Review Board, 50 participants fulfilling the inclusion criteria were selected and randomly divided into 2 groups, Group A and Group B. The study was conducted in the Physiotherapy OPD. The subjects were instructed regarding the benefits of participating in the study, and after obtaining their consent, they were asked to sign informed consent forms, assuring their confidentiality. Subjects in Group A performed visual vestibular exercises along with balance training: each step was repetitively performed for 15 minutes, 5 times/day, 5 days/week.

Subjects in Group B performed optokinetic training along with balance training: each movement was repetitively performed for 15 minutes, 5 times /day, 5 days/week. The tests were performed before and after the intervention.

Outcome measures:

The Motion Sensitivity Quotient (MSQ) demonstrates excellent reliability, with inter-rater ICC values around 0.99 and test–retest ICC values of 0.98 and 0.96, indicating it is a highly reliable measurement tool[30].

The MSSQ-Short showed great test-retest reliability ($r \approx 0.90$) and good internal consistency (Cronbach's $\alpha = 0.87$) in the original English edition[31].

The State–Trait Anxiety Inventory (STAI) manual has shown strong internal consistency with Cronbach's alpha values ranging from 0.86 to 0.95 for both the State and Trait scales[32].

Video-induced dizziness time is the outcome measure used in the study.

Intervention

Group A performed visual vestibular habituation exercises:

Step 1. Seated in a chair, the patient is asked to hold an index card with letters at arm's length in front of him/her at eye level. The patient is asked to move the card from left to right repeatedly as they maintain fixation on the letters. Continue for 10 seconds.

If the patient can see the letters clearly at this speed and doesn't have motion sickness, continue for 10 seconds, moving the card faster. Continue increasing speed until the patient identifies the speed that results in mild symptoms. Continue at a maximum speed for 30 seconds. When all the symptoms stop, repeat at the maximum level of speed for 30 seconds, 4 times.

Step 2. Repeat but move the arm and card in the up and down directions, centered in front of him/her.

Step 3. Seated in a chair, the patient is asked to repeat step 1, but to turn the head from left to right, holding the card steady and centered in front.

Step 4. Seated in a chair, the patient is asked to repeat step 3, except this time, to move the head in the up-down direction.

Step 5. Seated in a chair, the patient is asked to repeat step 4, except this time, to tilt the head side to side.

Next, repeat steps 1 through 5 in the standing position, single-leg stance, and tandem stance. March in place and count up to 50, tandem walking and standing on the foam.

Then, the patient is made to sit and asked to hold the card straight out in front, and move both the head and card simultaneously from left to right as they fix their eyes on the letters on the card and perform it at maximum speed as above, and continue for 30 seconds, and repeat 4 times.

Then, the patient is asked to move the arm and head in the up and down directions, next to move the arm and head in opposite directions, and, lastly, to move the arm and head in the opposite directions, but in the up and down directions.

Group B- optokinetic training:

Step 1. The patient is asked to sit on a chair and hold the screen at eye level in front of him/her. The screen moves from left to right and then from right to left. Hold on for 10 seconds.

Step 2. Repeat the previous step, except this time the screen travels from down to up and up and down.

Step 3. Now, the eyes should track the red dot on the screen.

If the patient experiences no symptoms of motion sensitivity and can see a clear image of the screen at this speed, gradually increasing the time of exposure, then the speed of the video can be increased.

Then, repeat steps 1 through 3 in the standing position, single-leg stance, and tandem stance. March in place, count up to 50, tandem walking and standing on the foam.

Statistical analysis

The collected data were tabulated and analysed using both descriptive and inferential statistics. All the parameters were assessed using a statistical package for the social sciences (SPSS) version 24, with a significance level of p-value less than 0.05 and a 95% confidence interval set for all analyses. The Shapiro-Wilk test was used to determine the normality of the data. In this study, the Shapiro-Wilk test showed that the data were normally distributed on the dependent values at p-value>0.05. Hence, the parametric test was adopted. The paired t-test was adopted to find the statistical difference within the groups, and the independent t-test (Student t-Test) was adopted to find the statistical difference between the groups.

Results

MSSQ score analysis

In Table 1, comparing the mean values of Group A and Group B on MSSQ score, it shows a significant decrease in the post-test mean values in both groups, but Group A (Visual Vestibular Habituation Exercises) shows 56.67±6.21, which has the lower mean value and is more effective than Group B (Optokinetic Training), 60.26±4.95

Table 1 Comparison of MSSQ, MSQ, STAI, and VIDT scores between and within group A and group B in the pre and post-test

Outcome measure	Group A Pre-test (Mean±S.D.)	Group A Post-test (Mean±S.D.)	Within group comparison between pre and post test	Group B Pre-test (Mean±S.D.)	Group B Post-test (Mean±S.D.)	Within group comparison between pre and post test	Between-group comparison (Post-test) t-value (p-value)
MSSQ	70.08±5.16	56.67±6.21	t=28.93 p=0.000**	69.99±4.23	60.26±4.95	t=25.93 p=0.000**	t=-2.25, p=0.028**
MSQ	17.00±3.58	11.92±3.17	t=14.68 p=0.000**	17.04±3.20	13.48±2.63	t=11.84 p=0.000**	t=-1.89, p=0.045**
STAI	62.24±4.33	41.76±3.43	t=44.29 p=0.000**	62.32±3.42	48.60±5.12	t=19.49 p=0.000**	t=-5.54, p=0.000**
VIDT	163.72±17.97	216.72±18.23	t= -35.84 p=0.000**	163.84±20.05	196.24±22.00	t= -28.52 p=0.000**	t=3.58, p=0.001**

*p-value>0.05 means Not Significant; **p-value≤0.05 means Significant, MSSQ=Motion Sickness Susceptibility Questionnaire, MSQ=Motion Sensitivity Quotient, STAI=State Trait Anxiety Inventory, VIDT=Video Induced Dizziness Time

at p-value≤0.05.

MSQ score analysis

In Table 1, comparing the mean values of Group A and Group B on MSQ score, it shows a significant decrease in the post-test mean values in both groups, but Group A (Visual Vestibular Habituation Exercises) shows 11.92±3.17, which has the lower mean value and is more effective than Group B (Optokinetic Training), 13.48±2.63 at p-value≤0.05.

STAI score analysis

In Table 1, comparing the mean values of Group A and Group B on STAI score, it shows a significant decrease in the post-test mean values in both groups, but Group A (Visual Vestibular Habituation Exercises) shows 41.76±3.43, which has the lower mean value and is more effective than Group B (Optokinetic Training), 48.60±5.12 at p-value≤0.05.

VIDT score analysis

In Table 1, comparing the mean values of Group A and Group B on VIDT score, it shows a significant increase in the post-test mean values in both groups, but Group A (Visual Vestibular Habituation Exercises) shows 216.72±18.23, which has the higher mean value and is more effective than Group B (Optokinetic Training), 196.24±22.00 at p-value≤0.05.

A comparison of the pre-test and post-test within Group A and Group B on MSSQ, MSQ, STAI, and VIDT scores shows significant differences in the mean values at p-value≤0.05.

Discussion

Motion sensitivity, often known as motion sickness, is triggered by incorrect spatial orientation, causing dizziness, blurry vision, nausea, vomiting, loss of balance, and cold sweating[33]. Even healthy individuals experience motion sensitivity when engaging in activities like roller coaster rides, boat rides, or reading in moving cars[34,35]. This experimental study compared the effect of visual-vestibular habituation exercises versus optokinetic training on healthy adults with chronic motion sensitivity. The discernment of motion sensitivity, anxiety, and latency of visually induced dizziness were the outcome measures in the study.

Both interventions led to significant improvements in symptoms; however, participants in Group A (visual vestibular habituation exercises) showed a significantly greater reduction in motion sensitivity than Group B (optokinetic training). This is similar to the conclusion by Rine et al., where visual-vestibular habituation and balance training were found to be effective in reducing motion sensitivity and improving postural stability[36].

Optokinetic training also produced significant improvements, similar to the conclusion of Alexis Mafret et al., who found that treating sea sickness by optokinetic stimulation improves the symptoms of motion sickness. Its effects last for longer periods, and it has also been suggested that it can be used to treat other forms of motion sickness[37].

Pavlou (2010) suggested that visual motion videos are an economical and user-friendly method of introducing optokinetic training in vestibular rehabilitation. He suggested that improvement in the symptoms of motion sickness after predisposition to optokinetic stimuli is due to neuroplastic adaptive changes that reduce visual dependency[38]. This study also agrees that optokinetic training using visual motion videos has shown a significant difference in the post-test values; however, visual vestibular habituation exercises showed a significantly greater improvement in VIDT-visually induced dizziness time. -This supports the hypothesis that habituation promotes stronger central adaptive changes.

Shilpa B. Gaikwad et al. reported that the sham group in their study on chronic motion sensitivity showed a decrease in anxiety levels post-intervention. This study also demonstrated that both interventions showed a significant difference in the post-test values of STAI scores, thus having a considerable effect on anxiety in individuals with motion sickness[39].

Visual vestibular habituation exercises and optokinetic training are rehabilitative approaches where patients are desensitised through progressive exposure to movements that provoke symptoms of motion sickness. When a sensory conflict arises, there is a disruption in the ability to select appropriate sensory input. These therapeutic approaches train individuals to maintain postural stability in circumstances in which the presence or accuracy of one or more sensory-input signals is disrupted. Optokinetic training, along with balance exercises, promotes desensitisation to visual stimuli and proprioceptive stimuli through exposure to visual motion videos and challenges of balance. Whereas visual vestibular habituation exercises, along with balance training, have a three-dimensional approach, stimulating the visual, vestibular, and proprioceptive systems through gaze stability exercises, head and neck movements, and challenges to balance; thus, this three-dimensional approach gives it an advantage over optokinetic training in treating subjects with motion sickness. When the symptoms of motion sickness are alleviated, the anxiety that is related to them is also reduced.

Thus, after analysing the results of this study, it is proven that visual-vestibular habituation exercises are more effective compared to optokinetic training because they alleviate the symptoms of motion sickness through the adaptive changes caused in the neural circuits.

Conclusion

From the results and statistical analysis, visual vestibular habituation appears effective due to its multisensory stimulation, though optokinetic training can be used, especially for patients with excessive visual dependency. Future studies should examine the long-term sustainability of improvements and examine these exercises in large and diverse populations. Research that incorporates modern technologies like virtual reality or combined rehabilitation procedures may improve the therapeutic efficacy and clinical applicability even further.

References

1. Murdin L, Golding JF, Bronstein AM. Managing motion sickness. BMJ 2011;343:d7430. doi: 10.1136/bmj.d7430.
2. Reuten AJC, Bos JE, Martens MH, Rausch J, Smeets JBJ. Mitigating motion sickness by anticipatory cues. Vibration 2024;7:1266-78. doi: 10.3390/vibration7040065.
3. Lackner JR. Motion sickness: more than nausea and vomiting. Exp Brain Res 2014;232:2493510. doi: 10.1007/s00221-014-4008-8.
4. Golding JF. Motion sickness susceptibility. Auton Neurosci 2006;129:6776. doi: 10.1016/j.autneu.2006.07.019.
5. Zhang LL, Wang JQ, Qi RR, Pan LL, Li M. Motion sickness: current knowledge and recent advance. CNS Neurosci Ther 2016;22:1524. doi: 10.1111/cns.12468.
6. Golding JF, Kadzere P, Gresty MA. Motion sickness susceptibility fluctuates through the menstrual cycle. Aviat Space Environ Med 2005;76:9703.
7. Koca CF, Bayindir T. Review of pathophysiology, epidemiology, diagnosis and treatment methods in motion sickness; a special issue. J Turgut Ozal Med Cent 2017;24:36570.
8. Stern RM, Koch KL, Leibowitz HW, Lindblad IM, Shupert CL, Stewart WR. Tachygastria and motion sickness. Aviat Space Environ Med 1985;56:10747.
9. Benson AJ. Motion sickness. In: Pandolf K, Burr R, editors. Medical Aspects of Harsh Environments. Vol. 2. Walter Reed Army Med Center; 2002;p.104883.
10. Golding JF, Gresty MA. Pathophysiology and treatment of motion sickness. Curr Opin Neurol 2015;28:838. doi: 10.1097/WCO.0000000000000163.
11. Kennedy RS, Drexler J, Kennedy RC. Research in visually induced motion sickness. Appl Ergon 2010;41:494503.
12. Schmäl F. Neuronal mechanisms and the treatment of motion sickness. Pharmacology 2013;91:22941. doi:10.1159/000350185.
13. Eyeson-Annan M, Peterken C, Brown B, Atchison D. Visual and vestibular components of motion sickness. Aviat Space Environ Med 1996;67:955–62.
14. Reason JT. Motion sickness adaptation: a neural mismatch model. J R Soc Med 1978;71:819–29.
15. Parker DM. A psychophysiological test for motion sickness susceptibility. J Gen Psychol 1971;85:87–92.
16. Chattha UA, Janjua UI, Anwar F, Madni TM, Cheema MF. Motion sickness in virtual reality: an empirical evaluation. IEEE Access 2020;8:130486–99.
17. Sanchez CK, Lusk KA. The pharmacologic management of motion sickness. US Pharm 2015;40:34–8.
18. Keshavarz B, Golding JF. Motion sickness: current concepts and management. Curr Opin Neurol 2022;35:107–12.
19. Ramaioli C, Steinmetzer T, Brietzke A, Meyer P, Xuan RP, Schneider E, et al. Assessment of vestibulo-ocular reflex and its adaptation during stop-and-go car rides in motion sickness susceptible passengers. Exp Brain Res 2023;241:1523–1531 doi: 10.1007/s00221-023-06619-4.
20. Herdman SJ. Vestibular rehabilitation. Curr Opin Neurol 2013;26:96–101.
21. Herdman SJ. Role of vestibular adaptation in vestibular rehabilitation. Otolaryngol Head Neck Surg 1998;119:49–54.
22. Herdman SJ. Advances in the treatment of vestibular disorders. Phys Ther 1997;77:602–18.
23. Gauthier GM, Robinson DA. Adaptation of the human vestibulo-ocular reflex to magnifying lenses. Brain Res 1975;92:331–5.
24. 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 2022;46:118-77. doi:10.1097/NPT.0000000000000382.
25. Han BI, Song HS. Vestibular rehabilitation therapy: a review of indications, mechanisms, and key exercises. J Clin Neurol 2011;7:184–96.
26. Ressiot E, Dolz M, Bonne L, Marianowski R. Prospective study on the efficacy of optokinetic training in the treatment of seasickness. Eur Ann Otorhinolaryngol Head Neck Dis 2013;130:263–8. doi: 10.1016/j.anorl.2012.03.009.
27. Obrero-Gaitán E, Sedeño-Vidal A, Peinado-Rubia AB, Cortés-Pérez I, Ibáñez-Vera AJ, Lomas-Vega R. Optokinetic stimulation for the treatment of vestibular and balance disorders: a systematic review with meta-analysis. Eur Arch Otorhinolaryngol 2024;281:4473–84 doi: 10.1007/s00405-024-08604-1.
28. Shumway-Cook A, Horak FB. Rehabilitation strategies for patients with vestibular deficits. Neurol Clin 1990;8:441–55.

29. Law JH, Koh HY, Kua A. Optokinetic stimulation in the rehabilitation of visually induced dizziness in people with vestibular disorders: a systematic review. Clin Rehabil 2024;38:1001-22. doi: 10.1177/02692155241244932.
30. Akin FW, Davenport MJ. The validity and reliability of the Motion Sensitivity Test. J Vestib Res 2003;13:415-22.
31. Golding JF. Predicting individual differences in motion sickness susceptibility by questionnaire. Pers Individ Dif 2006;41:237-48. doi: 10.1016/j.paid.2006.01.012.
32. Spielberger CD, Gorsuch RL, Lushene R, Vagg PR, Jacobs GA. Manual for the State-Trait Anxiety Inventory. Palo Alto (CA): Consulting Psychologists Press; 1983.
33. Wrisley DM, Pavlou M. Physical therapy for balance disorders. Neurol Clin 2005;23:855–74.
34. Koch A, Cascorbi I, Westhofen M, Dafotakis M, Klapa S, Kuhtz-Buschbeck JP. The neurophysiology and treatment of motion sickness. Dtsch Arztebl Int 2018;115:687–96. doi:10.3238/arztebl.2018.0687.
35. Albalwi AA, Johnson EG, Alharbi AA, Daher NS, Cordett TK, Ambode OI, et al. Effects of head motion on postural stability in healthy young adults with chronic motion sensitivity. Arch Physiother 2020;10:1. doi: 10.1186/s40945-020-00078-1.
36. Rine RM, Schubert MC, Balkany TJ. Visualvestibular habituation and balance training for motion sickness. Phys Ther 1999;79:949–57.
37. Maffert A, Aupy B. Optokinetic stimulation efficiency for sea sickness treatment. Int Marit Health 2020;71:249–52.
38. Pavlou M. The use of optokinetic stimulation in vestibular rehabilitation. J Neurol Phys Ther 2010;34:105–10. doi: 10.1097/NPT.0b013e3181dde6bf.
39. Gaikwad SB, Johnson EG, Nelson TC, Ambode OI, Albalwi AA, Alharbi AA, et al. Effect of gaze stability exercises on chronic motion sensitivity: a randomized controlled trial. J Neurol Phys Ther 2018;42:72–9.