LIBERTY UNIVERSITY

Effects of Noisy Galvanic Vestibular Stimulation (nGVS) on Fall Prevention in a Geriatric Population

Dawson, A.A & Bonser, R.J DAT, LAT, ATC, PES

Abstract

Clinical Scenario: Falls are a common experience in older adults and have been treated with physical aids (canes, walkers, or wheelchairs). However, the effectiveness of this treatment does not rid or fully treat the specific population of the problem; it aids in prevention.

Focused Clinical Question: In a commonly sedentary and fall-prone population, what is the effect of nGVS treatment on postural stability in older adults?

Summary of Key Findings: All three studies showed significant results that nGVS has a significant post-stimulation effect on postural stability improvement.

Clinical Bottom Line: Evidence supports the usage of nGVS. Each study reportedly found that this intervention induced long-term improvement in postural stability and decreases center of pressure (COP) sway.

Strength of Recommendation: Level 3B grade of evidence was determined by the evidence obtained from well-designed controlled trials without randomization of nGVS.[1]

Introduction and Research Question

Noisy Galvanic Vestibular Stimulation (nGVS) is a non-invasive treatment stimulating the vestibular system, crucial for balance. It involves applying low-level electrical current to the mastoid process. nGVS shows promise in fall prevention for older adults, which is a significant issue among this population[2] Current treatments mainly focus on balance therapy, with proven limited long-term effectiveness.[3]

nGVS has been studied generally, and has been found to enhance postural stability, yet its potential in fall prevention remains unexplored. Therefore, the purpose of this study is to examine available studies of nGVS and determine if this treatment can help prevent falls in an elderly population.

RQ, PICO format, and levels of evidence

Evidence Quality Assessment

In Figure 1, we can see the selected studies were identified as the best evidence for this CAT. The authors and researchers of these studies considered the use of nGVS in the treatment of posture control, balance, and abnormal COP to prevent falls in the geriatric population.

Results of Evidence Quality Assessment

Each of the articles chosen: Fujimoto et al.[4], Fujimoto et al.[5], and Inukai[6], all scored a differently on the PEDro scale. Fujimoto et al[4] scored a 9/10 on the PEDro scale due to the therapists that administered the therapy were not blinded to the study results, as well as the assessors. Fujimoto et al[5] scored a 7/10 on the PEDro score due to the subjects, therapists who administered the therapy, and the assessors were not blinded in this study and the allocation was not concealed. Inukai et al[6] scored an 8/10 on the PEDro scale due to the subjects, therapists who administered the therapy, and the assessors were not blinded during this study.

As seen in Table 1, we can see the selected studies were identified as the best evidence for this CAT. The authors and researchers of these studies considered the use of nGVS in the treatment of posture control, balance, and abnormal COP to prevent falls in the geriatric population.[1]

Clinical Bottom Line: Strength of Recommendation

This study found a level B grade of evidence. Because research does support the usage of Noisy Galvanic Vestibular Stimulation treatment, each study reported found this intervention to induce long-term improvement in postural stability and decrease center of pressure COP sway.

Search strategy

Sources of Evidence Searched

- PubMed
- EBSCO Host
- Google Scholar
- Nursing/academic MEDLINE

Inclusion Criteria

- Compared COP with each trial recorded
- Written in the English language
- Written in the last 10 years (2013-2023)
- Geriatric/older adults included in study
- Participants must be human

Exclusion Criteria

- Not yet completed
- Participants/subjects' age
- Outcome measures
- Measures only Studies which did not report pre and post-outcome measures

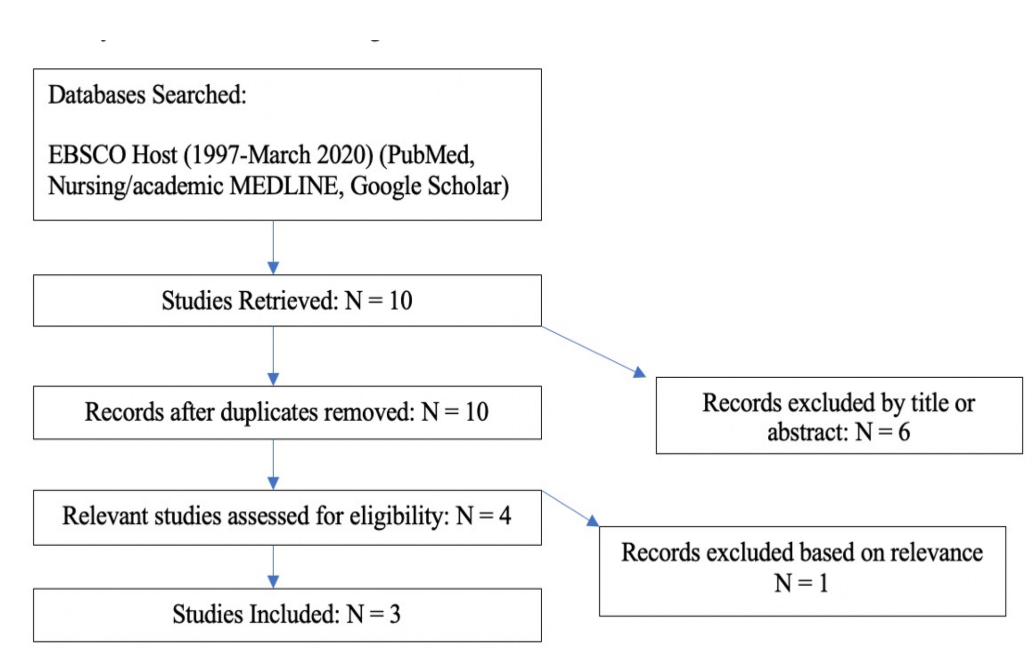

Figure 1 – Search Strategy.

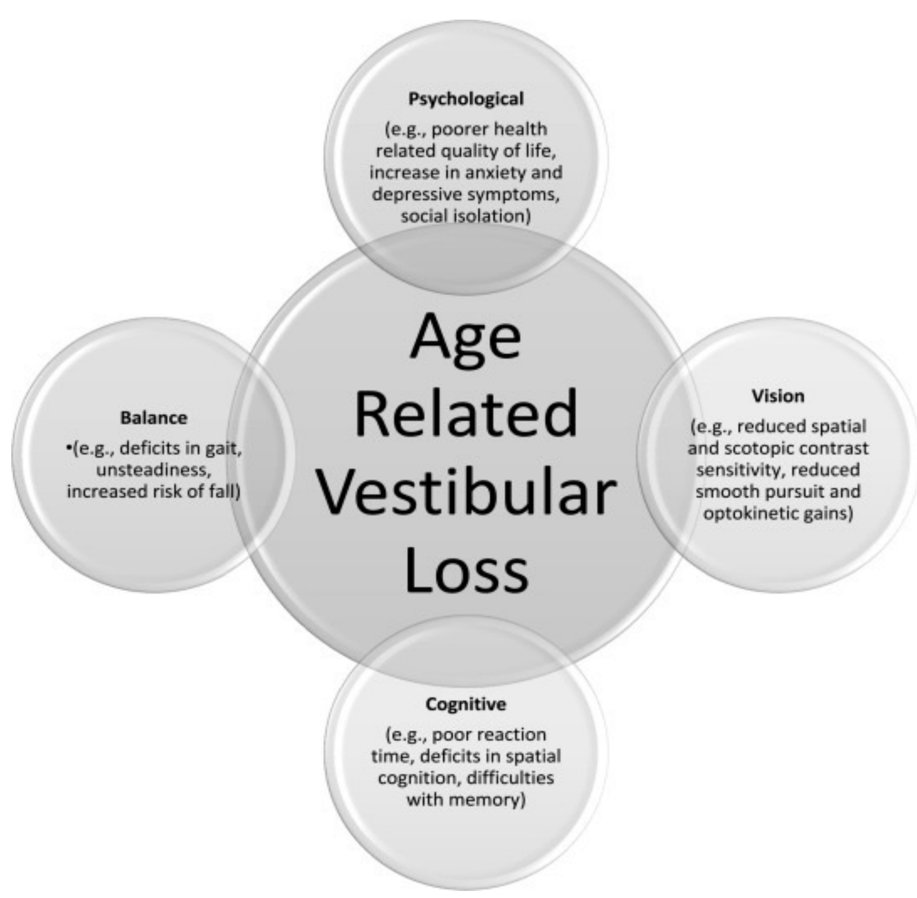

Figure 2 – Age Related Vestibular Loss
Image obtained from https://www.sciencedirect.com/science/article/pii/S1672293021000271

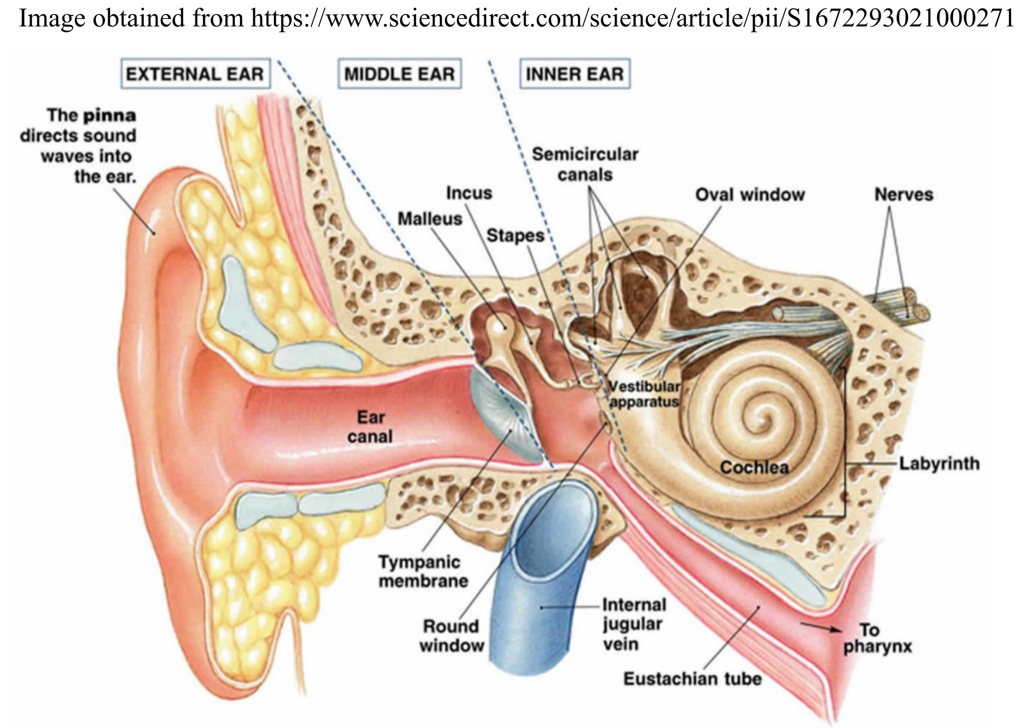

Figure 3: The Vestibular System
Image obtained by https://www.neurolab360.com/blog/vestibular-system-and-balance

Table 1 Results of PEDro Scale for Each Article

	Fujimoto et al.[4]	Fujimoto et al.[5]	Inukai et al.[6]
1. Eligibility criteria specified (yes/no)	yes	yes	yes
2. Subjects randomly allocated to groups (yes/no)	yes	yes	yes
3. Allocation was concealed (yes/no)	yes	no	yes
4. Groups similar at baseline (yes/no)	yes	yes	yes
5. Subjects were blinded to group (yes/no)	yes	no	no
6. Therapists who administered therapy were blinded (yes/no)	no	no	no
7. Assessors were blinded (yes/no)	no	no	no
8. Minimum 85% follow-up (yes/no)	yes	yes	yes
9. Intent to treat analysis for at least 1 key variable (yes/no)	yes	yes	yes
10. Results of statistical analysis between groups reported (yes/no)	yes	yes	yes
11. Point measurements and variability reported (yes/no)	yes	yes	yes
Overall Score (out of 10)	9/10	7/10	8/10

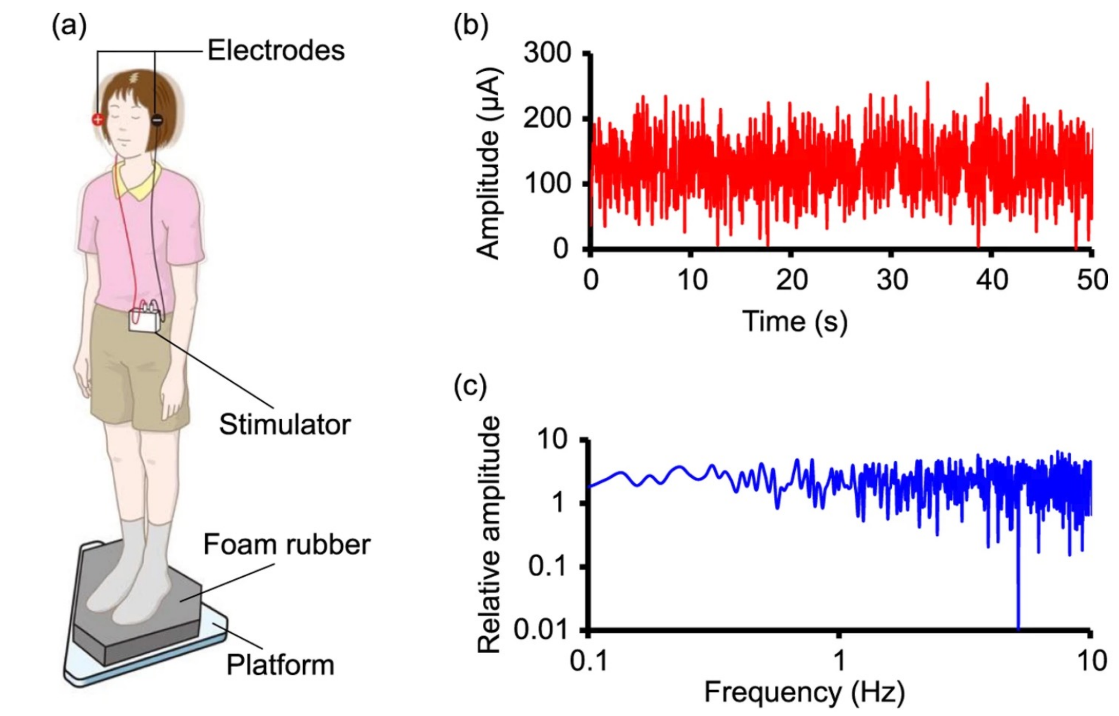

Figure 4 – Noisy Galvanic Vestibular Stimulation
Image obtained from https://www.nature.com/articles/srep37575/figures/1

	Fujimoto et al[4]	Fujimoto et al[5]	Inukai et al.[6]
Study Design	Randomized, controlled trial	Randomized, controlled trial	Clinical trial
Participants	"30 elderly healthy participants (17 men and 13 women; age range 64–70 years, mean age 67.0 [±0.3] years). The order of the sessions was randomly determined and assigned using a computer-generated permuted-block design with block size 2 in a 1:1 ratio."[4]	"13 Bilateral vestibulopathy patients (8 men and 5 women; age range 43–83 years, mean age 63.1 [± 4.0] years)"[5]	"32 community-dwelling elderly people ((7 males and 25 females; mean age 75.8 ± 0.8 years)"[6]
Interventions Investigated	*1. session 1:* participants received nGVS at its optimal intensity for 30 min twice with a 4-h interval; postural stability was measured for 4 h after each nGVS. [1] *2. session 2:* participants received nGVS at its optimal intensity for 3 h and were monitored without stimuli for 4 h; postural stability was measured during and after the nGVS [4]	*1. session 1: "Postural stability was measured after the nGVS for 30 min"* *2. session 2: "14 days after session 2 assessed the reproducibility of the measured results in session1* Procedures for session 2 were the same as session 2."[5]	*1.CON* group:* RMS area, sway path length, ML mean velocity, and AP mean velocity *2 nGVS group:* RMS area, sway path length, ML mean velocity, and AP mean velocity [6]
Outcome Measures	*Posturographic data*:* Posturographic data was analyzed at specific time points during both the postural stability test (PST) and stimulation period (ST) for two sessions. Normalized ratios (NRs) were calculated for velocity, area, and root mean square (RMS) at various intervals and sessions, including baseline comparisons and longitudinal changes.[4]	*Posturographic data:* analyzed at 0, 0.5, 1, 2, 3, 4, 5, and 6 h during the PST secondary endpoints: [1] amount of change from baseline until PST 6 h of the velocity, area, and RMS in each session; (2) longitudinal change in subjective improvement in each session; (3) determined optimal intensity in each session. They set a determined optimal intensity in each session as one of the secondary endpoints, because when they compared the optimal intensity between session 1 and session 2.[5]	*COP*:* measured for 30 s at 100 Hz in a standing position with eyes open and legs together, using a CFP400PA102RS (Leptrino, Japan) *TUG test*:* observed and timed standing from a chair, walking 3 m, turning around, walking back to the chair and sitting down *OLS test:* involved two trials of attempting to stand on one leg for 120 s.[6]
Main Findings	nGVS has a significant post-stimulation effect on postural stability improvement that lasts several hours in healthy adults.[4]	Significant post-stimulation effect on postural improvement that lasts several hours in BV patients, more specifically the velocity of the COP movement. [5]	Participants who underwent nGVS experienced significant reductions in sway path length and mean velocity compared to controls. No significant differences were found in baseline characteristics or postural stability measures between groups. There were correlations between baseline sway path length and sway path length during nGVS.[6]
Level of Evidence	3b	3b	3b
Validity Score	PEDro 9/10[1]	PEDro 7/10[1]	PEDro 8/10[1]
Conclusion	"nGVS can induce long-term improvement in postural stability. The discovered effects could contribute to an increased applicability of nGVS for postural stabilization in elderly adults."[4]	nGVS induces a long-term post-stimulation effect on the improvement of postural stability for BV patients with the reduction in the high-frequency components of their postural movement. [5]	nGVS decreases COP sway in a community-dwelling elderly population, producing a large stimulation effect in those with high COP sway path lengths in open-eyed standing who are at high risk of falls.[6]

Table 2 Characteristics of Included Studies
Abbreviations: nGVS, Noisy Galvanic Vestibular Stimulation; COP, Center of Pressure, PST, Post stimulation period, ST, Stimulation period, NR, Non-reactive, AP mean, Advanced Placement, RMS, Root mean square ML, Millimeter, BV, bilateral vestibulopathy.

Summary of Key Evidence

Three studies were examined, each focusing on different aspects of postural stability assessment. Fujimoto et al.[4] conducted two studies utilizing posturographic data. The first study analyzed posturographic data at various intervals during stimulation periods, finding a significant post-stimulation effect on postural stability improvement lasting several hours in healthy adults.[4] In the second study, posturographic data was analyzed at multiple time points post-stimulation, with secondary endpoints including assessing changes in velocity, area, and RMS up to 6 hours post-stimulation, as well as subjective improvement over time and determination of optimal intensity for each session.[5] Inukai et al. measured COP for 30 seconds at 100 Hz while participants stood with eyes open and legs together, using a device from Leptrino, Japan. They also conducted the timed up and go test (TUG), timing participants as they completed specific movements, and the One-legged stand test (OLS), where participants attempted to stand on one leg for 120 seconds each.[4]

To conclude each of the studies findings, Fujimoto's first study concluded that Noninvasive nGVS induces long-term improvement in postural stability. The findings suggest that increased applicability of nGVS for posture stabilization in elderly adults may provide an advantage for fall prevention.[1] In Fujimoto's second study the conclusion was that nGVS induces a long-term post-stimulation effect on the improvement of postural stability in patients with bilateral vestibulopathy (BV), characterized by a reduction in high-frequency components of postural movement.[5]

Lastly, Inukai's study concluded that nGVS decreases Center of Pressure (COP) sway in community-dwelling elderly individuals, particularly those with high COP sway path lengths during open-eyed standing. The authors observed the stimulation effect of nGVS was beneficial for individuals at high risk of falls due to decreased COP sway.[6]

Results and Discussion

Results

The authors and researchers of the 3 studies in this specific CAT found that nGVS to have a positive long-term effect on older adult's center of pressure (COP). The highest quality study found in this CAT was with 32 community-dwelling elderly people and preformed two sessions, a control group and a nGVS group.[6] After the statistical analysis, participants who underwent nGVS experienced significant reductions in sway path length and mean velocity compared to controls.[6]

Furthermore, the researchers in this study found nGVS decreases COP sway in a community-dwelling elderly population, producing a large stimulation effect in those with high COP sway path lengths in open-eyed standing who are at high risk of falls.[6]

Discussion

While the three studies showed promising results, implementing nGVS into a clinicians' practice should be used with precaution due to the lack of further research. Even though each study did show a significant outcome to support its objective of the study, it should be used with precaution due to every clinical case being specific to each patient's needs. Each study mainly used healthy adults who do not have any neurological/vestibular diseases that could be harmed due to this treatment. Additionally, it is important that we are to be aware that each of the studies did not assess elderly patients who suffer from repeated falls and did not assess if it decreased this populations' occurrence of falls. Interestingly, these studies showed that the stimulation of nGVS significantly reduces posture sway and improves COP. These new discovered effects could possibly contribute to an increased applicability of nGVS for postural stabilization in elderly adult population who experience falls. Thus, we cannot conclude with these studies alone that nGVS can prevent falls within the older population but is a very promising treatment that when undergone more research it can possibly help future elderly generations to come

Future Work

1. Assess fall prevention efficacy: Conduct large-scale clinical trials targeting at-risk geriatric populations to evaluate nGVS effectiveness in reducing falls and enhancing balance.
2. Explore neurological disorder applications: Investigate nGVS potential in treating various neurological disorders.
3. Investigate combined therapies: Study synergistic effects of combining nGVS with other neuromodulation techniques.
4. Address compliance and feasibility: Assess feasibility and acceptability of integrating nGVS into fall prevention programs for older adults, considering device usability, comfort, and adherence to stimulation protocols for practical implementation and sustained engagement.

References and/or Acknowledgments

1. "Pedro Scale - Pedro." *Physiotherapy Evidence Database*, https://pedro.org.au/english/resources/pedro-scale/. CDC. (2019).
2. *Keep on Your Feet*. Centers for Disease Control and Prevention. https://www.cdc.gov/injury/features/older-adult-falls/index.html
3. Wallén MB, Hagströmer M, Conradsson D, Sorjonen K, Franzén E. Long-term effects of highly challenging balance training in Parkinson's disease—a randomized controlled trial. Clinical Rehabilitation. 2018;32(11):1520-1529. doi:10.1177/0269215518784338
4. Fujimoto, C., Yamamoto, Y., Kamogashira, T., Kinoshita, M., Egami, N., Uemura, Y., Togo, F., Yamasoba, T., & Iwasaki, S. (2016). Noisy galvanic vestibular stimulation induces a sustained improvement in body balance in elderly adults. *Scientific reports*, *6*, 37575. https://doi.org/10.1038/srep37575
5. Fujimoto, C., Egami, N., Kawahara, T., Uemura, Y., Yamamoto, Y., Yamasoba, T., & Iwasaki, S. (2018). Noisy Galvanic Vestibular Stimulation Sustainably Improves Posture in Bilateral Vestibulopathy. *Frontiers in neurology*, *9*, 900. https://doi.org/10.3389/fneur.2018.00900
6. Inukai, Y., Masaki, M., Otsuru, N. *et al*. Effect of noisy galvanic vestibular stimulation in community-dwelling elderly people: a randomized controlled trial. *J NeuroEngineering Rehabil* **15**, 63 (2018). https://doi.org/10.1186/s12984-018-0407-6 McLaren, R., Smith, P. F., Lord, S., Kaur, P. K., Zheng, Y., & Taylor, D. (2021). Noisy Galvanic Vestibular Stimulation Combined With a Multisensory Balance Program in Older Adults With Moderate to High Fall Risk: Protocol for a Feasibility Study for a Randomized Controlled Trial. *JMIR research protocols*, *10*(10), e32085. https://doi.org/10.2196/32085
7. Oxford Centre for Evidence-based Medicine - Levels of Evidence (March 2009). (n.d.). Retrieved April 10th, 2023, from http://www.cebm.net/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/.
8. Blumenfeld, Hal. *Neuroanatomy through Clinical Cases*. 3rd ed., vol. 3 3, Sinauer Associates, 2022.
9. Netter, Frank H. *Atlas of Human Anatomy: Classic Regional Approach*. Elsevier, 2023.