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ORIGINAL ARTICLE

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Short-term effects of lifestyle modification on vestibular migraine

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ABSTRACT

Objective: Our primary purpose was evaluation of early benefits of lifestyle modification on symptoms of vestibular migraine. The secondary purpose was to determine if a patient's global sense of coping relates to outcomes with lifestyle modification.

Design: Prospective observational cohort. Participants completed questionnaires related to dizziness handicap, headache disability, and adherence to lifestyle modifications at baseline and weekly over 30 d. Sense of coping was measured pre-intervention.

Study sample: Thirty-eight patients with vestibular migraine diagnosed in tertiary care setting between 2022 and 2023.

Results: Symptoms were better at all four weeks post-intervention than pre-intervention ($p < 0.01$), with no difference across weeks two through four ($p > 0.10$) when symptoms were lowest and stable. By week two, 52% and 18.5% of participants had significant improvement in dizziness and headache compared to published critical difference scores, respectively. Sense of coping was inversely correlated with dizziness ($R = -0.53$, $p < 0.00001$) and headache ($R = -0.64$, $p < 0.0001$).

Conclusions: Lifestyle modification reduced dizziness and headache in many vestibular migraineurs in the first two weeks following intervention. Improvement in restful sleep was associated with improvement in symptoms. Sense of coping did not predict improvement but was inversely related to symptoms. Lifestyle modification could be considered as sole management or in addition to pharmacological intervention.

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Dizziness; headache; lifestyle modification; sense of coherence; vestibular; vestibular migraine

Introduction

Vestibular migraine (VM) has been described as the most common cause of episodic vertigo (Dieterich, Obermann, and Celebisoy 2016) with a prevalence of 2.7% in adults (Formeister et al. 2018). There is a ∼10% probability that a patient seen for vestibular evaluation in a tertiary care medical centre will be diagnosed with VM (Murphy et al. 2024). Symptoms of VM can include positional or visual-induced vertigo, disequilibrium, head-motion dizziness, and nausea, in addition to symptoms more commonly associated with migraine like headache, phonophobia, photophobia, etc. (Beh 2022; Lempert et al. 2022). The impact of these symptoms is demonstrated by Best et al. (2009) who found that patients with VM reported significantly higher handicap related to their vertigo than patients with other vestibular disorders including benign paroxysmal positional vertigo, Meniere's disease, or vestibular neuritis.

The understanding of effective clinical interventions for reducing the symptoms of VM is continuing to emerge. Power et al. (2018) found that 91% of their patients with VM managed in a tertiary care medical setting were prescribed medication as the primary treatment. However, there is also evidence supporting non-pharmacological management options. Extant literature demonstrates effectiveness of resistance exercise (Sun et al. 2022), vestibular rehabilitation therapy (VRT; Vitkovic et al. 2013), and lifestyle modification (Reploeg and Goebel 2002; Roberts et al. 2021). These non-pharmacological interventions could be beneficial because they keep activity that triggers VM symptoms below threshold. For example, resistance training is thought to decrease inflammation, while VRT has the benefit of promoting compensation to any peripheral vestibular impairment (Vitkovic et al. 2013). The goal of intervention through lifestyle modification is to improve control over potentially triggering events that may increase VM activity. It is possible, but not currently known, that this intervention could also improve the threshold for activation of migraine activity.

These non-pharmacological interventions can be used in isolation or in conjunction with pharmacological ones. Johnson (1998) wrote that 10/89 (11%) of his patients treated in an academic medical centre setting for, what would now be termed, VM had successful outcomes with lifestyle modification alone. Reploeg and Goebel (2002) incorporated lifestyle modification as a first step in management of patients with VM in a tertiary care setting. Thirteen of 81 (16%) of these patients improved with this intervention. More recently, Roberts et al. (2021) have shown that a lifestyle modification intervention including avoidance of dietary triggers, improvement of restful sleep, mealtime regularity, and exercise led to a significant decrease in dizziness for 39% of patients and in headache for 18% of patients at 105 d of intervention. Using the same lifestyle modification

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intervention, Kolberg et al. (2024) found that 25% of patients with VM were still reporting significant improvement in dizziness after 371 d. The participants in Roberts et al. and Kolberg et al. were diagnosed and managed in a tertiary care setting.

There is an interesting point found in the study by Reploeg and Goebel (2002). They note some patients successfully managed with lifestyle modification reported improvement within four weeks into the intervention period. This was sooner than the improvement they observed with pharmacological intervention. Pharmacological intervention for symptoms of VM may take as long as three months to reach full effect (Byun et al. 2020). Anecdotally, our lab has had similar reports from patients that the improvement seemed to happen soon after starting the lifestyle modification intervention, though we did not measure this systematically (Roberts et al. 2021).

In addition to time course, another factor to consider is the variability in intervention benefits. The literature indicates 11%–39% of patients may benefit from lifestyle modification intervention (Reploeg and Goebel 2002; Roberts et al. 2021). Clearly there are patients who benefit and patients who do not, but there has been no specific consideration of why certain patients may or may not improve within most investigations focused on lifestyle modification. Given that the patients must be self-reliant for the most part in making the changes in lifestyle that are associated with improvement in symptoms of VM, it is possible that individuals who have better coping abilities relying on both internal and external resources may do better with a lifestyle modification intervention. Antonovsky (1987) first published the Sense of Coherence (SOC) scale as a questionnaire to measure an individual's global coping ability. Briefly, the scale measures how components of comprehensibility, manageability, and meaningfulness interact to form an individual's world view and ability to understand, cope, and move through life stressors including those related to health issues (Antonovsky 1987; Antonovsky 1993). Therefore, it is possible that a measurement of sense of coherence might help explain which patients do well with lifestyle modification as intervention for symptoms of VM which would be useful to clinicians.

The primary purpose of this study was to determine the early time course of lifestyle modification on VM symptoms. If it was determined that lifestyle modification could create a significant improvement within a short period of time, clinicians might consider this approach in more patients as a sole intervention or as an adjunct intervention while patients are progressing to a therapeutic dosage of their pharmacological intervention. A secondary purpose was to determine the relationship of coping, as measured with the SOC scale, to VM symptoms of dizziness and headache, as well as intervention with lifestyle modification. A strong relationship would suggest the SOC could be used to determine which participants would benefit from lifestyle modification intervention and which participants should be considered for other management approaches.

Methods

Participants

This project was approved by the Vanderbilt University Medical Centre (VUMC) Institutional Review Board (#220295). During 2022–2023, participants were recruited from adult (18 years or older) patients whose preferred language was English and who had been diagnosed with definite VM during their consultation with one of three otolaryngology clinicians (authors KW, EB, or DS). KS and EB are otolaryngology nurse practitioners and DS is an otolaryngologist physician. All are experienced in treating patients with dizziness and imbalance. Patients with other vestibular co-morbidities (i.e., Meniere's disease) were excluded. The criteria in Lempert et al. (2022) were used to make the diagnosis. In brief, the criteria are five or more episodes with vestibular symptoms lasting five minutes to 72 h; current or previous history of migraine with or without aura; one or more migraine features with at least 50% of the vestibular episodes including headache, photophobia and phonophobia, or visual aura. Specific criteria are detailed in Lempert et al. All participants who met the inclusion criteria during the study enrolment period were recruited.

Participants were prescribed only lifestyle modification as intervention (Roberts et al. 2021) by their otolaryngology clinician. If a clinician felt changes or new medications were needed in addition to, or instead of lifestyle modification, then the patient was not considered for inclusion in this study. For example, a patient with daily, incapacitating vertigo and headache would be prescribed medication and referred to neurology rather than management with lifestyle modification only. Patients who met inclusion criteria completed an online informed consent document to indicate their willingness to participate. Inclusion or exclusion from this study was not affected by race, ethnicity, sex, gender, or sexual orientation. The sample was representative of the population of the middle Tennessee region. All materials including the lifestyle modification written intervention and the questionnaires were written in English.

Measures

Pre-intervention measures included the Dizziness Handicap Inventory (DHI; Jacobson and Newman 1990), the Headache Disability Inventory (HDI; Jacobson et al. 1994), the SOC scale (Antonovsky 1993), and a four-item lifestyle factor questionnaire used by Roberts et al. (2021). Participants completed the SOC, DHI, HDI, and lifestyle factor questionnaire once on the same day they were enrolled in the investigation. These responses for the DHI, HDI, and lifestyle questionnaire were used as pre-intervention, baseline measures. DHI, HDI, and the lifestyle questionnaire were then again completed weekly for 30 days (four times). All data were collected using a REDcap online survey (Harris et al. 2009).

Dizziness Handicap Inventory

The DHI, developed by Jacobson and Newman (1990), is a disease-specific quality of life measure used routinely in many balance clinics. It consists of 25 items relating to the impact of dizziness on a person's life (i.e., *Because of your problem, do you feel frustrated?*). Participants have the options of selecting *yes (4 points), sometimes (2 points),* or *no (0 points)* to represent their answer to each question. Higher scores (max 100 points) are indicative of greater perceived handicap due to dizziness. The DHI has strong internal consistency (Cronbach's alpha = 0.89) and test-retest reliability ($r = 0.97$; Jacobson and Newman 1990).

Headache Disability Index

The HDI, also developed by Jacobson et al. (1994), has a similar design to the DHI, consisting of 25 items relating to the impact of headaches on a person's life (i.e., *Because of my headaches I feel restricted in performing my routine daily activities*). Answer choices include *yes (4 points), sometimes (2 points),* or *no (0* *points).* Higher scores (max 100 points) indicate higher perceived handicap due to headaches. The HDI has strong internal consistency (Cronbach's alpha = 0.89) and test-retest reliability over 60 days ($r = 0.83$; Jacobson et al. 1994).

Sense of coherence

The 13-item scale includes questions and statements designed to gain insight into a person's global coping ability, their SOC. Responses are indicated using a 7-point Likert scale with anchors varying depending on the particular item. Considering an example item, *Do you have the feeling that you are in an unfamiliar situation and don't know what to do?,* participants indicate their response from *very often (1 point)* to *very seldom or never (7 points).* The associated points are summed with a maximum possible score of 91 and a minimum possible score of 13; higher scores indicate a better sense of coping. Internal consistency of the SOC 13-item scale is strong, ranging from 0.74 to 0.91 (Cronbach's alpha) with good test-retest stability of 0.54 out to two years (Antonovsky 1993).

Lifestyle factor questionnaire

The lifestyle factor questionnaire was developed by Roberts et al. (2021) to measure a participant's agreement with four lifestyle factors. Change on these measures is interpreted as change in lifestyle modification. This is also a subjective way to evaluate if participants are adherent to the lifestyle modification intervention. The questionnaire has a statement regarding each of the four lifestyle factors (i.e., *I exercise every day.*) and the participants are asked to rate their agreement on a 5-point Likert scale from *Strongly Disagree (1 point)* to *Strongly Agree (5 points).* Lower scores suggest patients are not complying with a particular factor while higher scores suggest they are compliant (Roberts et al. 2021).

Procedures

After a clinician diagnosed an individual with VM and determined lifestyle modification was an appropriate intervention, the patient was provided the same written instructions we have used previously. The instructions focused on improving restful sleep, mealtime regularity, exercise, and avoidance of dietary triggers (Roberts et al. 2021). The clinician discussed the intervention and answered any questions. Each patient meeting the inclusion criteria was provided a quick response (QR) code for a multiform REDcap survey which contained the informed consent document. After indicating voluntary consent, the participant completed the pre-intervention questionnaires. During the 30-d, participants were emailed a link to complete the DHI, HDI, and lifestyle factor questionnaire each week. The initial and weekly surveys each took approximately 5–10 min to complete. We did not randomise the order of administration of the surveys. There was no compensation for participation.

Data analysis

All analyses were conducted with R language for statistical computing (v 4.3.0; R Core Team 2023). To evaluate the effects of lifestyle modification on symptoms of vestibular migraine, total scores on the DHI and HDI were analysed separately using linear mixed-effects modelling. For each model, included fixed factors were time (baseline, week 1, week 2, week 3, week 4), SOC score (at baseline) and age (in years); a random intercept of participant was also included. Prior to analysis, the SOC and age values were scaled. Time was entered as an ordinal variable. Models were constructed with the lmer function of the lme4 package (Bates et al. 2015) and were analysed using the anova function of base R. Significant main effects and interactions were followed up using pairwise comparisons and the emmeans function of the emmeans package (Lenth 2019), adjusting for family-wise error rates (Benjamini and Hochberg 1995).

To evaluate the relationship between changes in lifestyle and changes in symptoms, change scores were calculated for the DHI, HDI, and all four items of the lifestyle questionnaire (restful sleep, exercise, mealtime regularity, avoidance of dietary triggers). Benefits for DHI and HDI were evaluated separately, each using linear mixed-effects models with fixed factors of restful sleep change score, exercise change score, mealtime regularity change score, and dietary trigger avoidance change score. Participant was included as a random intercept.

Given it is common for some researchers, and also clinicians, to use published critical difference scores to determine a significant change (improvement or decrement) in DHI and HDI, we also provide an analysis using this criterion. For DHI, a significant change has been defined as at least an 18-point difference (Jacobson and Newman 1990) and for the HDI at least a 29-point difference (Jacobson et al. 1994).

Results

Participants

Table 1 displays the characteristics at baseline of participants. Note that 11 participants withdrew or were withdrawn before the full 30 days because they stopped responding to the survey invitations ($n = 9$) or because they took new medication to address vestibular migraine symptoms ($n = 2$). Demographic characteristics of those who did and did not complete the study are both displayed in the table.

Considering the full dataset of 38 patients who consented to participate, average age was 48 years (range 23 – 84) with 84% female. Between-group analysis of the 27 participants who completed the study to the 11 participants who did not complete the study revealed the groups were similar in terms of age, sex, SOC, dizziness symptoms, headache symptoms, restful sleep, and mealtime regularity. However, participants who withdrew had lower scores for exercise and avoidance of dietary triggers at baseline than did participants who completed the study. Because the

Table 1. Characteristics of participants who completed and did not complete study procedures through four weeks.

Characteristic	Completed, $n = 27$[a]	Stopped, $n = 11$[a]	*p*-value[b]
Sex			0.7
Female	22 (81%)	10 (91%)	
Male	5 (19%)	1 (9.1%)	
Age	48 (16)	49 (14)	0.6
Sense of Coherence	65 (13)	59 (19)	0.3
Unknown	0	1	
Restful Sleep	2.63 (0.97)	2.55 (1.13)	0.8
Mealtime Regularity	2.59 (1.08)	2.09 (1.30)	0.12
Exercise	**2.89 (1.01)**	**1.73 (1.01)**	**0.004**
Avoidance of Dietary Triggers	**3.15 (0.95)**	**2.27 (1.35)**	**0.035**
Dizziness Handicap Inventory	51 (22)	55 (29)	0.6
Headache Disability Inventory	41 (24)	49 (31)	0.4

Significant differences are indicated by bold typeface.
[a]*n* (%); Mean (SD)
[b]Fisher's exact test; Wilcoxon rank sum test

groups generally did not differ on important baseline characteristics, and because linear mixed-effects models are robust to missing data points (e.g., Gordon 2019), all available data from the full set of 38 participants were included in the statistical analyses.

Changes in symptoms over time

Mean total scores for each time point and questionnaire are displayed in Table 2. Mean scores as a function of time for the DHI and HDI are displayed in Figure 1 left and right panels, respectively. Analysis of DHI scores revealed significant main effects of time (F[4, 97.0] = 25.5, $p < 0.01$) and SOC (F[1, 35.8] = 16.7, $p < 0.01$). The other main effect of age and all of the interactions were not statistically significant ($p > 0.50$). Follow-up analysis of the effect of time revealed DHI scores were higher at baseline than all other time points ($p < 0.01$ for all comparisons) and higher at week 1 than at the following weeks ($p < 0.05$ for all comparisons). However, scores were not significantly different between weeks 2, 3, and 4 ($p > 0.10$ for all comparisons. Figure 2 displays the relationship between sense of coherence and DHI scores (left panel) and demonstrates a significant inverse relationship (R = −.53, $p < 0.00001$) where dizziness handicap decreased as SOC increased.

Analysis of HDI revealed a similar pattern of results as the DHI. Specifically, there was a main effect of time (F[4, 95.2] = 16.1, $p < 0.01$) and SOC (F[1, 34.9] = 26.6, $p < 0.01$). The other main effect of age and all of the interactions were not statistically significant ($p > 0.20$). Follow-up analysis of the effect of time, revealed HDI scores were higher at baseline than all other time points ($p < 0.01$ for all comparisons) and higher at week 1 than at the following weeks ($p < 0.01$ for all comparisons). However, scores were not significantly different between weeks 2, 3, and 4 ($p > 0.80$ for all comparisons). Figure 2 displays the relationship between SOC and HDI scores (right panel) and demonstrates a significant inverse relationship (R = −64, $p < 0.0001$) where headache disability decreased as SOC increased

Combined, these findings demonstrate that low SOC was associated with high DHI and HDI scores. Although DHI and HDI scores improved from baseline to week 1 and from week 1

Table 2. Summary of mean scores (standard deviation) for each questionnaire at each time point.

Characteristic	Baseline $N = 38$	Week 1 $N = 38$	Week 2 $N = 38$	Week 3 $N = 38$	Week 4 $N = 38$
Restful Sleep	2.61 (1.0)	2.29 (1.8)	2.03 (1.6)	1.76 (1.8)	1.89 (1.5)
Unknown	0	7	9	13	11
Mealtime Regularity	2.45 (1.2)	1.90 (2.2)	1.86 (2.1)	1.52 (1.8)	1.56 (2.2)
Unknown	0	7	9	13	11
Exercise	2.55 (1.1)	2.35 (1.9)	2.34 (1.9)	2.36 (2.0)	2.19 (2.0)
Unknown	0	7	9	13	11
Avoidance of Dietary Triggers	2.89 (1.1)	1.77 (2.0)	2.24 (2.0)	1.96 (2.07)	2.11 (2.0)
Unknown	0	7	9	13	11
Dizziness Handicap Inventory	52 (24)	40 (26)	32 (23)	29 (26)	28 (25)
Unknown	0	7	9	13	11
Headache Disability Inventory	44 (26)	36 (29)	27 (25)	28 (29)	27 (27)
Unknown	0	7	10	13	11

Also indicated are the number of missing cases for each time.

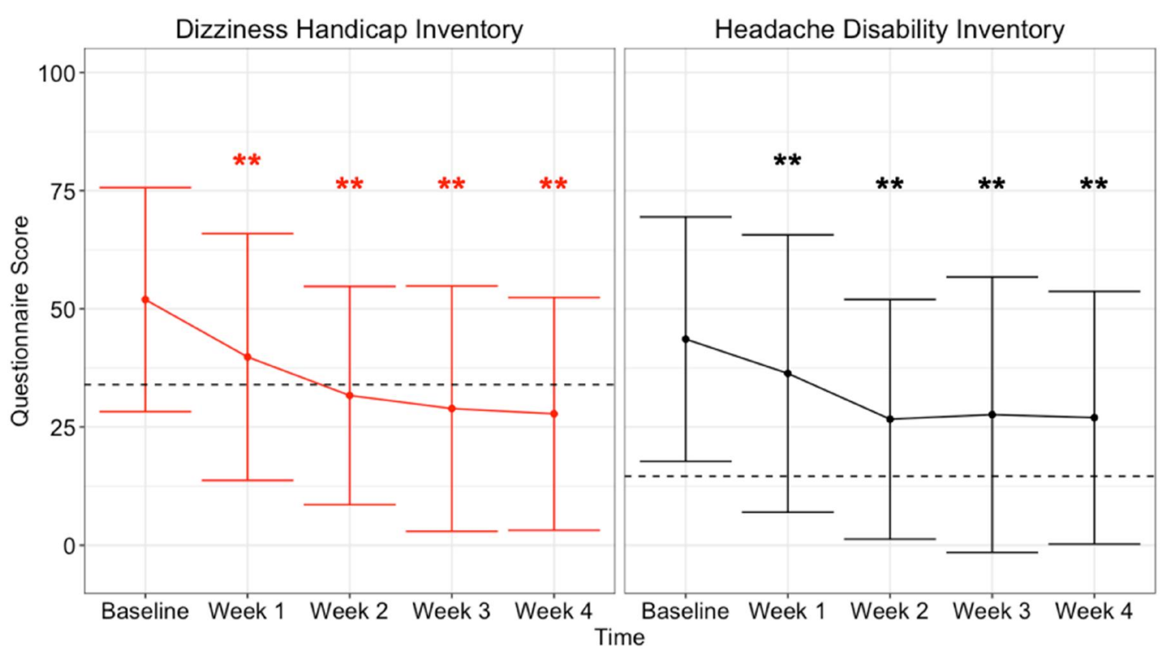

Figure 1. Mean Dizziness Handicap Inventory and Headache Disability Inventory scores (left and right panels, respectively) for each measurement time point. Error bars indicate standard deviation. Asterisks indicate scores in that condition are significantly different from baseline at that time point. Dashed lines indicate the mean score that would indicate clinical significance given the questionnaire (e.g., baseline score minus 18 or 29 for the Dizziness Handicap Inventory or Headache Disability Inventory, respectively).

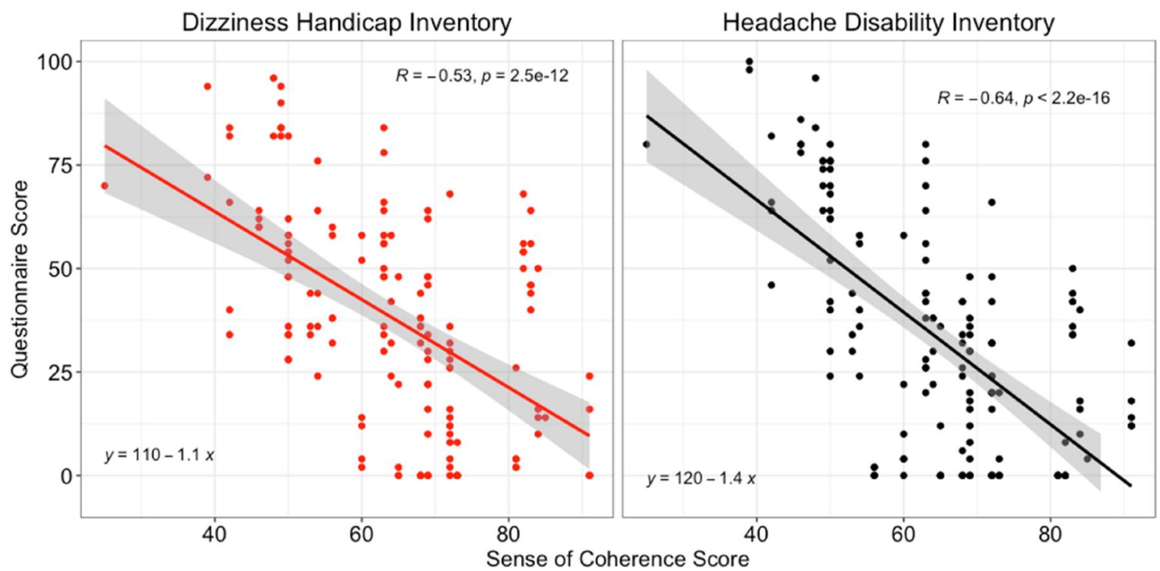

Figure 2. Correlation DHI score (left panel) or HDI score (right panel) and sense of coherence score. Dots represent individual participants at each of the five measurement times (baseline and weeks 1–4). Both relationships are statistically significant.

Table 3. Individual participant results using ≥18 point change from baseline for Dizziness Handicap Inventory (DHI) and ≥29 point change from baseline for Headache Disability Inventory (HDI).

	Total participants $n = 38$	Completed $n = 27$	Did not complete $n = 11$
DHI Improved	17/38 (44.7%)	16/27 (59%)	1/11 (9%)
DHI Worsened	1/38 (2.6%)	1/27 (3.7%)	0/11 (0%)
HDI Improved	5/38 (13.2%)	5/27 (18.5%)	0/11 (0%)
HDI Worsened	0/38 (0%)	0/27 (0%)	0/11 (0%)

to week 2, the non-significant interaction demonstrates that the relationship between DHI or HDI scores and SOC was evident at all 5 time points.

Benefits related to lifestyle changes

Analysis of DHI benefits revealed a significant main effect of restful sleep ($F[1, 103.1] = 5.6$, $p < 0.05$), but no effects of exercise, avoidance of dietary triggers, or mealtime regularity ($p > 0.20$). These results demonstrate that participants who had larger improvements in restful sleep demonstrated larger improvement in dizziness symptoms on the DHI, but no such relationships were evident for the other lifestyle modifications. Follow-up correlation analysis revealed the relationship between sleep changes and DHI changes are significantly related ($p < 0.05$; $R = 0.22$) and are described with the formula $y = 16 + 3.6x$, indicating that a 1-point improvement in sleep would be expected to result in a 3.6 point improvement in DHI score.

Analysis of the HDI benefits also revealed a significant effect of restful sleep ($F[1, 102.4] = 9.2$, $p < 0.01$), but no effects of exercise, avoidance of dietary triggers, or mealtime regularity ($p > 0.10$). These results demonstrate that participants who had larger improvements in restful sleep demonstrated larger improvement in headache symptoms on the HDI, but no such relationships were evident for the other lifestyle modifications. Follow-up correlation analysis revealed the relationship between sleep changes and HDI changes are significantly related ($p < 0.001$; $R = 0.29$) and are described with the formula $y = 9.5 + 3.9x$, indicating that a 1-point improvement in sleep would be expected to result in a 3.9 point improvement in HDI score.

Individual participant improvement

We compared responses on DHI and HDI to published critical difference scores. This allowed for determination of percent of participants who reported a significant improvement or decrement. These results are shown in Table 3 and the criterion are displayed in Figure 1 relative to the mean baseline scores in this study.

Regarding DHI, 17 of the 38 total participants (44.7%) had an 18-point or greater improvement in DHI. Sixteen of these were in the group who completed all 30 days in the study (59%) while one participant (9%) who did not complete the study also had an improvement in DHI using this criterion by week 1. Nine participants who completed the study (33%) reported improvement in week 1, 14 (52%) in week 2, 13 (48%) in week 3, and 16 in week 4. Only one of the 38 total participants (2.6%) reported a significant worsening in DHI and this was in week 4.

For HDI, five participants of the 38 total (13.2%) had an improvement of at least 29 points compared to pre-intervention baseline. All of these were in the 27 who completed the study (18.5%). Two participants who completed the study (7%) reported improvement in week 1 and five (18.5%) reported improvement in weeks 2 through 4. No participant among the 11 who did not complete the study reported a significant improvement in HDI. No participant had a worsened HDI using the 29-point criterion.

Discussion

Our results indicate that lifestyle modification was effective in reducing dizziness handicap and headache disability related to VM. The time course for improvement is early in the intervention period. There was an inverse relationship between SOC and both dizziness handicap and headache disability, but SOC did not predict which participants would do well with this intervention.

Improvement in symptoms over time

Reploeg and Goebel (2002) mention that their patients whose symptoms of VM improved with lifestyle modification experienced the benefit in less than four weeks. Roberts et al. (2021) measured significantly improved DHI and HDI at ∼105 d after intervention which is more similar to what has been used to measure the time course of pharmacological effects (Byun et al. 2020). However, we did not measure for change earlier in the intervention period in the prior study, although some participants did report noticeable improvement soon after starting the lifestyle modifications.

Results from the current investigation indicate a significantly higher dizziness handicap, on average, was reported comparing pre-intervention baseline to all other weeks, including week 1. Week 1 results were lower (better) than pre-intervention baseline and higher (worse) than weeks 2–4 but there was no difference, and so no further improvement, comparing weeks 2–4. This was measured not only for the DHI but also for the HDI. This result indicates participants reported decreased impact of dizziness and headache symptoms from the lifestyle modification intervention that was noticeable within the first two weeks of treatment which is in agreement with the report by Reploeg and Goebel (2002). Our results also suggest there is no further improvement after the second week within the 30-day period. It is possible that once participants made lifestyle modifications that led to significant improvement, there was little incentive to continue making further changes to improve even more.

These results support that lifestyle modification may be considered as a sole intervention for symptoms of VM with a shorter time to significant improvement than typically reported for pharmacological intervention (Byun et al. 2020). Byun et al. state that the most common follow-up-period of the studies included in their meta-analysis was 12 weeks to allow the medications to take effect. Since it may take longer to experience improvement with medications, clinicians may also consider lifestyle modification along with pharmacological intervention so patients may begin to experience a noticeable reduction in their symptoms of dizziness and headache while awaiting the positive effects from the prescribed medication.

Results also indicated an inverse relationship exists between SOC and both DHI and HDI. That is, participants with higher SOC reported lower impact of dizziness and headache symptoms on quality of life. Participants with lower SOC reported higher impact. This relationship was present throughout the intervention period. This suggests that global coping is an important component of managing symptoms of vestibular migraine, particularly as they relate to quality of life.

The results of the current investigation are similar to those reported for global sense of coping and symptoms of Meniere's disease (Ketola et al. 2013; Söderman et al. 2001). Higher SOC was related to less perceived impact of vertigo and tinnitus in those reports. Higher SOC was also associated with higher quality of life. There is a more recent study that investigated headache and VM symptoms in patients with Meniere's disease (Pyykkö et al. 2019). They reported higher SOC in patients with Meniere's disease and no headache compared to lower SOC in patients with Meniere's disease, migraine, and vertigo. The authors acknowledge they were unable to differentiate patients with VM and Meniere's disease using their statistical analyses which is likely due to the overlap of some symptoms. Considering headache, this is not surprising. There is not always a temporal relationship between headache and vertigo symptoms with VM and there may not even be symptoms of headache (Beh 2022).

This is an interesting relationship between SOC, DHI, and HDI, but the secondary purpose of this investigation was to determine if SOC is helpful in predicting which patients may benefit from lifestyle modifications. The mean SOC (standard deviation) of our participants who did not improve on DHI was 66.3 (14) compared to 64.8 (12.3) for the participants who did improve. Mean SOC for the participants who did not improve on HDI was also 66.3 (13.5) compared to 61.2 (8.6) for participants who did improve. Based on these results, it does not appear that SOC is helpful in predicting who would benefit from intervention with lifestyle modification. Our results do indicate that patients with higher SOC will experience less impact of symptoms of VM. This is in agreement with the literature for symptoms of Meniere's disease (Ketola et al. 2013; Söderman et al. 2001).

Benefits related to lifestyle modification

Improvement on each of the four lifestyle factors used in our intervention were compared to improvement on DHI and HDI. Only improvement in restful sleep was correlated with improvement in symptoms of dizziness and symptoms of headache. The correlations were weak at $R = 0.22$ for dizziness and $R = 0.29$ for headache. The same relationship with restful sleep and improvement in both DHI and HDI was observed in a previously published investigation using this same intervention (Roberts et al. 2021). It is possible there is a great deal of individual variability in terms of which factors are most important for improvement in symptoms of VM. This is important to note for clinicians because even though improving restful sleep is important for improvement in symptoms of dizziness and headache for many of the participants, the other factors may be as important or more important for individual participants. It is also possible that addressing various factors may also lead to benefit for another factor. For example, avoiding the potential dietary trigger caffeine would be expected to help improve restful sleep.

There is evidence supporting poorer sleep in patients with VM. Zhou et al. (2023) reported poorer sleep quality with subjective measures for participants with VM compared to controls. They also reported objective differences in polysomnography measures supporting higher states of arousal (poorer sleep) in participants with VM, among other objective measures that contribute to more fragmented sleep. The participants with VM performed the same when compared to participants with migraine. This helps to support that interventions which include factors that improve restful sleep would improve symptoms of VM as we observed in the current study.

Individual participant improvement

Previously, we found 39% of participants reported a reduction of dizziness handicap and 18% reported a decrease in headache disability using the same lifestyle modification intervention but for a longer follow-up period of 105 d (Roberts et al. 2021). For the current investigation, the focus was on short-term effects of the intervention. With the shorter follow-up period of 30 d, 44.7%−59% of participants had at least an 18-point improvement on the DHI. One participant who improved did not complete the study and one participant who completed the study had a worsening of dizziness. The combination of findings suggests lifestyle modification is a relatively low risk intervention, in terms of DHI outcomes.

Our results for symptoms of headache indicate improvement for 13.2%−18.5% of participants. This is similar to the 11%−16% reported by others (Johnson 1998; Reploeg and Goebel 2002) and is essentially the same (18%) published previously for improvement in headache at a follow-up period of 105 d (Roberts et al. 2021). This is noteworthy and could suggest the improvement in headache is stable over 30 − 105 d when using lifestyle modification. Considering dizziness, there may be a slight decline from 44.4%−59% at 30 d to 39% at 105 d. In a retrospective investigation, we saw that 25% of participants using lifestyle modification alone were still reporting improvement in DHI at 371 d which indicates a further decline over time (Kolberg et al. 2024). We did not report on headache symptoms in the prior investigation. It should be pointed out that decrease in adherence to intervention over time is common. For example, Hepp et al. (2017) found that only 25% of patients with chronic migraine were still adherent to prescribed oral migraine preventive medication at six months and only 14% were adherent at one year.

Clinical implications

The results of this investigation support that lifestyle modification is effective in decreasing symptoms of dizziness and headache in patients with VM. Moreover, the beneficial effects occur in a shorter time period than is typically reported for pharmacological interventions (Byun et al.). This is important for patients because the impact of VM on QOL is considerable (Best et al. 2009) and any intervention that can improve symptoms sooner should be offered. In addition, some patients prefer to avoid pharmacological intervention out of concern for side effects or interactions with other medications. Lifestyle modification could be a viable solution for those individuals.

Power et al. (2018) report that 91% of patients with VM are managed with pharmacological intervention, though it is known the beneficial effects take longer than we observed in the current study. Our results suggest that clinicians may consider lifestyle modification as sole intervention but could also include this as an adjunct to pharmacological intervention to help patients feel better while their medications are being titrated to therapeutic dosages. Lifestyle modification could be a realistic, management technique for symptoms of VM in areas that have reduced access and availability to first line interventions (i.e., medication).

It is even worthwhile to consider the possibility that non-pharmacological interventions like lifestyle modification could potentially be recommended by non-medical professionals who are important members of the multidisciplinary team. Audiologists, physical therapists, and even occupational therapists in some locations all work with patients with dizziness. Since VM is one of the most common disorders encountered (Dieterich, Obermann, and Celebisoy 2016; Murphy et al. 2024), it is possible, when the patient is appropriately diagnosed, that these clinicians may introduce or even reinforce the importance of lifestyle modification as a management technique. Dieticians, health coaches, and potentially counsellors may also play a role in equipping patients with evidence-based techniques to help support them through the lifestyle changes that can be challenging but effective. Integrating these non-medical providers into appropriate management of VM with lifestyle modification could also allow medical professionals to focus on more complex cases.

Limitations

The design of this study was a prospective observational cohort and not a randomised controlled trial. There is a need for more controlled investigations on management of VM (Mallampalli et al. 2022). It is not possible to control placebo or spontaneous recovery effects given this limitation. Our results are similar to a prior investigation with different participants and for a longer follow-up period (Roberts et al. 2021). Again, the agreement with our prior results at 105 days suggests the improvements are occurring soon after intervention and are maintained out to longer periods of time.

Eleven of the enrolled 38 participants did not complete the study. Nine stopped participating for undisclosed reasons and two decided to take medication for symptoms during the 30-day period of the study and were subsequently excluded. With almost 30% of patients stopping the intervention plan, lifestyle modification is not expected to be an effective intervention for every patient with VM. Work to understand which patients are more likely to be successful should be continued.

Another limitation is the reliance on subjective measures which may introduce response bias. Participants may have felt compelled to over-report adherence to lifestyle modifications because their health care providers had access to their responses. This could be true for DHI and HDI scores as well. The incorporation of health tracker devices could be a way to improve the objectivity of measures of restful sleep and exercise. Similarly, completion of polysomnography measures like Zhou et al. (2023) may provide objective and potentially more compelling evidence of the importance of improving restful sleep in patients with VM.

The preponderance of published data on the lifestyle modification intervention on vestibular migraine have been investigated in a tertiary care setting (Kolberg et al. 2024; Reploeg and Goebel 2002; Roberts et al. 2021). It is possible the results may not generalise to other settings. For this reason, it would be important for investigators to consider multi-centre trials with larger study samples in various clinical settings in the future.

Conclusions

The results of this investigation indicate lifestyle modification is an effective intervention for symptoms of dizziness and headache in patients with VM. Further, our results indicate the improvement is observed by the second week of intervention which is much sooner than typical of pharmacological intervention. This lifestyle modification intervention appears safe with only a single participant reporting worsened dizziness and no participants reporting worsened headache. Among the lifestyle changes, restful sleep was the modification that was significantly related to changes in dizziness handicap and headache disability. It does not seem SOC is useful in helping to predict which participants may benefit from lifestyle modification for VM; however, higher SOC does correlate with lower perceived impact of dizziness and headache on quality of life in participants with VM. This work supports that lifestyle modification may be considered as the sole intervention for some patients and could be considered as an adjunct to pharmacological treatment in others to help patients feel better sooner.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, [RAR], upon reasonable request.

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