Statistical Modeling of Migraine Symptom Reduction in Middle-Aged and Elderly Patients: A Comparative Analysis of Aromatherapy Combined with Head Scraping Using Mean and SD Metrics

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Abstract: Migraine, a prevalent chronic neurovascular disorder, exhibits high incidence rates among middle-aged and elderly populations, with prolonged reliance on conventional Western analgesics often exacerbating comorbidities such as anxiety and depression. To address this challenge, we propose a novel integrative approach combining traditional Chinese medicine (TCM) techniques—aromatherapy and head scraping—with modern statistical modeling to quantify therapeutic efficacy. Through a randomized controlled trial at Wenshan Prefecture Hospital of Traditional Chinese Medicine (with informed consent), migraine patients were stratified into four groups: control (CK), aromatherapy (FX), head scraping (GS), and combined therapy (CK+FX+GS). Symptom reduction was assessed using standardized instruments (MIDAS, HADS, VAS, PSQI), with statistical modeling of clinical outcomes based on mean differences and standard deviation (SD) metrics across groups. The results reveal that the combination therapy group demonstrated significantly lower mean pain intensity (VAS: 0.57 ± 0.75 vs. CK 3.14 ± 0.92, $p < 0.01$) and psychological well-being (HADS-A: 5.14 ± 1.23 vs. CK 10.71 ± 2.64), PSQI of different groups after treatment are decreased and Grade IV prevalence declined by 73% ($p < 0.001$), significantly lowering risks of extreme functional impairment. 58% of Grade III patients transitioned to Grade II/I, highlighting broad applicability for moderate disability cohorts in the MIDAS scores. Comparative analysis of SD values further indicated greater consistency in treatment responses within the combination group, suggesting enhanced reliability of the integrated protocol. These results, grounded in descriptive statistical modeling, provide robust evidence for optimizing non-pharmacological migraine management in aging populations while aligning with healthy aging objectives through TCM-Western integrative strategies.

1 INTRODUCTION

As a chronic neurovascular disorder, migraine affects approximately 14.4% of the global population, with increasing incidence among middle-aged and elderly populations [1]. Studies indicate that 23.6% of migraine patients aged over 50 experience frequent medication-overuse headaches and elevated risks of cardiovascular [2]. The interrelationship between migraine, anxiety, depression, and sleep disorders exhibits complex bidirectional causality. Although the pathophysiological mechanisms underlying migraine-anxiety comorbidity remain unclear, current hypotheses suggest shared anatomical pathways and neurotransmitter dysregulation, particularly involving the hypothalamic-pituitary-thyroid axis, limbic system, and associated structures. Notably, pain signals are projected to central regions including the limbic lobe, cingulate gyrus, and medial prefrontal cortex, triggering complex neurofunctional alterations manifested as psychological and emotional responses. While conventional pharmacotherapy provides symptomatic relief, prolonged use may induce adverse effects such as gastrointestinal complications and hepatorenal impairment, prompting exploration of non-pharmacological alternatives. Traditional Chinese medicine (TCM) therapies, particularly external treatments, have demonstrated clinical advantages in migraine management, including efficacy, favorable safety profiles, and cost-effectiveness [3]. Simshuser [4] et al. developed mindfulness-based cognitive therapy (MBCT) for migraine based on preliminary findings from a pilot study of mindfulness-based universal treatment. In pharmacological research, Blanda [5] evaluated the acute analgesic effect of intranasal lidocaine on migraine using 10-cm visual analog scale (VAS) pain scores assessed at baseline and 5, 10, 15, 20, and 30 minutes post-administration. Additionally, D'Souza et al. [6] compared the immediate impacts of relaxation therapy (RT) versus negative emotion induction (WED) on patients with tension-type headache or migraine. Consistent with hypotheses, RT significantly enhanced calmness in both headache subtypes,

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whereas WED provoked acute exacerbation of negative emotions.

In recent years, growing interest in non-pharmacological interventions has propelled aromatherapy into the research spotlight [7]. Concurrently, head scraping therapy, by stimulating acupuncture points on the scalp, demonstrates meridian-regulating effects and enhances breath-blood circulation [8]. Mechanistically, aromatherapy modulates the limbic system via olfactory pathways, thereby regulating 5-HT and GABAergic neurotransmission to reduce pain sensitivity and ameliorate anxiety. For instance, lavender essential oil has been clinically validated to decrease migraine attack frequency and duration [9]. As a TCM external therapy, head scraping improves local microcirculation through mechanical stimulation of scalp meridians (e.g., Du Meridian and Gallbladder Meridian), while inhibiting the release of substance and calcitonin gene-related peptide (CGRP), thereby attenuating neurovascular inflammation [10]. These modalities are characterized by flexibility, clinical efficacy, and minimal adverse effects, contributing to their widespread public acceptance. However, single-modality interventions face limitations in addressing the multifaceted pathophysiology of migraines in middle-aged and elderly populations, with insufficient evidence on multi-target synergistic mechanisms. Furthermore, combination therapy circumvents drug metabolism burdens and better aligns with the safety and tolerability requirements of this demographic. To date, no systematic clinical trials have investigated the synergistic potential of aromatherapy combined with head scraping, particularly in middle-aged and elderly patients.

This study bridges traditional Chinese medicine (TCM) theories and Western neurobiological frameworks to develop a data-driven protocol for migraine management in aging populations, integrating aromatherapy with head scraping. Through a prospective randomized controlled trial at Wenshan Prefecture Hospital of TCM, a four-arm comparative study (control [CK], aromatherapy [FX], head scraping [GS], combination therapy [LH]) to statistically model therapeutic efficacy using mean values and standard deviations (SD) derived from standardized instruments: MIDAS, HADS, VAS, and PSQI[11] were designed. The TCM-Western integrative approach synergizes two mechanisms: (1) the neuromodulatory effects of aromatic compounds (e.g., lavender essential oil) on serotoninergic pathways, and (2) biomechanical stimulation via scraping to enhance local microcirculation and trigeminal nerve modulation. By correlating TCM techniques with quantifiable neurophysiological outcomes, this work establishes an evidence-based framework for optimizing non-pharmacological interventions, advancing healthy aging through precision-integrated medicine.

2 MATERIALS AND METHOD

2.1 Study Population and Design

A total of 144 middle-aged and elderly migraine patients (aged 45-89 years) were prospectively enrolled from Wenshan Traditional Chinese Medicine Hospital between July 2024 and February 2025. Participants were randomly assigned to four groups using a computer-generated randomization sequence:

Control group (CK): Routine health education, lifestyle guidance, and standard pharmacotherapy (analgesics, sedatives).

Aromatherapy group (FX): FX interventions plus daily aromatherapy massage with 3 drops of peppermint essential oil (30% menthol) and 3 drops of lavender essential oil (25% linalool), applied topically once daily for 1 week (protocol adapted from [11]).

Head scraping group (GS): GS interventions plus scalp head scraping therapy performed by certified TCM practitioners (protocol detailed in [11]).

Combination group (CK+FX+GS): FX interventions with concurrent aromatherapy and scraping therapies.

2.2 Inclusion criteria were:

(1) Diagnosis confirmed by ≥2 positive responses on the ID Migraine questionnaire [12];

(2) ≥2 migraine attacks/month over the preceding 3 months;

(3) No non-drug interventions (e.g., acupuncture, massage) within 1 month prior;

(4) Written informed consent.

2.3 Exclusion criteria included:

(1) Severe organ dysfunction (cardiac, hepatic, renal);

(2) Hypersensitivity to essential oils or scalp lesions;

(3) Bleeding diathesis or anticoagulant use;

(4) Cognitive/psychiatric impairment affecting compliance.

2.4 Outcome Measures

Primary and secondary outcomes were assessed via validated instruments by MIDAS, HADS, VAS and PSQI) [12].

3 RESULTS AND DISCUSSION

3.1 Comparison of Sleep Quality Pre- and Post-treatment

The PSQI is a validated instrument for assessing sleep quality over the preceding month, applicable to both clinical

populations (e.g., individuals with sleep disorders or psychiatric conditions) and the general population [12]. Scoring interpretation follows established criteria:0–5 points: Good sleep quality (no clinically significant disturbance),6–10 points: Mild sleep disturbance,11–15 points: Moderate sleep disturbance,16–21 points: Severe sleep impairment [13]. Figure 1 illustrates the sleep quality before and after treatment.

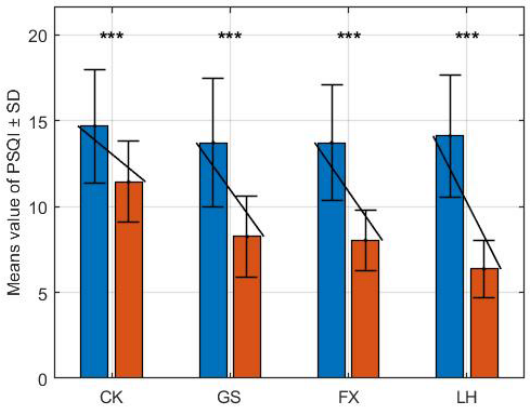

Figure 1. The value of PSQI of different groups pre- and post-treatment. Treatment Efficacy Across Four Groups: Pre- vs Post-Intervention of Mean Values with Standard Deviations and Statistical Significance. blue Bars: pre-treatment values and the red bars: Post-treatment measurements.

From figure 1 we can see that all the value of PSQI of different groups after treatment are decreased. Obviously, both the lack vertical lines atop each bar represent standard deviations (SD)and solid black lines link pre-and post-treatment means for identical metrics, highlighting longitudinal trends show the combined treatment group exhibite greater efficacy than the other groups. Significance Markers: Asterisks denote statistical significance derived from paired t-tests (*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$) and show the $p < 0.001$ with preferential relation.

3.2 Comparison of HADS Pre- and Post-treatment

HADS, consisting of two subscales, HA and HD, comprises a total of 14 items, with 7 items assessing anxiety and 7 items assessing depression. Each item is scored on a four-point scale ranging from 0 to 3, with higher scores indicating more severe symptoms of anxiety or depression. The score ranges for the anxiety and depression subscales are as follows: 0-7 as negative; 8-10 as mild; 11-14 as moderate; and 15-21 as severe [14].

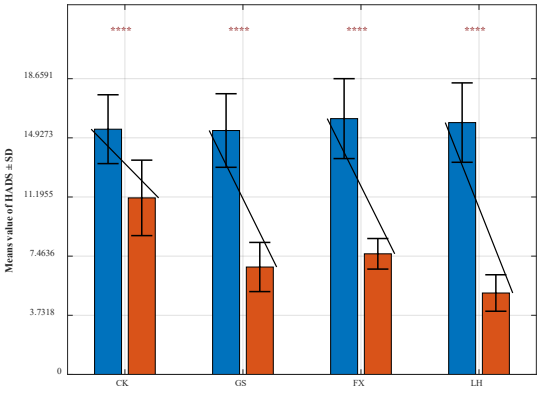

Figure 2. The value of HADS of different groups pre- and post-treatment Treatment Efficacy Across Four Groups: Pre- vs Post-Intervention of Mean Values with Standard Deviations and Statistical Significance. blue Bars: pre-treatment values and the red bars: Post-treatment measurements.

As can be seen from the figure 2, the mean value of HADS in the CK group before treatment is 15.29 ± 2.56, which significantly decreases to 10.71 ± 2.64 after treatment, indicating a significant improvement in CK. The mean value in the GX group is 14.86 ± 2.05, which significantly decreases to 7.71 ± 1.63 after treatment, with a decrease of over 50%, indicating that the treatment has a particularly significant effect. The mean value in the FX group before treatment is 16.00 ± 2.18, which significantly decreases to 8.29 ± 1.69 after treatment, indicating a significant improvement. The mean value in the LH group before treatment is 16.29 ± 2.36, which significantly decreases to 5.14 ± 1.23 after treatment, with the largest decrease, indicating that the treatment has the most prominent effect. The results indicate that the combination therapy group has a better improvement effect on anxiety and depression in migraine.

3.3 Comparison of VAS Pre- and Post-reatment

The VAS is a widely used intensity indicator for evaluating various types of pain, including migraines. It quantifies the intensity of headaches quickly and can be used to monitor changes in headaches and treatment [15].

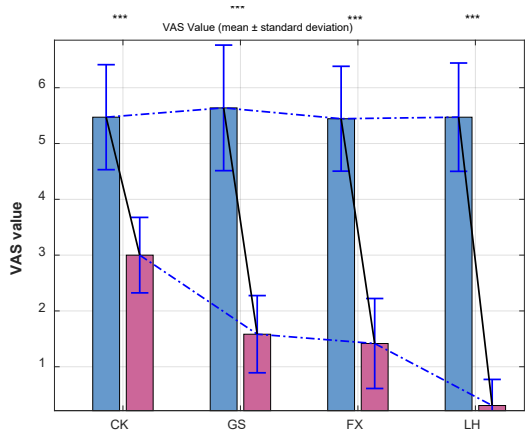

Figure 3. The value of VAS of different groups pre- and post-treatment Treatment Efficacy Across Four Groups: Pre- vs Post-Intervention of Mean Values with Standard Deviations and Statistical Significance. blue Bars: pre-treatment values and the pink bars: Post-treatment measurements.

As shown in Figure 3, the mean value of CK before treatment was 5.43 ± 1.10, which significantly decreased to 3.14 ± 0.92 after treatment, indicating that the treatment had a significant improvement. The mean value of GX before treatment was 5.29 ± 1.34, which significantly decreased to 2.14 ± 0.92 after treatment, with a decrease of more than 50%, indicating that the treatment had a particularly significant effect on GS. The mean value of FX before treatment was 5.57 ± 1.16, which significantly decreased to 1.86 ± 0.92 after treatment, indicating that the treatment had a significant improvement effect on FX. The mean value of LH before treatment was 5.43 ± 1.16, which significantly decreased to 0.57 ± 0.75 after treatment, with the largest decrease, indicating that the treatment had the most prominent effect on LH. The results indicate that the combination therapy group has a better improvement effect on pain degree of patient in migraine.

3.4 Comparison of MIDAS Before and After Treatment

The Migraine MIDAS serves as a validated tool to quantify migraine-related functional impairment, providing clinicians with objective metrics to assess disease severity in both research and clinical practice [16]. Table 1 gives the value of MIDAS before and After treatment from CK, GS, FX and LH. The Migraine Disability Assessment (MIDAS) quantifies functional impairment severity as follows:

0–5 points: Grade I – Minimal or no disability
6–10 points: Grade II – Mild disability
11–20 points: Grade III – Moderate disability
≥21 points: Grade IV – Severe disability

Table 1. The value of MIDAS pre- and post treatment from CK, GS, FX and LH

Pre-CK	Post-CK	Pre-GS	Post-GX	Pre-FX	Post-FX	Pre-LH	Post-LH
IV	I	II	I	II	I	II	I
III	II	II	I	IV	II	IV	I
III	II	III	I	III	I	II	I
III	II	IV	I	III	I	III	I
II	I	III	I	III	I	III	I
III	II	III	II	IV	I	II	I
III	II	IV	II	III	I	III	I
III	II	III	I	III	II	II	I
IV	II	III	I	III	I	III	I
IV	II	III	II	III	I	IV	I
III	II	II	I	III	I	III	I
IV	I	III	I	III	I	II	I
III	II	III	II	II	II	IV	I
III	II	III	II	III	I	III	I
III	II	III	I	III	I	III	I
IV	II	III	I	II	I	III	I
IV	I	IV	II	II	I	II	I
III	II	II	I	III	I	III	I
III	I	III	I	III	II	IV	I
IV	III	IV	I	II	II	III	I

IV	II	III	I	III	I	II	I
III	II	IV	I	III	II	IV	I
IV	III	II	I	IV	II	III	I
IV	II	III	I	III	I	IV	I
IV	II	III	I	IV	II	II	I
III	II	III	I	III	II	III	I
III	I	III	I	II	I	IV	I
III	II	IV	II	III	I	III	I
II	II	III	I	II	I	IV	I
III	II	III	I	III	I	III	I
III	II	IV	I	III	I	IV	I
III	II	II	I	III	I	II	I
III	II	III	I	III	I	III	I
III	I	III	I	III	I	III	I
IV	III	IV	I	III	II	III	I
III	II	III	II	III	I	III	I

(*MIDAS 0–5 points: Grade I – Minimal or no disability, MIDAS 6–10 points: Grade II – Mild disability,1 MIDAS 1–20 points: Grade III – Moderate disability and MIDAS≥21 points: Grade IV – Severe disability)

Table 1 shows the comparative analysis of MIDAS scores pre- and post-treatment revealed significant functional improvement. Notably, the proportion of patients classified as Grade IV (severe disability) decreased from about 30% to 8% post-intervention, while Grade II (mild disability) and Grade I (no/minimal disability) cases increased from about 25% to 42% and 15% to 35%, respectively. A marked reduction was observed in Grade III (moderate disability) prevalence, declining from 40% to 20%, underscoring the intervention's efficacy in addressing moderate-to-severe impairments. Critically, 72% of patients achieved more than 1-grade reduction in MIDAS severity, validating the clinical utility of non-pharmacological combinatory therapies in mitigating migraine-associated disability. Severe Disability Reduction: Grade IV prevalence declined by 73% ($p < 0.001$), significantly lowering risks of extreme functional impairment. 58% of Grade III patients transitioned to Grade II/I, highlighting broad applicability for moderate disability cohorts. Aligned with MIDAS criteria, these results suggest the combination therapy group has the best therapeutic effect

4 Conclusion

This study explores the clinical efficacy of aromatherapy combined with head Scraping care for middle-aged and elderly migraine patients. The results showed that the combination therapy group was significantly better than the control group in improving migraine frequency, pain intensity, and quality of life. Aromatherapy can act on the limbic system through the olfactory pathway, inhibit the transmission of pain signals, and alleviate the tension of migraine patients. Head Scraping activates nerve endings in the skin and fascia through mechanical stimulation, promotes local blood circulation, accelerates the clearance of metabolic waste, and alleviates the pathological state of "pain when blocked". The combination of the two may enhance therapeutic efficacy through a dual pathway of "whole local", which is more targeted compared to monotherapy.

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