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The Effect of walking with eyes closed (Makarach) on postural control and the autonomic nervous system (ANS) function: A randomized controlled trial

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ABSTRACT

Background: Postural control (PC) is essential for performing complex movements and often deteriorates over time due to various factors, necessitating more flexible exercise options. Mind-body practices are purported to improve postural control.

Objective: To determine the effect of Makarach, a mind-body practice, on postural control and the autonomic nervous system (ANS) function.

Materials and methods: A randomized controlled trial (RCT) was conducted involving 76 participants, divided into two groups: experimental group (EG, N=38) and control group (CG, N=38). The EG walked forward and backward on two yoga mats with eyes closed while the CG performed tandem walking (TW). Both groups underwent a four-week training program (15 minutes per day, three days per week). The Y Balance Test (YBT) assessed the dynamic postural control (PC) in the anterior (A), posterolateral (PL), and posteromedial (PM) directions. The composite score (CS) was used for overall performance in the YBT. The Balance Error Scoring System (BESS) assessed static PC on firm (FIS) and foam (FOS) surfaces. Heart Rate Variability (HRV) components, including low frequency (LF), high frequency (HF), and low to high frequency (LF/HF) ratio, were used to evaluate the ANS function. All outcomes were measured before and after training. Data analyses were performed using intention-to-treat analysis.

Results: The dynamic and static PC was found to increase in EG only. Significant differences were found in A, PL, PM, and overall dynamic PC (CS) in dominant and non-dominant legs ($p<0.05$) and ($p<0.05$), respectively. Significant differences were also found in static PC in FIS ($p<0.05$), while no significant difference was observed in FOS. There were no significant differences in any HRV components ($p \geq 0.05$). There was significant interaction between groups and time in dynamic PC and FIS, but no significant within-group difference in any CG variables.

Conclusion: Walking with eyes closed (Makarach) was found to significantly increase dynamic and static PC among healthy individuals after four weeks of training in comparison to before training. Additionally, Makarach demonstrated greater effectiveness in improving PC than TW.

Introduction

Postural control (PC) is a fundamental aspect of human motor function, allowing individuals to maintain balance and perform complex movements efficiently. Maintaining PC necessitates the ability of an individual to accurately detect sensory stimuli, interpret the information, and execute adequate responses through the integration of somatosensory, vestibular, and visual

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systems.[1-3] The ANS plays an essential role in the interplay of the sensory and motor systems and in maintaining homeostasis during physical activities to sustain PC.[4,5]

PC decreases over time from the age of 20 years.[6] Several studies have proposed training programs for improving and maintaining PC, such as TW,[7] Bosu ball,[8] Balance Error Scoring System (BESS),[9] knee position sense, and YBT,[10] highlighting the importance of sensory input in maintaining PC sensory deprivation, such as closing the eyes, has been shown to disrupt balance and postural stability, suggesting a significant reliance on visual information for PC.[6] To balance the body's responses to sensory detection from the numerous stimuli received by the central nervous system, the ANS manages cardiovascular, thermal, and gastrointestinal homeostasis when individuals feel safe or threatened by activating rest and digest/fight or flight.[11,12]

Makarach is a mindfulness-based walking meditation technique conducted with eyes closed, creating sensory deprivation that enhances reliance on proprioceptive feedback. In contrast to conventional walking meditation, typically performed with eyes open and influenced by visual cues, Makarach focuses on precise foot placement and body movement.[13-16] The current study uses Tandem walking (TW) as a comparative method since it is commonly used in clinical and research settings to assess PC. TW requires coordination and balance, providing reliable baseline for evaluating interventions like Makarach.

Therefore, the main purpose of this study is to investigate the effect of walking with eyes closed (Makarach) on PC. The second objective is to investigate the ANS function in Makarach of healthy individuals and compare the outcomes with TW exercises. The hypothesis of the study is that walking with eyes closed (Makarach) is more effective in improving PC than TW.

Materials and methods

Participants

A single-blinded RCT with a pre-test and post-test group was conducted. The sample size, based on the standard deviation of the SEBT in three directions from a previous study,[16] was calculated for 80% power and a 0.05 significance level, resulting in 60 participants. Including a 10% dropout rate, the final sample size was 76 participants (N=38 per group). The CONSORT flow diagram is shown in Figure 1. The study was approved by the Center for Ethics in Human Research, Khon Kaen University, Thailand (HE662196). The study protocol was registered in the RCT registry (TCTRXXXXXX on process)

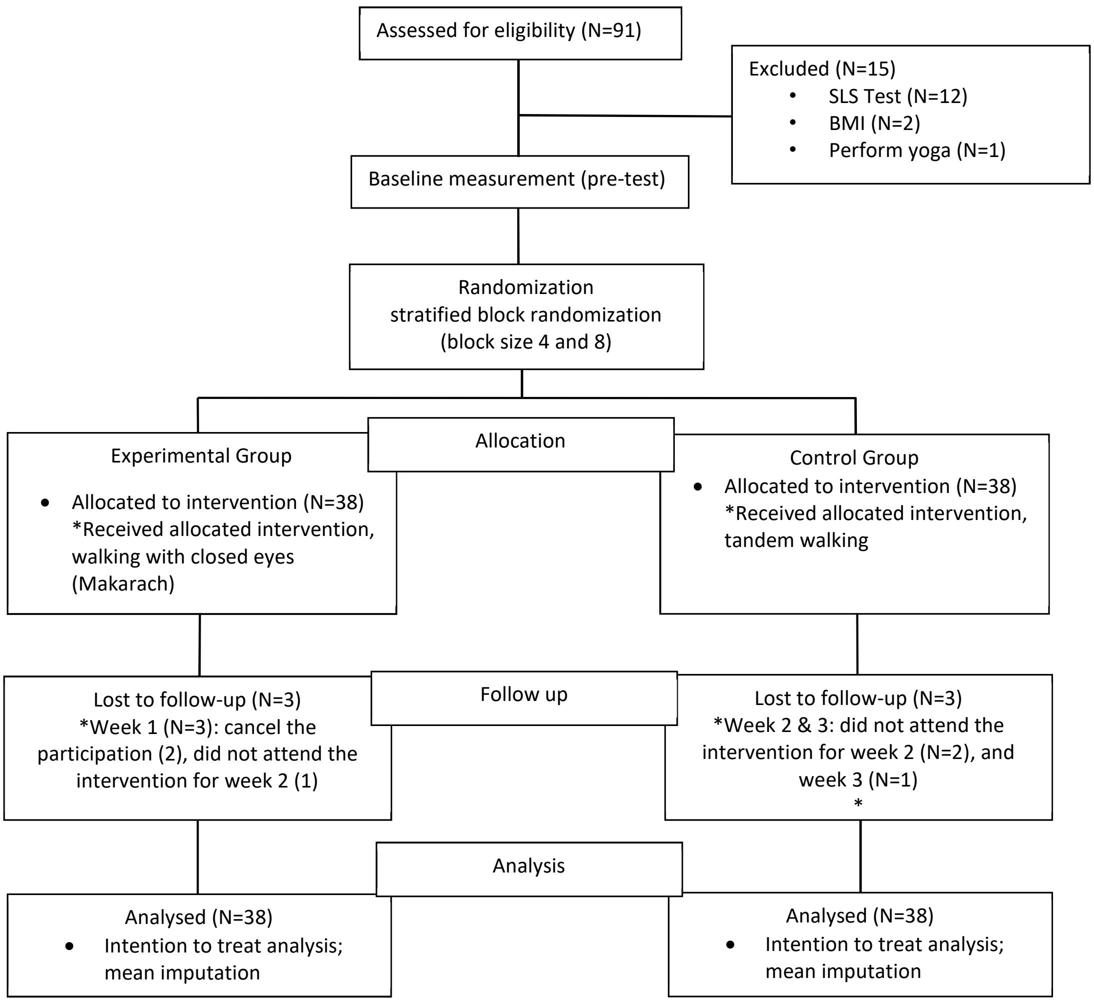


Figure 1*. CONSORT flow diagram of participant progression.*

Ninety-one participants were recruited, with 76 meeting the inclusion criteria: aged 20-35 years (22.79±2.59) with a BMI of 18.5-25.0 kg/m² (21.18±2.02). Eligibility required a single-leg stance test score with eyes closed of ≤13.1 seconds for females and ≤10.2 seconds for males on at least one leg. Exclusion criteria included prior walking meditation for a month, neurological or musculoskeletal disorders affecting balance, visual, auditory, and vestibular deficits, and regular smoking. Participants were instructed to avoid meditation activities, including yoga, during the intervention period.

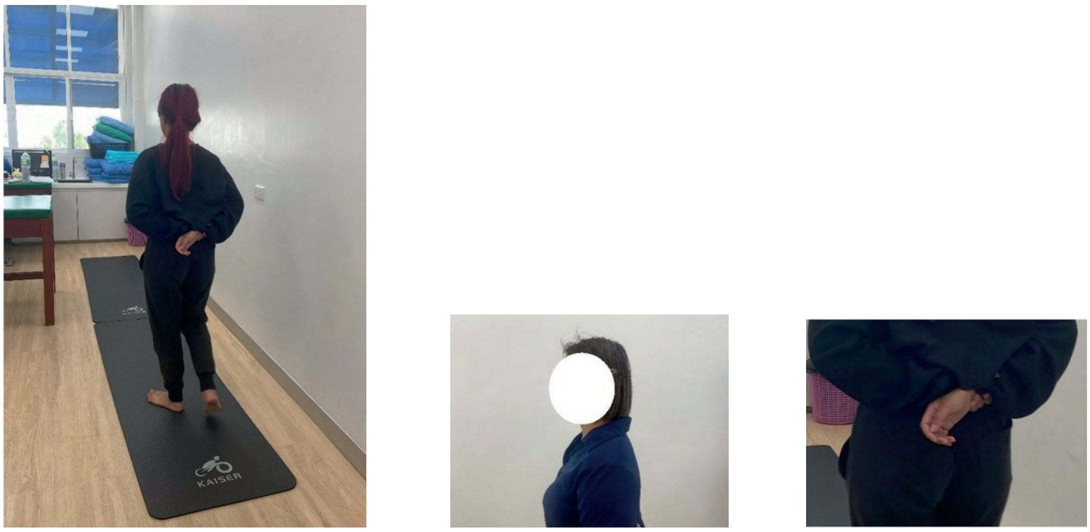
Experimental procedures

At baseline, each participant's balance ability was evaluated using the YBT and BESS. In this study, two assessors measured the YBT and BESS. The interrater reliability was excellent, with an ICC of 0.95-0.99, while the BESS showed good to excellent reliability, with ICC values ranging from 0.90-0.95.

The allocation was blinded to the assessor from the generated random group assignments by a concealed envelope. An internet randomized scheme generator, which generated blocks of four and eight, was used to allocate the participants into groups for the intervention. The randomization was stratified by groups. The main researcher undertook the randomization and allocation of the participants in the trial.

Walking with eyes closed (Makarach)

Participants in the EG practiced walking meditation with eyes closed for 15 minutes a day, three times a week, for four weeks. Makarach is a walking meditation practice performed by walking forward and backward with eyes closed on the yoga mat. The concept of Makarach in this study was from Mr. Saran Maitreewech, Bangkok, Thailand.[17] Two yoga mats (366 cm) were used (Kojima: each 183 x 61 cm, thickness 10 mm). This intervention focused on leg and foot movements. Participants removed their footwear and stood upright with hands behind their backs. After a three-minute familiarization trial, they started walking backward, closing their eyes, and continued for 15 minutes. The edge of the yoga mat was a benchmark that indicated when to switch directions. The Makarach intervention is shown in Figure 2.



(A) (B) (C)

***Figure 2**. Walking with closed eyes (Makarach): (A) Walking process, (B) Head position, (C) Hand position.*

Intervention for the control group (CG)

Participants in CG performed TW in a straight line with their eyes open, placing the heel of one foot in front of the toes of the other along a 3-m, 48-mm-wide line and turning 180 degrees at the end.[18] Each session lasted for 15 minutes, three days per week for four weeks. A spotter stood next to participants in both the experimental and CGs to prevent adverse events, such as loss of balance, and provide verbal cues when the session was up.

Outcome measurements

Y Balance Test (YBT)

The YBT was used for the assessment of dynamic balance based on the guidelines for both dominant and non-dominant legs, respectively. The dominant (DL) was determined by asking the participants to kick a ball placed on the floor and the kicking legs were recorded as the DL and the other leg as the non-dominant legs (NDL).[19]

Prior to the test, participants remove their shoes and perform the test barefoot. Leg length (LL) was measured in a supine position, from the anterior superior iliac spine to the most distal aspect of the medial malleolus. Participants complete four practice trials in three directions: anterior (A), posterolateral (PL), and posteromedial (PM). After a two-minute rest following the practice session, formal testing begins. During the formal testing, participants perform three trials per direction, standing on one leg with their hands on their hips and reaching as far as possible with the other leg while maintaining balance. A 15-second rest is given between trials, switching from one leg to the other in each direction and a two-minute break is provided between directions to avoid fatigue.

Participants touch the furthest point on the line with the most distal part of their reaching foot, then return to a bilateral stance while maintaining equilibrium. The examiner marks the touch point along the line and measures the distance in centimeters from the center of the grid using a tape measure. The composite score (CS) was measured for the analysis of overall performance. The represented YBT for each direction consisted of the normalized reach distance and the CS of both DL and NDL.[16,19] Any participant who withdrew for any reason or did not complete all interventions was considered for withdrawal from the study.

Balance Error Scoring System (BESS)

The static balance was measured using the BESS with an AIREX Balance Pad. The BESS includes six trials of 20 seconds each and the assessment of three stances (double leg, single leg, tandem) on two surfaces: firm (FIS) and foam (FOS). The foam surface is unstable. Participants stood still with their hands on iliac crests and eyes closed. Testing began once the proper stance had been assumed.[20] For the tandem stance, the non-dominant foot was behind the dominant foot. Errors were recorded for hands lifting off hips, opening eyes, stepping, stumbling, falling, lifting the heel, hip abduction over 30 degrees, or not returning to the test position within five seconds. Each surface had a maximum of 10 errors, and the total errors were summed as BESS scores.

Heart rate variability (HRV)

The HRV measurements were recorded in a quiet environment in the morning using the uBioMacpa version 70 (BioSense Creative, Korea). This reliable device, approved as a medical device (13-262) and certified for manufacturing (No. 3447), is patented (Patent No. 10-0954817). It measured 40-200 BPM with a 2% error rate and paired with the left index finger. The HRV was measured from 8 a.m. to 11 a.m. and maintained a comfortable level.[21] After five minutes of rest in a sitting position, the participants were asked to lie down on the bed, and the HRV was continuously assessed. The results were displayed on a notebook monitor and included frequency domain metrics: low frequency (LF, ms^2), high frequency (HF, ms^2), and the LF/HF ratio.

Statistical analysis

Data were expressed as mean±standard deviation (SD). The Shapiro and Wilk tests showed normal distribution. All analyses were performed on an intention-to-treat (ITT) basis. Missing data were handled using mean imputation of the average post-test scores. Paired sample t-tests were conducted to compare the differences within the groups (pre and post). Independent t-tests were used to compare the two groups at the baseline. The analysis of covariance (ANCOVA) was applied to determine the difference in dependent variables between groups after four weeks of intervention (post-test). The analysis used baseline (pre-test) scores as a covariate. Differences in the PC and HRV between the EG and CG were analyzed at the baseline (pre) and after four weeks of training (post) using two-way ANOVA (group × time). The precision of Makarach was interpreted using partial eta squared (η_p^2), which indicates the effect size in both the ANCOVA and two-way ANOVA analyses. Effect sizes were interpreted as $0.01<\eta_p^2<0.06$ is small, $0.06\leq \eta_p^2\leq 0.14$ medium, and $\eta_p^2>0.14$ large.[22] The significant difference level for all data analysis was set at below 0.05.

Results

A total of 76 individuals participated in this study; 35.5% (N=27) were male, and 64.5% (N=49) were female and randomly assigned to the EG and CG (38 in each), respectively. Throughout the study, adverse events were closely monitored in both EG and CG. One notable event was a tingling sensation reported by participants. This sensation occurred during the first week of the intervention, which involved three sessions per week, each lasting 15 minutes. Specifically, three participants (7.89%) in the EG and five (13.16%) in the CG reported experiencing a tingling sensation. Importantly, the sensation was typically resolved within 15 minutes after each session. These findings suggest that while a transient adverse event occurred, it did not result in any long-term effects on the participant's health, supporting the overall safety profile of the intervention.

The baseline characteristics of participants are shown in Table 1. There was no significant difference in the characteristics between EG and CG. The complete results of the primary and secondary objectives of the study are shown in Tables 2 and 3. The results showed significant differences in EG after four weeks of intervention in all components of dynamic PC ($p<0.05$). Meanwhile, only one component of static PC (FIS) showed a significant difference ($p<0.05$). The results showed significant group x time interaction for all components of dynamic PC ($p<0.05$). After four weeks of intervention, the significant group × time interaction also showed static PC in the FIS ($p<0.05$). There was no significant difference in all outcomes in the CG ($p>0.05$). There were no significant differences in the EG and CG at post-intervention for the LF, HF, and LF/HF ratio ($p>0.05$). There was no significant interaction between group × time interaction in any of the HRV outcomes ($p>0.05$).

Table 1. Baseline characteristic participants in the experimental group (EC) and control group (CG).

Variable	Experimental Group		Control Group		*p* value#
	mean±SD	min-max	mean±SD	min-max	
Gender, N (%) (male: female)	14 (36.8):24 (63.2)		13 (34.2): 25 (65.8)		0.81
Status, N (%)					0.87
Bachelor	30 (78.9)		30 (78.9)		
Master	3 (7.9)		2 (5.3)		
Employee	5 (13.2)		6 (15.8)		
BMI (kg/m^2)	21.28±2.18	18.6-24.8	21.07±1.87	18.5-24.9	0.65
Age (year)	22.76±2.48	20-32	22.82±2.74	20-33	0.93
Dominant Leg, N (%)					0.40
Right	36 (94.7)		34 (89.5)		
Left	2 (5.3)		4 (10.5)		
Non-Dominant Leg, N (%)					0.40
Right	2 (5.3)		4 (10.5)		
Left	36 (94.7)		34 (89.5)		
Impaired Leg (SLS Positive)					
Right, N (%)	12 (31.6)		7 (18.4)		
Left, N (%)	8 (21.1)		8 (21.1)		
Both, N (%)	18 (47.4)		23 (60.5)		
Performance, sec	5.68±2.41	1.29-10.08	4.51±2.01	1.67-8.32	
Normal Leg (SLS Negative)					
Right, N (%)	8 (21.1)		8 (21.1)		
Left, N (%)	12 (31.6)		7 (18.4)		
None, N (%)	18 (47.4)		23 (60.5)		
Performance, sec	10.44±5.98	1.56-23.99	8.81±6.17	2.27-26.40	
Adverse event, N (%)					
Tingling sensation	3 (7.89)		5 (13.16)		

Note*: kg/m^2: kilogram per square meter, SLS: single leg stance, sec: seconds. #comparison for gender, status, BMI, age, dominant and non-dominant leg by independent t-test.*

Table 2. Between- and within-group differences in Y Balance Test (YBT) on dominant and non-dominant legs and Balance Error Scoring System (BESS) in the experimental group (EG) and control group (CG) before and after the 4-week intervention.

Outcomes		EG (N=38)		CG (N=38)		*p*-value	Two-way ANOVA interaction effect	
		pre	post	pre	post		*p*-value	effect size
YBT Dominant[#1]	Anterior	66.30±6.47	69.19±6.31	67.02±5.88	67.07±5.79	<0.001* 0.010[#]	0.02[†]	0.07
	Posterolateral	79.71±10.39	87.05±11.51	82.67±12.33	82.60±15.13	<0.001* 0.010[#]	0.007[†]	0.10
	Posteromedial	88.00±8.50	94.29±8.49	90.63±6.94	89.67±7.85	<0.001* <0.001[#]	<0.001[†]	0.19
	Composite Score	78.10±6.99	83.51±7.20	80.11±6.75	79.81±8.34	<0.001* <0.001[#]	<0.001[†]	0.18
YBT non-dominant[#1]	Anterior	66.75±6.67	69.21±7.09	66.80±5.35	66.87±4.16	<0.001* 0.025[#]	0.02[†]	0.07
	Posterolateral	82.78±8.24	89.48±8.09	83.68±11.41	82.07±12.76	<0.001* <0.001[#]	<0.001[†]	0.17
	Posteromedial	88.34±7.57	92.64±9.89	90.91±7.51	89.71±10.76	<0.001* 0.017[#]	0.009[†]	0.09
	Composite Score	79.29±5.09	83.77±6.52	80.47±6.50	79.55±7.86	<0.001* <0.001[#]	<0.001[†]	0.20
BESS[#2]	Firm	2.79±1.85	1.63±1.50	2.29±1.68	2.24±1.91	<0.001* 0.021[#]	0.009[†]	0.09
	Foam	8.16±2.89	7.61±3.34	8.76±3.04	8.24±2.71	0.38 0.47	0.98	0.000

Note: **significantly different within-group (EG), p<0.05. [#]significantly different between group at the post intervention, p<0.05. [†]significantly interaction between group and time, p<0.05. There was no significant difference between-group at the pre-intervention (p>0.05). No significant difference within-group in all outcomes in control group (p>0.05). [#1]measured in centimetres (cm), [#2]error points (number).*

Table 3. Between- and within-group differences in Heart Rate Variability (HRV) components in the experimental group (EG) and control group (CG) before and after the 4-week intervention.

Outcomes[#3]		EG (N=38)		CG (N=38) interaction effect		*p*-value	Two-way ANOVA	
		pre	post	pre	post		*p*-value	effect size
HRV	LF	6.42±0.97	6.36±0.99	6.51±0.91	6.60±0.99	0.75 0.36	0.57	0.004
	HF	6.22±0.61	6.13±0.74	6.06±0.71	6.22±0.68	0.39 0.20	0.11	0.035
	LF/HF	1.14±0.66	1.03±0.15	1.08±0.14	1.06±0.14	0.33 0.41	0.43	0.008

Note: *There was no significant difference between-group at the pre-intervention (p>0.05). No significant difference within-group in all outcomes in control group (p>0.05). [#1]measured in centimetres (cm), [#2]error points (number). LF=low frequency, HF=high frequency, LF/HF=low to high frequency. [#3]measured in ms^2.*

Discussion

Effect of Makarach on postural control (PC)

The results of this study demonstrated that Makarach significantly enhanced dynamic and static PC, evaluated using YBT and BESS. After training, there was no significant difference in the FOS, LF, HF, and LF/HF ratio, either in the EG or CG, respectively. However, post-training, the EG presented a significant increase in YBT and BESS for the firm surface compared to the baseline.

Makarach is a walking meditation (WM) intervention. The study's findings reveal that Makarach can provide an enhanced dynamic PC. This result is supported by the previous study investigating the effect of WM on balance performance after a four-week intervention in the PL and PM direction.[16] Furthermore, a four-week walking meditation intervention can improve PC compared to gentle walking exercises.[15,23] One of the key mechanisms underlying Makarach is the enhanced proprioceptive feedback gained through walking meditation. As participants engaged in mindful walking—moving forward and backward with their eyes closed—they likely developed a heightened awareness of their body's positioning in space. Proprioception, the body's ability to sense its position and movement, is crucial for maintaining balance, especially in dynamic tasks.[24] This aligns with previous research demonstrating a strong correlation between proprioceptive training and improved balance performance.[25]

Makarach required participants to rely heavily on proprioceptive feedback from the ankles to maintain stability from the yoga mat surface and led participants to perform a slow walking pattern. This reliance was reflected in improved postural control, as evidenced by significant enhancements in YBT and BESS results. These findings suggest that the Makarach could influence proprioceptive function indirectly, even without direct measurement. According to previous studies, walking at a slow speed requires more coordination control of the lower limb muscles to create a smooth movement.[26] Consequently, slow walking, which needs multi-muscular control for smooth movement, resembles the neuromuscular system and proprioceptive sense. An increase in ankle proprioception allows participants to maintain the single-leg stance position for longer when performing both YBT and BESS. As a result, the SLS position can be maintained for longer and the reach distance of the leg becomes greater. These results support those reported in the previous study, namely that balance training with eyes closed leads to an increase in the maximal stance duration up to 60 seconds and reach distance in YBT components.[27]

Moreover, the meditative aspect of Makarach played a significant role in enhancing participants' mental focus and body awareness. Meditation practices have been linked to enhanced cognitive control and motor skills by promoting a deeper awareness of physical sensations.[28] Meditation practice engages specific brain areas, such as the insula. Regular meditation practice has been linked to increased cortical thickness in the right anterior insula, which is crucial for body awareness.[29] Body awareness refers to the conscious perception of one's body and its spatial position. Reduced cortical thickness is associated with cognitive impairment, affecting the ability to sense the body's position and movement. Meditation practice also increases the alpha modulation in the primary sensory cortex, which is involved in sensory perception, including proprioceptive sense.[30] Moreover, according to a systematic review and meta-analysis, meditation practice is associated with brain morphological adaptation in some areas (anterior and posterior cingulate cortex, hippocampus, and corpus callosum), responsible for self-control, emotion regulation, and movement control.[31] Practicing Makarach may promote the perception process of the brain for ankle adjustment and enhance proprioceptive feedback by focusing on leg and ankle movements. This mindful attention to each step trains the proprioceptive system to be more sensitive and responsive.

This study highlights the significant impact of surface type on static PC, measured by the BESS. Notably, improvements in balance (indicated by reduced errors) were observed only on firm surfaces, where participants effectively used proprioceptive feedback from their ankles to maintain their center of mass. This finding aligns with previous research emphasizing the importance of stable surfaces for balance assessment.[32]

In contrast, no significant improvements were found on foam surfaces. The instability of the foam disrupted the somatosensory information necessary for PC. The greater thickness of the AIREX Balance foam pad compared to the 10 mm yoga mat likely contributed to this instability, complicating balance maintenance and increasing errors.[33] This scenario reflects real-life conditions, where individuals rarely walk on unstable surfaces. The foam's thickness may increase postural sway and require more active engagement of core muscles to manage shifts in the center of mass.[34]

Effect of Makarach on the ANS Function

The ANS regulates internal organ functions to support rapid body movements during exercise, adjusting physiological parameters like blood pressure, sweating, respiration, and heart rate through their sympathetic and parasympathetic systems.[35] This study used HRV to measure ANS activity with low LF, HF, and LF/HF ratios. The results showed no statistically significant differences in LF, HF, or LF/HF ratios within or between groups.

Several factors may have influenced these results. Individual thermal sensations and comfort levels could have confounded measurements; despite maintaining a comfortable room temperature of 24°C,[21] some participants felt cold, covering their wrists with towels, potentially impacting measurement accuracy. Stress levels likely also affected the results since many participants were bachelor's degree students undergoing final exams and experiencing sleep deprivation associated with elevated stress. These findings agree with the previous study which reveals that stress indicates low parasympathetic activity, characterized by a decrease in the HF and an increase in the LF.[36] Additionally, variability in post-test measurement times may have introduced further inconsistencies. Although the procedure in this study required HRV post-tests to be conducted up to one day after the final intervention, some occurred two to three days later owing to the participants consuming coffee or alcohol, known to activate the SNS and increase blood pressure, adding variability to the HRV readings. Previous studies have claimed that caffeine consumption increases systolic and diastolic blood pressure, leading to increased SNS.[37] Another point to be discussed is the measurement time of HRV values. In prior studies, the HRV values were generally measured for five minutes. However, in this study the subjects were measured for 2.5 minutes based on the minimum amount of time required to measure the HRV according to the previous study.[38] Further research is required to examine whether there was no statistical significance in all components of HRV.

Efficacy of Makarach vs tandem walking in improving PC

The findings of this study reveal that Makarach, a form of walking meditation with eyes closed on a foam surface, presents unique and superior benefits for improving balance and sensory integration compared to TW.

The key distinctions between Makarach and TW are rooted in their fundamental mechanisms. Firstly, Makarach involves mindful walking—moving forward and backward with eyes closed—while TW is conducted with eyes open, providing visual cues about the surroundings. In Makarach, the absence of sensory information from visual input requires participants to rely on sensory feedback from their ankles and the vestibular system, heightening proprioceptive awareness to maintain PC. Consequently, the proprioceptive sense in the ankle demands that greater feedback be provided about the position of the feet, increasing sensory awareness and integration. The perturbation of sensory information induces movement adaptation to enhance somatosensory information, thereby assisting task performance.[39] This increased reliance enhances feedback on foot positioning and fosters sensory integration. The disruption of sensory information during Makarach prompts movement adjustment, aiding task performance. On the other hand, although TW also poses challenges related to precise foot placement and coordination, the availability of visual input facilitates balance adjustment.

Secondly, sensory input in Makarach is more challenging due to an unstable base of support (BoS), which may play a role in enhancing the proprioceptive sense to maintain PC. The unstable surface in Makarach requires continuous adjustment from the proprioceptive system, particularly in the ankle joints. When visual input is absent, the body relies more heavily on proprioceptive signals in the ankle to maintain balance. This increased demand enhances the sensitivity and responsiveness of the proprioceptive system. This is supported by a previous study, which reveals that balance control mostly involves ankle muscle proprioceptive signals under unstable support.[40] Another WM study also supports this result, revealing an improvement in ankle proprioception and balance performance after four weeks of walking meditation intervention in older adults and chronic ankle instability.[15,16,23] Another possible reason is the tendency to decrease the sway path, potentially contributing to the improvement in ankle proprioception.[33] In contrast, TW provides visual information about the environment, aiding the adjustment of posture and movement for balance. Although TW also appears challenging due to the requirement for precise foot placement and coordination, the presence of visual input aids significantly in integrating environmental cues with movement. While TW offers valuable benefits in terms of precision and coordination, Makarach stands out as a superior method for enhancing overall balance and sensory integration. Its emphasis on proprioceptive training, combined with the mindfulness component, makes Makarach a more effective and comprehensive approach for improving PC and stability.

This study utilized an ITT analysis to ensure that all randomized participants were included in the primary analysis. Missing data were handled using mean imputation, with missing values replaced with the mean value of the observed data for each variable. While mean imputation allows for the inclusion of all participants and maintains the sample size, it has some limitations. Specifically, it may underestimate the variability of the data and potentially attenuate the statistical power of the analysis. However, future studies should consider more sophisticated methods for handling missing data, such as multiple imputation or mixed-effects models, to address these limitations more effectively.

Conclusion

The concepts of Makarach highlight that individuals train their proprioceptive sense in the ankles to allow for the lack of visual input. Not only do they train their physical balance and proprioception, but the key brain regions associated with mindfulness are also strengthened. This holistic approach enhances both mental and physical well-being, leading to improved PC and a more balanced state of mind. Further research may use the concept of Makarach for various applications, including fall prevention and rehabilitation in different populations.

Conflicts of interest

The authors declare no conflict of interest.

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