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RESEARCH ARTICLE

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A controlled trial comparing the impact of guided forest bathing or a mindful urban walk on heart rate, blood pressure, and mood in young Thai adults

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Abstract

1. In Thailand, cardiovascular disease and mental health cause a large health and economic burden, with 10% of Thai adults and 32% of adolescents reporting depression. Forest bathing (FB) (mindful nature walking) is growing in popularity globally as a preventative health intervention. Most FB research compares FB with a non-active control of unguided urban walking, finding improved health and well-being in FB but not the urban condition. This controlled trial offers a unique and robust comparison of guided FB with an active control of guided mindful urban walking. This is also the first study testing the acceptability and effectiveness of guided FB in Thailand.
2. In a crossover design, heart rate, heart rate variability, blood pressure, and mood in 30 participants were compared before and after 1 h of guided FB and a guided mindful urban walk.
3. MANOVA and *t*-test analyses revealed that heart rate and blood pressure reduced in both conditions, but more in the mindful urban condition. Whilst negative mood was reduced in the FB condition but increased in the mindful urban condition.
4. The study offers evidence for the promising health and well-being benefits of both guided FB and mindful urban walking. Poor mental health and health inequalities are of increasing global concern, hence further research into the effectiveness of alleviating these difficulties through inexpensive interventions such as guided FB and mindful walking are encouraged. The study also offers the first data indicating that FB was acceptable and effective in a Thai population.

KEYWORDS

blood pressure, forest, forest bathing, heart rate variability, mindfulness, mood, urban

1 | INTRODUCTION

Forest bathing (FB) is a slow, silent, mindful nature walk which emerged from Japan as a public health intervention to address ill-health (e.g. hypertension and cardiovascular diseases) and stress in the workforce (Li, 2018, 2023; Miyazaki, 2018). It means bathing in the forest atmosphere or taking in the forest through our five senses (sight, hearing, taste, smell, and touch) (Li, 2018). There are two types of FB: unguided and guided. Guided walks can involve mindfulness, and sensory and nature connection activities to enhance the beneficial effects of FB on health and well-being (Forest Therapy Society, 2022).

Support for FB in the form of Government and Forestry policies (e.g. Forest Welfare Promotion Act of the Republic of Korea, 2015), investment in nature on prescription, FB trails, FB clinics, and FB intervention delivery is increasing internationally (Zhang & Ye, 2022). Out of the 266 papers reviewed by Gobster et al. (2022) on the topic of FB and forest walks, none assessed FB in Thailand, although 158 were set in Asian countries. Only one article surveyed learning experiences and environmental perceptions following unguided visits to a walking trail in a Thai forest (Suksri et al., 2021). In a non-English language published conference proceeding, Chansawang et al. (2022) suggest that FB could be offered as an eco-tourism activity in Thailand, which could meet their publics' demand to spend more recreational time in nature following the COVID-19 pandemic. Currently, Chansawang et al. (2022) note that FB is a new concept in Thailand, with few qualified guides.

Thailand offers many suitable sites for FB, owing to its 31.68% tree cover (BIOFIN, 2021), and offers the opportunity to observe a wide range of species through its high biodiversity. Thailand has ~15,000 plant species, representing 8% of the global total; and over 17,000 mammal, bird, reptile, and amphibian species, with ~5% of these endemic (BIOFIN, 2021). A greater connection with nature through practices such as FB, might encourage the protection of such sites and species, as it is noted by BIOFIN (2021) that unsustainable practices, impacts of climate change and biodiversity loss are a threat to the state of nature in Thailand, and to natures capacity to support health, well-being and economic growth.

Thailand is acknowledged by the World Health Organisation (WHO, 2023a) as one of the fastest-growing economies in Asia, transitioning from a low-income to an upper-middle-income country in less than one generation, with continuous reforms to improve its health system. Thailand nonetheless faces various health challenges, with non-communicable diseases (e.g. cardiovascular disease) and their risk factors (e.g. hypertension) causing premature mortality and resulting in an economic loss representing ~10% of the country's gross domestic product (WHO, 2023a). Mental health is also a concern in Thailand, where around 12% report a mental health problem, although the prevalence is lower in Thailand and other parts of Asia compared with Western Europe, America and Australia where prevalence is around 18% (Institute for Health Metrics and Evaluation [IHME], 2021). In Thailand, 10% of adults and 32% of adolescents were prone to depression, with rates increasing since the COVID-19 pandemic (WHO, 2023b). Hence, the implementation of FB to Thailand could offer a low-cost, sustainable, and accessible complementary approach to preventative health and improved mental well-being. This study will offer a first assessment of the acceptability and effectiveness of guided FB in a Thai population.

Recent review articles summarise that nature exposure and FB interventions have a medium effect size on cardiovascular health outcomes (Richardson et al., 2016), and a large effect size on mental well-being (Kang et al., 2022). Reviews also summarise that FB compared with a control condition (often an urban walk), can lower blood pressure (Ideno et al., 2017), improve cardiovascular health (measured with heart rate variability [HRV]) (Farrow & Washburn, 2019; Wen et al., 2019), and reduce negative mood states (measured with the Profile of Mood States [POMS]) (Kotera et al., 2022).

An indicator of stress which is often used to test stress reduction theory (SRT) (Ulrich et al., 1991), is that of physiological measures such as HRV, blood pressure, or inflammatory markers. In a meta-analysis of 47 studies, Gaekwad et al. (2023) found that natural environments had a small to medium effect on reducing physiological stress, compared with urban environments, thus supporting SRT. Hence, a rationale for including physiological measures is that these can provide a test of SRT. HRV is a common physiological measure in FB studies owing to its importance as a physiological indicator of cardiovascular health, notably the balance between the parasympathetic (i.e. rest and digest) and sympathetic (i.e. fight and flight) branches of the autonomic nervous system (Laborde et al., 2017). Previous FB studies have shown increases in HRV following FB activities (Lee et al., 2014; Park et al., 2010), indicating improved cardiovascular function and low arousal (i.e. relaxation). However, a few studies find either no change in HRV (Chun et al., 2023; Yu et al., 2017) or a reduction in HRV following FB (Scott et al., 2021).

Blood pressure is also a common measure in FB studies and high blood pressure is an indicator of hypertension, a risk factor for cardiovascular disease. Previous studies frequently found that FB activities reduced blood pressure (Chun et al., 2023; Yau & Loke, 2020). Older participants with higher blood pressure showed the greatest reductions in blood pressure following FB (Ideno et al., 2017; Li et al., 2011).

The POMS scale is the most common measure of mood in FB studies (Gobster et al., 2022). Across 20 studies summarised in a meta-analysis (Kotera et al., 2022), large effect sizes were found for reductions in the Tension, Depression, and Anger subscales following FB.

A recent review of FB and forest walk studies found that of the 266 articles considered, 98 used guided walks, 48 used sensory activities, and only 10 explicitly featured mindfulness as part of the intervention (Gobster et al., 2022). Hence, a novelty of the current study is that the FB approach included guided, sensory, and mindful walks, which is rare compared with previous FB studies predominantly featuring unguided walking and viewing at forest sites. Mindfulness is defined by Bishop et al. (2004) as the intentional regulation of attention with qualities of non-judgement, openness, curiosity, and acceptance of one's current experience and thoughts. Practitioners of both mindfulness and FB revealed during interviews, that their clients found mindfulness easier and more engaging when practiced outdoors compared with indoors (Clarke et al., 2021). Mindfulness training prior to outdoor walking was shown to enhance participants' awareness of their surroundings, nature connection, and reduce negative affect, compared with walkers without mindfulness training (Nisbet et al., 2019). Similarly, participants tasked with increasing their physical activity through outdoor walking, experienced improved well-being and attentional functioning if they first received cognitive awareness training, compared with a control condition of goal setting (Duvall, 2010). In a study of mindfulness towards nature images, Lymeus et al. (2017) found that the attentional effort of beginning mindfulness training was offset when practices were directed towards images of natural scenery. Further, practicing mindfulness in an outdoor natural setting reduced dropout and increased homework completion during mindfulness training (Lymeus et al., 2019). A meta-analysis of nature-based mindfulness found medium effect sizes of outdoor mindfulness practices (Djernis et al., 2019).

1.1 | Aims

Comparison of FB with walking in an urban area as a non-active control is a common experimental design in previous FB literature (Gobster et al., 2022). This study aimed to provide an assessment of the acceptability and effectiveness of guided FB in improving health and well-being outcomes, compared with a novel and robust active control condition of mindful urban walking. This is also the first study testing the acceptability and effectiveness of FB in Thailand. Based on previous FB research, the hypotheses are that blood pressure will reduce, heart rate will reduce, and HRV will increase (indicative of improved cardiovascular function and lower arousal i.e. relaxation); and total mood disturbance (POMS) will reduce in the guided FB walk. In contrast, blood pressure will increase, heart rate will increase, and HRV will reduce (indicative of poor cardiovascular function and higher arousal i.e. stress); and total mood disturbance (POMS) will increase in the city walk. Given that FB has been shown to be effective in Asian countries (e.g. Park et al., 2021), it is hypothesised that reductions in blood pressure and total mood disturbance and increases in HRV will also be seen in a Thai population.

2 | MATERIALS AND METHODS

2.1 | Design

The study assessed the acceptability of guided FB in this Thai sample, by recording dropout rates, and verbally reported adverse events and positive experiences. The study assessed the effectiveness of guided FB with a repeated measures crossover design with all participants engaging with the intervention condition of guided FB and the active control condition of a mindful urban walk. Data was collected at baseline and post-intervention.

2.2 | Participants

Ethical approval for the study was provided by the Faculty of Humanities at Kasetsart University, written consent was provided by all participants. Participants (N=30, 20 females, 10 males) were undergraduate medical humanities students recruited from Kasetsart University who responded to an announcement in their lectures. Participants ages ranged from 18 to 23 years (M=19.63, SD=1.26). Participants self-reported that they had never previously experienced FB. To ensure equal sample sizes in both conditions, students from one lecture were allocated to walk in the city first (N=15 comprising 3 males and 12 females) whilst students from another lecture were allocated to walk in the forest first (N=15 comprising 7 males and 8 females). Participants were thanked for their time with a payment of 500 baht.

2.3 | Measures

2.3.1 | Self-report questionnaire

At baseline and post-intervention, participants completed paper copies of the POMS (Heuchert & McNair, 2012) a 35-item scale which comprises five subscales measuring negatively valanced emotions: Tension-anxiety, Fatigue-inertia, Depression-dejection, Confusion-bewilderment, Anger-hostility, and one subscale measuring positively valanced emotion: Vigour-activity. All 35 items can be summed (and Vigour is subtracted) to give a score of total mood disturbance. The scale is scored on a Likert scale where 0=Not at all and 4=Extremely, with larger scores of total mood disturbance indicating larger negatively valanced mood disturbance. The scale has shown good reliability, with Cronbach's alpha's ranging 80 to 0.95 (Lin et al., 2014).

2.3.2 | Blood pressure

After sitting still for 15 min rest period, participants had their blood pressure measured at baseline and post-intervention using an OMRON RS1 blood pressure wrist-cuff (2024, https://www.omron-healthcare.co.uk/blood-pressure-monitors?filters%5Bdevice_type%5D=Wrist+Blood+Pressure+Monitor&filters%5Bvalidation%5D=). High or increased blood pressure usually indicates a stress response, whilst reduced blood pressure can indicate a relaxed state (Ideno et al., 2017).

2.3.3 | Heart rate variability

Heart rate variability data collection and reporting procedures followed recommendations from Malik (1996) and Laborde et al. (2017). For controlled collection of HRV data, participants were asked to: (a) follow a normal sleep routine the day before; (b) avoid alcohol for 24 h (Laborde et al., 2017). Both conditions were matched for distance (1 km total) and pace of walking (1 km per hour), to reduce the effects of physical activity on HRV (Hansen et al., 2017). After sitting still for a 15 min rest period (Malik, 1996), heart rate and HRV were recorded using ambulatory devices (POLAR H10 heart rate sensor, 2024, https://www.polar.com/uk-en/sensors/h10-heart-rate-sensor) and the Elite HRV Smartphone app. Participants' HRV was measured for 5 min (Malik, 1996) at baseline and post-intervention. Higher values or increases in HRV values of root mean square of successive differences (RMSSD) and high frequencies (HF) are both indicative of increased parasympathetic activity (rest and digest), good cardiovascular functioning, and relaxed emotional states. Whilst higher values or increases in HRV values of low frequencies (LF) and LF/HF (LF:HF) are both indicative of increased sympathetic activity (fight and flight) and poor cardiovascular functioning and stressed emotional states.

2.4 | Conditions

2.4.1 | Guided FB

Forest bathing walks were led by a qualified FB and mindfulness guide and involved guided discovery and mindful appreciation of an urban tropical forest (Bang Kachao) featuring mature trees, and lakes. Common tree species were coconut palm, pong-pong tree, and wild cotton tree, although 23 species of tree with a density of 988 trees/ha were present (see 'plot 2' in Sommeechai et al., 2018 for a full description of the site). Animals seen during the walk and recorded by one of the Researchers included a variety of birds, squirrels, and water monitor lizards. Temperatures ranged from 29 to 30°C, with humidity ranging 65%–71%. Guided exercises to aid mindful appreciation included: (i) visual exercises, for example, noticing colours and patterns of leaves and bark; (ii) auditory exercises, for example, cupping the ears forward to listen to running water; (iii) touch exercises, for example, exploring tree bark with the fingertips; (iv) smelling exercises, for example, smelling flowers. Participants finished the walk with 8 min of self-guided mindfulness whilst leaning against a preferred tree. Participants were invited to verbally share feedback on their experience.

2.4.2 | Mindful urban walk

Mindful urban walks were led by a qualified FB and mindfulness guide and involved mindful appreciation of a busy urban street in central Bangkok (Si Lom Road). Animals seen during the walk and recorded by one of the Researchers were very few and included squirrels and a cat. The urban walking route was along a narrow pavement with occasional street trees and heavy traffic, and largely comprised buildings occupied by businesses. Temperatures ranged from 28 to 34°C, with humidity ranging 65%–71%. Guided exercises to aid mindful appreciation included: (i) visual exercises, for example, noticing the colours and patterns of different buildings and building materials; (ii) auditory exercises, for example, cupping the ears forward to listen to sounds of the city; (iii) touch exercises, for example, noticing the temperature, breeze, and humidity on one's skin and through one's nostrils; (iv) smelling exercises, for example, smelling the scents of the city and street food. Participants finished the walk with 8 min of self-guided mindfulness whilst observing a piece of street-art on the side of a building. Participants shared verbal feedback on their experience. Photographs from the FB and urban walk locations can be found in Figure 1.

2.5 | Procedure

On day 1, participants visited the University campus and sat still for 15 min before completing the POMS questionnaire and having their blood pressure and heart rate measured at baseline. They were transported by University minibus to either the forest site for a guided FB walk or to the city centre for a mindful urban walk. Guided walks began around 10 a.m. and lasted 1 h, covering 1 km. After the walks, participants sat still again on benches at the end of their walking routes for 15 min before completing the POMS, having their blood pressure and heart rate measured, and providing verbal feedback on any adverse events or positive experiences (written down by a Researcher) post-intervention. On day 2, participants repeated all procedures but crossed over to the other condition (i.e. participants who attended the FB walk on day 1 now switched to the mindful urban walk, whilst those who attended the urban walk on day 1 now switched to the FB walk). All data were collected in December 2023 which is Winter in Thailand. Figure 2 shows a flow diagram of the procedure.

2.5.1 | Data analysis plan

All data were assessed for outliers using z-scores, one blood pressure value and nine HRV values were removed for having z-scores >3.00 and were replaced with the sample median scores. Normality was assessed using skewness and kurtosis which was found to range across variables as 0.087–2.15 for skewness; and −0.077–4.53 for kurtosis. High skewness and kurtosis were found for Anger (POMS), and the HRV values of LF and HF and hence these variables were log-transformed.

To assess whether participant groups were matched in baseline variables, independent t-tests were used. The group who walked in the city first showed significantly higher baseline values in HR ($t=2.30$, df $=58$, $p=0.025$) ($M=96.73$ vs. $M=90.27$) and significantly lower scores in Tension (POMS) ($t=-2.46$, df $=58$, $p=0.017$) ($M=2.33$ vs. $M=4.90$) compared with the group who walked in the forest first.

For the main analysis, a repeated measures three-way (i.e. time × condition × condition order) MANOVA was used to assess any main effects and interactions between the following independent variables: (1) time: baseline and post-intervention assessments; (2) condition: forest versus urban; and (3) condition order: forest or urban walk first. The dependent variables were the subscales and total mood disturbance scores of the POMS, blood pressure, HR, and HRV. Previous FB study data are commonly analysed using paired t-tests (e.g. Chen et al., 2018). However, this fails to control for multiple-testing and increases the risk of type one errors (Selvin, 1970). Hence, a MANOVA is used as the main analysis, whilst post hoc paired t-tests are still used to allow comparison with previous data.

FIGURE 1 Photographs during forest bathing walk and urban walk.

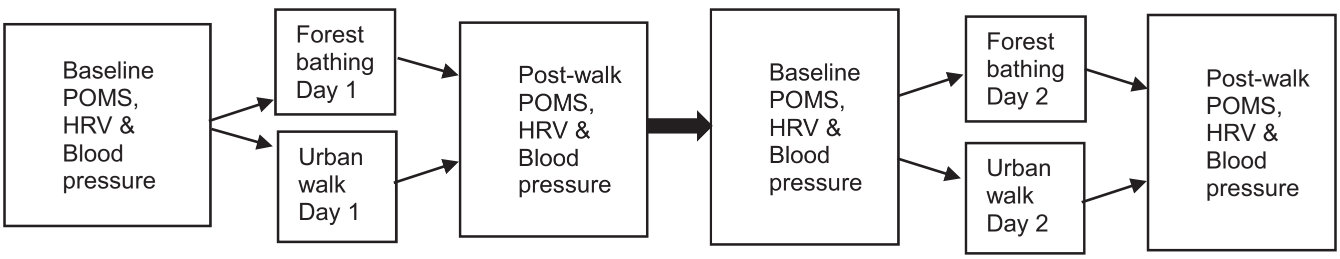

FIGURE 2 Procedure flow diagram.

3 | RESULTS

3.1 | Acceptability

Reviews highlight a failure to report data on acceptability, such as dropout rates (Lee et al., 2017) or adverse events (Wen et al., 2019). Of those who consented, 100% of participants attended both walks and provided full research data. The only adverse events verbally reported in the forest walk were that some participants feel a resentment to the forest site because of encroaching development from industry. In the mindful urban walk, there were a few reported sources of discomfort: the heat, humidity, and still air of the city, the bad smells of traffic and rubbish, the narrow busy paths, the traffic noise, and the kindness of street food vendors which led to feelings of guilt for not purchasing anything. In contrast, positive verbal feedback about the forest walk included: a new interest in nature and new tools to connect with it, an appreciation of trees, the breeze, and the sound of water, feeling more relaxed and worrying less about exams. There were positive comments from the mindful urban walk too: noticing attractive cafes and new shops, feeling excited after noticing Christmas decorations, noticing different styles of building—some of which provide a sense of culture and tradition, watching people skilfully make crafts and food, watching people's facial expressions, the smells of street food and feeling small amongst the tall buildings. All adverse events/feelings of discomfort were acknowledged and reported to a lecturer whom the students trusted and felt safe with, and further discussions were held at their next lecture.

3.2 | Effectiveness

Table 1 displays the means, standard deviations, and mean change scores for all outcome measures during both conditions.

3.3 | MANOVA results

3.3.1 | Effects of time, condition, and condition order

There was a significant main effect for time (i.e. baseline vs. post-intervention) Pillai Trace = 0.505 [$F(14, 43) = 3.13$, $p = 0.0024$, $\eta^2 = 0.505$]. There was a significant main effect for condition (i.e. forest or urban walk) [$F(14, 43) = 2.28$, $p = 0.019$, $\eta^2 = 0.426$]. There was no significant main effect for condition order (i.e. forest vs. urban walk first) [$F(14, 43) = 1.65$, $p = 0.103$, $\eta^2 = 0.350$].

There were no significant two-way interaction effects between time (i.e. baseline vs. post-intervention) and condition (i.e. forest vs. urban walk), Pillai Trace = 0.373 [$F(14, 43) = 1.83$, $p = 0.065$, $\eta^2 = 0.373$]; or between time and condition order (i.e. forest or urban walk first), Pillai Trace = 0.248 [$F(14, 43) = 1.01$, $p = 0.461$, $\eta^2 = 0.248$];

TABLE 1 Means (standard deviations), and mean change scores for all outcome measures during both conditions.

Outcome	Time	Forest condition	Forest mean change	Urban condition	Urban mean change
HR	Baseline	92.87 (9.54)	−1.30	94.13 (12.91)	−6.90
	Post	91.57 (10.25)		87.23 (10.96)	
RMSSD	Baseline	29.20 (19.32)	−0.44	27.16 (13.64)	+5.09
	Post	28.76 (18.68)		32.25 (20.23)	
LF	Baseline	643.72 (468.57)	+236.54	975.51 (646.64)	+29.49
	Post	880.27 (1003.69)		1005.01 (1029.99)	
HF	Baseline	335.25 (375.35)	+4.54	279.18 (216.60)	+202.96
	Post	339.79 (431.62)		482.15 (595.02)	
LF/HF	Baseline	3.42 (2.24)	−0.27	3.41 (1.76)	+0.33
	Post	3.15 (1.87)		3.75 (2.42)	
Systolic	Baseline	113.73 (11.15)	+1.83	114.63 (13.57)	−4.43
	Post	115.57 (11.42)		110.20 (11.69)	
Diastolic	Baseline	72.57 (9.47)	−1.83	72.60 (10.14)	−0.33
	Post	70.73 (11.49)		72.27 (7.73)	
Tension	Baseline	3.87 (4.65)	−1.97	3.37 (3.78)	−0.10
	Post	1.90 (2.37)		3.27 (3.18)	
Depression	Baseline	2.23 (3.56)	−0.93	2.40 (3.31)	+0.33
	Post	1.30 (1.97)		2.73 (3.81)	
Anger	Baseline	2.70 (3.91)	−1.83	2.57 (3.11)	+0.67
	Post	0.87 (1.68)		3.23 (3.95)	
Confusion	Baseline	3.30 (3.48)	−1.60	4.00 (3.44)	+0.17
	Post	1.70 (2.02)		4.17 (3.86)	
Fatigue	Baseline	7.47 (5.10)	−1.77	7.83 (6.19)	+3.30
	Post	5.70 (5.19)		11.13 (6.03)	
Vigour	Baseline	8.77 (3.97)	+1.27	7.37 (4.19)	−1.73
	Post	10.03 (5.59)		5.63 (4.99)	
Total mood disturbance	Baseline	10.80 (18.49)	−9.37	12.80 (18.42)	+6.10
	Post	1.43 (14.20)		18.90 (20.02)	

Abbreviations: HF, high frequencies; HR, heart rate; HRV, heart rate variability; LF, low frequencies; RMSSD, root mean square of successive differences.

or between condition and condition order, Pillai Trace = 0.373 [$F(14, 43) = 1.83$, $p = 0.065$, $\eta^2 = 0.373$]. However, there was a significant three-way interaction between time, condition and condition order, Pillai Trace = 0.417 [$F(14, 43) = 2.19$, $p = 0.025$, $\eta^2 = 0.417$].

3.3.2 | Effects of heart rate and HRV

There was a significant main effect of heart rate [$F(1) = 18.45$, $p < 0.001$, $\eta^2 = 0.248$], which reduced between baseline and post-intervention ($M = -1.30$ forest and $M = -6.90$ urban). HRV did not show any significant change across any of its indicators (i.e. RMSSD, HF, LF, LF:HF p's > 0.05).

There was a significant three-way interaction effect (i.e. time × condition × condition order) for heart rate [$F(1) = 26.35$, $p < 0.001$, $\eta^2 = 0.320$] with mean change scores indicating that in the forest condition, those who walked in the forest first saw a reduction in heart rate ($M = -3.53$) indicating reduced arousal; whereas those who walked in the forest second saw a small increase in heart rate ($M = +0.94$) indicating increased arousal. In the mindful urban condition, those who walked in the urban location first saw a large reduction in heart rate ($M = -14.46$) indicating reduced arousal; whereas those who walked in the urban location second saw a small increase in heart rate ($M = +0.67$), indicating increased arousal.

3.3.3 | Effects of blood pressure

There were no significant main effects of systolic blood pressure [$F(1) = 1.05$, $p = 0.310$, $\eta^2 = 0.018$] or diastolic blood pressure [$F(1) = 0.854$, $p = 0.359$, $\eta^2 = 0.015$]. There was however a significant three-way interaction effect (i.e. time × condition × condition order) for systolic blood pressure [$F(1) = 8.21$, $p = 0.006$, $\eta^2 = 0.128$], with mean change scores indicating that in the mindful urban condition, those who walked in the urban location first saw a notable mean reduction in blood pressure ($M = -8.00$), indicating reduced arousal. Whereas those who walked in the forest first saw a small mean reduction in blood pressure ($M = -0.86$), indicating reduced arousal. Whilst in the forest condition, those who walked in the urban location first saw a notable increase in blood pressure ($M = +5.54$), indicating increased arousal. Whereas those who walked in the forest first saw a reduction in blood pressure ($M = -1.86$) indicating reduced arousal.

3.3.4 | Effects of POMS

There was a significant main effect of Tension (POMS) [$F(1) = 5.64$, $p = 0.021$, $\eta^2 = 0.091$], which reduced between baseline and post-intervention. There were no significant main effects for any of the other POMS subscales (i.e. depression, Anger, Fatigue, Confusion, vigour) or for the POMS total mood disturbance score (all p's > 0.05).

There were significant two-way interactions for the following POMS subscales and total mood disturbance score. Total mood disturbance reduced in the forest ($M = -9.37$) and increased in the city ($M = +6.10$) [$F(1) = 6.06$, $p = 0.017$, $\eta^2 = 0.098$]. Vigour increased in the forest ($M = +1.27$) and reduced in the city ($M = -1.73$) [$F(1) = 8.16$, $p = 0.006$, $\eta^2 = 0.127$]. Fatigue reduced in the forest ($M = -1.77$) and increased in the city ($M = +3.30$) [$F(1) = 5.29$, $p = 0.025$, $\eta^2 = 0.086$]. Finally, Confusion reduced in the forest ($M = -1.60$) and increased in the city ($M = \pm 0.17$) [$F(1) = 5.49$, $p = 0.023$, $\eta^2 = 0.089$]. There were no two-way interaction effects for Tension, Depression, or Anger (all p's > 0.05).

3.3.5 | Post hoc tests

A post hoc paired t-test found that in the city condition, heart rate [t (29) 3.67, $p < 0.001$] and systolic blood pressure [t (29) 2.06, $p = 0.048$] reduced, whilst Fatigue increased [t (29) −2.92, $p = 0.007$] significantly. This supports the MANOVA finding which found that heart rate and blood pressure reduced more in the city and for the participants who walked in the city first. In the forest condition, Anger [t (29) 3.19, $p = 0.003$], Tension [t (29) 2.83, $p = 0.008$], Depression [t (29) 1.74, $p = 0.046$], Confusion [t (29) 2.75, $p = 0.008$] and total mood disturbance [t (29) 3.02, $p = 0.005$] all significantly reduced. This supports the MANOVA finding which found that in the forest, Fatigue, Confusion, and total mood disturbance score all reduced.

4 | DISCUSSION

This research aimed to assess the acceptability and effectiveness of guided FB for a young adult Thai population, compared with a guided mindful urban walk. In brief, the research found that guided walks in the forest and city were both acceptable, and that heart rate and blood pressure reduced overall, but more in the mindful urban condition, whilst total mood disturbance reduced in the forest but increased in the city. Most previous FB research has been conducted in Japan and South Korea where it has been shown to be effective (e.g. Park et al., 2021). The results of the current study are comparable with previous Asian FB studies, adding strength to the idea that FB can show similar effectiveness in Thailand. This study therefore offers the first evidence for the acceptability and effectiveness of FB in Thailand.

In terms of acceptability, 100% of consenting participants completed both forest and urban walks, indicating good acceptability in this Thai population. The only adverse events verbally reported in the forest walk were that some participants felt resentment to the forest site because of encroaching development from the industry. In the mindful urban walk, there were a few reported sources of discomfort: the heat, humidity, and still air of the city, the bad smells of traffic and rubbish, the narrow busy paths, the traffic noise, and the kindness of street food vendors which led to feelings of guilt for not purchasing anything. Positive verbal feedback was given in both the forest condition (e.g. a new interest in nature and new tools to connect with it) and the city condition (e.g. noticing attractive cafes and new shops).

Our hypothesis that heart rate would reduce in the forest but increase in the city and that HRV would increase in the forest but reduce in the city was not supported by the study results. Rather the MANOVA and *t*-test results showed that whilst heart rate reduced across both conditions, it reduced to a greater extent in the mindful urban walk condition, and no significant changes in HRV were found. It is possible that heart rate reduced (i.e. indicating good cardiovascular function and relaxation) in both conditions because the urban walk in this study featured mindfulness and sensory activities, making it an active and more robust control group. The lack of statistically significant HRV results could be due to small effect sizes. When compared with previous Asian FB literature, our heart rate and HRV findings are contrary to most previous findings which have shown increases in HRV after FB (Lee et al., 2014; Park et al., 2010). These previous studies used the standard urban walk (without mindfulness and sensory activities) as a non-active control and had larger sample sizes (i.e. $N = 48–280$). However, there are exceptions, with some studies like ours failing to find a change in HRV (Chun et al., 2023; Yu et al., 2017).

Our hypothesis that blood pressure would reduce in the forest but increase in the city was not supported, and contrary to expectation systolic blood pressure only reduced in the mindful urban walk. When compared with previous literature our blood pressure findings are inconsistent because blood pressure improved in the mindful urban condition but not in the FB condition. Previous Asian FB studies generally find reduced blood pressure following FB (Chun et al., 2023; Yau & Loke, 2020), although these studies used a standard urban control condition and participants were adults and those with hypertension. It could be the younger age of our participants which led to this lack of significant findings for blood pressure, it has been reported that FB lowers blood pressure in elderly people with hypertension (Ideno et al., 2017; Li et al., 2011) but does not lower blood pressure in young people whose blood pressure is often within the normal range (Song et al., 2019).

Our hypothesis that total mood disturbance would reduce in the forest and increase in the city was supported. Results revealed that total mood disturbance (POMS), Fatigue, Confusion, and Tension were reduced in the forest and increased in the city. In addition, vigour increased in the forest but reduced in the city. When compared with previous literature, our POMS findings are consistent with many predominantly Asian FB studies which find reductions in total mood disturbance following FB (Kotera et al., 2022).

When controlling for condition order effects, those who walked in the city first experienced notable reductions in heart rate and blood pressure in the mindful urban condition but saw a small increase in heart rate and a notable increase in blood pressure in the forest, appearing to feel more comfortable in the urban location. It is worth noting that the group of participants who walked in the city first had a higher baseline heart rate than participants who walked in the forest first. Therefore, the significant reduction in heart rate for those who walked in the city first might reflect these initial ceiling effects enabling more room for a reduction in heart rate, whereas the group who walked in the forest first may be demonstrating floor effects at baseline with no room for improvement in heart rate. For participants who walked in the forest first, they experienced small increases in heart rate and blood pressure in the city, in contrast in the forest where they had small reductions in heart rate and blood pressure, appearing slightly more comfortable in the forest.

5 | LIMITATIONS AND FUTURE DIRECTIONS

Whilst the sample size was comparable with previous FB studies (mean sample size is 38.5 according to Gobster et al., 2022), the sample size was only large enough to detect large effect sizes in HRV according to rules of thumb suggested by Laborde et al. (2017). To ensure equal sample sizes in both conditions, students from one lecture were allocated to walk in the city first, whilst students from another lecture were allocated to walk in the forest first, hence randomisation was not used and is recommended for future studies to ensure samples are balanced at baseline. For example, these groups were not balanced in terms of gender and had different baseline values for heart rate and tension (POMS). Whilst many crossover design studies are used in FB, very few assess or discuss carryover effects (Suchman & Ader, 1992), in our study, we found differences between those who walked in the city or the forest first. This might suggest that a longer washout period might be helpful. In previous FB studies, washout periods varied from 30 min (Horiuchi et al., 2014) to 28 days (Hong et al., 2012).

6 | CONCLUSIONS

This study used a crossover design to compare guided FB with an active control of a guided mindful urban walk. The research found that guided walks in the forest and city were both acceptable, and that heart rate and blood pressure were reduced in both conditions, but more in the mindful urban condition, whilst total mood disturbance reduced in the forest but increased in the mindful urban condition. This indicates that mindful walking in both the forest and the city can have beneficial effects on health and well-being. The research provided promising evidence for the potential of guided FB to reduce total mood disturbance. Future studies should aim to recruit larger sample sizes with a fully randomised controlled trial design. Most FB research has been conducted in Japan and South Korea where it is shown to be effective (e.g. Park et al., 2021), this study therefore offers the first evidence for the acceptability and effectiveness of guided FB in Thailand.

AUTHOR CONTRIBUTIONS

Dararat Simpattanawong led funding acquisition for participant travel and reimbursement, led data collection, and led project administration. Qing Li designed the study and contributed to the

interpretation of results and the revision of the manuscript. Kirsten McEwan wrote the protocol, assisted with data collection, checked correct data entry, analysed all data, wrote the first draft of the manuscript, and edited the manuscript for publication.

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CONFLICT OF INTEREST STATEMENT

The research activity was facilitated by Assistant Professor Dr. Thongrob Ruenbanthoeng, Dean of Faculty of Humanities, Kasetsart University. The authors have no relevant financial or non-financial conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

This manuscript collected the following data: Survey data; heart rate and heart rate variability data and blood pressure data. The ethical application for the study does not provide permission to upload the data into a repository. However, anonymised data are available from the Corresponding Author on request via email.

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