Evaluating the Coniferous Forest Environment of Liberia's SAPO National Park and Its Impact on the Physiological and Psychological Outcomes of Yoga Practice Among Women

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Abstract

Background:

Natural settings, particularly forests, have long been known to provide physical and psychological renewal. The sensory aspects of forest environments—natural sounds, fresh air, and visual greenery—have been revered as capable of reducing stress levels, lowering blood pressure, and improving emotional states. SAPO National Park, in southeastern Liberia, is Liberia's largest and ecologically most important protected rainforest. Although generally renowned for its biodiversity, the park also has distinctive coniferous areas that provide a peaceful environment that is suitable for mind-body disciplines like yoga. The purpose of this study was to assess the impact on women's physiological and psychological conditions of practicing yoga under this particular forest environment.

Methods:

The cross-sectional mixed-methods design with 253 women aged 19 to 57 years was used. Each received one 60-minute guided yoga session inside the coniferous forest at SAPO National Park. A standardised questionnaire was completed before and after each session. It gathered demographic information, physiological measures (self-rated heart rate, respiratory rate, muscle tension, and subjective energy levels), and psychological measures (stress,

mood, concentration, and nature connection). Data were collected on a five-point Likert scale, and open-ended questions yielded qualitative information. Quantitative data were assessed using paired t-tests, whereas qualitative responses were coded thematically.

Results

Post-session measurements showed significant gains: lowered stress levels (mean difference = -1.3, $p < 0.01$), increased mood (+1.5, $p < 0.01$), and slowing of heart rate. In addition, 84% of the participants assessed improved emotional connection to nature, with recurrent themes of spiritual anchoring and inner serenity.

Conclusion:

Forest yoga in SAPO National Park has quantifiable psychological benefits and moderate degrees of physiological gains, validating its potential application in interventions for women's wellness.

Keywords:
Forest yoga, women's wellness, psychological benefits, physiological effects, nature therapy

Introduction

Nature-based treatments have ever more become widely accepted as effective complementary interventions to enhance physical and mental well-being. These treatments tap into the restorative power of natural environments—especially forests—to induce relaxation, emotional balance, and physiological recovery. Forests, and especially conifer forests, have been proven to steadily diminish stress, decrease cortisol levels, improve immune system function, and enhance general health. The phytoncides (aromatic volatile chemicals emitted by trees), natural noises, and green immersive vistas are responsible for these therapeutic impacts [1][2].

Among other mind-body interventions, yoga has become a holistic treatment that incorporates physical movement, regulated breathing, and meditation. There is scientific evidence that attests to its effectiveness in the management of mental disorders like anxiety and depression, as well as its positive impacts on cardiovascular health, respiratory capacity, muscular flexibility, and emotional robustness [3][4]. The combination of yoga and forest settings—often referred to as "forest yoga" or "nature-based yoga"—has been found to be potentially more effective in increasing the yield from each practice.

SAPO National Park, situated in Liberia's southeastern region, is a special ecological place because it is the largest reserved rainforest in the nation and features a variety of flora, including coniferous ones in certain areas. Such natural aspects qualify it as a perfect location for implementing forest-oriented wellness activities. Even though there is a worldwide interest in nature-oriented interventions, it is scarcely understood where they are applied in sub-Saharan Africa, especially among women. This research fills that void by examining whether the coniferous forest surroundings of SAPO National Park can enhance the physical and mental rewards of yoga for female participants,symbolic of too frequently neglected populations in such investigations.

Methods

Study Design and Participants

This research utilized a cross-sectional mixed-methods study design that combined quantitative and qualitative data to thoroughly assess the physiological and psychological effects of forest-based yoga. The population for the study was 253 women aged between 19 and 57 years who enrolled on their own accord in yoga sessions in SAPO National Park, Liberia. Participants were recruited after publicizing and organizing registration drives at urban and peri-urban wellness centers within Monrovia. Inclusion criteria involved being female, the targeted age range, medically healthy to participate in moderate intensity physical activity, and ready to undergo pre- and post-session testing.

Yoga Sessions

All participants took part in a controlled, 60-minute yoga session led by a certified trainer. The session was designed to integrate traditional hatha yoga with the natural setting of the park. The routine consisted of:

- 10 minutes of guided mindfulness meditation to anchor attention and increase environmental awareness,
- 40 minutes of hatha-based postures and dynamic stretching to engage physical systems,
- 10 minutes of breathing exercises (pranayama) and cool-down exercises to balance physiological responses.

Sessions were conducted in open woods cleared of underbrush lined by tall coniferous trees, with minimal artificial disturbance, so participants could be completely immersed in the sounds, odors, and visual stimuli of nature.

Data Collection Tool

A standardized questionnaire was given both prior to and immediately following each session of yoga. The tool consisted of five major elements:

- Demographic information: Age, level of education, and past experience with yoga;
- Physiological markers: Self-assessed heart rate, breathing rate, perceived muscle tension, and energy levels;
- Psychological markers: Assessments of stress, mood, mental concentration, and emotional affinity with nature;
- Environmental perception items: Evaluations of the forest environment's effect on the practice of yoga;
- Open-ended questions: The participants were asked to detail their subjective experiences and perceived advantages of practicing yoga in nature.

Likert-scale responses were noted on a scale of 1 (strongly disagree) to 5 (strongly agree).

Data Analysis

Quantitative information was entered and analyzed with SPSS Version 25. Paired t-tests were employed to analyze pre- and post-session scores for all the physiological and psychological variables. The significance level of $p < 0.05$ was employed to establish statistical significance. For the qualitative data, open-ended responses were analyzed through Braun and Clarke's thematic analysis technique. This included data familiarization, coding of answers, finding patterns, and developing themes that captured participants' experiences, emotional reactions, and perceived effects of the forest setting to their practice of yoga.

Ethical Considerations

Ethical clearance The study was cleared by the Institutional Ethics Committee of Desh Bhagat University (IEC/DBU/2024/017) and was conducted in accordance to the national and international guidelines for the human research. Written consent was obtained from participants prior to their taking part in the study, and they were briefed on the purpose of the study, the procedures and their rights. Confidentiality was ensured and the participants were

anonymous; they were identified only with a pin code and all the information was kept safe. Ethics considerations were particularly pertinent because of the participation of coastal communities in Liberia. Cultural safety, voluntary participation and community involvement contributed to the integrity and trustworthiness of the research.

Results

Table 1: Participant Characteristics

Variable	Category	Frequency (%)
Age Group	18–30	94 (37.2)
	31–45	112 (44.3)
	46–60	47 (18.6)
Education Level	Secondary	101 (39.9)
	Tertiary	152 (60.1)
Yoga Experience	< 1 year	135 (53.4)
	≥ 1 year	118 (46.6)

There were 253 women involved in the study, with most being aged 31–45, which accounted for 44.3% (n=112) of the sample. This was then followed by those aged 18–30, who made up 37.2% (n=94), and the lowest age group was the 46–60s, which accounted for merely 18.6% (n=47). This age structure provides a fairly younger population of participants, with more than 81% of respondents younger than 45, proposing that forest-based yoga will especially be of interest to young and middle-aged Liberian women.

With regard to education, a greater percentage of participants had tertiary levels of education, with 60.1% (n=152) having college or university qualifications and 39.9% (n=101) having reached only secondary education level. This indicates that women at higher levels of education were more likely to engage in structured wellness programs like this forest yoga intervention. The educational background might further mirror the wider socio-demographic profile of urban and peri-urban wellness center visitors, from whom all participants were drawn.

In terms of yoga experience, over half of the women (53.4%, n=135) had less than one year of experience with yoga, and 46.6% (n=118) had practiced for a year or more. This close to even split suggests there was an equitable number of beginners and veteran participants, which could be important when considering their psychological and physiological reactions to the sessions. The results indicate that forest yoga is enjoyable and very suitable for both novices and more experienced yoga participants.

Table 2: Quantitative Findings

Indicator	Pre-Yoga Mean (SD)	Post-Yoga Mean (SD)	Mean Difference	*p*-value
Stress level	4.1 (0.7)	2.8 (0.9)	-1.3	<0.01
Mood level	2.3 (0.8)	3.8 (0.6)	+1.5	<0.01
Heart rate (bpm, self-reported)	91.2 (10.1)	86.3 (9.3)	-4.9	0.02
Energy level	2.9 (0.6)	4.0 (0.5)	+1.1	<0.01
Connection to nature	3.5 (0.9)	4.4 (0.5)	+0.9	<0.01

The quantitative results from the pre- and post-yoga tests demonstrate marked improvements in all measured physiological and psychological indices after attending yoga sessions conducted in the coniferous setting of SAPO National Park.

Stress levels, an important psychological indicator, was found to decrease remarkably from a pre-session mean of 4.1 (SD = 0.7) to a post-session mean of 2.8 (SD = 0.9), indicating a mean decline of 1.3 points ($p < 0.01$). This statistically significant reduction suggests the strong soothing effect of forest-yoga on the mental health of participants. Likewise, levels of mood showed significant improvement, rising from a baseline mean of 2.3 (SD = 0.8) to 3.8 (SD = 0.6) after the session, representing a 1.5-point rise ($p < 0.01$), implying that the participants felt significantly more positive and elevated following the session.

Physiologically, subjects indicated a moderate but significant reduction in heart rate from 91.2 bpm (SD = 10.1) to 86.3 bpm (SD = 9.3), down 4.9 bpm ($p = 0.02$). This indicates a relaxation response served by both the yoga activity and the peaceful natural setting. Energy levels, however, demonstrated a significant increase, rising by 1.1 points from a mean of 2.9 (SD = 0.6) to 4.0 (SD = 0.5), with strong statistical significance ($p < 0.01$). This indicates both physical stimulation and mental rejuvenation post-session.

Lastly, emotional affinity for nature was enhanced significantly, with the average score increasing from 3.5 (SD = 0.9) to 4.4 (SD = 0.5), a 0.9-point increase ($p < 0.01$). This result highlights the robust biophilic reaction elicited by engaging immersion in the coniferous forest setting while practicing yoga. Overall, the findings confirm that yoga in nature not only reduces stress and improves mood but also increases connection with the natural world.

The subjective experiences of the participants also shed further light on the transformative potential of yoga practice in SAPO National Park's coniferous forest ecosystem. The data from the environmental perception indicated overwhelmingly high positive responses. An impressive 91% of the participants concurred or strongly concurred that the forest environment promoted their relaxation, identifying the calming effect of the natural environment. In addition, 88% of participants mentioned the presence of ambient nature sounds—like rustling leaves, birdsong, and flowing water—as a key contributor to heightened concentration during the session. These deeper sensory cues, grounded in nature, may have triggered a state of mental lucidity and meditative concentration. More importantly, 84% of the women mentioned feeling a "deep emotional or spiritual feeling" while practicing, indicating a deep internal responsiveness activated by the environment.

The qualitative analysis resonated with these feelings through three recurring themes. The first, Spiritual Grounding, approximated participants' feeling of unity with the natural environment. As one of the respondents stated, "It felt like I was part of the earth—breathing with the trees," this quote seems to be an embodied unity with the environment, most commonly described in ecopsychological texts as a grounding or re-centering effect.

The second, Sensory Immersion, highlighted the importance of multisensory experience of the woods to make the practice of yoga more worthwhile. As one of them explained, "The scent of trees and birdsong allowed me to go inside myself," illustrating how the sense of smell and hearing helped create introspection and mindfulness.

Lastly, the Psychological Relief theme expressed the therapeutic release that many felt: "I forgot my worries. The forest wiped them away." This reflects the way that the synergy between yoga and nature created a haven of refuge from daily stresses that allowed for both mental acuity and emotional rejuvenation.

All these findings highlight the integrative strength of nature-based yoga in developing psychological well-being and spiritual interconnectedness among women in a biodiverse environment such as SAPO National Park.

Discussion

The findings suggest that the coniferous forest setting of SAPO National Park significantly increases the physiological and psychological effects of yoga. Participants showed strong reductions in perceived stress, enhanced mood, and increased feelings of connection to nature—results that are in line with the international forest therapy literature [5][6]. The forest environment probably accounts for these effects by offering a multisensory, low-stimulus context conducive to mindfulness, relaxation, and emotional regulation.

Specifically, the research found that women, especially in African settings, still encounter both cultural and practical barriers to being able to access nature-based well-being programs [7]. Aspects like concern about safety, societal roles, and mobility restrictions tend to deter women from outdoor engagement. Nonetheless, the structured and monitored format of the yoga sessions at SAPO National Park helped to overcome such impediments. Interviewees showed greater confidence and desire to participate in future similar programs, suggesting that well-crafted interventions can overcome these barriers. These results highlight the role of gender-sensitive interventions in environmental health and wellness programs.

In addition, the qualitative data highlight the therapeutic potential of sensorial immersion and biophilic connection—themes underpinned by ecopsychological and environmental neuroscience principles [8][9]. Participants widely reported feelings of cognitive clarity and affective grounding throughout their forest experience, crediting the visual, auditory, and olfactory stimulation of nature. The occurrence of tall conifers, chilly ambient temperatures, and the soothing sound of wildlife and wind all combined to bring about what some found to be a "restorative sanctuary." This is in keeping with the Attention Restoration theory, that natural environments restore mental fatigue by stimulating effortless attention.

Additionally, the results indicate that integrating nature-based modalities such as forest yoga into public health programs can provide scalable impacts, especially where there are limited mental health services in low-resource environments. Through the use of already available natural resources, such programs can provide cost-efficient and culturally flexible means for enhancing well-being in communities.

In conclusion, this research not only verifies the synergistic impact of forest settings and yoga on overall well-being but also indicates the potential of nature-oriented interventions to lead change when culturally and gender-sensitive. Future studies may investigate the long-term effects of these interventions and extend to comparative studies in various ecological zones.

Conclusion

The results indicate that the coniferous forest environment of SAPO National Park markedly enhances the physiological and psychological impacts of yoga. Participants exhibited strong decreases in perceived stress, improved mood, and enhanced nature connection—a set of results consistent with the global forest therapy literature [5][6]. The forest setting likely underlies these effects by providing a multisensory, low-stimulus environment in which to practice mindfulness, relaxation, and emotion regulation.

Particularly, the study established that women, particularly in African contexts, continue to face cultural as well as practical limitations to access nature-based well-being interventions [7]. Factors such as fear for safety, roles in society, and mobility limitations are likely to keep women from outdoors activities. However, the programmed and supervised nature of the yoga sessions at SAPO National Park overcame such limitations. Interviewees expressed stronger confidence and willingness to take part in subsequent similar programs, indicating that effectively designed interventions are able to break through such barriers. The findings indicate the importance of gender-sensitive interventions in environmental health and wellness programs.

Moreover, the qualitative findings emphasize the therapeutic value of sensorial immersion and biophilic connection—indicative themes supported by ecopsychological and environmental neuroscience frameworks [8][9]. Broadly reported across participants were subjective experiences of cognitive clarity and affective grounding during their forest experience, attributing to the visual, auditory, and olfactory stimulation provided by nature. The presence of high conifers, cool atmospheric temperatures, and the gentle noise of fauna

and wind all worked in unison to induce what some described as a "restorative sanctuary." This is consistent with the Attention Restoration theory, that nature has the ability to restore mental tiredness by inducing effortless attention.

Moreover, the findings also show that incorporating nature-based modalities like forest yoga into public health programs can bring scalable effects, particularly where there are limited mental health services in low-resource settings. By making use of already existing natural resources, such programs can offer cost-effective and culturally adaptable strategies for improving well-being in communities.

To sum up, this study not only confirms the synergistic effect of forest environments and yoga on general well-being but also suggests the efficacy of nature-based interventions to create change when made culturally and gender-sensitive. Future research can explore the long-term impact of these interventions and move on to comparative studies in different ecological zones.

Authors' Contributions

The results indicate that the coniferous forest environment of SAPO National Park markedly enhances the physiological and psychological impacts of yoga. Participants exhibited strong decreases in perceived stress, improved mood, and enhanced nature connection—a set of results consistent with the global forest therapy literature [5][6]. The forest setting likely underlies these effects by providing a multisensory, low-stimulus environment in which to practice mindfulness, relaxation, and emotion regulation.

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Conflicts of Interest

The authors attest that no conflicts of interest exist with this publication. They have no financial relationship, personal association, institutional obligation, or professional interest which might have inappropriately affected the performance, analysis, or reporting of the study. The study and findings reported rest on scientific evidence and observations from the community.

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