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ARTICLE

Walking for Mental Health: Effects of Mobile-Based Walking on Stress and Affectivity in College Students

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ABSTRACT: Objectives: Recent research has shown that college students experience high levels of stress from various sources, which contribute to heightened rates of psychological distress and make them particularly vulnerable to mental health issues. Hence, we conducted a study, aimed to analyze the influence of a mobile-based walking routine on mental health outcomes, such as perceived stress and positive and negative affect. **Methods:** The participants were divided into two groups: the walking group (N = 23) and the control group (N = 24). The walking group engaged in an approximately 25-min walking session for at least 3 days per week, which was carefully monitored and facilitated with the help of the Nike Run Club application. The statistical analysis of the quantitative data was carried out with the help of SPSS 25.0. In addition to calculating descriptive statistics, we conducted an independent samples t-test, a repeated-measures ANOVA, and a paired sample t-test to analyze the effectiveness of the intervention. **Results:** A repeated-measures ANOVA revealed that the walking group exhibited significant reductions in perceived stress (t = 2.03, p = 0.049, Cohen's D = 0.60) and negative affect (t = 2.19, p = 0.033, Cohen's D = 0.65) after the intervention, whereas the control group showed no significant changes across time in any of the proposed variables. **Conclusion:** The results of the study continue to be indicative of the positive effects of regular walking on perceived stress and negative affect, preserving its role as a straightforward and accessible tool for reducing stress and negative affect.

KEYWORDS: Mental health; low-intensity exercise; mental health outcomes; mobile intervention; positive and negative affect

1 Introduction

Mental health problems are extremely common among college students [1]. According to recent research, more than 60% of college students face at least at least one psychological disorder; this is a significantly higher rate than that ten years ago [2]. The primary mental health problems include depression, anxiety, and stress, to which various factors such as extreme academic pressure, social stress, and deprivation of proper mental care contribute [3]. These factors can cause distress to such an extent that this can hinder a student's academic performance and social life, and this can have a long-lasting effect on their emotional and physical well-being [4–6]. Thus, it is important for these vulnerable populations to have buffering interventions available to protect them from mental health issues.

Walking is the most natural and oldest form of human movement, and it is the most environmentally friendly and convenient form of human movement that people of all ages can include in their daily routine [7–9]. Walking has a wide range of physical effects, including enhancing cardiovascular fitness [10–12],

lowering blood pressure and cholesterol levels, and controlling weight and insulin levels [13–15]. Research also suggests that a walking program helps to enhance the psychosocial well-being of people with chronic mental health issues, including reducing depression and anxiety [15–18]. Therefore, walking may be a particularly suitable physical activity option that can be utilized by college students struggling with mental health issues.

While traditional walking programs have shown benefits for mental health, they often face challenges related to participant engagement, adherence, and monitoring. The integration of mobile technology into walking interventions can address these limitations by offering real-time feedback, goal-setting features, and automated tracking of activity [19,20]. Mobile health (mHealth) interventions, such as smartphone applications, have demonstrated improved adherence rates in physical activity programs, particularly among young adults who are highly familiar with digital tools [21,22]. These applications not only enable users to monitor their progress but also enhance motivation by providing personalized feedback and encouraging goal achievement [19]. Accordingly, this study leverages a mobile-based walking intervention to address the limitations of traditional approaches and maximize accessibility and engagement.

One key physiological mechanism that underlies the positive effects of physical activity on mental health is its influence on the hypothalamic-pituitary-adrenal (HPA) axis. Previous research has found that physical activity influences HPA axis activity, thereby decreasing physiological stress reactions [23,24]. The HPA axis is one of the primary systems in our body responsible for managing stress responses, secreting cortisol in reaction to stressors. Regular physical activity has been found to modulate the responsiveness of the HPA axis, suppressing excessive cortisol secretion and stabilizing the physiological response to stress [24,25]. Additionally, physical activity stimulates the release of neurochemicals in the brain, such as endorphins. Endorphins help to mitigate feelings of stress and anxiety while increasing positive affect [26,27]. Physical activity also stimulates the release of other neurotransmitters such as serotonin and norepinephrine, which results in decreased feelings of depression [28,29]. Overall, these findings show that physical activity can significantly enhance mental health by regulating the HPA axis and promoting the release of neurochemicals that alleviate stress, anxiety, and depression. Regular engagement in physical activity not only stabilizes the body's stress response but also fosters a more positive emotional state, making it a valuable tool for improving overall mental health.

The theoretical framework of this study can be grounded in Self-Determination Theory (SDT) [30]. SDT is a theory that explains human motivation and behavior, emphasizing the fulfillment of three core psychological needs: autonomy, competence, and relatedness. When these needs are satisfied, intrinsic motivation is enhanced, leading to positive behavioral changes and improvements in mental health [31].

From the perspective of SDT, walking exercise satisfies psychological needs by allowing individuals to make their own choices (autonomy), achieve goals (competence), and experience social interaction or connection with their environment (relatedness) [31]. Therefore, a walking exercise program based on self-determination is considered an effective intervention for improving mental health.

While the benefits of walking on mental health are well-established, the majority of research has focused primarily on depression and anxiety as indicators of mental health. There is a notable gap in the literature concerning the impact of walking on stress and affect, particularly among college students. Most studies have not explored this issue, despite evidence suggesting that stress is highly prevalent in this population [2] and can significantly affect overall well-being, academic performance, and long-term health [4–6]. Furthermore, stress and negative affect are distinct psychological constructs that can lead to detrimental outcomes such as burnout, emotional exhaustion, and lowered resilience [32]. Given the unique challenges that college students face, including academic pressure, social stressors, and being in the midst of transitional life stages, it is crucial to investigate how walking can mitigate stress and negative effects. Accordingly, we conducted

a study to examine the effects of walking on stress and negative affect, providing a more comprehensive understanding of how physical activity can support mental health in this vulnerable population.

The main objective of the study is to explain how a mobile-based walking intervention has the potential to influence college students reported stress levels and positive and negative effects to provide a more comprehensive understanding of how physical activity can support mental health in this vulnerable population. For the study, the psychological effect of the given type of intervention was measured among young adults. Such an intervention is especially appropriate for young adults given that almost all of them regularly use smartphones.

2 Methods

2.1 Participants

The participants in this study were college students aged 18 to 30 from Gyeonggi-do Province in South Korea. From the first week to the last week of March 2024, a combination of posters and online advertisements was employed to enlist the participants. The purpose and objectives of the study were explained to the 45 students who expressed interest in participation, and a pre-screening was conducted to select participants who met the following criteria: 1) no diagnosed diseases by a physician and not undergoing any special medication treatment; 2) no experience with walking exercise at least six months prior; 3) no difficulties in using smartphone applications; 4) able to download and use the Nike Run Club app, and 5) understood the purpose of the study and consented in writing to participate. The experimental group was selected through convenience sampling and consisted of those who could participate in walking daily during the eight weeks of the study, while the control group was scheduled to receive the same program after the study was completed. The demographic information of the study participants is presented in Table 1.

Table 1: Participant characteristics by demographics at the baseline-evaluation

Characteristics	Walking group $N = 23$	Control group $N = 24$	*p*-value
Categorical variables, N (%)			
Gender			
Male	14 (60.9%)	17 (70.8%)	0.54
Female	9 (39.1%)	7 (29.2%)	
Continuos variables ($M \pm SD$)			
Age	21.96 ± 1.33	22.75 ± 1.51	0.06
Body mass index	24.17 ± 4.65	24.59 ± 6.14	0.79
Internet use (minutes/day)	236.09 ± 96.04	202.75 ± 94.93	0.23
Internet self-efficacy	3.39 ± 0.84	3.50 ± 0.66	0.62
Perceived stress	1.44± 0.60	1.59 ± 0.56	0.41
Positive affectivity	3.03 ± 0.60	2.96 ± 0.72	0.72
Negative affectivity	1.88 ± 0.73	2.15 ± 0.82	0.25

The sample size was estimated to be 20 participants per group, based on a significance level of 0.05, a power of 0.8, two groups, and an effect size of 0.3 using the G*Power 3.1.2 program [33]. However, anticipating 10%–20% dropouts, we selected 23 participants for the experimental group and 24 for the control group.

Three participants in the control group dropped out due to injuries from accidents and failure to respond to the post-evaluation, resulting in a final count of 44 participants.

2.2 Design and Procedures

The objective of this study was to validate its hypothesis that the adoption of an 8-week walking routine would yield a beneficial effect on the mental health of college students. At the commencement and conclusion of the experiment, participants completed a self-administered questionnaire. More specifically, a Google Form survey link was distributed to the participants for completion via personal messaging. In this stage, each participant was provided with an informed consent form and comprehensive information regarding the nature, goals, and objectives of the eight-week experiment. During the subsequent phase, participants were randomly assigned to either the walking group or the control group using a computer-generated randomization sequence. The randomization was conducted by an independent researcher to ensure allocation concealment, thereby minimizing the risk of selection bias. Each participant was assigned a unique ID number prior to the allocation process, and the researchers were blinded to the assignment during the randomization procedure. The walking group participated in a walking regimen facilitated via a physical exercise smartphone application. Participants in the control group were instructed to maintain their usual lifestyle and refrain from participating in any structured physical activity programs during the eight-week study period. Initially, the questionnaire evaluating the outcome variables was completed prior to the commencement of the experiment. At the conclusion of the 8-week trial of the aforementioned walking routine, the same survey was administered.

Throughout the eight-week trial, participant engagement was meticulously monitored. Participants were required to submit photographic evidence of their daily activities. Individuals in the walking group were instructed to complete a minimum of three walking sessions per week, with each session lasting at least 20 min. As a result, participants walked for an average of 25.42 min per session (SD = 0.001). The average walking speed was calculated to be 1.307 m/s (SD = 0.085), and participants completed an average of 2.97 sessions per week (SD = 0.112). These measures ensured adherence to the intervention protocol and allowed for the detailed tracking of deviations from the prescribed program. To ensure consistency, participants were encouraged to maintain a pace of approximately 7–10 min per kilometer, avoiding speeds that would cause them to run or feel breathless. Adherence to the protocol was monitored by reviewing weekly screenshots submitted via the Nike Run Club app. The research team calculated the average number of walking sessions completed per week and tracked any deviations from the prescribed program. To provide the necessary degree of anonymity and adhere to the privacy and confidentiality standards of the study, these entries were submitted using ID numbers. The research team executed the necessary protocols to ensure the confidentiality of the participants' names and adhere to the widely accepted ethical norms of research. A detailed study flowchart is presented in Fig. 1.

This study received authorization from the Hankuk University of Foreign Studies Institutional Review Board (IRB) under reference HIRB-202404-HR-008. All participants signed the informed consent in this study. The study's objectives and methodology were explained to potential participants, and only those who gave written agreement were included. Registered at the Clinical Trials Registry, the study was assigned the ClinicalTrials.gov Identifier KCT0009502.

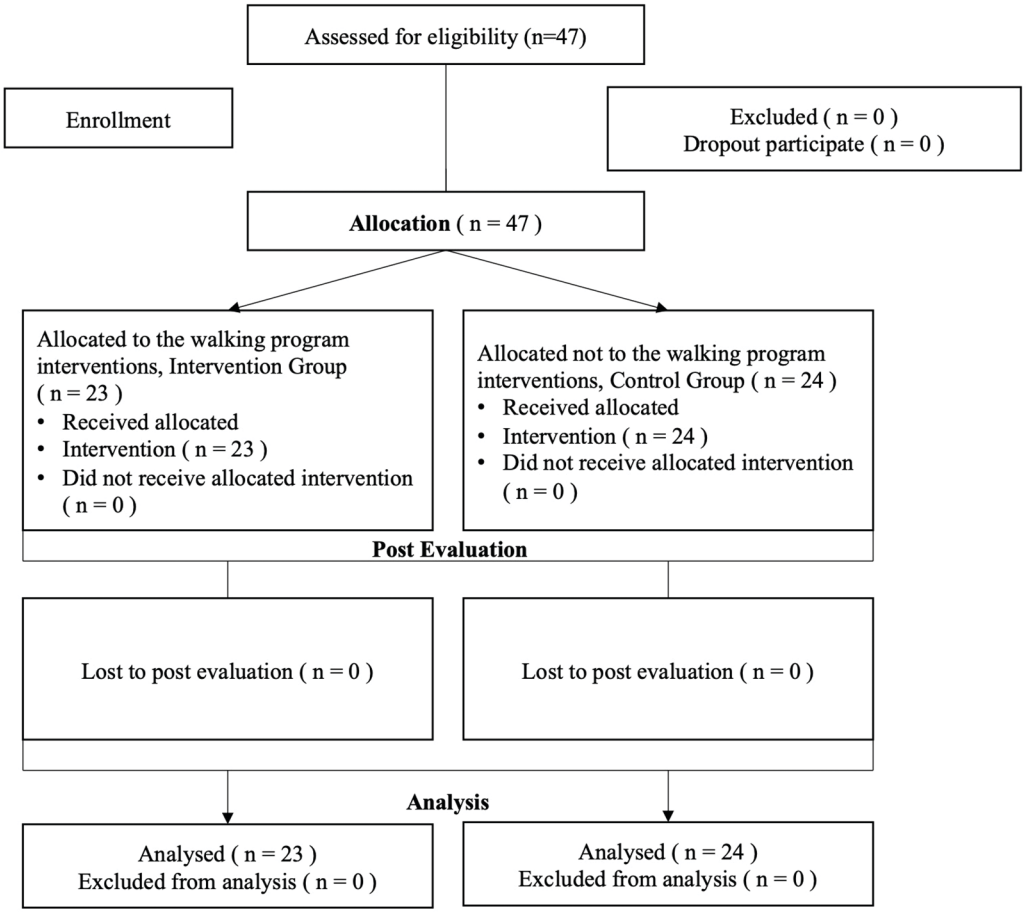

Figure 1: Research flowchart

2.3 Implementation of the Walking Intervention

Participants in the walking group completed a walking regimen overseen and controlled via the Nike Run Club application. The selection of the Nike Run Club application was based on its extensive tracking data and intuitive functionality. The app automatically provides users with real-time data on fundamental parameters, including distance, time, speed, calories expended, changes in elevation, and heart rate. Additionally, the app displays the time taken per kilometer as pace, allowing researchers to assess participants' walking intensity. The primary data gathered for the study included measurements of walking distances and durations. To ensure the accuracy and reliability of the data collected for the study, the participants were directed to capture screenshots of their regular tracking by the system and make them available to the research team.

2.4 Measures

2.4.1 Perceived Stress

We used the Korean version of the Perceived Stress Scale (PSS) [34], a psychological tool developed to specifically measure people's perception of or psychological experiences with stress. The scale is a 10-item measure assessing the degree of unpredictability, lack of control, and overwhelming burden respondents perceive in their lives. Responses were on a 5-point Likert scale ranging from 0 meaning "never" to 4 meaning

"very often"; the total scores thus vary from 0 to 40. It is well known as a reliable instrument for evaluating stress in various populations [35] and this study showed an acceptable Cronbach's alpha of 0.83.

2.4.2 Positive and Negative Affect

We also used the short form of the Positive and Negative Affect Schedule (PANAS) [36]. Specifically, we used the condensed version of this instrument [37], consisting of five items each that effectively quantify both effects. Each item in the scale delineates a positive and negative emotional state, such as being excited or distressed, and the corresponding evaluation comprises assessments of the frequency with which an individual experiences that state during a specific period. The reaction is quantified using a 5-point Likert scale, ranging from 1 indicating just minimal or no presence of the emotion to 5 indicating highly intense emotion. The aggregation of the scores from the five items yields the overall score, which in turn correlates with increased levels of negative affect. It is worth noting that the abbreviated version of the scale has demonstrated acceptable validity and reliability in assessing negative emotional states in previous studies [37] (Cronbach's alpha = 0.75 for positive affect and 0.86 for negative affect) and the current study (Cronbach alpha = 0.77 for positive affect and 0.89 for negative affect).

2.5 Data Analysis

In the current study, several quantitative statistics were computed, relying primarily on SPSS version 25.0 for computational statistics. The analytical procedure was carried out in a series of stages, as outlined below. Initially, descriptive statistics were computed to examine the overall attributes of the two groups. In order to succinctly summarize the demographic information and core variables, the means, standard deviations, and frequency distributions were computed. Secondly, the demographics of the two groups were compared using independent samples *t*-tests to verify the comparability of the two groups prior to the intervention. Furthermore, the efficacy of the therapies was assessed in this study using repeated-measures analysis of variance with a 2 (group: walking program vs. control) × 2 (time: before intervention vs. after intervention) design. Both the main impact of time and group, as well as any potential interaction effect between time and group, on the variables of interest, namely depression, perceived stress, self-esteem, and resilience, were examined. Additionally, we conducted paired-sample *t*-tests following the analysis of variance to do post hoc comparisons of the observed differences.

3 Results

3.1 Verification of Homogeneity of Demographic Characteristics and Dependent Variables between Walking and Control Groups at the Baseline

Prior to the intervention, an independent sample *t*-test was performed to compare the characteristics of the experimental and control groups at the baseline. As can be seen in Table 1, the findings indicated that there were no statistically significant differences between the two groups ($p > 0.05$). Furthermore, the homogeneity test for perceived stress and affect between the experimental and control groups before the intervention indicated no statistically significant differences ($p > 0.05$).

3.2 Effectiveness of the Walking Group Intervention

To investigate the effects of the walking intervention, a 2 (baseline vs. post-test) × 2 (group: walking vs. control) repeated-measures ANOVA was conducted. There was a significant main effect of time on perceived stress ($F(1, 42) = 11.61$, $p = 0.001$, $\eta_{p^2} = 0.22$) and negative affect ($F(1, 42) = 6.00$, $p = 0.019$, $\eta_{p^2} = 0.13$), but not on positive affect ($F(1, 42) = 0.90$, $p = 0.35$, $\eta_{p^2} = 0.02$). Further, the paired sample *t*-test

results for perceived stress and negative affect showed a significant difference between the pre-and post-intervention scores (t(44) = 2.02, p = 0.049 for perceived stress; t(44) = 2.20, p = 0.033 for negative affect) for the intervention group, but not for the control group. In short, after participating in the program, participants' scores for depressive symptoms significantly decreased. However, the paired sample t-test for positive affect did not show a significant difference (t(44) = −1.63, p = 0.28). Further, there were no significant interaction effects between the group and time for perceived stress (F(1, 42) = 3.04, p = 0.09, η_{p^2} = 0.07), positive affect (F(1, 42) = 2.92, p = 0.10, η_{p^2} = 0.07), and negative affect (F(1, 42) = 0.004, p = 0.95, η_{p^2} = 0.001). The results for each group are presented in Fig. 2 and Tables 2 and 3.

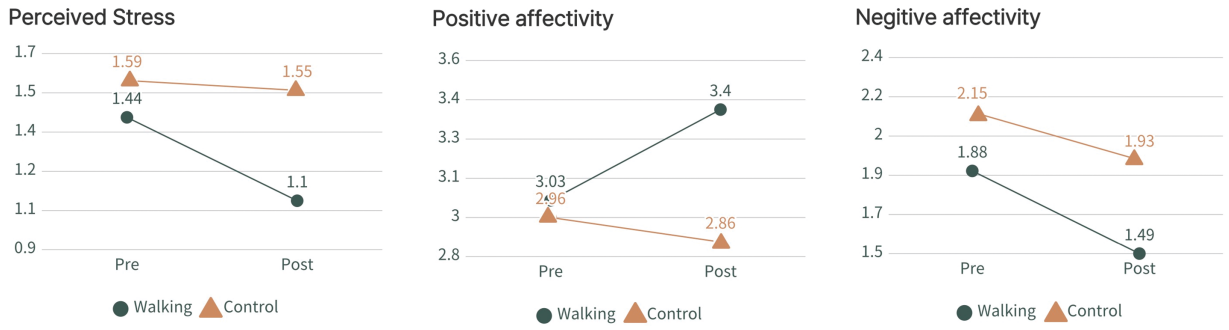

Figure 2: Results from the interaction analysis

Table 2: Comparison of mean score: Baseline vs. post-evaluation for both groups

	Walking Group					Control Group				
	Baseline Mean ± SD	Post Mean ± SD	t-value	p-value	Cohen's D	Baseline Mean ± SD	Post Mean ± SD	t-value	p-value	Cohen's D
Perceived stress	1.44 ± 0.60	1.10 ± 0.52	2.03	0.049*	0.60	1.59 ± 0.56	1.55 ± 0.62	0.19	0.84	0.06
Positive affectivity	3.03 ± 0.60	3.40 ± 0.88	−1.63	0.11	0.49	2.96 ± 0.72	2.86 ± 0.87	0.42	0.67	0.12
Negative affectivity	1.88 ± 0.73	1.49 ± 0.43	2.19	0.033*	0.65	2.15 ± 0.82	1.93 ± 0.62	0.98	0.33	0.30

Note: *$p < 0.05$.

Table 3: 2 × 2 RMANOVA results: investigating main and interaction effects

Variables	df	Time			Time*Group		
		F	p-value	η_p^2	F	p-value	η_p^2
Depression	42	11.61	0.001**	0.22	3.04	0.09	0.07
Perceived stress		0.89	0.35	0.02	2.92	0.10	0.07
Negative affectivity		6.00	0.019*	0.13	0.004	0.95	0.001

Note: *$p < 0.05$, **$p < 0.01$.

4 Discussion

The aim of the current study was to examine the impact of a mobile-based walking intervention on college students' mental health outcomes, specifically perceived stress and affect. The findings of this study demonstrate the benefits of adding walking programs into mental health care as a low-cost and easily accessible way to reduce perceived stress and negative effects over time. Additionally, this study's focus on

mobile-based interventions aligns with modern trends in health promotion that leverage digital tools for increased accessibility and engagement [20].

The significant decrease in perceived stress among members of the walking group is consistent with several studies indicating that regular physical activity is a strategy to safeguard one's body against stress [38,39]. Numerous studies have shown that physical activity can regulate the activity of the hypothalamic-pituitary-adrenal axis in a person suffering from stress [24,40]. It also lowers cortisol levels and increases stress resistance, lowering perceived stress [25]. Most college students face significant stress due to academic demands and new social challenges, often within the constraints of tight schedules [2]. Stress levels may also fluctuate depending on variations in academic schedules, such as experiencing heightened stress during exam periods compared to regular semesters. These fluctuations highlight the dynamic nature of stress in everyday life, influenced by the academic calendar and related responsibilities.

Walking, as a simple and accessible activity, can be considered an effective strategy for managing stress. It requires neither specialized equipment nor extensive time, making it a practical option for students with demanding schedules. By incorporating walking into their routine, college students may find a feasible method to cope with the varying levels of stress encountered throughout their academic journey.

Additionally, this reduction in perceived stress appears to play a key role in mediating improvements in negative affect. Negative affect includes emotions such as anxiety, fear, and distress [36], and it tends to worsen in the presence of chronic stress [41,42]. The walking intervention appears to have contributed to improvements in emotional regulation by alleviating perceived stress, resulting in reduced negative affect scores. This finding highlights the interconnected relationship between stress and negative affect, supporting the concept that physical activity acts as a buffer against both physiological and psychological stressors [43]. Although many scholars have looked into the significant impact of physical activity or exercise on stress in the past, this is the first study that examined walking as a specific type of physical activity that can dramatically reduce stress levels. As a result of its demonstrated capacity to reduce stress, walking may be an accessible strategy that can be quickly integrated into daily routines to reduce stress, particularly for people with limited time or resources.

The significant reduction in negative affect observed in the walking group aligns with previous research that supports the role of physical activity in improving emotional regulation [44]. Negative affect, which encompasses feelings such as distress, fear, and nervousness [36], has been linked to heightened stress levels and diminished mental well-being [45,46]. Physical activity, particularly aerobic exercise such as walking, has been shown to influence neurochemical changes in the brain, such as the release of endorphins and serotonin, which help mitigate feelings of distress and anxiety [26–29]. Walking specifically, as a light form of exercise, promotes emotional regulation by providing a mental break from stressors and allowing individuals to engage in rhythmic and repetitive movements that reduce negative emotional arousal [47]. College students, who are often burdened by academic, social, and financial pressures, may find walking a convenient and low-barrier intervention for reducing negative emotions. The current study extends prior research by demonstrating that walking, even in a relatively short 8-week intervention, can significantly decrease negative effects, making it a feasible option for improving emotional well-being in college populations.

Contrary to expectations, we found no significant improvement in positive affect among the walking group. Positive affect, which involves emotions such as enthusiasm, alertness, and excitement [36], maybe less immediately influenced by light-intensity physical activities like walking. While numerous studies have demonstrated that physical activity can enhance positive emotions and overall mood [48–50], the intensity and duration of the walking intervention in this study were likely insufficient to stimulate the neurochemical changes required for a measurable increase in positive affect.

Specifically, prior research indicates that higher-intensity exercises, such as resistance training, are more effective in enhancing positive affect by stimulating the release of neurotransmitters like dopamine, which are closely associated with reward and pleasure [47]. However, in this study, the lack of significant improvement in positive affect may be attributed to the low-intensity nature of the walking intervention. Additionally, the 8-week intervention period may not have been long enough to produce sustained improvements in positive affect, which often emerge with longer-term physical activity engagement [51].

It is also important to consider the chronic stressors faced by college students, such as academic demands, financial pressures, and social uncertainties [52,53]. These persistent stressors may have limited the ability of a relatively light-intensity intervention to significantly enhance their positive emotional states. Additionally, the lack of significant improvements in positive affect may reflect the unique stress profile of college students, which is characterized by chronic and multifaceted challenges such as academic stress, financial pressures, social stress, and uncertainty about the future [3]. Therefore, achieving significant improvements in positive affect may require addressing these multifaceted factors more comprehensively. A multi-modal approach could effectively tackle both the immediate and underlying causes of reduced positive affect in the college student population. While walking may help alleviate negative emotions and stress, fostering a sustained increase in positive emotions may require more comprehensive interventions that target broader aspects of well-being, such as social connectedness or goal achievement. Future research could explore the combined effects of physical activity with other interventions, such as mindfulness or social support, to determine whether multi-modal approaches can more effectively enhance positive affect.

Practical Implications

The findings of this study provide several key insights that can be translated into practical applications, particularly for healthcare professionals, educators, and policymakers seeking effective interventions to enhance mental health among college students. First, the study underscores the value of integrating walking routines into mental health care programs as a cost-effective and accessible strategy for reducing perceived stress and negative effects. Healthcare providers, especially those in university health centers or community-based mental health services, can incorporate walking interventions into their therapeutic practices. By promoting regular, light-intensity walking as part of mental health care plans, professionals can offer a low-cost, non-pharmacological treatment option for individuals experiencing stress and emotional challenges.

Furthermore, the study's findings can be used by universities to develop student-centered wellness initiatives. At times, high-stress on-campus events (such as finals week) may include a walk as part of an intentional effort to engage students in wellness activities. These programs can be implemented in group settings to give social support while improving mental health results.

Finally, as mobile health modalities become more widely used in healthcare, app developers have the opportunity to capitalize on the potential benefits of this research. Healthcare apps could include elements such as permitting moderate walking routines, tracking how an individual feels internally, and providing immediate feedback on stress levels; all of this may be combined into a single feature. In a broader sense, the research suggests that walking interventions might be scaled up as part of larger public health initiatives focused on improving mental health.

5 Limitations and Future Research Directions

This study, while yielding important insights into the effects of walking and self-affirmation exercises on mental health, is not without limitations. First, the sample size, while adequate for detecting effects, may have limited power to detect more subtle changes, particularly in variables such as positive affect. A larger sample size could provide a more comprehensive understanding of the intervention's effects. Second, the

intervention was only 8 weeks long. It may be the case that longer-duration interventions might be needed to see changes in positive mental health indicators (e.g., positive affect) compared to negative mental health indicators (e.g., perceived stress and negative affect).

Third, the participants in the control group were instructed not to perform any organized Physical Activity, but as their activities were uncontrolled, this could have caused potential confounding variables. It is possible that some of the participants in the control group were informally engaging in some exercises. Future studies may ensure the activities of the control group are monitored more closely to minimize the potential confounding effects.

Further, the low intensity and relatively short duration of the intervention may have limited its ability to generate significant increases in positive effects. Future studies may investigate whether the interventions with longer interventions and higher intensities show greater effects on both positive and negative effects.

Lastly, this study was conducted with a population of college students, who may have unique stressors and mental health challenges. Future research could be expanded to other demographic groups, such as working adults or older populations, to examine the generalizability of the findings. It would also be valuable to investigate the specific mechanisms through which walking and self-affirmation interact to influence mental health, potentially incorporating neurobiological measures or more in-depth qualitative data.

6 Conclusion

In conclusion, this study provides additional evidence that walking has beneficial effects on perceived stress and negative effects among college students. These findings demonstrate the potential of walking as a scalable and cost-effective intervention for improving perceived stress and negative effects in this population. Given its accessibility and simplicity, walking can be incorporated into public health and campus wellness initiatives to promote well-being on a broader scale. Future research should explore longer intervention durations, diverse populations, and higher-intensity exercise programs to gain a deeper understanding of walking's full potential as a mental health intervention.

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Availability of Data and Materials: The data that support the findings of this study are available upon reasonable request.

Ethics Approval: This study was approved by the Hankuk University of Foreign Studies Institutional Review Board (IRB) under reference HIRB-202404-HR-008. All participants signed the informed consent in this study.

Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.

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