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Feasibility of a Digital Mindfulness Intervention for Stress Reduction Among Dental Students: A Pilot Study

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J Fourie,[1] Carla Kotze,[2] Hamza Hendricks,[3] Ahmed Bhayat[4]

ABSTRACT

Objectives

To evaluate the feasibility, uptake and preliminary effects of an app-based mindfulness meditation intervention on perceived stress among undergraduate dental students in South Africa.

Methods

All oral hygiene and 2nd–4th year dentistry students were invited to complete the PSS-10 and participate in an 8-week daily mindfulness practice using the free Medito app. This single-arm pilot captured self-rated stress (0–10), PSS-10 scores, and app usage.

Results

Thirty-one students enrolled (12% response rate), and nine (29%) completed follow-up. Mean self-rated stress decreased from 7.54±1.27 to 5.78±2.11 (non-significant trend), and mean PSS-10 decreased from 25.81±7.96 to 20.33±8.31 (non-significant trend). Adherence was modest (~53 minutes total; ~6 days of practice).

Conclusions

This pilot suggests potential acceptability of app-based mindfulness, but sustained engagement was limited, and reductions were not statistically significant. Larger, controlled studies are required.

Key words

Mindfulness, dentistry, stress, feasibility, pilot study.

Authors Information

1. Jeanine Fourie, Department of Periodontics and Oral Medicine, University of Pretoria. ORCiD: 0000-0002-8674-8145
2. Carla Kotze, Department of Psychiatry, University of Pretoria. ORCiD: 0000-0002-5015-9293
3. Hamza Hendricks, undergraduate dental student, Department of Periodontics and Oral Medicine, University of Pretoria. ORCiD: 0009-0003-8086-0237
4. Ahmed Bhayat, Department of Community Dentistry, University of Pretoria. ORCiD: 0000-0002-8103-1233

Corresponding author:
Jeanine Fourie
Department of Periodontics and Oral Medicine
University of Pretoria, Pretoria, South Africa
Email: jeanine.fourie@up.ac.za

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Jeanine Fourie, Hamza Hendricks and Ahmed Bhayat. The first draft of the manuscript was written by Jeanine Fourie and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

1. INTRODUCTION

Stress is defined as "a state of mental or emotional strain or tension resulting from adverse or demanding circumstances".[1] It represents a fundamental response that enables adaptation to daily challenges. [2] Coping strategies determine an individual's perception of stressors and ultimately affect the mental well-being of a person.[3]

Dental students, both in South Africa and globally, experience significant levels of stress;[4-9] exceeding those reported by medical students.[5]

The annual trend varies among curricula across different faculties, notably intensifying with clinical work.[8] Stress levels fluctuate depending on assessment tools; the Depression, Anxiety and Stress Scale (DASS-21) showed 11% of Australian students had above-normal stress levels,[10] while 56% of UK students, assessed using the PSS, demonstrated high stress levels (considering a PSS score of 20 or greater as 'high stress').[8] Standardising assessment tools is necessary to facilitate comparisons.

Various instruments evaluate stress experience, with the Perceived Stress Score (PSS) most frequently used among health professional students.[11] A recent South African study provided valid psychometric evidence for its reliability across diverse (race and gender) student populations.[12] Stress impacts students' academic performance, causing burnout, mental health issues (including anxiety, depression and psychological distress) and impaired concentration.[7,13] Academic faculties should prioritise preventing and reducing stress among undergraduate students,[5,14] particularly dental students.[15] Mindfulness is a widely used stress management technique,[16] defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding experience moment by moment."[16]

Mindfulness may include formal meditation practice, where the practitioner focuses on sensations of the breath. When the mind wanders, focus is redirected, without judgment, to the breath.[17] Other formal practices include 'mindful walking', 'body scanning' or 'observations of thoughts and emotions'.[18]

Mindfulness practice has shown numerous positive outcomes,[19] including reduced stress, depression and anxiety[20] through improved adaptive coping strategies.[21] It can enhance academic performance by improving focus and productivity through increased concentration and reduced distraction.[18,22] Mindfulness can also mitigate burnout, characterised by emotional, physical, and mental exhaustion leading to decreased motivation among healthcare professionals and students.[19]

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Mindfulness practices can be implemented through online platforms or mobile applications. By 2020, 605 mindfulness-based mobile applications (MBMA) existed in the European market.[23] However, few applications had empirical evidence supporting their efficacy in mindfulness training or health indicators,[24] with only 7 MBMAs tested in randomised controlled trials,[23] despite offering advantages in accessibility, standardisation, personalisation and efficacy [25]. Studies have demonstrated the viability of such cellphone applications to reduce student stress.[26-32] A digital delivery format for mindfulness-based practice may offer practical advantages, flexibility, scalability and low cost, suited to students who face time constraints and variable schedules.

This pilot study assessed the feasibility of an 8-week mindfulness intervention via a smartphone application to alleviate stress in dental students at a South African university focusing on uptake, adherence and preliminary changes in perceived stress.

2. METHODS

A prospective, single-arm, interventional study was conducted among undergraduate dental students at a dental school in South Africa. All undergraduate oral hygiene students, and 2nd- 4th year dentistry students enrolled in 2024 were invited to participate. Recruitment occurred over three weeks from late July to early August 2024. Recruitment used posters, and an introductory lecture. Students were enrolled in a university website module titled "Meditation Challenge". The module page provided an explanation of meditation and study protocol, participant information letter, a link to self-select a unique identification number, links to complete the Perceived Stress Scale (PSS) anonymously (via Qualtrics) and a link to the Medito application and privacy policy. Students received contact information for university emotional support services. The 'meditation challenge' ran for eight weeks, from August 2024 to October 2024.

2.1 Measure

The Perceived Stress Scale (PSS) assessed self-perceived stress levels before and after the study intervention. The PSS evaluates how individuals perceive situations in their lives as stressful. Events in the preceding four weeks may be experienced as unpredictable, uncontrollable or overwhelming; respondents are also asked about feeling stressed. Ten items are rated on a Likert scale from '0' to '4', corresponding to never, almost never, sometimes, fairly often, and very often. The minimum score was 0 and the maximum score 40. Scores were reversed for the positively worded items and summed. While scores are not diagnostic, and Cohen *et al.* (1983) did not establish cut-offs, total scores of 0-13 indicated low stress, 14-26 moderate stress, and 27-40 high perceived stress.

The PSS shows strong internal consistency among university students, with adequate reliability over two-week and four-week periods. It displays construct validity in measuring perceived helplessness and self-efficacy, and convergent validity with stressful life events.[33] The PSS also demonstrates concurrent validity with anxiety and depression.[33]

The pre-intervention questionnaire asked respondents to rate their stress levels and meditation interest, on a scale from 1 to 10, and indicate prior meditation experience. The post-intervention questionnaire asked participants to evaluate their stress levels, report significant life stressors during the eight weeks, and indicate their intention to continue meditation. Participants retrieved their total number of meditation minutes and days from the Medito application.

2.2 Intervention

Participants engaged in mindfulness meditation for 10 minutes daily over 8 weeks using the Medito smartphone application. The Medito application was selected by undergraduate dental students during protocol development due to its free accessibility. This application offers beginner and intermediate meditation courses, daily meditations, offline use, and tracks usage in minutes, sessions, and days completed. The daily meditation sessions are available in various durations, including 10-minute intervals. An introductory course introduces techniques like breathing exercises, walking meditations, and mantra meditations, as well as mindfulness aspects including open awareness, observing the observer, and non-judgment. The application was developed by the Medito Foundation, a non-profit organisation committed to making mindfulness and meditation accessible.

2.3 Data analysis

The data were retrieved from Qualtrics in Excel format, and subsequently exported into Statistical Package for the Social Sciences (SPSS) version 21. All statistical analyses were conducted in SPSS following cleaning of the data. Descriptive statistics summarized uptake and adherence; emphasis was placed on means with 95% confidence intervals rather than p-values. Paired testing results are reported for transparency but interpreted cautiously.

A CONSORT extension checklist for pilot and feasibility trials is provided as supplementary material.

2.4 Ethical approval

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the university where the study was conducted (REC 263/2024). Student participation was voluntary and anonymous, without incentives or consequences for withdrawal. Participants were provided with an information letter detailing the study requirements and gave their informed consent by choosing to participate in the study.

RESULTS

A total of 31 students (among 259 students) enrolled in this study, yielding a response rate of 12%. Five students did not complete the initial assessment, and 9 (34.6%) participants who completed the initial assessment completed the study (attrition 67%). Based on predetermined threshold values of total PSS scores, 13 students (50%) reported high perceived stress levels (PSS > 26), while the remaining 13 students reported moderated perceived stress levels at the study's commencement (PSS 14 – 26). Following the intervention, one student reported high perceived stress, one student reported low perceived stress, and the remainder reported moderate perceived stress.

The mean PSS score decreased from 25.81 ±7.96 to 20.33 ±8.31 (p=0.500), and the mean self-reported stress levels reduced from 7.54±1.27 out of 10 to 5.78±2.11 (p=0.50) post-intervention. These changes were non-significant. The individual stress scores are presented in Figure 1.

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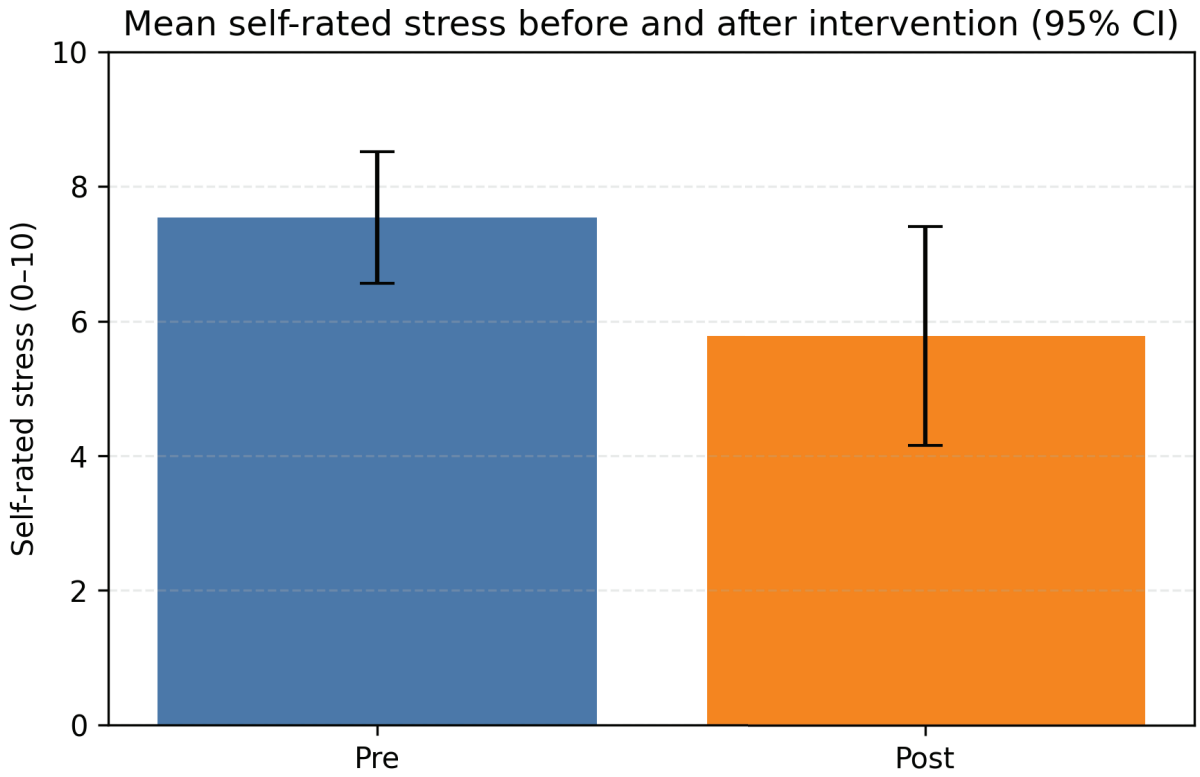

Figure 1 Mean self-rated stress before and after intervention with 95%CI.

Prior to the study, 19 (73%) of the participants scored their interest in meditation as 6 or more out of 10, indicating a high level of interest in learning about meditation. Only 4 students possessed prior meditation experience. Following the study, 6 students expressed their intention to continue using the Medito application.

Adherence was modest (mean duration of meditation sessions = 53 minutes, for 6 days of meditation).

4. DISCUSSION

Studies have investigated mindfulness applications' effects on mental health and perceived stress across populations, including the general public,[34-40] undergraduate students [26-28,30-32], and postgraduate students.[29] Most studies used Headspace,[26,28-30,36-37,39] and were conducted over 30 days or less.[26,28-32,34,36-37]

Among students, mindfulness applications enhanced mood and mindfulness of medical residents [29], and reduced stress among medical [26], and dental students [32], as well as undergraduate students in general, measured by the PSS [27-28,30-31].

4.1 Recruitment and incentives

A total of 31 (12%) dental students participated in this pilot study; only 33 students accessed the introduction page on the website, and merely 5 viewed the TEDx talk on meditation. This sample size is smaller than other studies; yet, a proportional comparison is possible with Yang *et al.* (2018) who also enrolled 12.29% of their undergraduate medical students [26], and Kuhlman *et al.* (2016) who enrolled 21.46% of eligible students [41], though the latter study did not employ a mindfulness app.

Unlike studies by other authors,[28,30-31,35,41] we did not incentivise participation. We did not exclude students with prior meditation experience, as Huberty *et al.* (2019) and Zollars *et al.* (2019) had done,[27,30] which appears unnecessary as it does not influence outcomes,[38] but may risk selection bias.[28] Yang *et al.* (2018) also raised their concern about selection bias, as students perceiving high stress levels are more likely to volunteer, and their volunteers, like ours, expressed a keen interest in meditation.[26] Imposing mindfulness meditation upon all students may be considered unethical and result in resistance to the practice.

In fact, stress-relieving effects of mindfulness programs among healthcare students were by some only shown in studies with voluntary enrolment,[42] suggesting that a receptive environment is necessary for the efficacy of mindfulness interventions.

High stress levels alone are insufficient to motivate students to engage in mindfulness practice.[30] Huberty *et al.* (2019) used high perceived stress as a criterion for participation, potentially exaggerating mindfulness benefits, as a higher initial PSS score predicts greater score changes.[38] Stress is pervasive among our dental students; however, despite being offered a stress management strategy, only a small proportion volunteered, and fewer completed the study.

4.2 Retention

Nine students completed the final assessment, resulting in a 67% attrition rate. This rate is comparable to the 65% attrition rate reported by Kuhlmann *et al.* (2016),[41] yet substantially higher than the 29% reported by Zolllars *et al.* (2019).[30] Remskar *et al.* (2024), using the Medito application across 91 countries, observed a retention rate of 16.2%.[40] In all these studies, participants received monetary incentives, thus, retention cannot be fully attributed to extrinsic rewards. Jayewardene *et al.* (2017) reported that 67% of participants were lost to follow-up in their meta-analysis of randomised controlled trials examining preventive online mindfulness

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interventions on stress [43]. From this, as well as other studies, retention appears to be a significant barrier to the successful delivery of mindfulness meditation interventions.

4.3 Adherence

Following Yang *et al.*'s (2018) methodology,[26] we adopted a non-interventional approach to evaluate students' intrinsic motivation. They reported that 60% of participants downloaded the app and used the application at least once during the study period. They suggested that personal contact after the study's start might have enhanced student motivation.[26] In our study, direct contact with participants was not feasible without compromising anonymity, except for motivational reminders via the LMS announcement. Personal contact should strongly be considered in future studies to improve adherence. Self-reported adherence was relatively low, with students meditating for an average of 53 minutes, or 6 out of 56 (10%) days, significantly less than the 11.97 out of 30 (40%) days reported by Yang *et al.* (2018).[26] Other studies have employed reliable measures of participant adherence,[26-27,30] however, it seems that students accurately represent their meditation efforts[30] and that such measures are not necessary for future studies.

Six (66%) of our students indicated their intention to continue meditating and using the application, whereas Yang *et al.* (2018) found that 72% of the students who used the application continued using it for the subsequent 30 days.[26] Most Calm application users (68%) expressed satisfaction and likelihood of continued use, although their weekly meditation hours decreased by 50% during follow-up.[27] Pharmacology students also perceived meditation as valuable and were likely to pursue it.[30] Nevertheless, Flett *et al.* (2018) observed that despite initial high adherence, when left to use the application at their discretion, only half continued, with no more than 16.4% using it twice or more per week.[28] While most students recognise mindfulness benefits and express intention to continue,[26-27,30] many struggle to establish a consistent practice.[27-28] Thus, overcoming the initial barrier of starting the practice,[26] may be the first challenge; however, establishing a persistent meditation practice may present an even greater challenge.[27-28] Barriers may include the academic load and motivational constraints.

4.4 Baseline stress levels

Students reported moderate to high levels of self-perceived stress, with a mean PSS score of 25.81, and no student scored below 16 at baseline. This score is higher than PSS scores ranging from 16.89 to 20.9 observed among undergraduate students,[26,28,30] and dental students (19.83). [8] Only Huberty *et al.* (2019), who established a PSS score of ≥ 14 as an entry criterion, reported higher PSS scores among control and intervention groups, with scores of 21.88 and 23.11, respectively.[27] This finding warrants investigation into factors contributing to elevated stress levels among our students, and development of interventions to address stress at individual and organisational levels.[19]

4.5 Correlation between adherence and outcome

Evidence indicates no correlation between compliance with app-based meditation protocols and stress-relief benefits among undergraduate students. Neither Zollars *et al.* (2019) nor Flett *et al.* (2019) identified any correlation between adherence levels and changes in PSS scores.[28,30] The study by Zollars *et al.* (2019) was limited in drawing correlations due to most participants showing perfect adherence.[30] While Flett *et al.* (2019) found that increased app usage during discretionary use correlated with improved college adjustment and mindfulness, but it did not affect perceived stress.[28] Bailey *et al.* (2018) showed in a community sample that increased app usage correlated with higher positive affect but not with reduced perceived stress. Each meditation session results in decreased PSS scores, though the effect is not cumulative over time.[31]

The high attrition rates and reduced adherence can be attributed to our study's extended duration, compared to Flett *et al.*'s (2019) 10-day intensive period and other studies' shorter durations,[26,29-30,34,36-37] as well as the long contact-free interval (8 weeks). Initial contact and preliminary data collection should occur early in the study.[26,28-29] However, this pilot study aimed to determine the uptake and sustainability of a self-motivated mindfulness intervention that mimics real-life interest and compliance.

4.6 Limitations

This single-arm pre–post pilot lacked a control group, limiting causal inference. The small, self-selected sample and high attrition reduce generalisability and statistical power. Outcomes relied on self-report and minimal demographic detail was collected to preserve anonymity.

4.7 Future direction

Research shows MBSR practices effectively reduce perceived stress among graduate health science students, without risks and at minimal cost.[42,44-45] Health science faculties should implement MBSR programs to enhance students' and graduates' well-being.[8,44-47] Final-year dental students benefit from stress identification and reduction techniques; however, this education should start earlier in their programme[47] and be reinforced annually.[48]

Optimally, MBSR programs should include a didactic component, guided practices, and practical homework.[44] Experienced instructors can address barriers to mindfulness-based self-help, such as negative thoughts and self-criticism, rather than leaving students to navigate these experiences alone.[49] Programs should align instruction to the student audience, maintaining engagement, and address participants' challenges.[25]

This study proposes that MBMA may be utilised as homework assignments, while addressing low engagement, superficial learning, and unresolved frustrations in class,[25] hopefully reducing high dropout rates and abandoning meditation practice.[42]

5. CONCLUSIONS

App-based mindfulness appears acceptable to some dental students, but sustained engagement was limited. Stress scores decreased numerically, but changes were not statistically significant. Larger, controlled studies with strategies to support adherence are warranted.

DISCLOSURE:

Conflict of Interest declaration: The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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ETHICS

Ethical approval for this study was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (REC 263/2024) and was conducted in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

CONSENT

Student participation was voluntary and anonymous, without incentives or consequences for withdrawal. Participants were provided with an information letter detailing the study requirements and indicated their informed consent by choosing to participate in the study.

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