

DailyCalm, a Malay-Language Mobile Application, for Reducing Perceived Stress among Secondary School Students in Melaka, Malaysia: A School-Based Cluster-Randomized Controlled Study

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ABSTRACT

Objective:

This study aimed to evaluate the effectiveness of DailyCalm, a Malay-language mobile application, in reducing perceived stress among secondary school students in Melaka, Malaysia.

Materials and Methods:

Six secondary schools were randomly allocated to intervention or control groups, with three schools in each group. Students in both groups received a one-hour online stress-management talk, while students in the intervention group were additionally encouraged to use DailyCalm at least twice weekly for eight weeks. Perceived stress was assessed at baseline and 8 weeks using the Malay version of the Perceived Stress Scale-10 (PSS-10).

Results:

A total of 298 students completed both baseline and 8-week assessments, comprising 146 students in the intervention group and 152 in the control group. The median age for both groups was 14.00 (IQR = 3.00) years, with no significant differences in the reported sociodemographic characteristics between groups. The mean frequency of DailyCalm video use over eight weeks was 9.63 (SD 13.04) sessions. In the intervention group, mean PSS-10 scores decreased from 13.60 (SD 5.60) at baseline to 11.38 (SD 5.31) at 8 weeks ($p < 0.001$; $r = 0.49$). In the control group, mean PSS-10 scores decreased from 15.57 (SD 6.53) to 15.20 (SD 6.86), which was not statistically significant ($p = 0.566$; $r = 0.05$). The proportion of students with low perceived stress increased from 46.58% to 65.75% in the intervention group, while the proportion with moderate perceived stress decreased from 50.68% to 32.88%.

Conclusion: DailyCalm was associated with a reduction in perceived stress among secondary school students over the eight-week intervention period. These findings provide preliminary evidence that a brief, Malay-

language mobile intervention may support stress management among adolescents in school settings and warrant further evaluation in larger studies.

Keywords: adolescent, effectiveness, mobile phone, application, stress

INTRODUCTION

Adolescents experience multiple sources of stress, including academic demands, peer relationships, family dynamics, social media exposure, and broader social uncertainties. Globally, approximately 15% of adolescents experience a mental disorder, highlighting the importance of early and preventive approaches to mental health¹. In the ASEAN region, the prevalence of mental disorders among adolescents aged 15 to 19 years increased from 12.2% in 1990 to 13.6% in 2021².

In Malaysia, the National Health and Morbidity Survey (NHMS) 2022 reported a substantial burden of mental health concerns among adolescents. Among secondary school students, 16.2% reported feeling lonely most of the time or always, while 12.9% reported being unable to sleep because of worry. Suicidal ideation, suicidal plans, and suicide attempts were reported by 13.1%, 10.0%, and 9.5% of adolescents, respectively, while 26.9% were screened positive for depression³. These findings highlight the continuing need for accessible and preventive approaches to support adolescent mental health.

Stress during adolescence may be intensified by disruptions to daily routines, school activities, social relationships, and opportunities for face-to-face interaction. During the COVID-19 pandemic, adolescents experienced disruptions in schooling, physical activity, sleep, and social interaction, which may have contributed to stress and unhealthy behaviours during school closures⁴. In Malaysia, adolescents reported disrupted sleep, insufficient physical activity, stress-related fatigue, and unhealthy eating behaviours during the school closures⁵. Some adolescents also adopted negative coping strategies, including internet use, substance use, and escapism^{6,7}. Prolonged or poorly managed stress during adolescence may have consequences for both mental and physical health⁸. Early development of effective stress-management skills is therefore important for promoting resilience and preventing the escalation of stress-related difficulties.

Evidence-based stress-management strategies, including relaxation and deep-breathing techniques, have been shown to reduce perceived stress among adolescents⁹⁻¹². Research on coping with stressful situations has identified different coping responses, including approach, avoidance, and problem-solving, highlighting the importance of developing effective coping strategies¹³. School-based relaxation and stress-management programmes may also support adolescents in developing practical coping strategies for stressful situations^{10,12}. However, adolescents may not consistently have access to structured opportunities to learn and practise these skills. Although mental health information is readily available through internet searches and social media, access to information does not necessarily translate into the acquisition or regular practice of effective stress-management skills. Online information may be fragmented and vary in quality, requiring adolescents to identify, evaluate, and select appropriate information themselves.

The widespread use of digital technology provides an opportunity to deliver structured stress-management support through mobile health (mHealth) interventions. By 2022, approximately 99% of individuals in Malaysia aged below 20 years were internet users, indicating substantial digital reach among younger populations¹⁴. Previous studies have reported beneficial effects of internet- and app-based interventions in reducing stress in young adults and other populations¹⁵⁻¹⁷. Adolescents have also identified safety, engagement, functionality, accessibility, and relevance to their needs as important considerations when using mental health mobile applications¹⁸. A mobile intervention may therefore provide a practical means of bringing evidence-informed stress-management techniques together in a single, accessible platform that adolescents can use at their convenience.

DailyCalm was therefore developed as a structured self-management tool rather than simply an information source, providing brief guided exercises in deep breathing and relaxation in the Malay language through an Android-based mobile application. The initial version of DailyCalm underwent usability and feasibility testing among secondary school students in Kedah and demonstrated promising results¹⁹. Building on this preliminary

evidence of usability and feasibility, this study aimed to evaluate the effectiveness of the second version of DailyCalm, compared with standard stress-management education, in reducing perceived stress among secondary school students in Melaka, Malaysia.

MATERIAL AND METHODS

Study Design and Participants

This was a school-based cluster-randomized controlled study conducted among secondary school students in Melaka, Malaysia, from June to November 2021. The reporting of this study was guided by the CONSORT extension for cluster-randomized trials²⁰. Melaka was selected as the study setting because the research team had established access to secondary schools through collaboration with the State Education Department, which facilitated school recruitment, intervention implementation, and follow-up. The study focused on semi-urban schools to evaluate the feasibility of delivering a mobile-based stress-management intervention in a school setting outside major urban centres. As an initial effectiveness study, the findings were intended to provide preliminary evidence to inform potential wider implementation across different geographical and school settings in Malaysia.

Using a multistage sampling approach, 14 semi-urban co-educational schools with comparable sociodemographic profiles were shortlisted from the State Education Department. In the first stage, six schools were selected using simple randomization. In the second stage, the selected schools were randomly allocated to the intervention group (three schools) or the control group (three schools) using computer-generated randomization. Following school allocation, school counsellors briefed students about the study and invited volunteers to participate. Student recruitment and eligibility assessment were subsequently conducted within the participating schools. Researchers and students were not blinded to group allocation.

Eligibility criteria for students in both groups included Malaysian adolescents aged 13–17 years. Students in Forms 1, 2, and 4 were included, while students in Forms 3 and 5 were excluded because they were preparing for major examinations during the study period. Students in the intervention group were additionally required to have access to an Android device with an internet connection, as DailyCalm Version 2 was an Android-based application that they needed to use throughout the intervention period. They were also required to have access to Telegram for study communication and technical support. These additional two requirements did not apply to students in the control group.

Students from both groups were excluded if parental consent was not obtained, or if they had a chronic illness, a mental health disorder, were actively practising mindfulness, or had used a mobile application for stress management during the preceding four months. Written informed consent from parents or guardians and assent from students were obtained electronically.

Sample Size

Sample size was calculated using G*Power v3.1.9.4 for repeated measures ANOVA with between-group factors, considering two groups (intervention and control) and two time points (baseline and post-intervention). A small effect size ($f=0.21$) was derived from a partial eta squared ($\eta^2=0.042$) reported in a similar study¹⁷. With $\alpha=0.05$ and power=0.95, the minimum required sample was 224 (112 per group). Accounting for an anticipated 20% attrition, the final target was 269 students (approximately 135 per group).

Intervention

Students in the intervention group downloaded DailyCalm Version 2, a Malay-language mobile application collaboratively developed by a Family Medicine Consultant, Clinical Psychologist, and Software Technologist at Universiti Kebangsaan Malaysia. The first version of DailyCalm had undergone usability and feasibility testing among secondary school students in Kedah and demonstrated promising results¹⁹.

The app included sociodemographic and Perceived Stress Scale (PSS-10) questionnaires and two short videos on deep breathing and relaxation therapy. The PSS-10 was selected as the primary measure of perceived stress because the study focused specifically on adolescents' subjective perception of stress rather than on clinical symptoms of depression or anxiety. The PSS-10 assesses the extent to which individuals perceive their lives as unpredictable, uncontrollable and overloaded during the preceding period and is widely used to evaluate perceived stress in research and intervention studies. The PSS-10 is a 10-item questionnaire using a 5-point Likert-type response scale, with higher total scores indicating greater perceived stress²¹. The total score ranges from 0 to 40. In this study, scores were categorised as low (≤ 13), moderate (14–26), and high (27–40). The Malay version has demonstrated acceptable internal consistency, with a Cronbach's alpha of 0.78²¹.

After completing the baseline questionnaire (sociodemographic profiles and PSS-10), students in the intervention group attended a one-hour online talk on stress management (definition, symptoms, impacts, and coping strategies), verified by content experts. Students were encouraged to use the app at least twice weekly for eight weeks, with weekly Telegram reminders. App usage, including frequency of use and video viewing duration, was automatically recorded. At the end of the eight-week, perceived stress levels were reassessed using the Malay PSS-10.

Control

Students in the control group completed the same sociodemographic and PSS-10 questionnaires and attended the same one-hour online stress-management talk but did not have access to the DailyCalm application. At the end of the eight-weeks, they repeated the PSS-10 assessment.

Statistical Analysis

Data were exported from Excel and analysed using IBM SPSS version 26.0. Descriptive statistics were used to summarise sociodemographic and study variables. Categorical data were expressed as frequencies (n) and percentages (%), while continuous data were expressed as mean (SD) or median (IQR), as appropriate. The Mann–Whitney U test was used to compare continuous variables between groups, while the Wilcoxon signed-rank test was used to assess within-group changes in PSS-10 scores. Analyses followed a per-protocol approach and included students who completed both pre- and post-intervention assessments. Similar digital health studies have also adopted a per-protocol approach²². Statistical significance was set at $p < 0.05$.

Ethical Considerations

Ethical approval for the study was obtained from the Research and Ethics Committee (FF-2020-357) of the researchers' institution. Permission to conduct the study was obtained from the Ministry of Education, the State Education Department, and the participating schools. Written informed consent from parents or guardians and assent from students were obtained electronically. Participation was voluntary, and students could withdraw from the study at any time. Students with moderate or high levels of stress were referred to school counsellors and, where indicated, to primary care clinics for further assessment.

RESULTS

Description of Student Recruitment

In the intervention group, 260 students were screened. Of the 174 eligible students, 28 did not complete the post-intervention data (10 were lost to follow-up, 12 uninstalled DailyCalm, and six had incomplete post-questionnaires). A total of 146 students completed both assessments and were included in the analysis (83.9%) (Figure 1).

In the control group, 266 students were screened. Of the 177 eligible students, 25 did not complete the post-intervention data (15 were lost to follow-up and 10 had incomplete post-questionnaires). A total of 152 students completed both assessments and were included in the analysis (85.9%) (Figure 1).

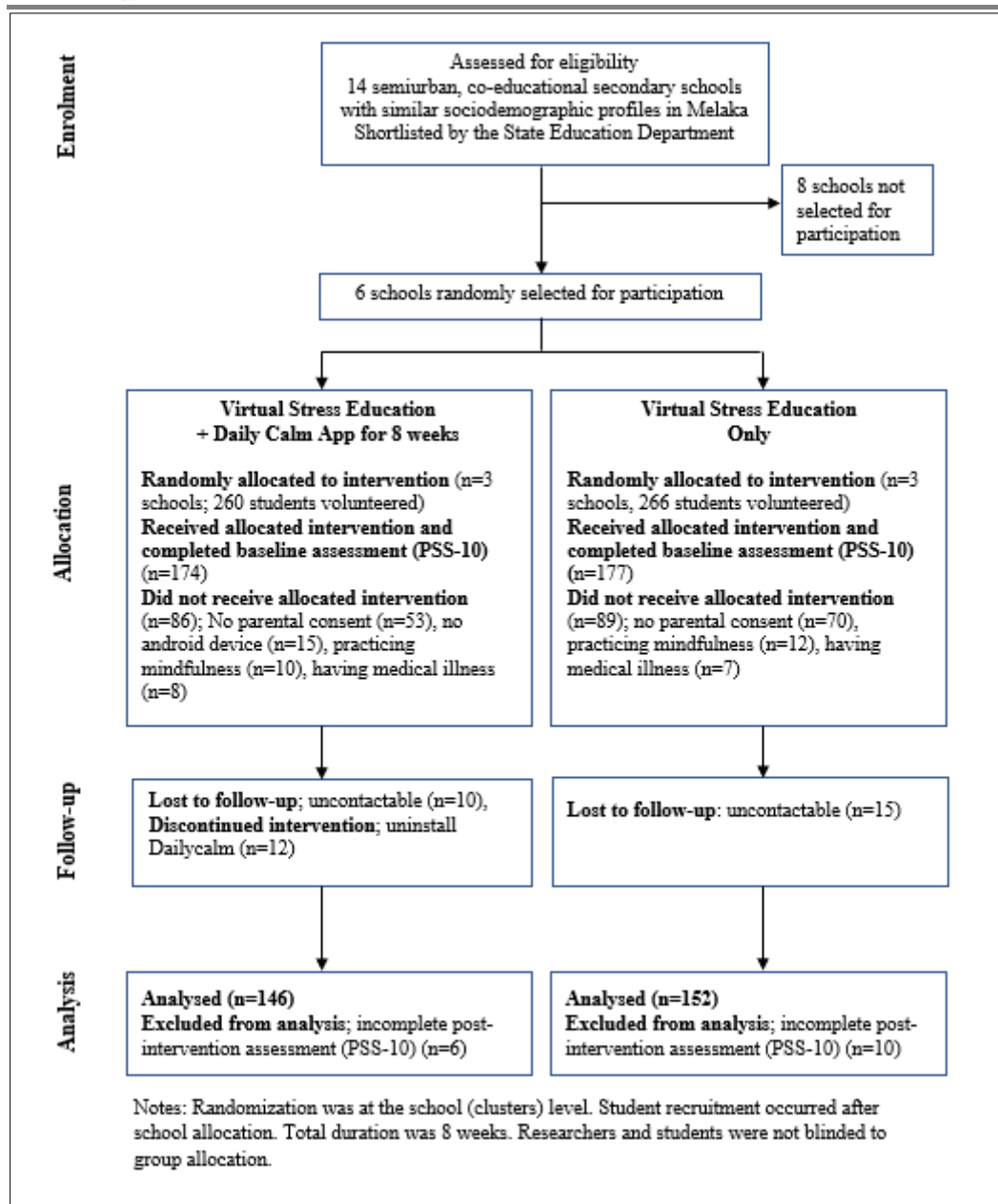


Figure 1. Flow diagram of school randomization, student recruitment, follow-up, and analysis

Students' Sociodemographic Profiles

Table 1 summarizes student characteristics. The median age was 14 years (IQR=3) in both groups. Most were female (n=212, 71.1%) and Malay (n=193, 64.8%). The majority of parents had at least secondary education (fathers: n=287, 96.3%; mothers: n=286, 96.0%) and belonged to middle-income households (n=196, 65.8%). There were no significant sociodemographic differences between intervention and control groups (p-value=0.08–0.74).

Table 1. Sociodemographic profiles of the students (N=298).

Variables		Intervention (n=146)	Control (n=152)	p-value
Age(years), median (IQR)		14.00 (3.00)	14.00(3.00)	0.627
Gender, n (%)	Male	49 (33.56)	37 (24.34)	0.079
	Female	97 (66.44)	115 (75.66)	

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Race, n (%)	Malays	94 (64.39)	99 (65.13)	0.513
	Chinese	37 (25.34)	31 (20.39)	
	Indian	14 (9.59)	19 (12.51)	
	Others	1 (0.68)	3 (1.97)	
Father's highest education, n (%)	Primary	2 (1.37)	5 (3.29)	0.736
	Secondary	82 (56.16)	86 (56.58)	
	Tertiary	60 (41.10)	59 (38.82)	
	None	2 (1.37)	2 (1.31)	
Mother's highest education, n (%)	Primary	2 (1.37)	8 (5.26)	0.160
	Secondary	66 (45.21)	77 (50.66)	
	Tertiary	77 (52.74)	66 (43.42)	
	None	1 (0.68)	1 (0.66)	
Parents' marital status	Married	136 (93.16)	134 (88.16)	0.178
	Divorced	5 (3.42)	13 (8.55)	
	Single parents	5 (3.42)	5 (3.29)	
Household monthly income (RM)	<3000	36 (24.66)	42 (27.63)	0.363
	3000-7000	101 (69.18)	95 (62.50)	
	>7000	9 (6.16)	15 (9.87)	

Baseline stress levels of students in the intervention and control groups

Table 2 shows the comparison of mean PSS-10 scores at baseline between the intervention and control groups. At baseline, the control group had a significantly higher mean PSS-10 score than the intervention group (15.57 [SD 6.53] vs. 13.60 [SD 5.60], $p = 0.011$; $r = 0.15$). However, the distribution of participants across low, moderate, and high perceived stress categories was similar between the groups and did not differ significantly ($\chi^2 = 0.63$, $p = 0.73$; Figure 2).

Table 2. Comparison of the mean (SD) of the PSS-10 score at baseline between the intervention and control groups.

PSS-10 score	Intervention Mean (SD)	Control Mean (SD)	Mann-Whitney U test (z score)	p-value
Baseline	13.60 (5.60)	15.57 (6.53)	-2.554	0.011
Effect size (r)				0.15

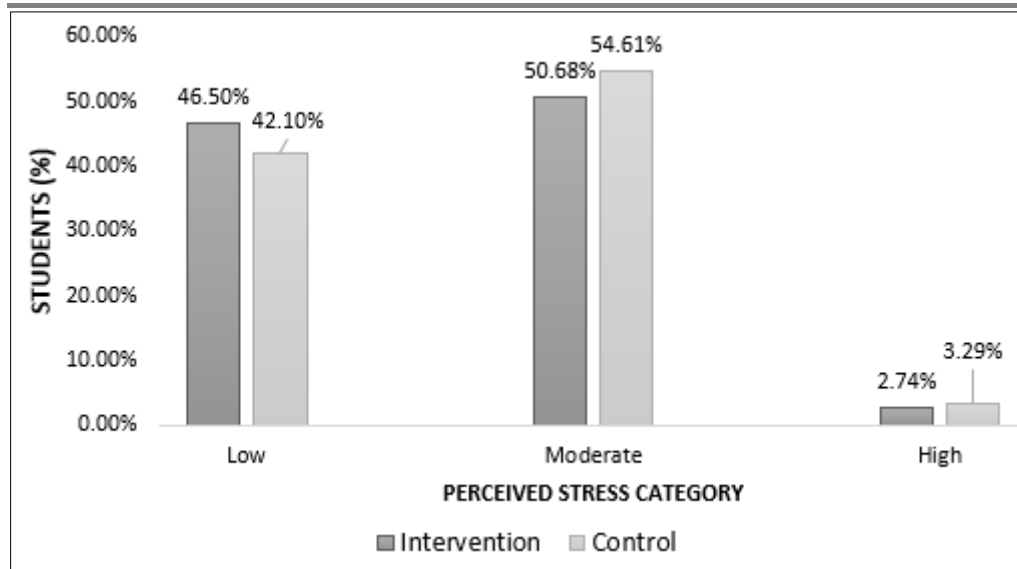


Figure 2. Baseline distribution of perceived stress categories in the intervention and control groups.

Frequency of DailyCalm videos used over 8 weeks

The mean (SD) frequency of DailyCalm video use over the eight-week intervention period was 9.63 (13.04) times, with a minimum of 1 and a maximum of 92 times. This corresponded to an average of approximately 1.2 sessions per week, below the recommended minimum of twice weekly. The duration of video viewing was not analysed because of substantial missing data in the application's monitoring system.

Changes in the PS-10 score from baseline to 8 weeks

Table 3 shows the within-group changes in PSS-10 scores from baseline to 8 weeks. Students in the intervention group demonstrated a significant within-group reduction in mean (SD) PSS-10 score of 2.21 (4.19) points ($p < 0.001$), with a moderate effect size ($r = 0.49$). In the control group, the mean (SD) PSS-10 score decreased by 0.37 (4.19) points, but the within-group change was not statistically significant ($p = 0.566$), with a small effect size ($r = 0.05$).

Table 3. Changes in mean PSS-10 scores from baseline to 8 weeks within the intervention and control groups

PSS-10 score	Intervention group		Change	Control group		Change
	Baseline	8 weeks		Baseline	8 weeks	
Mean (SD)	13.60 (5.60)	11.38 (5.31)	2.21 (4.19)	15.57 (6.53)	15.20(6.86)	0.37(4.19)
z score*	-	-	-5.89	-	-	-0.57
p-value	-	-	<0.001	-	-	0.566
Effect size (r)			0.49			0.05

*Wilcoxon Signed Rank test. Change is baseline score minus 8-week score. Positive values indicate a reduction in perceived stress.

Changes in perceived stress categories from baseline to 8 weeks

Table 4 shows the distribution of perceived stress categories at baseline and 8 weeks in the intervention and control groups. The proportion of students classified as having low perceived stress increased from 46.58% at baseline to 65.75% at 8 weeks in the intervention group, while the proportion with moderate perceived stress

decreased from 50.68% to 32.88%. In the control group, the distribution of perceived stress categories showed little change over the same period.

Table 4. Distribution of perceived stress categories at baseline and 8 weeks in the intervention and control groups

PSS-10 category	Intervention		Control	
	Baseline n (%)	8 weeks n (%)	Baseline n (%)	8 weeks n(%)
Low	68 (46.58%)	96 (65.75%)	64 (42.10%)	62 (40.79%)
Moderate	74 (50.68%)	48 (32.88%)	83 (54.61%)	82 (53.95%)
High	4 (2.74%)	2 (1.37%)	5 (3.29%)	8 (5.26%)

DISCUSSION

This study evaluated the effectiveness of DailyCalm, a Malay-language mobile application, in reducing perceived stress among secondary school students compared with standard stress-management education. The majority of participants were female, and the ethnic distribution was predominantly Malay, followed by Chinese, Indian, and other ethnic groups. There were no significant differences in the sociodemographic characteristics of students between the intervention and control groups, suggesting broadly comparable participant profiles at baseline.

It is noteworthy that more than half of the students reported moderate to high levels of perceived stress at baseline, with 53.42% in the intervention group and 57.89% in the control group. The relatively high levels of perceived stress observed in this study may partly reflect the context in which the data were collected, during the COVID-19 pandemic. A local study conducted among secondary school students in Kedah during the first wave of the COVID-19 pandemic similarly reported that 83.4% of students experienced moderate to high levels of stress¹⁹. Restrictions on movement, disruption of face-to-face classes, reliance on online learning and activities, and reduced opportunities to interact physically with friends and teachers may have contributed to heightened stress among adolescents during this period²³.

Although the schools were randomly allocated to the intervention and control groups, the control group had a significantly higher baseline PSS-10 score than the intervention group. This baseline difference may reflect variations between schools despite random allocation, particularly given the small number of clusters in this study. One of the control schools was a high-performing school, which may have contributed to higher perceived stress among its students, as students in high-achieving schools may experience greater academic and adjustment-related pressures, presenting with internalizing or externalizing symptoms²⁴. Therefore, the baseline difference should be considered when interpreting the changes in perceived stress observed over the intervention period.

The mean frequency of DailyCalm video use over the eight-week intervention was 9.63 (SD 13.04) sessions, equivalent to approximately 1.2 sessions per week, which was below the recommended minimum of twice weekly. Several factors may have contributed to this relatively low level of engagement. Students may have experienced competing demands from online learning during the COVID-19 pandemic, limited internet connectivity, or reduced motivation to continue using the application. Previous studies have similarly reported that lack of interactive features, limited desired functions, data-entry burden, and loss of interest may reduce engagement with health-related mobile applications^{25,26}. Some adolescents may also prefer face-to-face interventions over digital approaches²⁷. In addition, students may have perceived that they had acquired sufficient skills during their initial use of the application and subsequently practised the relaxation and breathing techniques without continuing to access the app²⁶.

Although app use was below the recommended level, students in the intervention group demonstrated a significant reduction in PSS-10 scores over the eight-week intervention period with a moderate within-group effect size ($r=0.49$). In contrast, no significant within-group reduction was observed in the control group. The proportion of students with low perceived stress increased from 46.58% to 65.75% in the intervention group, while the proportion with moderate perceived stress decreased from 50.68% to 32.88%. These findings suggest a potential benefit of DailyCalm in supporting stress management among secondary school students. The reduction in perceived stress is consistent with findings from previous studies of mobile- and internet-based interventions, which have reported potential benefits for stress management¹⁵⁻¹⁷.

An important strength of DailyCalm is its local development and contextual relevance. The application was developed by local researchers and delivered in Malay language, potentially improving accessibility and comprehensibility for Malaysian adolescents. The intervention also builds on earlier usability and feasibility work, providing a logical progression from intervention development to evaluation.

This study has several limitations. Only six schools were included, with three schools allocated to each study group. The original sample-size calculation was based on an individual-level repeated-measures approach and did not account for the design effect associated with cluster randomization. The small number of clusters may also have contributed to baseline imbalance and limits the precision of the findings. Although the schools were randomly allocated, the control group had a significantly higher baseline PSS-10 score than the intervention group, which may have influenced the observed changes in perceived stress. A direct between-group, baseline-adjusted analysis accounting for school-level clustering was not conducted. Such an analysis would have provided a more appropriate estimate of the intervention effect given the cluster-randomized design and baseline difference in PSS-10 scores. The small number of school clusters further limited the ability to account robustly for clustering. Therefore, the observed within-group changes should be interpreted cautiously, particularly given the baseline imbalance between groups. The per-protocol analysis may also have introduced attrition bias because only students who completed both baseline and post-intervention assessments were included. Future studies should include a larger number of schools and incorporate an appropriate cluster design effect in sample-size calculations, with cluster- and baseline-adjusted analyses to provide more robust estimates of intervention effectiveness.

The study was conducted in semi-urban schools in Melaka, which may limit the generalisability of the findings to other settings. Voluntary participation and the requirement for an Android device with an internet connection in the intervention group may also have introduced selection bias and affected group comparability. Detailed school-level characteristics were not collected as study variables, limiting the ability to assess differences between participating schools. Future studies should consider cross-platform applications and alternative delivery modes to improve accessibility.

Form 3 and Form 5 students were excluded because they were preparing for major national examinations during the study period. Although this helped minimise disruption to the intervention and follow-up, it limits the applicability of the findings to examination-year adolescents, who may experience substantial academic stress. Future studies should specifically evaluate DailyCalm in this population. The study also relied on self-reported PSS-10 scores, which may be subject to response bias. Although app usage frequency and video viewing duration were recorded, video viewing duration could not be analysed because of missing entries in the application's monitoring system. Finally, the intervention was evaluated over only eight weeks; therefore, the sustainability of the observed reduction in perceived stress and the longer-term effects of DailyCalm remain uncertain. The study was also not prospectively registered in a clinical trial registry.

CONCLUSION

Providing timely support for adolescents experiencing stress is important for promoting mental health and wellbeing. DailyCalm was associated with a reduction in perceived stress among secondary school students over the eight-week intervention period. These findings provide preliminary evidence that a brief, Malay-language mobile intervention may support stress management among adolescents in school settings. However, the baseline difference in perceived stress between the study groups and the small number of participating schools warrant cautious interpretation of the findings. Future multicentre studies involving a larger number of schools, longer

follow-up, and broader digital accessibility are needed to further evaluate the effectiveness and generalisability of DailyCalm.

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Conflict of Interest

There are no potential conflicts of interest to declare.

Data availability:

The data generated and analysed during this study are not publicly available due to ethical and privacy considerations involving data collected from secondary school students.

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