

Original Paper

A Mobile App for Stress Management in Middle-Aged Men and Women (Calm): Feasibility Randomized Controlled Trial

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Abstract

Background: Middle-aged adults (40-65 years) report higher stress levels than most other age groups. There is a need to determine the feasibility of using a meditation app to reduce stress and improve stress-related outcomes in middle-aged adults with a focus on men, as previous meditation app-based studies have reported a low proportion of or even no male participants.

Objective: This study aims to (1) determine the feasibility (ie, acceptability and demand with a focus on men) of a consumer-based meditation app (Calm), to reduce stress among middle-aged adults reporting elevated stress levels, and (2) explore the preliminary effects of Calm on perceived stress, psychological outcomes (anxiety, depressive symptoms, mindfulness, and general coping), health behaviors (physical activity and eating habits), and COVID-19 perceptions.

Methods: This feasibility randomized controlled trial evaluated an app-based meditation intervention in middle-aged adults (N=83) with elevated stress levels (ie, Perceived Stress Scale score ≥ 15) and limited or no previous experience with meditation. Participants were randomized to the intervention group (Calm app) or a control (educational podcasts; POD) group. Participants completed self-report assessments at baseline and postintervention (week 4). Feasibility was measured as acceptability and demand using Bowen framework. Feasibility and COVID-19 perceptions data were examined using descriptive statistics, and preliminary effects were evaluated using repeated measures analysis of variance.

Results: Participants were satisfied with Calm (27/28, 96%) and found it appropriate or useful (26/28, 93%). Most reported they would likely continue using the Calm app (18/28, 64%). More Calm users reported satisfaction, appropriateness or usefulness, and intent to continue app use than POD users. Calm users (n=33) completed a mean of 20 (SD 31.1) minutes of meditation on the days they meditated and 103 (SD 109.1) minutes of meditation per week. The average adherence rate to the prescribed meditation was 71% among Calm app users, compared to 62% among POD users. Recruitment rate of men was 35% (29/83). Of those randomized to Calm, 55% (15/29) were men, and retention among them was higher (14/15, 93%) than that among women (12/20, 60%). No significant within or between group differences were observed.

Conclusions: A 4-week, app-based mindfulness meditation intervention (Calm) may be feasible for middle-aged adults and a useful stress-management tool. Calm users expressed satisfaction with the app and felt it was appropriate and useful. Significant improvements in perceived stress and psychological outcomes or stress-related health behaviors were not observed. Even though men spent less time in meditation than women did and completed fewer weekly sessions, they were more likely to adhere to the prescription. Further research is needed for improving stress and stress-related outcomes among middle-aged adults with emphasis on the effects of mindfulness meditation apps for men.

Trial Registration: ClinicalTrials.gov NCT04272138; <https://clinicaltrials.gov/ct2/show/NCT04272138>

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KEYWORDS

stress; meditation; mHealth; COVID-19; mobile app; mental health; mindfulness; digital intervention; psychological outcomes

Introduction

Middle-aged adults (40–65 years) [1] report higher stress levels than most other age groups [2,3], with 75% reporting moderate to high stress and 33% reporting extreme stress [4]. Major sources of stress include managing children, employment, and aging parents [5]. In 2020, 78% of middle-aged adults reported the COVID-19 pandemic as a significant source of stress, and 67% reported increased stress during the pandemic [6]. When left unmanaged, stress is a risk factor for age-related chronic health conditions [7].

Meditation is the most prevalent nonpharmacological approach known to reduce stress [8,9]. Meditation interventions of only 5 to 10 minutes for 3 to 4 sessions a week can buffer reactivity to stress [10]. The use of smartphone apps to deliver meditation and manage stress is rapidly increasing [11] owing to their reach, accessibility, and low cost [12–15]. Meditation apps may overcome in-person participation barriers, such as travel, time, costs, stigma, and risk of infectious disease [16–18].

Engagement in health behaviors (eg, physical activity and eating habits) and treatment preferences for stress reduction often differ between men and women [19]. Previous studies on meditation apps have reported a low percentage of men in their samples [20,21], whereas some studies did not include men at all [22–24]. Feasibility and efficacy studies using the meditation app Calm have been conducted [25,26], but this is the first study testing Calm specifically in middle-aged adults with a focus on recruitment of men. There is a need to conduct additional feasibility studies using meditation apps to reduce stress and improve stress-related outcomes in middle-aged men and women [27].

The aims of this study were to (1) determine the feasibility (ie, acceptability and demand with a focus on men) of a

consumer-based meditation app (ie, Calm), to reduce stress in middle-aged adults reporting elevated stress levels, and (2) explore the preliminary effects of Calm on perceived stress, psychological outcomes (ie, anxiety, depressive symptoms, mindfulness, and general coping), health behaviors (ie, physical activity and eating habits), and perceptions of COVID-19.

Methods

Research Design and Participants

This was a randomized controlled feasibility study approved by an institutional review board (STUDY00011219; NCT04272138). Middle-aged adults with elevated stress levels (Textbox 1) were recruited for an “app-based health and well-being study,” via flyers encouraging men to participate shared on social media platforms (eg, Instagram and Facebook) and the *ResearchMatch* website [28]. All participants provided electronic consent. Eligibility, consent, demographic, and survey data were collected using REDCap (Research Electronic Data Capture), a secure, web-based software platform, hosted by Arizona State University [29,30].

Participants were randomized to an app-based meditation intervention (Calm) or an app-based education control group (POD, an app that delivered podcasts on health and well-being, but excluding mindfulness, stress, or sleep content in the same context that a consumer-based mindfulness meditation app delivers content [31]) by using a randomized numbered list generated through simple randomization via the *Research Randomizer* website [32]. Participants were asked to complete 10-minute meditations daily on the Calm app or to listen to 10-minute educational podcasts daily on the POD app, for 4 weeks. All participants received weekly reminders and links to REDCap assessments via email.

Textbox 1. Eligibility criteria for participation in the study.

Inclusion criteria

- man or woman
- age 40–64 years
- report a score of ≥ 15 on the Perceived Stress Scale
- have access to a smartphone on a daily basis
- willing to download the Calm app
- willing to be randomized to a meditation group or a health education podcast control group

Exclusion criteria

- have practiced mindfulness for >60 minutes/month in the last 6 months
- currently using the Calm app or another meditation app
- currently prescribed mood medication(s)
- currently residing outside the United States

Measures

Participants completed self-report assessments at baseline and postintervention (ie, week 4). Feasibility was measured as

acceptability and demand using the Bowen framework (Table 1) [27], and feasibility benchmarks were established using a previously established methodology of feasibility trials with Calm [25,33]. Benchmarks for acceptability were more than

75% of participants reporting each of the following: satisfaction with the intervention, perceiving the app as appropriate and useful, and intent to continue using the app. Benchmarks for demand were more than 40% of the sample comprising male participants, more than 70% of the Calm app user group adhering to at least 70% of the meditation intervention (ie, ≥ 10 minutes/day of using Calm), and more than 75% retention of

men allocated to the intervention group. Adherence was measured using objective app usage data collected by both Calm and POD. The measures used to explore preliminary effects and COVID-19 perceptions are listed in Table 2. The COVID-19 Perceptions Survey was added to the postsurveys in March 2020 following the start of recruitment.

Table 1. Feasibility outcome measures.

Outcome	Measure	Acceptability	Demand	Baseline	Postintervention
Satisfaction	Satisfaction survey	✓			✓
Appropriate and useful	Satisfaction survey	✓			✓
Intent to continue use	Satisfaction survey	✓			✓
Recruitment of men	Demographics survey		✓	✓	✓
Adherence	App usage data		✓	✓	✓
Retention of men	Postintervention surveys		✓		✓

Table 2. Self-reported outcome measures.

Outcome	Measure	Baseline	Postintervention
Demographics	Demographics survey	✓	
Perceived stress	Perceived Stress Scale [34]	✓	✓
Anxiety	Hospital Anxiety and Depression Scale [35]	✓	✓
Depression	Hospital Anxiety and Depression Scale [35]		
Mindfulness	Mindful Attention Awareness Scale [36]	✓	✓
Physical activity	International Physical Activity Questionnaire Short Form [37]	✓	✓
Eating habits	Salzburg Stress Eating Scale [38]	✓	✓
General coping	Brief COPE ^a [39]	✓	✓
COVID-19 perceptions	COVID-19 Perceptions Survey		✓

^aCOPE: Coping Orientation to Problems Experienced (Scale).

Statistical Analysis

Feasibility and COVID-19 perceptions data were examined using descriptive statistics. Preliminary effects on perceived stress, anxiety, depressive symptoms, mindfulness, coping, physical activity, and eating habits were examined using repeated measures analysis of variance. Data were analyzed in SPSS (version 26; IBM Corporation) and SAS (version 9.4; SAS Institute). Results were considered significant at a 2-tailed α value $< .05$.

Results

Overview

In total, 83 middle-aged adults were consented and randomized, of which 60 (72%) were included in the analysis (Figure 1). Demographic characteristics of the sample are presented in Table 3.

Figure 1. Enrollment of participants in the study. Note: Some participants did not meet more than one inclusion criteria. COPE: Coping Orientation to Problems Experienced (Scale); IPAQ: International Physical Activity Questionnaire.

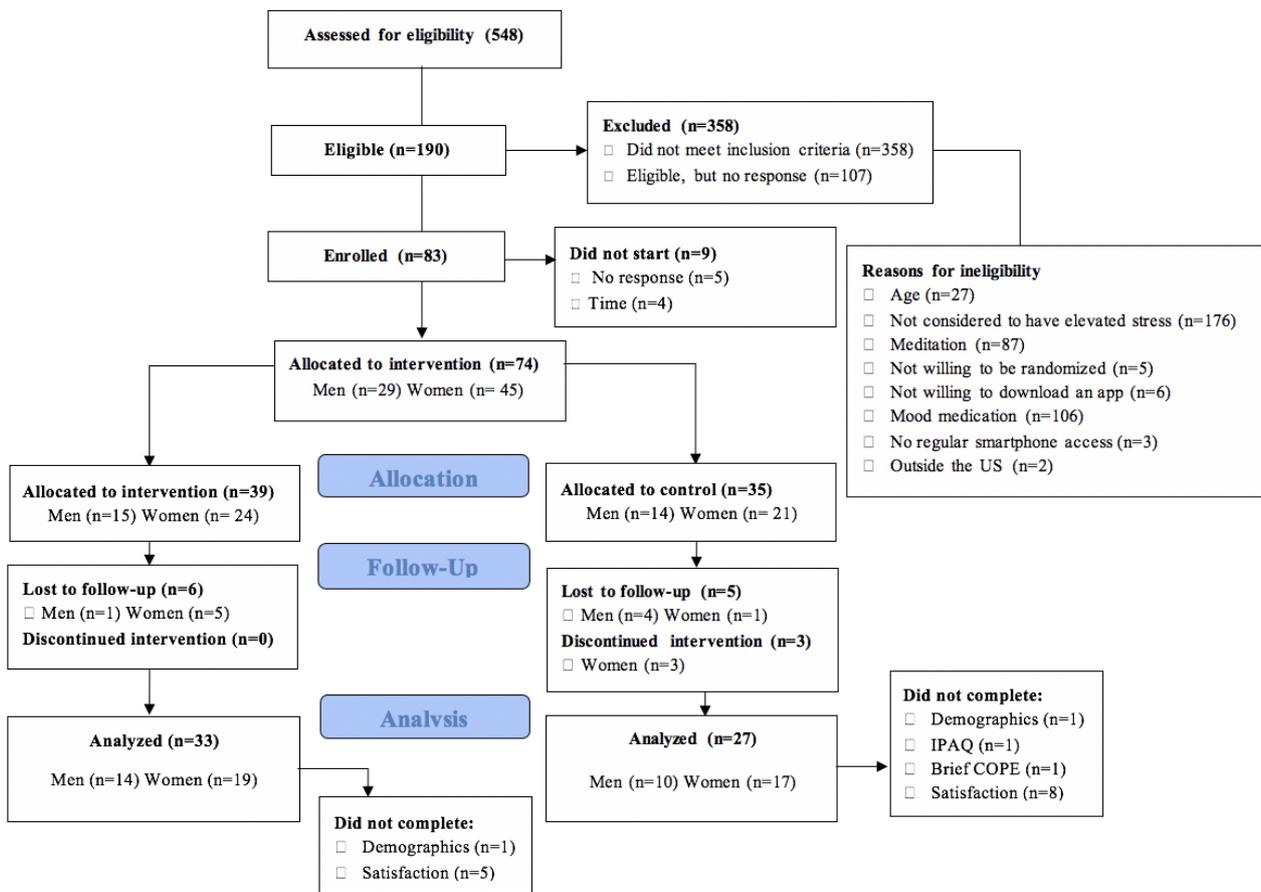


Table 3. Baseline demographics of study participants.

Characteristic	Calm group (n=32) ^a	POD group (n=26) ^a	P value
Age in years, mean (SD)	52.1 (6.7)	50.8 (6.9)	.18
Gender, n (%)			.59
Male	12 (37.5)	8 (30.8)	
Female	20 (62.5)	18 (69.2)	
Education, n (%)			.67
Bachelor's degree or higher	22 (68.7)	20 (76.9)	
Ethnicity, n (%)			.41
Hispanic	3 (9.4)	1 (3.8)	
Non-Hispanic	29 (90.6)	25 (96.2)	
Race, n (%)			.27
White or Caucasian	27 (84.4)	19 (73.1)	
Asian or Asian American	1 (3.1)	0 (0)	
Black or African American	4 (12.5)	7 (26.9)	
Income, n (%)			.57
US \$61,000 or higher	22 (68.8)	16 (61.5)	
US \$60,000 or lower	10 (31.2)	10 (38.5)	
Marital status, n (%)			.41
Married	23 (71.9)	13 (50)	
Single	5 (15.6)	6 (23.1)	
Divorced	2 (6.3)	2 (7.7)	
Partnered	2 (6.3)	4 (15.4)	
Separated	0 (0)	1 (3.8)	
History of PTSD^b, n (%)			.53
Yes	7 (21.9)	4 (15.4)	
No	25 (78.1)	22 (84.6)	
History of depression, n (%)			.60
Yes	8 (25)	5 (19.2)	
No	24 (75)	21 (80.8)	
Health status, n (%)			.11
Excellent	3 (9.4)	2 (7.7)	
Very good	6 (18.8)	11 (42.3)	
Good	14 (43.8)	10 (38.5)	
Fair	8 (25)	1 (3.8)	
Poor	1 (3.1)	2 (7.7)	

^aOne participant did not complete the survey.

^bPTSD: posttraumatic stress disorder.

Feasibility

Acceptability of Calm

Participants were satisfied with the meditation intervention (27/28, 96%) and found it appropriate or useful (26/28, 93%). Most participants reported that they were likely to continue

using Calm in the future (18/28, 64%; [Table 4](#)). There were no notable differences in satisfaction, appropriateness or usefulness, or intent to continue use by gender ([Table 5](#)). More participants in the Calm group reported satisfaction, appropriateness or usefulness, and intent to continue use than in the control group ([Table 4](#)).

Table 4. Acceptability results of the Calm app classified by study group.

Question	Value, n (%)	
	Calm group (n=28) ^a	POD group (n=19) ^b
Overall satisfaction with study	27 (96.4)	10 (52.6)
Participation of the app was appropriate and useful	26 (92.9)	8 (42.1)
Would continue to use the app	18 (64.3)	6 (31.6)
Reduced stress in short term	16 (57.1)	7 (36.8)
Will help reduce stress in long term	19 (67.9)	10 (52.6)
Increased awareness of the importance of addressing stress	23 (82.1)	12 (63.2)
Will help reduce stress in the future	17 (60.7)	4 (21.1)
Likely to recommend the app to others	22 (78.5)	8 (42.1)

^aFive participants did not complete the survey.

^bEight participants did not complete the survey.

Table 5. Acceptability results of the Calm app classified by participants' gender.

Question	Value, n (%)	
	Female (n=19) ^a	Male (n=9) ^b
Overall satisfaction with study	18 (94.7)	9 (100)
Participation of the app was appropriate and useful	18 (94.7)	8 (88.9)
Would continue to use the app	18 (64.3)	14 (73.7)
Reduced stress in the short term	16 (57.1)	10 (52.6)
Will help reduce stress in the long term	15 (79)	4 (44.4)
Increased awareness of the importance of addressing stress	15 (78.9)	8 (88.9)
Will help reduce stress in the future	19 (100)	8 (88.9)
Likely to recommend the app to others	22(78.5)	16(84.2)

^aFive participants did not complete the survey.

^bEight participants did not complete the survey.

Demand of Calm (Adherence, Recruitment of Men, and Retention of Men)

Calm participants (n=33) completed a mean of 20 (SD 31.1) minutes of meditation on the days they meditated, and a mean of 103 (SD 109.1) minutes of meditation per week during the study (Figure 1). On average, the adherence rate was 71% in the Calm group (ie, those who completed at least 70% of the meditation prescription) to the prescribed meditation, compared to 62% in the POD group. Men (n=14) completed a mean of 17.3 (SD 14.6) minutes of meditation per day (on the days they meditated), 79 (SD 37.9) minutes of meditation per week, and

8.5 (SD 5.7) meditation sessions per week during the study. Women (n=19) completed a mean of 21.5 (SD 31.1) minutes of meditation per day, 113 (SD 126.6) minutes of meditation per week, and 6.3 (SD 2.7) meditation sessions per week. Men showed greater adherence (12/14, 86%) to the Calm app than did women (12/19, 63%; Figures 2-4).

Recruitment rate of men into the study (before excluding those who were randomized and had completed baseline but did not start the study, those who dropped out, or those who did not complete the study) was 35% (29/83). Of those randomized to the Calm app, 55% (15/29) were men. Retention among men was higher (14/15, 93%) than that among women (12/20, 60%).

Figure 2. Average meditation time (in minutes) per week.

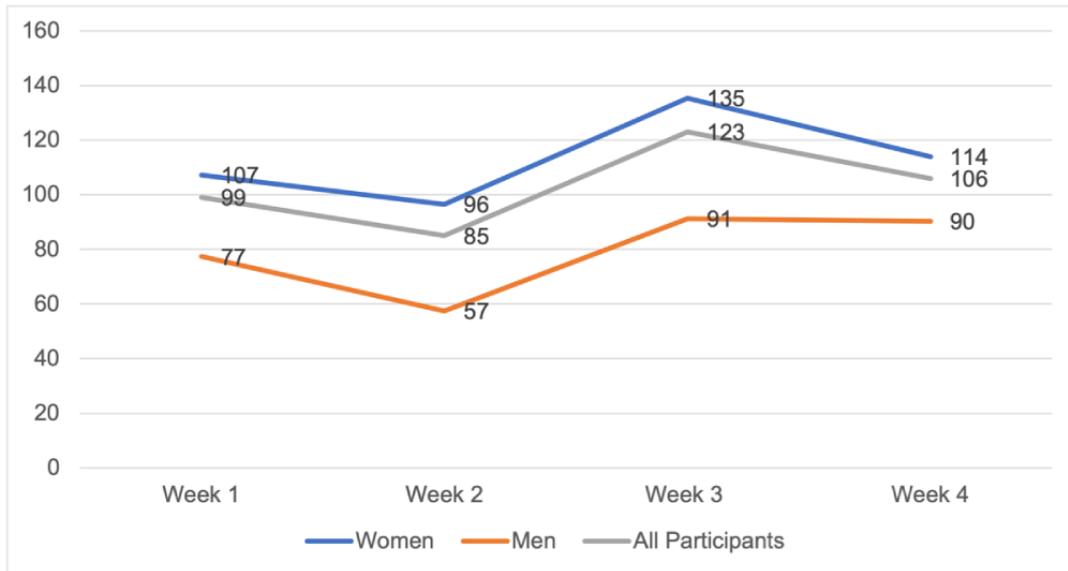


Figure 3. Average daily meditation time (in minutes) by gender.

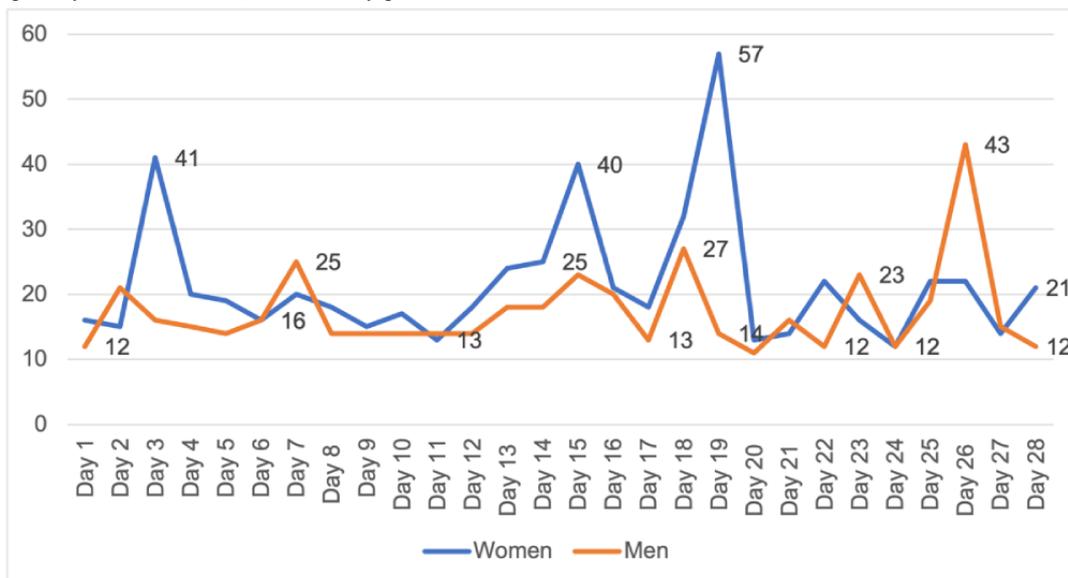
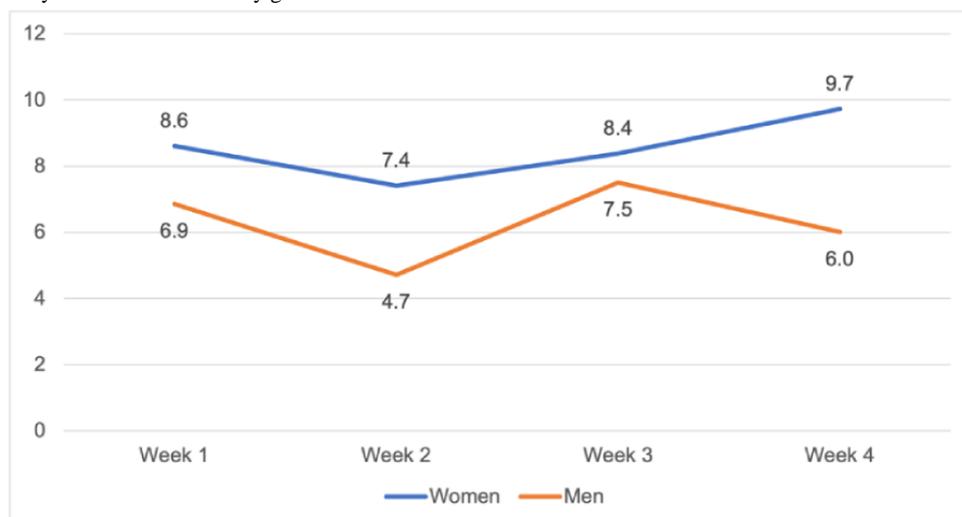


Figure 4. Average weekly meditation sessions by gender.



Stress and Related Outcomes

No significant within or between group differences in stress or

psychological outcomes related to stress were observed, nor were significant differences observed in health behaviors related to stress (Table 6).

Table 6. Pre- and postintervention values for outcome measures.

Variable	Calm group (n=33), mean (SD)	<i>t</i> test (<i>df</i> =32)	<i>P</i> value	POD group (n=27), mean (SD)	<i>t</i> test (<i>df</i> =26)	<i>P</i> value	<i>F</i> test (<i>df</i> =58)	<i>P</i> value
Stress (PSS^a)		1.8	.58		-0.2	.82	0.3	.86
Preintervention	19.2 (7.3)			18.8 (8.0)				
Postintervention	19.9 (8.1)			19.1 (6.4)				
Anxiety (HADS^b)		-0.3	.77		-1.7	.10	2.2	.28
Preintervention	8.8 (4.3)			7.2 (2.8)				
Postintervention	8.9 (4.4)			8.2 (3.5)				
Depression (HADS)		-0.6	.58		-2.1	.04	7.1	.47
Preintervention	5.8 (3.4)			4.5 (3.4)				
Postintervention	6.5 (3.5)			5.7 (3.9)				
Mindfulness (MAAS^c)		1.9	.07		1.0	.32	4.1	.55
Preintervention	56.6 (14.0)			59.9 (10.3)				
Postintervention	53.7 (13.6)			58.3 (10.3)				
Physical Activity (IPAQ^d)		1.5	.13		-0.6	.56	1.1	.44
Preintervention	706.9 (383.1)			753.9 (335.6) ^e				
Postintervention	637.2 (315.6)			766.4 (396.4) ^e				
Eating Habits (SSES^f)		-1.9	.07		0.1	.95	1.9	.15
Preintervention	28.8 (9.6)			29.7 (8.5)				
Postintervention	31.6 (10.7)			29.6 (8.8)				
Coping (Brief COPE^g)		1.2	.23		1.5	.16	3.3	.98
Preintervention	64.8 (9.2)			64.8 (9.3) ^e				
Postintervention	62.8 (12.1)			62.7 (8.9) ^e				

^aPSS: Perceived Stress Scale.

^bHADS: Hospital Anxiety and Depression Scale.

^cMAAS: Mindful Attention Awareness Scale.

^dIPAQ: International Physical Activity Questionnaire.

^eOne POD participant did not complete the survey.

^fSSES: Salzburg Stress Eating Scale.

^gCOPE: Coping Orientation to Problems Experienced (Scale).

COVID-19 Survey

Most participants in Calm reported that the COVID-19 pandemic affected their stress levels (26/28, 93%), mental health (23/28, 82%), and physical health (17/28, 61%) (Table 7).

Table 7. COVID-19 survey results.

Question	Value, n (%)	
	Calm group (n=28) ^a	POD group (n=23) ^b
Pandemic has affected stress	26 (92.9)	22 (95.7)
Pandemic has affected mental health	23 (82.1)	20 (87)
Pandemic has affected physical health	17 (60.7)	17 (73.9)
Perception of personal risk to be high	5 (17.9)	3 (13)
Perception of personal risk to be higher than others in the United States	4 (14.3)	3 (13)
Ability to prevent contracting COVID-19 is high	11 (39.3)	11 (47.8)
Ability to prevent contracting COVID-19 is higher than others in the United States	9 (32.1)	12 (52.2)
Ability to prevent contracting COVID-19 is higher than other infectious diseases	5 (17.9)	7 (30.4)
Personally worried about contracting COVID-19	22 (78.6)	20 (86.9)
Worried about a family member contracting COVID-19	26 (92.9)	22 (95.7)
Worried about the spread of COVID-19	24 (85.7)	22 (95.7)

^aFive participants did not complete the survey.

^bFour participants did not complete the survey.

Discussion

Principal Findings

A 4-week, app-based mindfulness meditation intervention (ie, Calm app) may be feasible for use among middle-aged adults. Calm group participants expressed satisfaction with the intervention and felt it was appropriate and useful. However, significant improvements in perceived stress and psychological outcomes (ie, anxiety, depressive symptoms, mindfulness, and general coping) or health behaviors related to stress (ie, physical activity and eating habits) were not observed among these participants. The majority of participants reported that COVID-19 has negatively affected their stress, mental health, and physical health.

Feasibility of Calm

We exceeded our benchmark (>75%) for acceptability rating of the Calm app among middle-aged adults experiencing stress. This finding was similar to that of other studies assessing the feasibility of Calm in patients with cancer and among college students [25]. Our benchmark for adherence to the meditation prescription (ie, >70% of the sample who completed at least 70% of the meditations) was met and better than most 4-week randomized controlled trials using an app to reduce stress [13,23,40]. Men had a higher adherence to the intervention than women (86% vs 71%), but this finding is not entirely consistent with other studies and does not necessarily suggest overall gender differences in meditation app use [41,42]. Research on app-based interventions targeting stress reduction and related outcomes, including objective app-usage data in middle-aged men, is warranted.

Our benchmark was to recruit 40% men, and we recruited 35% men (29/83) in our study. We were able to recruit more men than other app-based meditation studies (5.7%-27%), including studies that focused on middle-aged adults [21,25,43-46]. The retention of men (14/15, 93%) was also higher than that of

women (19/24, 60%). Although, on average, men spent less time meditating than women did (approximately 57-91 vs 107-135 min/week) and completed fewer weekly sessions (4.7-7.5 vs 7.4-9.7 sessions/week), they were more likely to adhere to the 10-minute prescription. This finding suggests that Calm may be a useful self-management tool for both men and women to manage stress [21,44,45]. Future app-based meditation interventions should focus on recruitment and retention of men, especially because men are less likely to seek stress management strategies than women [47,48].

Stress and Health-Related Behaviors

Significant changes in stress and related psychological outcomes or health behaviors were not observed. In another study testing the efficacy of meditation delivered via Calm, changes in stress and mindfulness in college students were observed after 8 weeks of participation. When taken together with these findings, the present data suggest that any significant changes in stress levels may take longer than 4 weeks to be noticeable [25].

Few studies have tested the effects of app-based mindfulness meditation on health behaviors related to stress [49] and have reported inconsistent findings [23,40,50,51]. We observed a negative trend regarding physical activity and eating habits. These may, however, have been related to lifestyle modifications due to the COVID-19 pandemic (eg, quarantine and closure).

Perceptions of COVID-19

Perceptions of COVID-19 could have had an important impact on stress in relation to the findings of this study. It is possible that meditation helped the study participants in the intervention group to maintain their stress and anxiety levels, as well as depressive symptoms (as opposed to elevated levels), during the COVID-19 pandemic [52]. Likewise, the general health education content of the control app may have helped mitigate the impact of the pandemic through avoidance or redirecting negative thoughts [53]. However, data regarding how participants felt their app usage impacted their

COVID-19–related stress was not measured. More research on the effects of COVID-19 on stress and related health outcomes and how a meditation app may buffer that impact is warranted.

Limitations

Limitations to this study include the following: (1) the majority of the sample comprised White participants, and generalizability of the findings may thus be limited; (2) the intervention was only 4 weeks long and did not include a follow-up; and (3) the

COVID-19 pandemic may have had a notable impact on the findings of this study.

Conclusions

This study supports the feasibility of a 4-week, mobile app–based mindfulness meditation intervention (ie, Calm) in middle-aged men and women with specific application for the recruitment of men to inform future studies.

Conflicts of Interest

None declared.

Multimedia Appendix 1

CONSORT-eHEALTH checklist (V 1.6.1).

[\[PDF File \(Adobe PDF File\), 842 KB-Multimedia Appendix 1\]](#)

References

1. Oyama H, Sakashita T. Effects of universal screening for depression among middle-aged adults in a community with a high suicide rate. *J Nerv Ment Dis* 2014 Apr;202(4):280-286. [doi: [10.1097/NMD.000000000000119](https://doi.org/10.1097/NMD.000000000000119)] [Medline: [24647214](https://pubmed.ncbi.nlm.nih.gov/24647214/)]
2. Almeida DM, Charles ST, Mogle J, Drewelies J, Aldwin CM, Spiro A, et al. Charting adult development through (historically changing) daily stress processes. *Am Psychol* 2020 May;75(4):511-524 [FREE Full text] [doi: [10.1037/amp0000597](https://doi.org/10.1037/amp0000597)] [Medline: [32378946](https://pubmed.ncbi.nlm.nih.gov/32378946/)]
3. American PA. Stress in America: The State of Our Nation. In: American Psychological Association. Washington, DC: American Psychological Association; 2017.
4. Stress Research. The American Institute of Stress. URL: <https://www.stress.org/stress-research> [accessed 2021-08-01]
5. Erickson M. Study looks at stress in middle age. The American Institute of Stress. 2020 Jul 17. URL: <https://www.stress.org/study-looks-at-stress-in-middle-age> [accessed 2022-04-28]
6. Stress in America 2020: A National Mental Health Crisis. Washington, DC: American Psychological Association; 2020.
7. Keyes CLM. Chronic physical conditions and aging: Is mental health a potential protective factor? *Ageing International* 2005 Dec;30(1):88-104. [doi: [10.1007/bf02681008](https://doi.org/10.1007/bf02681008)]
8. Blewett L, Rivera DJ, Griffin R, King M, Williams K. IPUMS Health Surveys: National Health Interview Survey, Version 6. IPUMS 2017 Jan 01:1-1.
9. Sieverdes JC, Adams ZW, Nemeth L, Brunner-Jackson B, Mueller M, Anderson A, et al. Formative evaluation on cultural tailoring breathing awareness meditation smartphone apps to reduce stress and blood pressure. *Mhealth* 2017 Oct 19;3:44-44 [FREE Full text] [doi: [10.21037/mhealth.2017.09.04](https://doi.org/10.21037/mhealth.2017.09.04)] [Medline: [29184896](https://pubmed.ncbi.nlm.nih.gov/29184896/)]
10. Creswell JD. Mindfulness Interventions. *Annu Rev Psychol* 2017 Jan 03;68(1):491-516. [doi: [10.1146/annurev-psych-042716-051139](https://doi.org/10.1146/annurev-psych-042716-051139)] [Medline: [27687118](https://pubmed.ncbi.nlm.nih.gov/27687118/)]
11. Neary M, Schueller SM. State of the field of mental health apps. *Cogn Behav Pract* 2018 Nov;25(4):531-537 [FREE Full text] [doi: [10.1016/j.cbpra.2018.01.002](https://doi.org/10.1016/j.cbpra.2018.01.002)] [Medline: [33100810](https://pubmed.ncbi.nlm.nih.gov/33100810/)]
12. Duraimani S. A Cross-sectional and longitudinal study of the effects of a mindfulness meditation mobile application platform on reducing stress and anxiety. *Int J Yoga* 2019;12(3):226. [doi: [10.4103/ijoy.ijoy_56_18](https://doi.org/10.4103/ijoy.ijoy_56_18)]
13. Flett JAM, Hayne H, Riordan BC, Thompson LM, Conner TS. Mobile mindfulness meditation: a randomised controlled trial of the effect of two popular apps on mental health. *Mindfulness* 2018 Oct 31;10(5):863-876. [doi: [10.1007/s12671-018-1050-9](https://doi.org/10.1007/s12671-018-1050-9)]
14. Price M, Yuen EK, Goetter EM, Herbert JD, Forman EM, Acierno R, et al. mHealth: a mechanism to deliver more accessible, more effective mental health care. *Clin Psychol Psychother* 2014;21(5):427-436 [FREE Full text] [doi: [10.1002/cpp.1855](https://doi.org/10.1002/cpp.1855)] [Medline: [23918764](https://pubmed.ncbi.nlm.nih.gov/23918764/)]
15. Singh P. Unhooking the Drama: Meditation App Statistics to Know in 2020. *appinventiv* 2021 Jan 22:1-1.
16. Editorial. The health crisis of mental health stigma. *The Lancet* 2016 Mar;387(10023):1027. [doi: [10.1016/s0140-6736\(16\)00687-5](https://doi.org/10.1016/s0140-6736(16)00687-5)]
17. Thornicroft G, Mehta N, Clement S, Evans-Lacko S, Doherty M, Rose D, et al. Evidence for effective interventions to reduce mental-health-related stigma and discrimination. *The Lancet* 2016 Mar;387(10023):1123-1132. [doi: [10.1016/s0140-6736\(15\)00298-6](https://doi.org/10.1016/s0140-6736(15)00298-6)]
18. Heber E, Ebert DD, Lehr D, Nobis S, Berking M, Riper H. Efficacy and cost-effectiveness of a web-based and mobile stress-management intervention for employees: design of a randomized controlled trial. *BMC Public Health* 2013 Jul 15;13:655 [FREE Full text] [doi: [10.1186/1471-2458-13-655](https://doi.org/10.1186/1471-2458-13-655)] [Medline: [23855376](https://pubmed.ncbi.nlm.nih.gov/23855376/)]

19. Liddon L, Kingerlee R, Barry JA. Gender differences in preferences for psychological treatment, coping strategies, and triggers to help-seeking. *Br J Clin Psychol* 2018 Mar 09;57(1):42-58. [doi: [10.1111/bjc.12147](https://doi.org/10.1111/bjc.12147)] [Medline: [28691375](https://pubmed.ncbi.nlm.nih.gov/28691375/)]
20. Krusche A, Cyhlarova E, Williams JMG. Mindfulness online: an evaluation of the feasibility of a web-based mindfulness course for stress, anxiety and depression. *BMJ Open* 2013 Nov 29;3(11):e003498 [FREE Full text] [doi: [10.1136/bmjopen-2013-003498](https://doi.org/10.1136/bmjopen-2013-003498)] [Medline: [24293203](https://pubmed.ncbi.nlm.nih.gov/24293203/)]
21. Hwang WJ, Jo HH. Evaluation of the effectiveness of mobile app-based stress-management program: a randomized controlled trial. *Int J Environ Res Public Health* 2019 Nov 03;16(21):4270 [FREE Full text] [doi: [10.3390/ijerph16214270](https://doi.org/10.3390/ijerph16214270)] [Medline: [31684169](https://pubmed.ncbi.nlm.nih.gov/31684169/)]
22. Jones DR, Lehman BJ, Noriega A, Dinnel DL. The effects of a short-term mindfulness meditation intervention on coping flexibility. *Anxiety Stress Coping* 2019 Jul 30;32(4):347-361 [FREE Full text] [doi: [10.1080/10615806.2019.1596672](https://doi.org/10.1080/10615806.2019.1596672)] [Medline: [30929458](https://pubmed.ncbi.nlm.nih.gov/30929458/)]
23. Rung AL, Oral E, Berghammer L, Peters ES. Feasibility and acceptability of a mobile mindfulness meditation intervention among women: intervention study. *JMIR Mhealth Uhealth* 2020 Jun 02;8(6):e15943 [FREE Full text] [doi: [10.2196/15943](https://doi.org/10.2196/15943)] [Medline: [32442147](https://pubmed.ncbi.nlm.nih.gov/32442147/)]
24. Coelho CC, Tobo PR, Lacerda SS, Lima AH, Barrichello CRC, Amaro E, et al. A new mental health mobile app for well-being and stress reduction in working women: randomized controlled trial. *J Med Internet Res* 2019 Nov 07;21(11):e14269 [FREE Full text] [doi: [10.2196/14269](https://doi.org/10.2196/14269)] [Medline: [31697244](https://pubmed.ncbi.nlm.nih.gov/31697244/)]
25. Huberty J, Green J, Glissmann C, Larkey L, Puzia M, Lee C. Efficacy of the mindfulness meditation mobile app “Calm” to reduce stress among college students: randomized controlled trial. *JMIR Mhealth Uhealth* 2019 Jun 25;7(6):e14273 [FREE Full text] [doi: [10.2196/14273](https://doi.org/10.2196/14273)] [Medline: [31237569](https://pubmed.ncbi.nlm.nih.gov/31237569/)]
26. Huberty JL, Green J, Puzia ME, Larkey L, Laird B, Vranceanu A, et al. Testing a mindfulness meditation mobile app for the treatment of sleep-related symptoms in adults with sleep disturbance: A randomized controlled trial. *PLoS One* 2021 Jan 7;16(1):e0244717 [FREE Full text] [doi: [10.1371/journal.pone.0244717](https://doi.org/10.1371/journal.pone.0244717)] [Medline: [33411779](https://pubmed.ncbi.nlm.nih.gov/33411779/)]
27. Bowen DJ, Kreuter M, Spring B, Cofta-Woerpel L, Linnan L, Weiner D, et al. How we design feasibility studies. *Am J Prev Med* 2009 May;36(5):452-457 [FREE Full text] [doi: [10.1016/j.amepre.2009.02.002](https://doi.org/10.1016/j.amepre.2009.02.002)] [Medline: [19362699](https://pubmed.ncbi.nlm.nih.gov/19362699/)]
28. ResearchMatch. URL: <https://www.researchmatch.org/> [accessed 2022-02-17]
29. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009 Apr;42(2):377-381 [FREE Full text] [doi: [10.1016/j.jbi.2008.08.010](https://doi.org/10.1016/j.jbi.2008.08.010)] [Medline: [18929686](https://pubmed.ncbi.nlm.nih.gov/18929686/)]
30. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, REDCap Consortium. The REDCap consortium: building an international community of software platform partners. *J Biomed Inform* 2019 Jul;95:103208 [FREE Full text] [doi: [10.1016/j.jbi.2019.103208](https://doi.org/10.1016/j.jbi.2019.103208)] [Medline: [31078660](https://pubmed.ncbi.nlm.nih.gov/31078660/)]
31. Huberty J, Eckert R, Puzia M, Laird B, Larkey L, Mesa R. A novel educational control group mobile app for meditation interventions: single-group feasibility trial. *JMIR Form Res* 2020 Jul 21;4(7):e19364 [FREE Full text] [doi: [10.2196/19364](https://doi.org/10.2196/19364)] [Medline: [32706719](https://pubmed.ncbi.nlm.nih.gov/32706719/)]
32. Research Randomizer. URL: <https://www.randomizer.org/> [accessed 2022-02-27]
33. Huberty J, Eckert R, Larkey L, Kurka J, Rodríguez De Jesús SA, Yoo W, et al. Smartphone-based meditation for myeloproliferative neoplasm patients: feasibility study to inform future trials. *JMIR Form Res* 2019 Apr 29;3(2):e12662 [FREE Full text] [doi: [10.2196/12662](https://doi.org/10.2196/12662)] [Medline: [31033443](https://pubmed.ncbi.nlm.nih.gov/31033443/)]
34. Khalili R, Sirati Nir M, Ebadi A, Tavallai A, Habibi M. Validity and reliability of the Cohen 10-item Perceived Stress Scale in patients with chronic headache: Persian version. *Asian J Psychiatr* 2017 Apr;26:136-140. [doi: [10.1016/j.ajp.2017.01.010](https://doi.org/10.1016/j.ajp.2017.01.010)] [Medline: [28483077](https://pubmed.ncbi.nlm.nih.gov/28483077/)]
35. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale. *J Psychosom Res* 2002 Feb;52(2):69-77. [doi: [10.1016/S0022-3999\(01\)00296-3](https://doi.org/10.1016/S0022-3999(01)00296-3)]
36. Brown K, Ryan R. Mindfulness Attention Awareness Scale (MAAS). *J Pers*. Published online 2003 Jan 01:822-848.
37. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003 Aug;35(8):1381-1395. [doi: [10.1249/01.MSS.0000078924.61453.FB](https://doi.org/10.1249/01.MSS.0000078924.61453.FB)] [Medline: [12900694](https://pubmed.ncbi.nlm.nih.gov/12900694/)]
38. Meule A, Reichenberger J, Blechert J. Development and preliminary validation of the Salzburg Stress Eating Scale. *Appetite* 2018 Jan 01;120:442-448. [doi: [10.1016/j.appet.2017.10.003](https://doi.org/10.1016/j.appet.2017.10.003)] [Medline: [28986162](https://pubmed.ncbi.nlm.nih.gov/28986162/)]
39. Yusoff N, Low W, Yip C. Reliability and validity of the Brief COPE Scale (English version) among women with breast cancer undergoing treatment of adjuvant chemotherapy: a Malaysian study. *Med J Malaysia* 2010 Mar;65(1):41-44 [FREE Full text] [Medline: [21265247](https://pubmed.ncbi.nlm.nih.gov/21265247/)]
40. Champion L, Economides M, Chandler C. The efficacy of a brief app-based mindfulness intervention on psychosocial outcomes in healthy adults: A pilot randomised controlled trial. *PLoS One* 2018 Dec 31;13(12):e0209482 [FREE Full text] [doi: [10.1371/journal.pone.0209482](https://doi.org/10.1371/journal.pone.0209482)] [Medline: [30596696](https://pubmed.ncbi.nlm.nih.gov/30596696/)]
41. Guo X, Han X, Zhang X, Dang Y, Chen C. Investigating m-health acceptance from a protection motivation theory perspective: gender and age differences. *Telemed J E Health* 2015 Aug;21(8):661-669. [doi: [10.1089/tmj.2014.0166](https://doi.org/10.1089/tmj.2014.0166)] [Medline: [25919800](https://pubmed.ncbi.nlm.nih.gov/25919800/)]

42. Plaza García I, Sánchez CM, Espílez ÁS, García-Magariño I, Guillén GA, García-Campayo J. Development and initial evaluation of a mobile application to help with mindfulness training and practice. *Int J Med Inform* 2017 Sep;105:59-67. [doi: [10.1016/j.ijmedinf.2017.05.018](https://doi.org/10.1016/j.ijmedinf.2017.05.018)] [Medline: [28750912](https://pubmed.ncbi.nlm.nih.gov/28750912/)]
43. Howells A, Ivtzan I, Eiroa-Orosa FJ. Putting the 'app' in happiness: a randomised controlled trial of a smartphone-based mindfulness intervention to enhance wellbeing. *J Happiness Stud* 2014 Oct 29;17(1):163-185. [doi: [10.1007/s10902-014-9589-1](https://doi.org/10.1007/s10902-014-9589-1)]
44. Krusche A, Cyhlarova E, Williams JMG. Mindfulness online: an evaluation of the feasibility of a web-based mindfulness course for stress, anxiety and depression. *BMJ Open* 2013 Nov 29;3(11):e003498 [FREE Full text] [doi: [10.1136/bmjopen-2013-003498](https://doi.org/10.1136/bmjopen-2013-003498)] [Medline: [24293203](https://pubmed.ncbi.nlm.nih.gov/24293203/)]
45. Mak WW, Tong AC, Yip SY, Lui WW, Chio FH, Chan AT, et al. Efficacy and moderation of mobile app-based programs for mindfulness-based training, self-compassion training, and cognitive behavioral psychoeducation on mental health: randomized controlled noninferiority trial. *JMIR Ment Health* 2018 Oct 11;5(4):e60 [FREE Full text] [doi: [10.2196/mental.8597](https://doi.org/10.2196/mental.8597)] [Medline: [30309837](https://pubmed.ncbi.nlm.nih.gov/30309837/)]
46. Cavanagh K, Strauss C, Cicconi F, Griffiths N, Wyper A, Jones F. A randomised controlled trial of a brief online mindfulness-based intervention. *Behav Res Ther* 2013 Sep;51(9):573-578. [doi: [10.1016/j.brat.2013.06.003](https://doi.org/10.1016/j.brat.2013.06.003)] [Medline: [23872699](https://pubmed.ncbi.nlm.nih.gov/23872699/)]
47. Mayor E. Gender roles and traits in stress and health. *Front Psychol* 2015;6:779 [FREE Full text] [doi: [10.3389/fpsyg.2015.00779](https://doi.org/10.3389/fpsyg.2015.00779)] [Medline: [26106354](https://pubmed.ncbi.nlm.nih.gov/26106354/)]
48. Cohen S, Janicki-Deverts D. Who's stressed? Distributions of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *J Appl Soc Psychol* 2012 Feb;1320-1334. [doi: [10.1111/j.1559-1816.2012.00900.x](https://doi.org/10.1111/j.1559-1816.2012.00900.x)]
49. Strowger M, Kiken LG, Ramcharran K. Mindfulness meditation and physical activity: evidence from 2012 National Health Interview Survey. *Health Psychol* 2018 Oct;37(10):924-928. [doi: [10.1037/hea0000656](https://doi.org/10.1037/hea0000656)] [Medline: [30234351](https://pubmed.ncbi.nlm.nih.gov/30234351/)]
50. Firth J, Torous J, Nicholas J, Carney R, Rosenbaum S, Sarris J. Can smartphone mental health interventions reduce symptoms of anxiety? A meta-analysis of randomized controlled trials. *J Affect Disord* 2017 Aug 15;218:15-22 [FREE Full text] [doi: [10.1016/j.jad.2017.04.046](https://doi.org/10.1016/j.jad.2017.04.046)] [Medline: [28456072](https://pubmed.ncbi.nlm.nih.gov/28456072/)]
51. Economides M, Martman J, Bell MJ, Sanderson B. Improvements in stress, affect, and irritability following brief use of a mindfulness-based smartphone app: a randomized controlled trial. *Mindfulness (N Y)* 2018 Mar 1;9(5):1584-1593 [FREE Full text] [doi: [10.1007/s12671-018-0905-4](https://doi.org/10.1007/s12671-018-0905-4)] [Medline: [30294390](https://pubmed.ncbi.nlm.nih.gov/30294390/)]
52. Green J, Huberty J, Puzia M, Stecher C. The Effect of Meditation and Physical Activity on the Mental Health Impact of COVID-19-Related Stress and Attention to News Among Mobile App Users in the United States: Cross-sectional Survey. *JMIR Ment Health* 2021 Apr 13;8(4):e28479 [FREE Full text] [doi: [10.2196/28479](https://doi.org/10.2196/28479)] [Medline: [33788698](https://pubmed.ncbi.nlm.nih.gov/33788698/)]
53. Zimmer-Gembeck M, Skinner E. The development of coping: implications for psychopathology and resilience. Volume Four. Risk, Resilience, and Intervention. In: *Developmental Psychopathology*. Hoboken, NJ: John Wiley & Sons, Inc; Feb 10, 2016.

Abbreviations

RedCap: Research Electronic Data Capture

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