
What is mindfulness?
Mindfulness is paying attention to the present moment with openness, curiosity and without judgment.

Effects of a mindfulness app on employee stress: results of a randomised controlled trial in an Australian public sector workforce

Background: Workplace-based mindfulness programs (WMPs) have good evidence for improving employee stress and mental health outcomes, but less is known about effects on employee productivity and citizenship behaviours. Most of the evidence for WMPs is derived from randomised controlled trials (RCTs) of programs that use in-person or online class-based approaches. Mindfulness apps have potential to increase access to training for distributed workforces, but whether self-directed app use is sufficient to realise benefits equivalent to WMPs that include classes is unknown.

Objective: This study primarily aimed to assess the effectiveness of a mindfulness app, both with and without supporting classes, for reducing employees' perceived stress. Changes in mindfulness, mental health, quality of life, perceptions of job demand, control and support, productivity indicators, organisational citizenship and mindful behaviours at work were also investigated.

Methods: Employees of the Tasmanian State Service workforce were invited by the Tasmanian Training Consortium to join a three-arm RCT investigating the effects of a mindfulness app on stress. Expressions of interest and surveys were conducted online. The app used in the Smiling Mind Workplace Program (SMWP) formed the basis of the intervention. The app has 43 elements, including lessons, activities and guided meditations, and is supported by four instructional emails delivered over eight weeks. Engagement with the app for 10-20 minutes, five days a week was recommended. Reported data were collected at baseline (T0), three-months from baseline (T1) and six-months follow-up (T2). At T0 participants could nominate a work-based observer to answer some questions about the participant's behaviours. Eligible participants (n=211) were randomly assigned to self-guided app use plus four one-hour classes (App+, n=70), self-guided app use (App-only, n=71), or wait-list control (WLC, n=70). Linear mixed effects models were used to assess changes in the two active groups compared with the WLC at T1, and for head-to-head comparison of the App+ and App-only groups at follow-up.

Results: App engagement by the App+ group (35%) and App-only group (13%) was considerably lower than recommended. Compared with the WLC at T1, no significant change in perceived stress was observed in either active group. However, the App+ group reported lower psychological distress (β= -1.77, SE=0.75, *P*=.02, d=0. -21) and higher mindfulness (β=0.31, SE=0.12, *P*=.01, d=0.19). These beneficial effects were retained in the App+ group at six-months. No significant changes were observed for the App only group, or for the other study outcomes. Compared with the WLC at T1, observers reported no significant changes, however, at T2 the App+ participants were more noticeably mindful and altruistic at work than App-only participants.

Conclusions: Including classes in the training protocol appears to have motivated engagement and led to benefits, while self-guided app-use did not realise any significant

results. Effect sizes were smaller and less consistent than meta-analytic estimates for class-based mindfulness training.

Trial Registration: ANZCTR Ref: 12617001386325

Keywords: mindfulness, stress, apps, smart-phone application, employee, workplace, performance

--

Introduction

There is growing evidence in support of workplace-based mindfulness programs (WMPs) for increasing employee mindfulness, reducing stress and improving mental health and wellbeing [1, 2]. In the workplace literature, mindfulness correlates positively with psychological capital, organisational citizenship and perceived job control, and inversely with perceived job demands [3-5]. Accordingly, it is theorised that increasing employee mindfulness through training may help protect against stress, poor mental health and work-based psychosocial risks. However, few randomised controlled trials (RCTs) have examined intervention effects of WMPs on psychosocial risk factors or organisational outcomes such as employee productivity or performance [1].

Unmanaged stress is known to lead to psychological distress, depression and anxiety [6, 7], which are well evidenced contributors to lost productivity via higher levels of employee absenteeism and presenteeism [8]. In Australia, the combined annual cost of absenteeism and presenteeism attributable to poor mental health is over $11 billion, representing a significant economic burden [9]. Furthermore, consequences of chronic stress include inattentiveness and antisocial or aggressive behaviour that can be detrimental to work-based relationships and performance [10].

The occupational health psychology and workplace management literature points to the importance of considering factors that impact employee stress at both organizational and individual levels [11]. A combined focus on minimising work-related risk factors for mental health problems, promoting positive aspects of work and fostering employee strengths, and providing tertiary supports to address presenting problems is considered best practice [12]. While redressing adverse working conditions and improving management practices are vital components of workplace wellbeing strategies, supporting staff to access and develop personal coping strategies is also an important aspect of a healthy work environment [13]. Mindfulness training can provide personal support for employees because it actively cultivates adaptive coping skills that can buffer the effects of stress on employee health and wellbeing [14, 15]. It may also help redress the organisational burden of health-related lost productive time by improving mental health [16].

Mindfulness meditation involves the sustained practice of intentionally applying non-judgmental attention to current experience. There is some evidence that this practice improves attentional capacities [17], prosocial acting [18], and qualities that influence interpersonal relationships such as gratitude and forgiveness [19]. Aggression has also been

shown to reduce following mindfulness training [20]. Amassing evidence does suggest that increasing mindfulness through training can improve workplace performance, relationships and wellbeing [21, 22].

Smart-phone applications (apps) are an increasingly popular and accessible mode of delivery for mindfulness training and practice [23]. App functionality enables high quality multi-media delivery of learning content that can be entirely pre-programmed to maximise intervention integrity and support self-guided learning [24]. For behavioural research, apps also have the ability to record engagement and usage data. These data offer a more accurate measure of program engagement than participant recall, which is often used in mindfulness studies [25].

According to a review of 23 mindfulness apps against the Mobile Application Rating Scale [MARS; 26], the top four were Headspace, Smiling Mind, iMindfulness and Mindfulness Daily [23]. Mani's review noted an absence of RCT evidence for the efficacy of mindfulness apps. Several trials of mindfulness apps have since been published, reporting results for stress, anxiety, depression and wellbeing [e.g. 27, 28-32]. Only one of these RCTs was conducted in a workforce sample [27] in which self-guided use of the Headspace app gave rise to significant small- to moderate-sized effects for wellbeing, anxiety, depression and psychosocial risk factors: job control and social support. This study thus supports the potential for an app-based WMP to positively influence job-related and affect-related variables associated with employee stress [33, 34]. However, effects of app-based WMPs have not yet been assessed for changing employee stress appraisals, chronic stress symptomology or for organisational performance outcomes such as productivity, citizenship behaviours and social interactions [21, 22].

The current study examines the efficacy of an app-based, low-dose WMP in a large, geographically and occupationally diverse Australian public service workforce. The trial followed an earlier pilot RCT of a five-week Mindfulness at Work Program (MaWP) within the same workforce [35]. The MaWP involved five 90-minute in-person classes and prescribed 20 minutes' daily meditation practice. Results of the pilot showed strong effects for stress reduction, mental health and wellbeing but no significant improvements in health-related productivity. In-person class attendance in work time was found to be unfeasible for a high proportion of employees, due to scheduling and geographical barriers. The current study was conceived to examine if low-dose mindfulness training using a mindfulness app could overcome accessibility challenges and realise the beneficial outcomes for employee stress observed in the face-to-face program. The app that underpins the Smiling Mind Workplace Program (SMWP) [36] was selected, as it is already established in the Australian market and was ranked highly against the MARS criteria [23].

The primary aim for the current study was to assess the efficacy of the SMWP App offered both with, and without supporting classes, for reducing employee stress (Aim 1). We hypothesised that employees using the SMWP App in conjunction with a series of four one-hour classes (App+ group) or using the SMWP App self-guided, without supporting classes (App-only group), would each report a consistent moderate sized reduction in perceived stress when compared with a wait-list control (WLC group).

Secondary aims were to explore the effects of this low-dose mindfulness intervention on psychological distress, mindfulness, health-related quality of life, perceived job demands, control and resources (Aim 2); changes in health-related lost productive time (Aim 3); and observer-reported changes in participants' organisational citizenship and mindful behaviours (Aim 4). Effect retention was also investigated (Aim 5).

Methods

A three-arm open label parallel group RCT was conducted between February 2018 and April 2019. The study was approved by the University of Tasmania Health and Medical Human Research Ethics Committee (Ref: H0016587) and registered with the Australian and New Zealand Clinical Trials Register in February 2018 (Ref: 12617001386325). Baseline data were collected using online surveys administered during February 2018 (T0). Post-intervention surveys were conducted three-months from baseline, in May 2018 (T1), with six-month follow-up in July 2018 (T2). App usage data were obtained at T1 and T2. The active intervention groups completed their training between T0 and T1. The control group were invited to access the intervention between T1 and T2. A further data collection wave was conducted 14 months from baseline (T3), but analyses were not conducted due to high (85%) attrition (data not reported).

Participants

The study sample was drawn from the Tasmanian State Service (TSS). The TSS employs approximately 18,000 people in 18 service agencies and centres across the island state of Tasmania, Australia. TSS employees work in a wide variety of roles (e.g. front-line service, professional, administration, information and asset management and maintenance). An invitation was widely disseminated via email and staff newsletters to express interest in joining a study of app-based mindfulness training for employee stress protection (Appendix 1: Supplementary materials). The Tasmanian Training Consortium (TTC), which provides TSS staff development and training services, coordinated invitation dissemination and collated responses.

Participants needed to have access to a smart-phone of any brand for personal use, permission from their supervisor to attend four one-hour seminars in person or via video-conference and to make a commitment to complete the surveys. Eligibility was assessed after baseline, based on no concurrent mindfulness or stress-management program of any type, including the use of other mindfulness apps, and not having unmanaged depression or other mental health condition that might be exacerbated with unsupervised meditation. Mental health eligibility was assessed using baseline survey data for the Patient Health Questionnaire [PHQ-9; 37] and two questions about current and past mental health diagnoses. If respondents indicated a current or previously diagnosed mental health condition or their PHQ-9 score exceeded 15, indicating moderate to severe depression symptoms, their study eligibility was subject to review by a registered psychologist.

In the baseline surveys (T0), respondents were asked if they wished to nominate a work-based observer to join the study, to answer some questions about the participant's behaviours at work. If "yes" was selected, the first name and email address of the nominee was entered, and the observer was invited to complete brief surveys about their observations of their paired participant's behaviours at each of the study timepoints.

Randomisation, blinding and consent

An independent statistician (PO) randomised eligible participants to the three groups, stratified by whether or not they had an observer. Group allocations were sent to the TTC, who notified participants of their training schedule and coordinated the seminars. It was not feasible to blind the TTC staff, study participants or teacher to treatment [38]. All data were collected online using surveys administered using REDCap [39]. The Checklist for Reporting the Results of Internet e-Surveys [40] study is included in Supplementary materials. Research personnel only interacted with randomised participants by email to administer the online surveys, and all analyses were conducted on de-identified data. Consent to participate in the research was given at the commencement of each survey, and no incentives were provided. The CONSORT Checklist is included in Appendix 1: Supplementary materials.

Interventions

Released to market in 2014, the SMWP aims to enable working adults to develop mindfulness skills and embed mindfulness practices into daily life. The established low-dose mindfulness program involves a series of five learning modules delivered in four interactive one-hour face-to-face workshops. These are led by a Smiling Mind facilitator over eight weeks and supported by use of the SMWP App. The SMWP App includes 41 elements, including videos and audio lessons, guided meditations and practical activities such as moving with awareness between meetings, breathing techniques and listening exercises to help cultivate workplace mindfulness. Use of the app-based activities and meditations is supported by fortnightly emails relating to the content covered in the workshops and app-based lessons. The recommended minimum engagement with the SMWP App is 10 minutes meditation and/or activities per weekday. The SMWP history and content are provided in Appendix 1: Supplementary materials.

To maximise accessibility, SWMP workshops were delivered in a seminar format in university venues located in the north, north-west and south of the state. Classes ran twice, in the morning and afternoon, on the advertised dates. Participants were able to attend in person or via video conferencing, and catch-up recordings were made available. All classes were led by the same mindfulness teacher with certification from the University of Massachusetts Centre for Mindfulness and more than 10-year's teaching experience. No supplementary messaging, incentives or other forms of contact from the study team were used to encourage intervention engagement.

The App+ Group (App+) participants were invited to download and use the SMWP App and attend four one-hour classes scheduled fortnightly during work time. These participants were sent fortnightly generic emails from the Smiling Mind team to support use of the app-based materials.

The App-only Group (App) participants were invited to download and use the SMWP App and received the fortnightly emails but were not invited to attend the classes.

The wait-list control group (WLC) participants received no information during T0 to T1. After data collection for T1 was complete, the WLC were invited to a single two-hour seminar and to download and use the SMWP App self-guided, in conjunction with the fortnightly emails.

All groups retained access to the SMWP App for 12 months.

Measures

Demographic variables (age, sex, marital status, educational attainment, work role and schedule) were collected from participants at T0, as were past or planned exposure to other mindfulness or stress management training, and self-ratings of readiness for change (percent).

The 10-item Perceived Stress Scale [PSS; 41] was used to assess the primary outcome at all time-points. Response options were summed (range 0-40) with higher scores indicating higher perceived stress. Baseline PSS data showed good internal consistency (α= 0.92).

The nine-item Patient Health Questionnaire [PHQ-9; 37] was used for eligibility screening. Established clinical cut points were followed for mild (5), moderate (10), moderately severe (15) and severe (20) depression. Baseline data indicated good internal consistency (α= 0.86).

The Kessler 10-item measure [K10; 42] was used to assess psychological distress at all time points. Cut points from Australian norms signify a severe risk of a clinical mental health condition for people who score over 30, high risk between 22 and 29, moderate risk between 16 and 21 and low risk for below 15 [43]. Baseline data indicated good internal consistency (α= 0.91).

The 15-item Mindful Attention and Awareness Scale (MAAS) [44] was used to measure the mindfulness of respondents at all time points. Mean responses across the 15 items were computed, with higher mean scores (range 1-6) indicating higher trait mindfulness. Internal consistency was good at baseline (α= 0.91).

The 35-item, eight-dimension, Assessment of Quality of Life measure (AQoL-8D) [45], which assesses quality of life relating to physical health (independent living, pain and senses) and psycho-social health (mental health, happiness, coping, relationships and self-worth), was used at all time points. Scores were computed using the AQoL-8D algorithm (range 0.09 – 1.00). A score of 0.00 equates to death and 1.00 equates to full health.

Perceptions of job demand, control and support were used to assess work-related psychosocial risk at all time points. Demand and control were assessed using seven items drawn from the Household Income and Labour Dynamics in Australia survey [46]. Scores were summed for four demand items (range 0-24) and three control items (range 0-18). Higher risk of job-related stress is indicated when demands scores are higher and control scores are lower. Job support was assessed using summed responses to six items drawn from the Swedish Demand, Control and Support Survey [47]. Higher scores (range 4-24) indicate lower psychosocial risk of job stress. Internal inconsistency was weaker for the demand scale (α= 0.65), than the control (α= .80) and support (α= 0.80) measures.

Effects on productivity were based on estimates of health-related lost productive time (HRLPT) [48]. Participants were asked to think about their work attendance in the previous four weeks, and report the number of days they stayed away from work due to ill health

(absentee days) and the number of days they went to work but were unwell (presenteeism days). Absentee days were considered 100% lost (e.g. 2 absentee days = 2 lost days). If presenteeism days were reported, an estimate of productivity (percent) on those days was recorded. The number of lost productive days was assessed as the product of the number of presenteeism days and lost productivity on those days. For example, three presenteeism days at 60% productivity: (3 x (100-60)) = 1.2 lost days. The total number of days lost through absenteeism and presenteeism was then calculated and reported as HRLPT.

The degree to which changes in participants' mindful behaviours (e.g. attentiveness, awareness and acceptance) were noticeable to work colleagues was assessed at all time points using a nine-item Observed Mindfulness Measure [OMM; 49]. This instrument includes items such as '*The person has difficulty staying focused on what is happening to/around them as it occurs* (Attentiveness)', *'When asked how he or she is feeling, the person can identify their emotions easily* (Awareness)', and *'The person seems to recover well from unpleasant or stressful experiences* (Acceptance)'. Response options indicated the frequency of observed behaviours (1=Not at all, 5=All the time). Scores for three items (1, 4 and 7) were reversed prior to summing to obtain subscale scores for observed mindful acceptance, awareness and attentiveness, and the total score. Internal consistency for OMM data at baseline was good (α= 0.88).

A 16-item Organisational Citizenship Behaviours (OCB) observer-report instrument [50] was used at all time points to assess noticeable participant behaviours at work. Response options indicated the frequency of observed behaviours and higher summed scores indicate higher degrees of altruism (range 5-30) and compliant behaviours (range 4-20). Cronbach's test showed some internal inconsistency at baseline (altruism α= 0.72, compliance α= 0.62).

Intervention adherence was assessed using self-reported seminar attendance and app-usage data from the SMWP server. Whether participants downloaded and engaged with the App (yes/no) was recorded. Engagement was calculated as a proportion of time spent in the SWMP app activities, out of a potential maximum of 343 minutes for the entire program. Participant perceptions of acceptability of the intervention were assessed using qualitative data from two open questions in the T1 survey. Observers provided free-text responses at the end of each survey about their experience in the study and to share any additional information about their paired participant.

Statistical analysis

The required sample size was calculated using a pooled PSS estimate from a meta-analysis from 13 RCTs of WMPs (d= -0.54, mean difference -4.21, SE=0.14) [1]. To achieve power of 0.8 and α=0.025 (maintaining a family-wise error rate of 0.05) [51], a minimum of 198 participants was required. The recruitment target (n=261) allowed for 25% attrition.

Intention to treat analyses were conducted using an original assigned group approach [52]. Significance tests (α=0.05) were adjusted using the Tukey method for multiple comparisons when more than two groups were in the model. Analyses were conducted in R [53], using the psych [54], lme4 [55] and lmerTest packages [56]. Repeated measures linear mixed models were used to assess changes in the App+ and App only groups compared with the WLC from T0 to T1, with age, sex, prior mindfulness training and main occupation included

to inform missing data computations. Two-group comparisons were used to test the difference in effect retention between the App+ and App groups beyond T1. Cohen's *d* standardised mean difference effect estimates were computed using Lakens [57] guidelines (0.2 = weak, 0.5 = moderate and 0.8 = strong). Agreement between participants and their observers was assessed using ICC estimates in two-way random effects models following Koo and Li [58] guidelines (0.5 = poor, 0.5 to 0.75 = moderate, 0.75 to 0.9 = good and over 0.9 is excellent agreement). Spearman's correlations were used to test the relationship between program adherence and study outcomes. Chi-squared and Fisher's exact tests were used to explore differences in intervention engagement and HRLPT. Qualitative data was read twice by two authors (AM and LB) and with frequent themes identified, coded and assessed using a content analysis approach [59].

Results

Participant enrolment and attrition

The flow of participants and observers is illustrated in Figure 1. Baseline was completed by 229 out of an approved pool of 285 TSS employees. Ninety (39%) respondents were invited to a screening interview by the study psychologist, of whom 14 were deemed clinically ineligible, an additional four withdrew and two were excluded due to non-response. The starting sample (n=211) included 136 (64%) with a paired observer. Group assignments were: App+ (participant n=70, observer n=45), App-only (participant n=71, observer n=46) and WLC (participant n=70, observer n=45). Statistical power for the hypothesised moderate-sized PSS effect was achieved in the starting sample.

[Insert Figure 1 about here]
Figure 1. Participant flow diagram

A total of 15 participants and six observers advised withdrawal during the study period, citing time pressures (n=4), changing job (n=4), difficulty accessing the app-based materials (n=1), extended leave (n=3) and no reason (n=3). Observers' reasons included no longer being in contact with their paired participant (n=3) or their participant had withdrawn (n=3). Complete survey data were provided by 167 (79%) participants at T1 and 129 (61%) participants at T2.

Participant characteristics

Participant characteristics were similar across the intervention groups (Table 1), except for full time workers. Just under half of the sample reported some prior exposure to mindfulness and readiness to commence training was higher than 80% across groups.

Table 1. Participant characteristics

Characteristics variables	**WLC**		**App**		**App+**		**Difference**
	70		71		70		*P*
Age category	n	%	n	%	n	%	.60
18 to 34 years	7	(10)	9	(13)	9	(13)	
35 to 44 years	18	(26)	20	(28)	23	(33)	
45 to 55 years	20	(29)	22	(31)	24	(34)	
55 to 64 years	23	(33)	17	(24)	14	(20)	
Over 65 years	2	(3)	3	(4)	0	0	
Gender = Female	53	(76)	50	(70)	50	(71)	.76
Educational attainment							.37
High school	2	(3)	6	(9)	6	(9)	
College	24	(34)	16	(23)	19	(27)	
University	44	(63)	49	(69)	45	(64)	
Living as married	55	(79)	56	(79)	52	(74)	.77
Prior mindfulness training	34	(49)	35	(49)	31	(44)	.81
Main occupation							.21
Blue collar	1	(1)	1	(1)	1	(1)	
Clerical/Admin	15	(21)	5	(7)	12	(17)	
Technical/Services	4	(6)	9	(13)	10	(14)	
Professional	38	(54)	48	(68)	35	(50)	
Senior Manager	12	(17)	8	(11)	12	(17)	
Works full time	49	(70)	61	(86)	56	(80)	.07
Work schedule							.85
Regular daytime	64	(91)	61	(86)	62	(89)	
Regular eve/night	2	(3)	2	(3)	2	(3)	
Irregular/rotating	4	(6)	8	(11)	6	(9)	
% Readiness for training, M(SD)	86	(16)	85	(18)	82	(21)	.45

WLC: Wait-List Control group; App: Self-guided App use only; App+ Self-guided App use plus four seminars; Difference between groups p-values computed using ANOVA for continuous variables and Chi-squared tests of group equivalence for categorical variables.

Intervention effects for perceived stress (Aim 1)

Post-intervention RCT effect estimates are presented in Table 2. While there was a downward trend in perceived stress, when compared with the WLC there was no significant change for either the App+ or App-only group. Prior exposure to mindfulness, readiness to commence training or depression severity at baseline were not significant moderators.

Class attendance among the App+ group diminished over time, with 45 (83%) attendees in the first class, 36 (67%) in the second, 33 (62%) in the third and 32 (59%) in the fourth class. Table 3 shows the SMWP App was downloaded by 49 (70%) of the App+ group and 35 (49%) of the App group. The App+ group also engaged more with the learning and practice elements within the app (35%) and did more meditation practice over the eight-week period (73 meditation minutes) than the App-only group (13% engagement and 27 meditation minutes). Perceived stress change was significantly correlated with intervention engagement in the App+ group (r= -.33), but not in the App-only group. Investigation of T0:T1 change in PSS scores by meditation time and program engagement suggest an inverse linear dose-response pattern in the App+ group. This pattern was not evident in the App-only group (Figure 2).

Table 2. Post intervention RCT effect estimates

Outcome variables		T0		T1		Effect estimates				
		M	SE	M	SE	β	SE	*P*	d	95%CI
Perceived stress										
	WLC	16.37	(0.75)	15.32	(0.77)					
	App	17.40	(0.74)	14.91	(0.84)	-1.44	(1.01)	.16	-0.06	-0.39, 0.27
	App+	17.15	(0.75)	15.38	(0.81)	-0.73	(0.98)	.46	0.01	-0.32, 0.34
Mindfulness										
	WLC	3.83	(0.09)	3.65	(0.10)					
	App	3.83	(0.09)	3.79	(0.10)	0.15	(0.12)	.23	0.17	-0.16, 0.50
	App+	3.69	(0.09)	3.81	(0.10)	0.31	(0.12)	.01	0.19	-0.14, 0.52
Psychological distress										
	WLC	18.68	(0.67)	19.46	(0.68)					
	App	19.08	(0.66)	18.65	(0.73)	-1.21	(0.78)	.12	-0.14	-0.47, 0.19
	App+	19.21	(0.66)	18.22	(0.71)	-1.77	(0.75)	.02	-0.21	-0.55, 0.12
Job demands										
	WLC	16.41	(0.43)	15.64	(0.45)					
	App	16.79	(0.43)	15.90	(0.49)	-0.13	(0.59)	.83	0.07	-0.26, 0.40
	App+	16.93	(0.43)	15.69	(0.47)	-0.47	(0.57)	.41	0.01	-0.32, 0.34
Job control										
	WLC	10.11	(0.47)	10.45	(0.48)					
	App	10.67	(0.47)	11.25	(0.52)	0.25	(0.55)	.65	0.19	-0.14, 0.52
	App+	10.60	(0.47)	11.03	(0.50)	0.10	(0.53)	.86	0.14	-0.19, 0.47
Job support										
	WLC	18.43	(0.39)	18.40	(0.40)					
	App	17.85	(0.39)	18.70	(0.44)	0.88	(0.50)	.08	0.09	-0.24, 0.42
	App+	18.03	(0.39)	18.08	(0.42)	0.08	(0.48)	.87	-0.09	-0.42, 0.24
QoL: physical health										
	WLC	0.75	(0.02)	0.75	(0.02)					
	App	0.76	(0.02)	0.77	(0.02)	0.00	(0.02)	.83	0.12	-0.21, 0.45
	App+	0.75	(0.02)	0.76	(0.02)	0.01	(0.02)	.74	0.06	-0.27, 0.39
QoL: mental health										
	WLC	0.37	(0.02)	0.39	(0.02)					
	App	0.37	(0.02)	0.43	(0.02)	0.03	(0.02)	.13	0.24	-0.09, 0.57
	App+	0.35	(0.02)	0.40	(0.02)	0.02	(0.02)	.26	0.06	-0.27, 0.39

QoL: utility score									
	WLC	0.71	-0.02	0.73	(0.02)				
	App	0.72	-0.02	0.76	(0.02)	0.02	(0.02)	.28	0.18	-0.15, 0.51
	App+	0.69	-0.02	0.73	(0.02)	0.02	(0.02)	.33	0.00	-0.33, 0.33

Mean, SE, β, p: Estimated marginal means and effect estimates from maximum likelihood linear mixed models with age, sex, education and prior mindfulness exposure as auxiliary variables; All analyses were based on intention-to-treat principles with all cases analysed in their original assigned group. P: significant with α=0.05; *d*: Cohen's standardised mean difference effect estimate computed using T1 EMMEANS and SE. WLC: Wait-list control group (n=70); App: self-guided App group (n=71); App+: Self-guided App use plus supporting classes (n=70). Perceived Stress: Perceived Stress Scale (10 item); Mindfulness: Mindful Awareness and Attention Scale; Psychological distress: Kessler-10; QoL: Quality of life, Assessment of Quality of Life – 8 Dimension

Table 3. SMWP App engagement indices for the App+ and App-only groups between T0 and T1

Engagement variables	**App**		**App+**		**Test of difference**
App downloads, n (%)	35	(0.49)	49	(0.70)	
App usage	Median	(IQR)	Median	(IQR)	*P*
Number lessons completed	2	[0, 14]	4	[0, 16]	.01
Number activities completed	0	[0, 4]	1	[0, 7]	.09
Total meditation minutes	27	[0, 296]	73	[0, 476]	.03
Number meditations completed	4	[0, 44]	11	[0, 55]	.03
% of possible total engagement	13	[0, 126]	35	[1, 160]	.05

SMWP App: Smiling Mind Workplace App; App: Self-guided App use; App+: Self-guided App use plus classes; PSS: Perceived Stress Scale; K10: Kessler-10 Psychological Distress; MAAS: Mindful Attention and Awareness Scale; Tests of difference used 2 sample t-test using complete case data for normally distributed variables and Kruskal-Wallis Rank Sum Test for non-normally distributed variables.

[Figure 2 about here]

Psychological distress, mindfulness, work-related psychosocial risks and quality of life (Aim 2)

Results (Table 2) show that compared with the WLC, the App+ group reported small improvements for psychological distress (*d*= -0.21) and mindfulness (*d*=0.19). The K10 data showed eight (15%) participants in the App+ group transitioned into a lower category for risk of clinical mental health problems, while one participant (2%) shifted into a higher-risk category. No significant effects were found for either psychological distress or mindfulness in the App-only group, and an equal number reported beneficial (4, 8%) and detrimental

changes in risk status (4, 8%). In the WLC, nine participants (14%) shifted into higher risk, and six (9%) into lower risk categories during the initial intervention period.

No discernible trends in the quality of life data were evident for either the App+ group or the App-only group when compared with the WLC. Similarly, psychosocial risk factors did not change significantly for either active group at T1.

Productivity and workplace incidents (Aim 3)

Raw productivity and workplace incident results are presented in Appendix 1: Supplementary materials (Table S.1). Health-related lost productive time (HRLPT) was categorised into four levels: no HRLPT; up to one day; one to three days; and more than three days. The App+ and App-only groups trended lower in HRLPT than the WLC at post intervention, but the difference was not significant. The number of App+ participants who reported work successes increased from 26% at T0 to 39% at T2. This change was stronger than observed in the App-only (39% to 42%) and WLC (26% to 28%) groups. Work failures reduced from T0 to T2 for the active groups (App+ 9% to 7%; App-only 14% to 10%), while failures increased in the same period for the WLC (6% to 9%). Workplace accidents were infrequent in all groups, with 1 (1%) participant in the App+ group, 5 (7%) in the App only group and 4 (6%) in the WLC endorsing this item at T0.

Observer reported mindfulness and organisational citizenship (Aim 4)

Observer-reported outcomes are illustrated in Figure 3. The results are detailed in Appendix 1: Supplementary materials (Table S.2). Changes in observer-reported mindful behaviours and self-reported mindfulness showed consistent agreement at each time point (T0: ICC=.35, *P*=.01; T1: ICC=.32, *P*=.03; T2: ICC=.39, *P*=.03). At T1 observers reported a small but non-significant trend toward higher observed mindful behaviours in both active groups compared with the WLC. At six-month follow-up (T2), head-to-head comparison between the active groups showed the App+ participants displayed more noticeably mindful behaviours than App-only participants (*d*=0.34, 95%CI -0.08, 0.75).

The distribution of data in the organisational citizenship compliance subscale showed responses were bounded at the top from baseline, so these data were excluded from analyses. While the results for altruism were not significant, plots (Figure 3) illustrate the App+ group trended higher on this measure at T1 and T2, while the App-only group initially trended toward lower altruism at T1, which was ameliorated at T2.

Effect retention (Aim 5)

Results comparing the App+ and App-only groups at six-months follow-up (T2) are reported in Table 4. The effects observed for mindfulness and psychological distress developed further in both groups beyond intervention completion (T1) such that there was no significant difference between groups at T2. The App+ group continued to trend lower than the App-only group in perceived job demands and higher in job control from T1 to T2, however the social support results observed at T1 showed no further development at T2.

Table 4. Effect estimates for the App+ group compared with the App group from baseline to six-month follow-up for mindfulness, psychological distress, job demands and job control

Outcome variable	Group	T0		T2		Effect estimate T0:T2		
		M	SE	M	SE	β	SE	*P*
Mindfulness	App	3.82	(0.10)	3.91	(0.11)	REF		
	App+	3.68	(0.10)	3.94	(0.11)	0.04	(0.16)	.82
Psychological distress	App	19.08	(0.70)	18.21	(0.79)	REF		
	App+	19.16	(0.70)	17.69	(0.78)	-0.52	(1.11)	.64
Job demands	App	16.72	(0.44)	16.46	(0.52)	REF		
	App+	16.90	(0.44)	15.08	(0.51)	-1.38	(0.73)	.06
Job control	App	10.70	(0.45)	10.65	(0.53)	REF		
	App+	10.64	(0.46)	11.39	(0.52)	0.73	(0.74)	.33

T0: Baseline; T1: Post-intervention; T2: Six-months from baseline. M: Estimated marginal means; β, SE and p-values from two-group comparison of effects in linear mixed models, with App group set as reference.

Intervention acceptability

The frequency of themes derived from qualitative data are reported in Table 5. Reports from the two active groups show overall satisfaction with the mindfulness training. Responses to the free-text questions from 57 (40%) of the participants indicated that they found the training useful, practical, helpful or beneficial, more frequently among the App+ (35, 50%) than App-only participants (22, 31%). Thirteen members (19%) of the App+ group reported finding the program immediately beneficial, while this was volunteered by only four (6%) of the App-only participants. The app was considered easy to use by 21 (15%) of all participants. However, while 12 (9%) of participants reported they were incorporating practice into daily life, 18 (13%) respondents found establishing a routine difficult and 12 (9%) participants reported it was not feasible to engage with the program while at work. Comments from 17 (24%) of App+ group participants indicated they found the seminars motivating. However, more App+ group participants reported difficulties associated with time demands (5, 7%) and establishing a practice routine (12, 17%) than App-only group participants (3, 4% and 6, 8% respectively). A small number of participants reported technical problems with the app and/or seminars. One individual in each group reported they felt the research surveys were independently helpful in sensitising them to their mental wellbeing. The in-app elements considered most useful by participants in both active groups were the meditations, ranked highest by 55 (57%) of respondents. Micro-practices, which are brief mindful activities that can be employed throughout the day were rated very useful by 40 (41%) participants, in-app lessons by 31 (32%) participants, and body scan practices by 30 (31%) (data not shown).

Table 5. Frequency of themes derived from post-intervention free-text responses regarding the usefulness of the program

Themes derived from qualitative data	All respondents		App+ group		App group	
	n	% of 70	n	% of 71	n	% of 70
Participant view of outcomes						
Improved wellbeing	7	5%	4	6%	3	4%
Improved sleep	4	3%	2	3%	2	3%
Improved productivity	3	2%	2	3%	1	1%
Improved recovery	2	1%	1	1%	1	1%
Improved relationships	1	1%	0	0%	1	1%
Acceptability						
Useful, practical, helpful, beneficial	57	40%	35	50%	22	31%
Immediate benefit, real time application	17	12%	13	19%	4	6%
Variety, choices, range of app elements	11	8%	7	10%	4	6%
Found app irritating, disruptive	6	4%	2	3%	4	6%
Would recommend	4	3%	3	4%	1	1%
Feasibility						
Easy to use, accessible, flexible	21	15%	9	13%	12	17%
Establishing routine is difficult	18	13%	12	17%	6	8%
Seminars were motivating, beneficial	17	12%	17	24%	0	0%
Incorporating practices into daily life	12	9%	6	9%	5	7%
Not feasible at work	12	9%	5	7%	7	10%
Technical problems with app	8	6%	5	7%	3	4%
Time challenges / demands of training	8	6%	5	7%	3	4%
Self-guided program difficult	7	5%	1	1%	6	8%
Technical problems with seminars	3	2%	3	4%	0	0%
No benefit from seminar attendance	3	2%	3	4%	0	0%
Contextual circumstances						

Major life stresses during study	10	7%	5	7%	2	3%
Life got in the way - didn't do training	10	7%	8	11%	2	3%
Didn't use the app	8	6%	0	0%	8	11%
Surveys made difference on their own	2	1%	1	1%	1	1%

Discussion

This RCT assessed the effects of participating in a low-dose, app-based WMP delivered both with and without supporting classes in a sample of public sector employees. The study hypothesis, that using the SMWP App either self-guided or with supporting classes would result in moderate-sized reductions in perceived stress, was not supported. While the App+ group engaged more with the training, neither group achieved the recommended dose. Despite the low engagement, when compared with the inactive control group, the App+ group reported significant increases in mindfulness and decreases in psychological distress. These benefits were retained at six-month follow-up, at which point the App+ group also reported significantly lower perceived job demands than the App-only group. No significant effects were observed for either intervention group for health-related quality of life or productivity. While the SMWP App was well received by most participants in the active groups, those whose training protocol was entirely self-guided engaged less with training and reported no statistically significant changes on any of the study outcomes.

The null result for perceived stress was unexpected given consistent positive findings from other WMPs [1] and the apparent efficacy of the current intervention for significant and lasting benefits for psychological distress. While the two constructs are usually correlated, they are not the same. Perceived stress refers to the perceived capacity to meet the demands of presenting stressors, whereas psychological distress refers to health risks associated with sustained or unrelieved stress [60]. It is plausible that participants in the App+ group developed skills through their mindfulness training protocol to regulate their emotions and thereby attenuate distress, while their perception of the demands and frequency of stressors may have remained unchanged. The PSS results for all three groups, including the control, trended lower over the main intervention period (T0 to T1), which might suggest a sample-wide reduction in stressor exposure, however this was not detected or reported in other data collected for this study.

The significant changes in mindfulness and distress were encouraging, but lower than meta-analytic estimates from WMPs delivered via face-to-face classes or online learning platforms [61-63]. These findings support the likelihood of a dose-response relationship, where the degree of exposure to mindfulness training and practice is associated with the size of effects [64]. Despite the lower effect sizes the psychological distress results suggest the App+ training protocol was sufficient to realise meaningful mental health risk reduction for 15% of participants.

Higher engagement with the SMWP App by App+ participants appears to have been motivated by seminar attendance, a sentiment volunteered in free-text data by 12% of

App+ participants. For example, one participant stated “I was fortunate to be selected to attend sessions which I believe was VERY important. This helped tremendously with getting the motivation to work through the app sessions. Other colleagues from my work who were not selected to attend sessions have very low motivation and barely did any of the app sessions.” The self-guided App-only group not only missed the class-based educational and discursive opportunities but engaged less than the App+ participants with the in-app educational videos, lessons and practice resources. This poorer engagement may explain the pattern in PSS changes depicted in Figure 2, where the App+ group reported a clearer and more consistent dose-response than the App-only group. It is feasible that in the absence of feedback and guidance by a teacher, or the opportunity to discuss experiences with other learners, the App-only participants were less able to apply mindful awareness and acceptance as their experiences “arise and pass away” during meditation practices, and thus derived less benefit [65].

The absence of significant improvement in mindfulness or distress in the App-only group indicates self-guided use of the SMWP App was insufficient to realise consistent changes within the main intervention period (T0 to T1). This finding is in keeping with previous work that has shown face-to-face classes in the training protocol are associated with stronger improvements in mindfulness [64]. The continued development of mindfulness and reduction in psychological distress in the App-only group beyond T1 suggests that while classes boost training engagement and augment the benefits of app use, self-guided mindfulness training may still be beneficial with ongoing engagement, but benefits may take longer to manifest.

Compared with the WLC, no change was observed immediately post intervention for either intervention group for participants’ perceptions of psychosocial risk factors, job demand, control and support. However, at six-months, the App+ group reported a reduction in job demands that approached significance, and a trend toward higher job control compared with the App-only group. Job demands and control are key factors associated with work-related stress in the theoretical job-demands-resources model, where it is the perception that demands outweigh available resources that leads to job strain. Job strain is understood to be responsible for a range of workplace health and performance problems [33]. Mindfulness training aims to cultivate adaptive coping skills and should thus be considered a secondary level strategy for workplace health and wellbeing [12]. However, in this study it does appear that higher mindfulness may also support changes in the way psychosocial stressors are perceived. Our findings for job demands (and the trends for job control) indicate the SMWP App, when supported with classes, might be protective against job strain through reducing perceptions of imbalance between work-related demands, and improving personal resources and perceived control over work experiences [e.g. 3]. The fact these effects were evident only at six-months follow-up might mean that changed perceptions of work-related psychosocial risks emerge sequentially following the development of higher mindfulness.

An explanation for the sequential development of benefits following mindfulness training is provided in Garland’s Mindfulness to Meaning model [66]. According to this model the initial stages of learning mindfulness meditation can help reduce stress reactivity by developing attentional control, however it is the sustained application of mindful awareness

in meditation practice that cultivates acceptance and reappraisal skills. These skills in turn support regulatory and coping resources and are known to underpin positive affect and general wellbeing [5, 15, 67].

The null result for quality of life was unexpected given significant improvements were recorded on the briefer AQoL-4D following the pilot face-to-face WMP in the same population [35]. Also, prior work has shown increased general wellbeing following WMPs [2], even when delivered via an app [27]. Findings from an RCT of the Wildflowers mindfulness app in a non-work setting [32] reported that changes in mindful acceptance appear to take longer and require a greater amount of meditation practice than changes in stress and mood. It is feasible the degree of engagement with the App+ intervention in the current study was sufficient for the acquisition of elementary mindfulness skills (attentional control and awareness) that support stress-appraisals, and that these changes underpinned the beneficial findings for distress and psychosocial risk factors (job-demand and job-control). However, the training dose appears to have been inadequate for developing skills associated with positive affect and general wellbeing, key factors associated with quality of life [66].

Trends in productivity data indicate all three groups decreased the number of health-related presenteeism and absenteeism days at six months follow-up. Changes in productivity may also be sequential to changes in stress and mindfulness, but our results do not show a causal link between mindfulness training and increased productivity. We propose HRLPT is an informative measure for assessing productivity effects in future WMP research, because higher mindfulness has been shown to alleviate psychological distress, depression and anxiety, and these conditions are strongly associated with absenteeism and presenteeism [1, 68].

The use of observer data to supplement self-reported changes in mindfulness and related behaviours addresses a limitation noted in about half published mindfulness studies [25]. While the magnitude of inter-rater agreement was low, the consistent correspondence between self-reported mindfulness (MAAS) and observer-reported mindful behaviours (OMM) strengthen the results reported in this study [69, 70]. The work-based observers reported noticing increased mindful behaviours and a trend toward higher altruism among participants in the App+ group, but not the App-only group at six months. These results lend weight to the potential for WMPs to have prosocial benefits in the workplace [18, 71].

Limitations, strengths, and future research

There were timing and contextual considerations within our study. Baseline data collection coincided with the end of the summer break, a period during which many public sector employees are returning from annual leave. In contrast, the post-intervention surveys coincided with political elections and major flooding in and around the State's capital city where many public sector employees are located. Thus, employee stress levels may have been lower than usual in the pre-intervention surveys, and elevated at post-intervention through these contextual factors.

The necessary lack of blinding and use of a wait-list rather than an active control means nonspecific factors such as social desirability, expectancy or experimenter effects cannot be

ruled out as potential effect moderators. For example, our qualitative data appears to suggest participants in the App only group may have felt their lower-dose training protocol to have a lower status than the App+ protocol. Careful design of the wait-list control conditions in future research is recommended to help address this bias risk. While an additional survey was conducted 14 months from baseline (T3), there was a very high degree of attrition with only 32 (15%) of the starting sample providing data. Follow-up analyses were therefore limited to six-month data. Raw data for productivity and workplace incidents are provided in supplementary materials to support future pooled analyses.

Strengths include participant characteristics reflecting those of the broader TSS workforce, meaning the reported findings can be generalised to similar public sector workplaces with some confidence. Collecting objective app-usage data enabled us to overcome a reliance on self-report adherence to the training protocol, however we did not record engagement with the Smiling Mind generic emails and were therefore not able to include exposure to this guiding material in our dose-exposed calculations. The use of observer reports was another strength of this study, even though the ceiling effects in the organisational citizenship and observed mindfulness data prevented complete analyses. Use of multi-source data increases confidence in self-reported study findings and this study has shown the collecting and use of observer-reported data to be both feasible and informative. We suggest more studies collect observer-reports to help build an evidence base around the effects of mindfulness training on workplace social and performance outcomes. More work is needed to understand the effects of mindfulness training on workplace productivity and health-related lost productive time.

Conclusion

Despite the absence of effects for the primary study outcome, perceived stress, the results for mindfulness, distress and job demands support the SMWP App as a workplace stress reduction intervention, when supported by classes. Importantly, no evidence of adverse effects was observed from this low-dose mindfulness intervention. However, previous workplace mindfulness training research [1, 2] indicates WMPs with stronger engagement and higher training dose are likely to realise greater benefits, both for employees' stress-related health and wellbeing, and for organisational outcomes such as productivity and performance.

Acknowledgements and declaration of interests

The project was conceived and progressed by LB as part of her PhD (Medical Sciences) at the University of Tasmania's Menzies Institute for Medical Research. Co-authors [AN (Primary), KS, AM and MK] were supervisors for the first-author [LB]. PO provided statistical expertise. LB led the development of the manuscript with contributions from all co-authors. LB has since commenced a post-doctoral appointment with the University of Tasmania's Wicking Dementia Research and Education Centre. The authors are very grateful to the study participants for their involvement in this research and for the partnership between the Tasmanian State Service Management Office, the Tasmanian Training Consortium, Smiling Mind and the University of Tasmania, which underpinned the project. Valuable assistance was provided by Sue Cole (volunteer) and Tim Albion (survey development). The authors have no conflicts of interests to declare.

Funding details and disclosure

The reported research was undertaken by [LB] as part of a PhD project. [LB] was supported throughout her PhD by an Australian Research Training Program scholarship, and the TasNetworks Elite Health and Wellbeing Scholarship. ALN is supported by a Select Foundation Senior Research Fellowship. None of the authors have a financial or other conflict of interest to disclose.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author [LB].

Abbreviations

App+: App plus classes group
App: App only group
AQoL-8D: Assessment of Quality of Life (8 Dimensions)
HRLPT: Health-related lost productive time
K10: Kessler 10-item distress measure
MAAS: Mindful Attention and Awareness Scale
MARS: Mobile Application Rating Scale
MAWP: Mindfulness at Work Program
OCB: Organisational Citizenship Behaviours
OMM: Observed Mindfulness Measure
PHQ-9: Patient Health Questionnaire (9-item)
PSS: Perceived Stress Scale
RCT: Randomised controlled trial
SMWP: Smiling Mind Workplace Program
TSS: Tasmanian State Service
TTC: Tasmanian Training Consortium
WLC: Wait-list Control group
WMP: Workplace-based mindfulness program

References

1. Bartlett L, Martin A, Neil AL, Memish K, Otahal P, Kilpatrick M, et al. A systematic review and meta-analysis of workplace mindfulness training randomized controlled trials. Journal of Occupational Health Psychology. 2019;24(1):108-26. PMID: 30714811. doi: 10.1037/ocp0000146.
2. Vonderlin R, Biermann M, Bohus M, Lyssenko L. Mindfulness-Based Programs in the Workplace: a Meta-Analysis of Randomized Controlled Trials. Mindfulness. 2020;11(7):1579-98. doi: 10.1007/s12671-020-01328-3.

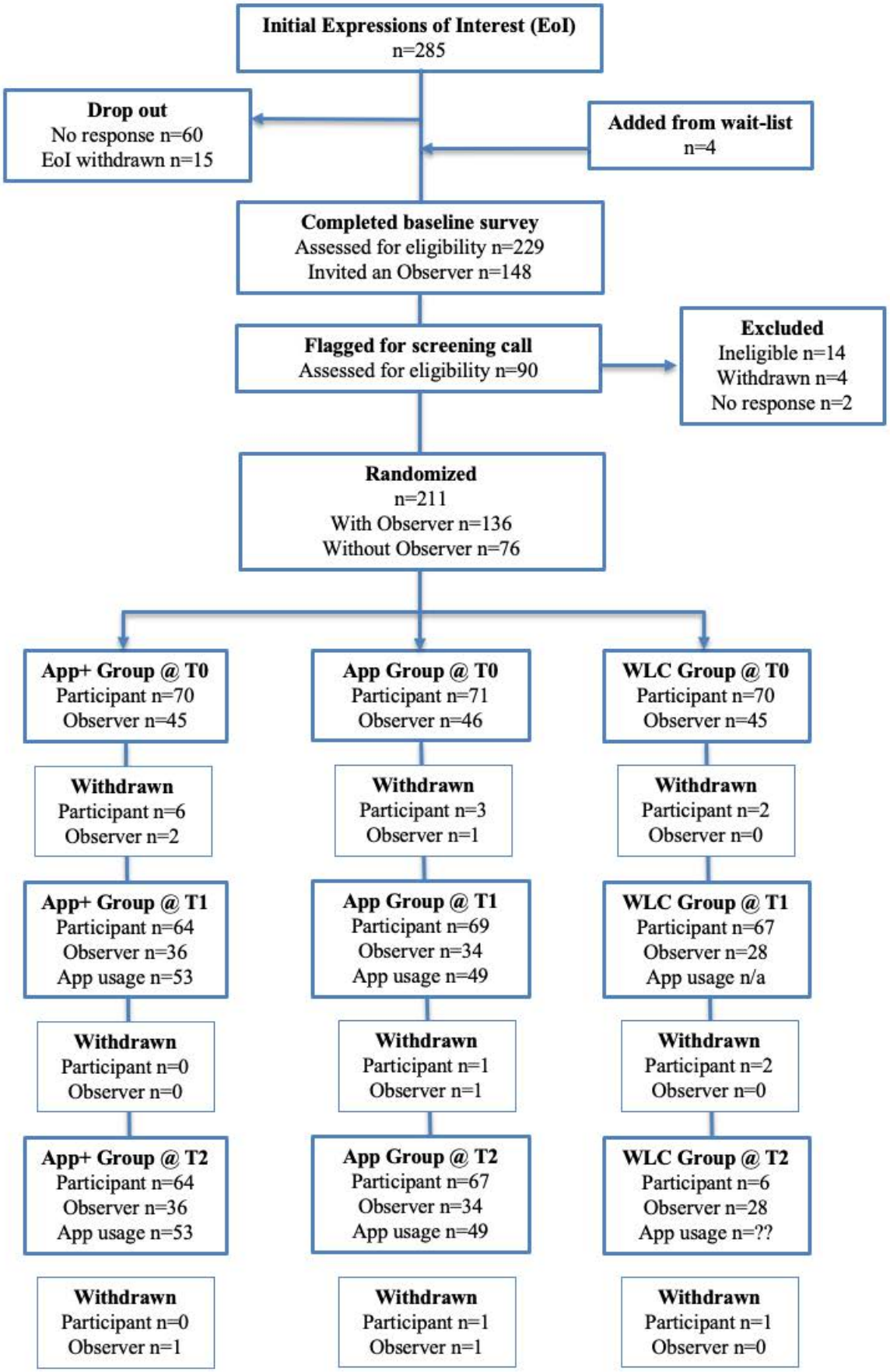
3. Grover SL, Teo STT, Pick D, Roche M. Mindfulness as a personal resource to reduce work stress in the job demands-resources model. Stress and Health. 2017;33(4):426-36. doi: 10.1002/smi.2726.
4. Roche M, Haar JM, Luthans F. The role of mindfulness and psychological capital on the well-being of leaders. Journal of Occupational Health Psychology. 2014;19(4):476. doi: 10.1037/a0037183.
5. Avey JB, Luthans F, Jensen SM. Psychological capital: A positive resource for combating employee stress and turnover. Human Resource Management. 2009;48(5):677-93. PMID: 44435610.
6. Ganster DC, Rosen CC. Work Stress and Employee Health: A Multidisciplinary Review. Journal of Management. 2013;39(5):1085-122. PMID: WOS:000319528200002. doi: 10.1177/0149206313475815.
7. Cohen S, Janicki-Deverts D, Miller GE. Psychological Stress and Disease. JAMA. 2007;298(14). PMID: 17925521. doi: 10.1001/jama.298.14.1685.
8. Johns G. Attendance Dynamics at Work: The Antecedents and Correlates of Presenteeism, Absenteeism, and Productivity Loss. Journal of Occupational Health Psychology. 2011. doi: 10.1037/a0025153.
9. Cocker F, Sanderson K, LaMontagne AD. Estimating the Economic Benefits of Eliminating Job Strain as a Risk Factor for Depression. Journal of Occupational and Evironmental Medicine. 2017;59(1):12-7. doi: 10.1097/JOM.0000000000000908.
10. Demsky CA. Workplace Aggression: A Multi-Study Examination of Work and Nonwork Consequences [Ph.D.]. Ann Arbor: Portland State University; 2015.
11. Memish K, Martin A, Dawkins S, Bartlett L, Sanderson K. Workplace Mental Health: A Review of Guidelines. Preventive Medicine. 2017 Mar 25;101:213-22. PMID: 28347696. doi: 10.1016/j.ypmed.2017.03.017.
12. LaMontagne AD, Martin A, Page KM, Reavley NJ, Noblet AJ, Milner AJ, et al. Workplace mental health: developing an integrated intervention approach. BMC Psychiatry. 2014 May;14(131). PMID: WOS:000336063000001.
13. Bhui K, Dinos S, Galant-Miecznikowska M, de Jongh B, Stansfeld S. Perceptions of work stress causes and effective interventions in employees working in public, private and non-governmental organisations: a qualitative study. BJPsych Bull. 2016 Dec;40(6):318-25. PMID: 28377811. doi: 10.1192/pb.bp.115.050823.
14. Creswell JD, Lindsay EK, Villalba DK, Chin B. Mindfulness Training and Physical Health. Psychosomatic Medicine. 2019;81(3):224-32. PMID: 00006842-900000000-98659. doi: 10.1097/psy.0000000000000675.
15. Folkman S. Positive affect and the other side of coping. American Psychologist. 2000;55(6):647-54. doi: 10.1037/0003-066X.55.6.647.
16. Garland EL, Hanley AW, Baker AK, Howard MO. Biobehavioral Mechanisms of Mindfulness as a Treatment for Chronic Stress: An RDoC Perspective. Chronic Stress. 2017;1:1–14. PMID: 28840198. doi: 10.1177/2470547017711912.
17. Tang Y-Y, Holzel BK, Posner MI. The neuroscience of mindfulness meditation. Nature Review: Neuroscience. 2015 04//print;16(4):213-25. doi: 10.1038/nrn3916.
18. Donald JN, Sahdra BK, Van Zanden B, Johannes Duineveld J, Atkins PWB, Marshall S, et al. Does Your Mindfulness Benefit Others? A Systematic Review and Meta-Analysis of the Link Between Mindfulness and Prosocial Behavior. British Journal of Psychology. 2019;110(1):101-25. PMID: 30094812. doi: 10.1111/bjop.12338.
19. Karremans JC, van Schie HT, van Dongen I, Kappen G, Mori G, van As S, et al. Is mindfulness associated with interpersonal forgiveness? Emotion 2019 2019/01//. PMID: 30652883. doi: 10.1037/emo0000552.

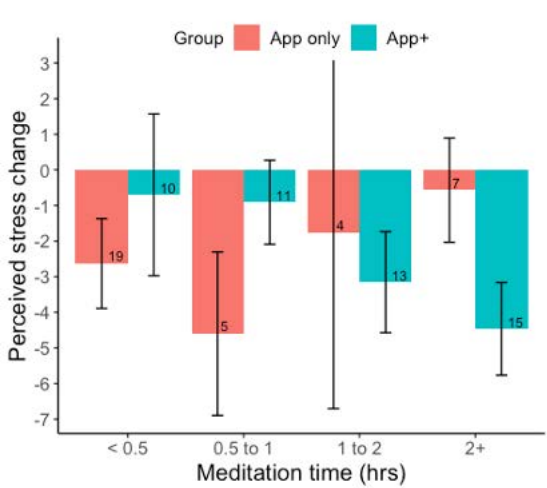
20. Gillions A, Cheang R, Duarte R. The effect of mindfulness practice on aggression and violence levels in adults: A systematic review. Aggression and Violent Behavior. 2019 2019/08/21/. doi: 10.1016/j.avb.2019.08.012.
21. Good DJ, Lyddy CJ, Glomb TM, Bono JE, Brown KW, Duffy MK, et al. Contemplating Mindfulness at Work. Journal of Management. 2016;42(1):114. PMID: WOS:000366159100005. doi: 10.1177/0149206315617003.
22. Reb J, Choi E. Mindfulness in organizations. Psychology of Meditation: Nova Science Publishers, Hauppauge, NY; 2014. p. 279-309.
23. Mani M, Kavanagh DJ, Hides L, Stoyanov SR. Review and Evaluation of Mindfulness-Based iPhone Apps. JMIR mHealth and uHealth. 2015;3(3):e82. PMID: 26290327. doi: 10.2196/mhealth.4328.
24. Cavanagh K, Strauss C, Forder L, Jones F. Can mindfulness and acceptance be learnt by self-help?: A systematic review and meta-analysis of mindfulness and acceptance-based self-help interventions. Clinical Psychology Review. 2014 3/1/March 2014;34(2):118-29. PMID: S0272735814000026. doi: 10.1016/j.cpr.2014.01.001.
25. Goldberg SB, Tucker RP, Greene PA, Simpson TL, Kearney DJ, Davidson RJ. Is mindfulness research methodology improving over time? A systematic review. PLOS ONE. 2017;12(10). doi: 10.1371/journal.pone.0187298.
26. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. JMIR Mhealth Uhealth. 2015 Mar 11;3(1):e27. PMID: 25760773. doi: 10.2196/mhealth.3422.
27. Bostock S, Crosswell AD, Prather AA, Steptoe A. Mindfulness on-the-go: Effects of a mindfulness meditation app on work stress and well-being. Journal of occupational health psychology. 2018 2018/05//. PMID: 29723001. doi: 10.1037/ocp0000118.
28. 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 2019/06/25;7(6):e14273. doi: 10.2196/14273.
29. 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. 2019;13(12):e0209482. doi: 10.1371/journal.pone.0209482.
30. 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 2018/10/31. doi: 10.1007/s12671-018-1050-9.
31. 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. Journal of Happiness Studies. 2016 Feb;17(1):163-85. PMID: WOS:000369250300009. doi: 10.1007/s10902-014-9589-1.
32. Walsh KM, Farb N. Effects of a Mindfulness-Meditation App on Subjective Well-Being: An Active Randomized Controlled Trial and Experience Sampling Study. JMIR Mental Health. 2018;6(1):310844. doi: 10.2196/10844.
33. Bakker A, Demerouti E. Job Demands-Resources Theory: Taking Stock and Looking Forward. Journal of Occupational Health Psychology. 2017;22(3):273-85. PMID: 27732008. doi: 10.1037/ocp0000056.
34. Creswell JD, Lindsay EK. How Does Mindfulness Training Affect Health? A Mindfulness Stress Buffering Account. Current Directions in Psychological Science. 2014;23(6):401-7. doi: 10.1177/0963721414547415.

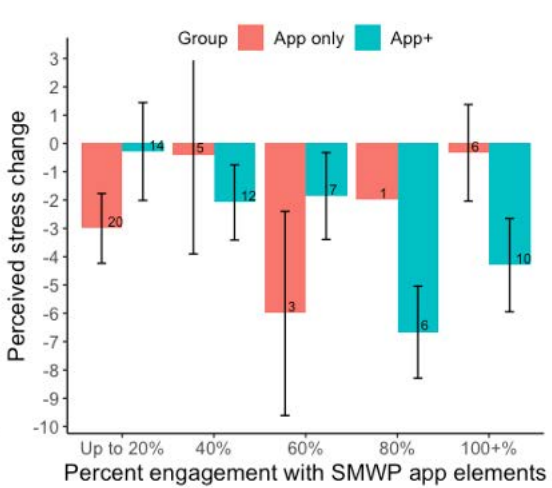
35. Bartlett L, Lovell P, Otahal P, Sanderson K. Acceptability, Feasibility, and Efficacy of a Workplace Mindfulness Program for Public Sector Employees: a Pilot Randomized Controlled Trial with Informant Reports. Mindfulness. 2016;8(3):639-54. doi: 10.1007/s12671-016-0643-4.
36. Smiling Mind. Smiling Mind Workplace Program. 2018 [4 February, 2018]; Available from: www.smilingmind.com.au/mindfulness-workplace.
37. Kroenke K, Spitzer RL, Williams JB. The PHQ‐9: Validity of a Brief Depression Severity Measure. Journal of General Internal Medicine. 2001 Sep;16(9):606-13. PMID: 11556941. doi: 10.1046/j.1525-1497.2001.016009606.x.
38. Boutron I, Moher D, Altman DG, Schulz KF, Ravaud P. Extending the CONSORT Statement to Randomized Trials of Nonpharmacologic Treatment: Explanation and Elaboration. Annals of Internal Medicine. 2008;148(4):295-309. doi: 10.7326/0003-4819-148-4-200802190-00008.
39. Harris PA, Taylor R, Thielke R, Payne J, NGonzalez N, Conde JG. Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support. Journal of Biomedical Information. 2009 April;42(2):377-81.
40. Eysenbach G. Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). Journal of medical Internet research. 2004;6(3):e34-e. PMID: 15471760. doi: 10.2196/jmir.6.3.e34.
41. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. Journal of Health and Social Behavior. 1983;24(4):385-96. PMID: 6668417.
42. Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SLT, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. Psychological Medicine. 2002 Aug 2002 2013-01-30;32(6):959-76. PMID: 204501207; 12214795.
43. Slade T, Grove R, Burgess P. Kessler psychological distress scale: normative data from the 2007 Australian national survey of mental health and wellbeing. Australian and New Zealand Journal of Psychiatry. 2011 Apr;45(4):308-16. PMID: 21332432. doi: 10.3109/00048674.2010.543653.
44. Brown KW, Ryan RM. The benefits of being present: Mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology. 2003;84(4):822-48. PMID: 614377438; 2003-02410-012. doi: 10.1037/0022-3514.84.4.822.
45. Richardson J, Iezzi A, Khan MA, Maxwell A. Validity and Reliability of the Assessment of Quality of Life (AQoL)-8D Multi-Attribute Utility Instrument. The Patient - Patient-Centered Outcomes Research. 2014 2014//;7(1):85-96. doi: 10.1007/s40271-013-0036-x.
46. Butterworth P, Leach LS, Rodgers B, Broom DH, Olesen SC, Strazdins L. Psychosocial job adversity and health in Australia: analysis of data from the HILDA Survey. Australian & New Zealand Journal of Public Health. 2011 Dec;35(6):564-71. PMID: 22151164. doi: 10.1111/j.1753-6405.2011.00771.x.
47. Sanne B, Torp S, Mykletun A, Dahl A. The Swedish Demand–Control–Support Questionnaire (DCSQ): Factor structure, item analyses, and internal consistency in a large population. Scandinavian Journal of Public Health. 2005;33(3):166-74. PMID: 17210759. doi: 10.1080/14034940410019217.
48. Sanderson K, Tilse E, Nicholson J, Oldenburg B, Graves N. Which presenteeism measures are more sensitive to depression and anxiety? Journal of Affective Disorders. 2007;101(1-3). doi: 10.1016/j.jad.2006.10.024.

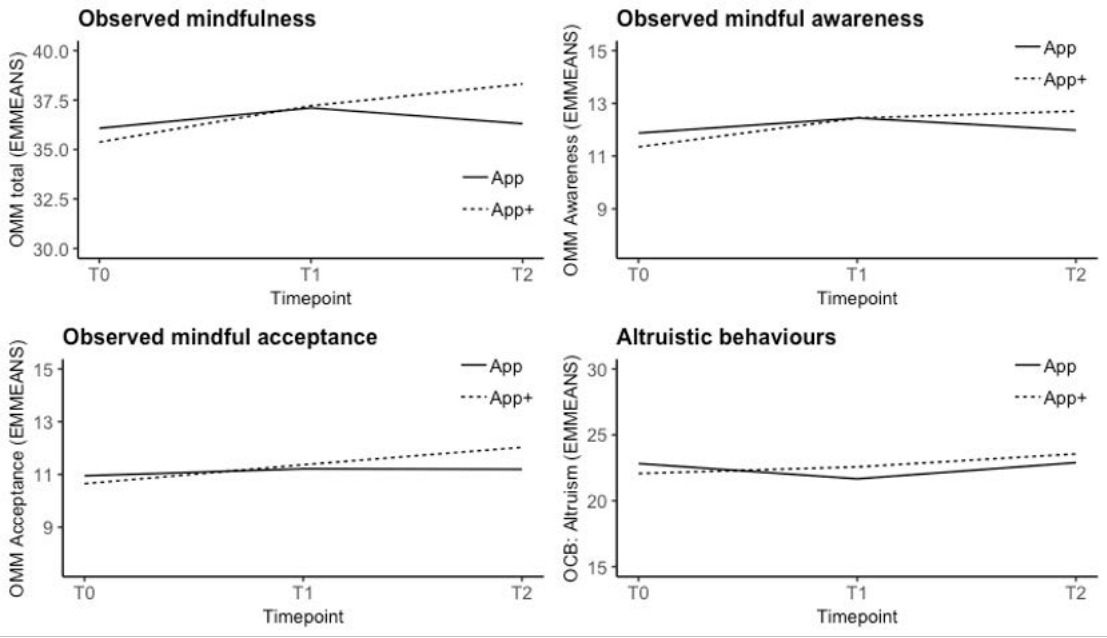
49. Bartlett L, Martin AJ, Bruno R, Kilpatrick M, Sanderson K, Neil AL. Is Mindfulness a Noticeable Quality? Development and Validation of the Observed Mindfulness Measure. Journal of Psychopathology & Behavioral Assessment. Under review.
50. Smith C, Organ DW, Near JP. Organizational citizenship behavior: Its nature and antecedents. Journal of applied psychology. 1983;68(4):653. PMID: WOS:A1983RQ07300017. doi: 10.1037/0021-9010.68.4.653.
51. Cohen J. A power primer. Psychological Bulletin. 1992 2015-02-03;112(1):155-9. PMID: 614317877; 1992-37683-001. doi: 10.1037/0033-2909.112.1.155.
52. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, Devereaux PJ, et al. CONSORT 2010 Explanation and Elaboration: updated guidelines for reporting parallel group randomised trials. Journal of Clinical Epidemiology. 2010 8//;63(8):e1-e37. doi: 10.1016/j.jclinepi.2010.03.004.
53. R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria2014.
54. Revelle W. psych: Procedures for Personality and Psychological Research. Northwestern University. Evanston, Illinois2018.
55. Bates D, Mächler M, Bolker BM, Walker SC. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software. 2015;67. doi: 10.18637/jss.v067.i01.
56. Kuznetsova A, Brockhoff PB, Christensen RHB. lmerTest Package: Teses in Linear Mixed Effects Models. Journal of Statistical Software. 2017;82(13):1-26. doi: 10.18637/jss.v082.i13.
57. Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Frontiers in Psychology. 2013;4:863. PMID: PMC3840331. doi: 10.3389/fpsyg.2013.00863.
58. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. Journal of Chiropractic Medicine. 2016;15(2):155-63. PMID: PMC4913118. doi: 10.1016/j.jcm.2016.02.012.
59. Frost N. Qualitative Research Methods in Psychology: Combining Core Approaches. Maidenhead: Open University Press : McGraw-Hill Education; 2011. ISBN: 9780335241507-0335241506.
60. Kessler RC, Sampson NA, Berglund P, Gruber MJ, Al-Hamzawi A, Andrade L, et al. Anxious and non-anxious major depressive disorder in the World Health Organization World Mental Health Surveys. Epidemiology and Psychiatric Sciences. 2015;24(3):210-26. doi: 10.1017/S2045796015000189.
61. Stratton E, Lampit A, Choi I, Calvo RA, Harvey SB, Glozier N. Effectiveness of eHealth interventions for reducing mental health conditions in employees: A systematic review and meta-analysis. PLOS ONE. 2017;12(12):e0189904. doi: 10.1371/journal.pone.0189904.
62. Spijkerman MPJ, Pots WTM, Bohlmeijer ET. Effectiveness of online mindfulness-based interventions in improving mental health: A review and meta-analysis of randomised controlled trials. Clinical Psychology Review. 2016;45:102-14. PMID: 27111302. doi: 10.1016/j.cpr.2016.03.009.
63. Virgili M. Mindfulness-Based Interventions Reduce Psychological Distress in Working Adults: a Meta-Analysis of Intervention Studies. Mindfulness. 2015;6(2):326-37. doi: 10.1007/s12671-013-0264-0.
64. Strohmaier S. The Relationship Between Doses of Mindfulness-Based Programs and Depression, Anxiety, Stress, and Mindfulness: a Dose-Response Meta-Regression of Randomized Controlled Trials. Mindfulness. 2020;11(6):1315-35. doi: 10.1007/s12671-020-01319-4.

65. Baer RA, Kuyken W. Is mindfulness safe? Oxford, UK2017 [updated February 27, 2017]; Available from: http://oxfordmindfulness.org/insight/is-mindfulness-safe/.
66. Garland EL, Hanley AW, Goldin PR, Gross JJ. Testing the mindfulness-to-meaning theory: Evidence for mindful positive emotion regulation from a ranalysis of longitudinal data. PLoS ONE. 2017;12(12): e0187727. doi: 10.1371/journal.pone.0187727.
67. Folkman S. Stress: Appraisal and Coping. In: Gellman MD, Turner JR, editors. Encyclopedia of Behavioral Medicine. New York: Springer 2013. p. 1913-5.
68. Sanderson K, Andrews G. Common Mental Disorders in the Workforce: Recent Findings From Descriptive and Social Epidemiology. Canadian Journal of Psychiatry. 2006 Feb 2006
2014-04-30;51(2):63-75. PMID: 222842691; 16989105.
69. Olino TM, Klein DN. Psychometric Comparison of Self- and Informant-Reports of Personality. Assessment. 2015 December 1, 2015;22(6):655-64. doi: 10.1177/1073191114567942.
70. Vazire S, Mehl MR. Knowing Me, Knowing You: The Accuracy and Unique Predictive Validity of Self-Ratings and Other-Ratings of Daily Behavior. Journal of Personality & Social Psychology. 2008 Nov;95(5):1202-16. PMID: 18954202. doi: 10.1037/a0013314.
71. Choi E, Tobias J. Mind the Gap: The Link Between Mindfulness and Performance at Work Needs More Attention. Industrial and Organizational Psychology. 2015;8(04):629-33. doi: doi:10.1017/iop.2015.90.


Initial Expressions of Interest (EoI)
n=285
Drop out
No response n=60
EoI withdrawn n=15
Added from wait-list
n=4
Completed baseline survey
Assessed for eligibility n=229
Invited an Observer n=148
Flagged for screening call
Assessed for eligibility n=90
Excluded
Ineligible n=14
Withdrawn n=4
No response n=2
Randomized
n=211
With Observer n=136
Without Observer n=76
App+ Group @ T0
Participant n=70
Observer n=45
App Group @ T0
Participant n=71
Observer n=46
WLC Group @ T0
Participant n=70
Observer n=45
Withdrawn
Participant n=6
Observer n=2
Withdrawn
Participant n=3
Observer n=1
Withdrawn
Participant n=2
Observer n=0
App+ Group @ T1
Participant n=64
Observer n=36
App usage n=53
App Group @ T1
Participant n=69
Observer n=34
App usage n=49
WLC Group @ T1
Participant n=67
Observer n=28
App usage n/a
Withdrawn
Participant n=0
Observer n=0
Withdrawn
Participant n=1
Observer n=1
Withdrawn
Participant n=2
Observer n=0
App+ Group @ T2
Participant n=64
Observer n=36
App usage n=53
App Group @ T2
Participant n=67
Observer n=34
App usage n=49
WLC Group @ T2
Participant n=6
Observer n=28
App usage n=??
Withdrawn
Participant n=0
Observer n=1
Withdrawn
Participant n=1
Observer n=1
Withdrawn
Participant n=1
Observer n=0


Group
App only
App+
Perceived stress change
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
19
10
5
11
4
13
7
15
< 0.5
0.5 to 1
1 to 2
2+
Meditation time (hrs)


Group
App only
App+
Perceived stress change
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
20
14
5
12
3
7
1
6
6
10
Up to 20%
40%
60%
80%
100+%
Percent engagement with SMWP app elements


Observed mindfulness
OMM total (EMMEANS)
40.0
37.5
35.0
32.5
30.0
T0
T1
T2
Timepoint
App
App+
Observed mindful awareness
OMM Awareness (EMMEANS)
15
13
11
9
T0
T1
T2
Timepoint
App
App+
Observed mindful acceptance
OMM Acceptance (EMMEANS)
15
13
11
9
T0
T1
T2
Timepoint
App
App+
Altruistic behaviours
OCB: Altruism (EMMEANS)
30
25
20
15
T0
T1
T2
Timepoint
App
App+

Bartlett, L. Martin, A., Kilpatrick, M., Otahal, P., Sanderson, K., Neil, A.L. Does using a mindfulness app reduce employee stress? Results of a randomised controlled trial in a public sector workforce. Submitted to JMIR, May 2021.

SUPPLEMENTARY ONLINE MATERIALS

Please find the full published article at: https://doi.org/10.2196/preprints.30272

RCT protocol: Appendix C.2.
Participant invitation

App-based Mindfulness Training

for employee stress protection

We know that work can be stressful, and that accumulated stress has poor health and wellbeing outcomes. We also know stress can lead to safety, conflict and productivity problems at work.

There is good evidence (including from a 2015 pilot study) that workplace-based mindfulness training can reduce stress and improve employee health and wellbeing. The pilot study results suggested that because of the wide range of work schedules and locations of the State Service workforce, flexible delivery might be more suitable than standard class-based training.

So, in the first half of 2018 the Smiling Mind Workplace App training program will be rolled out to about 400 public sector employees in Tasmania. The State Service Management Office, Department of Premier and Cabinet, has partnered with the University of Tasmania's Menzies Institute for Medical Research to study the effectiveness of this approach to stress management training.

Participating in the training requires that you register for

UNIVERSITY of TASMANIA MENZIES Institute for Medical Research

Program Details

Expression of Interest:

To register your interest for this training/study:

1. Review the **Study Information Pack** for participants and informants
2. Obtain approval to participate from your manager
3. **Register your interest**

Timeline:

30 November 2017 - registrations close

2018

the study, which involves completing four surveys over 12 months. Participants will be randomly assigned into 3 different training groups:

- Group A (App+ group) - self guided use of the App plus 4 x 1 hour seminars
- Group B (App group) - self guided use of the App without the need to attend seminars
- Group C (WLC group) - self guided use of the App plus 1 x 2 hour seminar. This group commences training after the other two groups have finished and will act as the study's wait-list control.

Once you have registered you will be asked to complete the baseline survey, which includes eligibility screening for the research. When you are accepted into the study you will be randomly allocated to a group and advised your training dates and details.

At the end of the study the survey data will be used to compare outcomes by group. All analyses are on de-identified data and no individual outcomes will be known or reported.

Participant requirements

- A smart phone, tablet or other device that can be used in personal time as well as at work
- A commitment to do the four surveys
- A commitment to attend seminars on the scheduled dates. Seminars for those in the App+ group will be held in Hobart and Launceston, with video conference attendance available in Burnie. Online participation for those located in more remote areas may be arranged.

You will be invited to nominate up to two work-based people (informants), who are willing to respond to a series of brief survey questions about you four times over the 12-month study period. Nominating informants is not compulsory, but it is encouraged as it will help us understand any social effects that arise following training.

16 February - survey 1 completed

23 February - groups allocated

2 March - App available to App and App+ groups

6 March - seminar 1 for App+ group

20 March - seminar 2 for App+ group

27 March - seminar 3 for App+ group

10 April - seminar 4 for App+ group

4 May - survey 2 completed

15 May - seminar and App available to WLC group

18 August - survey 3 completed

22 February 2019 - survey 4 completed

Print this flyer

Cost

$95.00 (GST inc) this covers administration and delivery of the seminars and a 12 month licence for the App. This fee will be covered by

About the App

All participants will receive a 12 month licence to the *Smiling Mind* workplace App. This App is different to *Smiling Mind's* freely available one. It is richer in content, uses explanatory videos and is designed for use by working adults. The App has been designed by organisational psychologists to address challenges common in today's working environments.

Module 1 - Everyday Mindfulness (Introduction, moving with awareness)
Module 2 - Calm (Focusing on stress, transition and change management)
Module 3 - Clarity (Building concentration and focus)
Module 4 - Connection (With yourself, others and bringing out the inner leader)
Module 5 - Mindful Mastery (Consolidating skills and building routine)

Features of the App include:

- Exercises that develop skills for detecting and coping with stress
- Activities aimed at cultivating concentration and focus, managing change and transition, and building leadership attributes
- Daily practices such as brain break and sitting exercises, with about 30 brief guided mindfulness meditations customised for use at work
- Practical activities to help bring moments of informal mindfulness into the everyday, such as moving with awareness between meetings, breathing techniques, listening exercises
- Regular emails with tips from an experienced mindfulness teacher to help embed learning into daily life.

your employer

Terms and Conditions

Expressions of interest are subject to agency review and approval of funding.

Acceptance into the study is subject to a suitability screening process undertaken after completing the first survey.

More information:

P 03 6232 7511
E ttc@dpac.tas.gov.au

To view all courses visit www.ttc.tas.gov.au

Tasmania
Explore the possibilities

Bartlett et al. Does using a mindfulness app reduce employee stress? Results of a randomised controlled trial in a public sector workforce.

Supplementary online materials

The Smiling Mind Workplace Program – history, structure and contents

The archive, source code and algorithms for the SMWP app are the commercial property of Smiling Mind. Please contact Smiling Mind directly to gain access for review - info@smilingmind.com.

Smiling Mind is a not-for-profit Australian organisation founded in 2012. The marketed SMWP, which utilises the SMWP App, was designed by organisational psychologists from IBM Australia New Zealand and mindfulness expert and psychologist Olivia Downing. The objective of the SMWP is to enable working adults to develop mindfulness skills and embed mindfulness practices into daily life. The program was developed using an iterative approach incorporating data obtained through employee interviews, organisational review and extensive pilot testing. An internal (unpublished) evaluation of participant satisfaction with the program, user experience and pre-post efficacy for stress, wellbeing and productivity preceded release of the market-based SMWP in 2014.

The established SMWP runs for eight weeks and involves a series of learning modules delivered in four interactive one-hour workshops led by a Smiling Mind facilitator. Each workshop has a key message: choosing to respond mindfully to stressors; remaining calm in the face of demands; managing attention wisely; and cultivating good relationships with the self and others. The workshops are run in conjunction with self-guided use of the SMWP App. The SMWP App includes 41 elements containing the videos and audio lessons, guided meditations and practical activities such as moving with awareness between meetings, breathing techniques and listening exercises to help cultivate workplace mindfulness. Use of the SMWP App is supported by an eight-week communications strategy, which comprises fortnightly generic emails relating to the content covered in the workshops and app-based lessons. The recommended minimum engagement with the SMWP App includes undertaking between 10 and 20 minutes per day of guided mindfulness meditation practice and/or activities.

The Smiling Mind Workplace Program: App contents

Module	Content and practices
Introduction to Mindfulness	What is Mindfulness? Get started: 1 Minute exercise The next step: 5 Minute exercise
Module 1 – Everyday Mindfulness	VIDEO – Everyday Mindfulness Brain break: the breath Daily 7 Minute Sitting Practice Moving with Awareness Daily Body Scan Eating with Awareness Practical activity 1: S.T.O.P and breathe
Module 2 - Calm	VIDEO - CALM Brain break: Pause & Reset Stress Management Managing Transitions and Change Work wind down Sleep: rest, relax, dream. Practical activity 2: Meditation Corridor/Stairs

Module 3 - Clarity	VIDEO - CLARITY Brain break: Take a closer look Starting your day Daily 15 Minute Sitting Practice Concentration and Focus Creativity Practical activity 3: Curiosity
Module 4 - Connection	VIDEO - CONNECTION Daily Brain Break Daily 7 Minute Sitting Practice Connecting with Yourself Connecting with Others Connecting with your Inner Leader Practical activity 4: Deep Listening
Module 5 - Mindfulness Mastery	Building resilience Decision making Befriending your inner critic Communicating mindfully
Daily Practices	3 Minute Brain Break 7 Minute Sitting Practice 15 Minute Sitting Practice 15 Minute Body Scan

The Smiling Mind Workplace App+ Seminar Series

<u>Workshop 1: Introduction</u>

The key message is that we as individuals can choose how we respond to the stressors we find at work and at home and can manage our modern lives with more Clarity, Calm and Connection through bringing the skill of mindfulness into our lives.

The introductory session will address the following areas:

- Why is mindfulness and meditation important in business now?
- Impacts of stress on health, happiness and productivity
- A brief overview of the science of mindfulness
- Key benefit of mindfulness at work
- What is mindfulness and what is meditation?
- How do we practice mindfulness formally and informally at home and at work?
- Default vs. Active mode of the brain
- Formal meditation practice and debrief
- 6 Key Mindfulness Mindsets
- Neuroplasticity and mindfulness and the brain
- Practical Mindfulness Tool Kit
- Individual Commitments to bringing mindfulness into the work day

<u>Workshop 2: Calm</u>

The key message in this session is that even though there are more demands placed on us now than any other time in history due to, among other things, technology, globalization and constant change we can manage our stress and emotional responses with more ease through practicing mindfulness.

- Reflection of personal responses to stress
- Overview of flight or fight response
- Stress and Performance – how can stress serve us?
- Emotions and Emotional Intelligence at work
- Mindfulness Mindsets – Non-judgement and Letting Go
- Formal Mindfulness Practice
- Practical Tools – Mindsets, Practices and Actions
- Individual commitments to bringing more Calm into the workplace

Workshop 3: Clarity

The key message in this session is that we all have access to more mental horsepower than we are currently using, we just need to learn how to manage our attention more wisely. Mindfulness and meditation help us to do this.

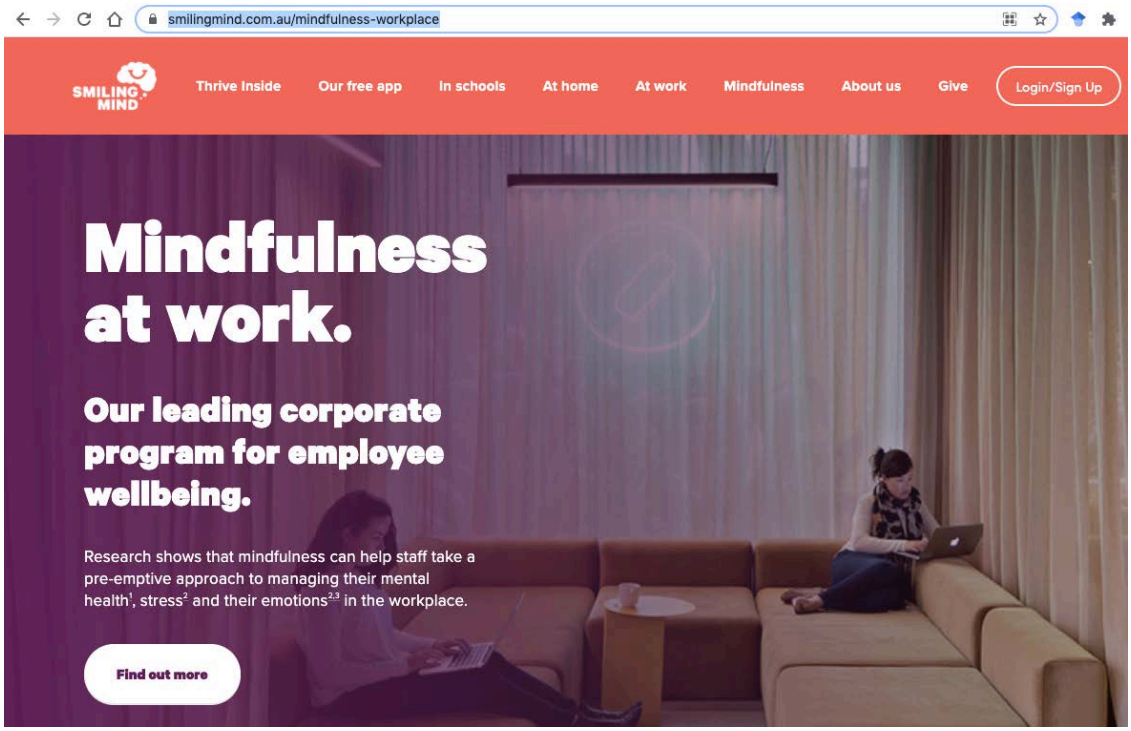
- What is the impact of mindlessness on our performance?
- Exploring when individuals feel most in flow
- Mindfulness can upgrade the hardware of the brain
- Focus and Memory
- Creativity and Innovation
- Mindfulness Mindsets – Beginners' Mind & Non-Striving
- Formal Meditation Practice
- Intuitive decision making and problem solving
- Practical Tools – Mindsets, Practices and Actions
- Individual Commitments to bringing more Clarity into the workplace

Workshop 4: Connection

The key message for this session is that we are not currently maximizing the access we could have to deeper relationships with both ourselves and others. Building our Mindfulness skills can support us to develop more self-awareness and self-respect and in turn more collaborative team relationships as well as authentic leadership skills.

- We are all wired for connection – mindfulness can help us to satisfy this need
- Formal Meditation Practice
- Building self-awareness (the foundation of emotional intelligence) and self-respect
- Mindfulness Mindsets – Compassion & Acceptance
- Teamwork and Mindful Listening
- How to become and authentic leader
- Practical Tools – Mindsets, Practices and Actions

- Individual Commitments to bringing more Connection into the workplace
- 4-Session Program Review
- Organizational Mindfulness Initiatives



Supplementary Table S.1. Raw productivity and workplace incident data by group and timepoint

Group	WLC						App						App+					
Timepoint (n responses)	T0 (n=70)		T1 (n=64)		T2 (n=45)		T0 (n=71)		T1 (n=48)		T2 (n=39)		T0 (n=70)		T1 (n=55)		T2 (n=43)	
Health-related lost productive days, n (%)																		
None	44	(63)	30	(43)	36	(51)	36	(51)	39	(55)	47	(66)	39	(56)	43	(61)	49	(70)
Up to one day	11	(16)	18	(26)	13	(19)	16	(23)	10	(14)	3	(4)	12	(17)	10	(14)	4	(6)
One to three days	10	(14)	15	(21)	7	(10)	12	(17)	13	(18)	15	(21)	13	(19)	9	(13)	10	(14)
More than three days	5	(7)	7	(10)	14	(20)	7	(10)	9	(13)	6	(9)	6	(9)	8	(11)	7	(10)
Absenteeism days, n (%)																		
None	56	(80)	40	(63)	30	(60)	54	(76)	36	(69)	27	(66)	54	(77)	40	(70)	30	(67)
Up to two days	13	(19)	19	(30)	11	(22)	12	(17)	11	(21)	11	(27)	13	(19)	11	(19)	10	(22)
Two to five days	1	(1)	3	(5)	5	(10)	3	(4)	3	(6)	2	(5)	3	(4)	5	(9)	4	(9)
More than five days	0	0	2	(3)	4	(8)	2	(3)	2	(4)	1	(2)	0	0	1	(2)	1	(2)
Presenteeism days, n (%)																		
None	41	(59)	32	(50)	21	(42)	41	(58)	22	(42)	20	(49)	43	(61)	32	(56)	28	(62)
Up to two days	16	(23)	12	(19)	10	(20)	14	(20)	11	(21)	8	(20)	12	(17)	13	(23)	12	(27)
Two to five days	8	(11)	16	(25)	15	(30)	11	(16)	12	(23)	8	(20)	8	(11)	6	(11)	3	(7)
More than five days	5	(7)	4	(6)	4	(8)	5	(7)	7	(14)	5	(12)	7	(10)	6	(11)	2	(4)
Productivity on presenteeism days, n (%)																		
100% productive	47	(76)	33	(60)	22	(51)	41	(63)	23	(54)	20	(54)	44	(70)	33	(73)	28	(76)
75% or more	6	(10)	13	(24)	8	(19)	9	(14)	10	(23)	11	(30)	13	(21)	6	(13)	4	(11)
50% to 75%	7	(11)	9	(16)	11	(26)	15	(23)	10	(23)	5	(14)	6	(10)	5	(11)	4	(11)
50% or less	2	(3)	0	0	2	(5)	0	0	0	0	1	(3)	0	0	1	(2)	1	(3)
Work successes, n (%)	18	(26)	19	(30)	13	(28)	28	(39)	18	(38)	17	(42)	18	(26)	21	(38)	17	(39)
Work failures, n (%)	4	(6)	7	(11)	4	(9)	10	(14)	8	(17)	4	(10)	6	(9)	2	(4)	3	(7)
% Impacted, M (SD)	71	(9)	78	(9)	75	(8)	73	(21)	61	(26)	82	(11)	65	(14)	81	(1)	78	(20)
% Recovered, M (SD)	60	(30)	41	(13)	76	(31)	51	(25)	63	(40)	41	(28)	70	(22)	87	(18)	66	(46)
Work accidents, n (%)	4	(6)	3	(5)	2	(4)	5	(7)	3	(6)	2	(5)	1	(1)	0	-	1	(2)
% Impacted, M (SD)	57	(42)	62	(16)	63	(18)	85	(14)	83	(9)	74	(3)	90	-	-	-	34	-
% Recovered, M (SD)	74	(29)	69	(9)	98	(4)	80	(20)	34	(49)	78	(4)	25	-	-	-	87	-

WLC: Wait-list control group; App: Self-guided App use; App+: Self-guided App use supported with classes; T0: Baseline; T1: Post-intervention; T2: Six-months from baseline

Table S.2. Intervention effect estimates by group and timepoint: observer-reported outcomes

Outcomes	Estimated marginal means by timepoint						T0:T1 Effect estimates					T0:T2 Effect estimates				
	T0		T1		T2		App+ and App vs WLC					App+ vs App				
OMM total	M	SE	M	SE	M	SE	β	SE	p	d	95%CI	β	SE	p	d	95% CI
WLC	35.31	(0.86)	36.05	(0.91)			REF									
App	36.08	(0.82)	37.09	(0.84)	36.31	(0.89)	0.27	(0.88)	0.77	0.18	-0.23, 0.59	REF				
App+	35.38	(0.82)	37.21	(0.83)	38.31	(0.89)	1.09	(0.87)	0.22	0.20	-0.21, 0.62	2.71	(0.97)	0.01*	0.34	-0.08, 0.75
OMM Awareness																
WLC	11.50	(0.36)	11.73	(0.38)			REF									
App	11.88	(0.34)	12.43	(0.35)	11.98	(0.37)	0.33	(0.43)	0.44	0.29	-0.13, 0.70	REF				
App+	11.35	(0.34)	12.44	(0.35)	12.70	(0.37)	0.86	(0.42)	0.04	0.29	-0.12, 0.71	1.25	(0.44)	0.01*	0.29	-0.12, 0.70
OMM Acceptance																
WLC	10.56	(0.37)	10.82	(0.40)			REF									
App	10.95	(0.35)	11.22	(0.37)	11.20	(0.38)	0.01	(0.45)	0.98	0.16	-0.26, 0.57	REF				
App+	10.65	(0.35)	11.37	(0.36)	12.03	(0.38)	0.46	(0.45)	0.31	0.22	-0.20, 0.63	1.13	(0.43)	0.01*	0.33	-0.09, 0.74
OCB Altruism																
WLC	22.25	(0.79)	21.27	(0.85)			REF									
App	22.83	(0.75)	21.61	(0.78)	22.89	(0.83)	-0.24	(0.97)	0.81	0.06	-0.35, 0.47	REF				
App+	22.08	(0.75)	22.57	(0.78)	23.56	(0.84)	1.47	(0.96)	0.13	0.24	-0.17, 0.65	1.41	(1.03)	0.17	0.12	-0.29, 0.53

Mean, SE, β, p: Estimated marginal means and effect estimates from maximum likelihood linear mixed models with age, sex, education and prior mindfulness exposure as auxiliary variables; * significant with α=0.05; d: Cohen's Standardized Mean Difference effect estimate computed using EMMEANS and SE. OMM: Observed Mindfulness Measure, range 9-45); OMM Awareness and Acceptance dimensions, range 3-15; OCB Altruism: Organisational Citizenship Behaviours Altruism dimension, range 5-30. WLC: Wait-List Control; App+ and App: active intervention group

Effects of a mindfulness app on employee stress: results of a randomised controlled trial in an Australian public sector workforce

Please visit https://doi.org/10.2196/preprints.30272 for the full article.

Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Checklist Item	***Explanation***	***Page Number***
Describe survey design	Describe target population, sample frame. Is the sample a convenience sample? (In "open" surveys this is most likely.)	p.4
IRB approval	Mention whether the study has been approved by an IRB.	p.4
Informed consent	Describe the informed consent process. Where were the participants told the length of time of the survey, which data were stored and where and for how long, who the investigator was, and the purpose of the study?	p.4-5
Data protection	If any personal information was collected or stored, describe what mechanisms were used to protect unauthorized access.	p.4 and supplementary
Development and testing	State how the survey was developed, including whether the usability and technical functionality of the electronic questionnaire had been tested before fielding the questionnaire.	p.5
Open survey versus closed survey	An "open survey" is a survey open for each visitor of a site, while a closed survey is only open to a sample which the investigator knows (password-protected survey).	Surveys were closed.
Contact mode	Indicate whether or not the initial contact with the potential participants was made on the Internet. (Investigators may also send out questionnaires by mail and allow for Web-based data entry.)	No
Advertising the survey	How/where was the survey announced or advertised? Some examples are offline media (newspapers), or online (mailing lists – If yes, which ones?) or banner ads (Where were these banner ads posted and what did they look like?). It is important to know the wording of the announcement as it will heavily influence who chooses to participate. Ideally the survey announcement should be published as an appendix.	p.4
Web/E-mail	State the type of e-survey (eg, one posted on a Web site, or one sent out through e-mail). If it is an e-mail survey, were the responses entered manually into a database, or was there an automatic method for capturing responses?	p.4-5
Context	Describe the Web site (for mailing list/newsgroup) in which the survey was posted. What is the Web site about, who is visiting it, what are visitors normally looking for? Discuss to what degree the content of the Web site could pre-select the sample or influence the results. For example, a survey about vaccination on a anti-immunization Web site will have different results from a Web survey conducted on a government Web site	N/A
Mandatory/voluntary	Was it a mandatory survey to be filled in by every visitor who wanted to enter the Web site, or was it a voluntary survey?	voluntary

Incentives	Were any incentives offered (eg, monetary, prizes, or non-monetary incentives such as an offer to provide the survey results)?	No
Time/Date	In what timeframe were the data collected?	p.4
Randomization of items or questionnaires	To prevent biases items can be randomized or alternated.	N/A
Adaptive questioning	Use adaptive questioning (certain items, or only conditionally displayed based on responses to other items) to reduce number and complexity of the questions.	Yes
Number of Items	What was the number of questionnaire items per page? The number of items is an important factor for the completion rate.	Each questionnaire had a separate survey page.
Number of screens (pages)	Over how many pages was the questionnaire distributed? The number of items is an important factor for the completion rate.	A maximum of 12 pages of questions was presented.
Completeness check	It is technically possible to do consistency or completeness checks before the questionnaire is submitted. Was this done, and if “yes”, how (usually JAVAScript)? An alternative is to check for completeness after the questionnaire has been submitted (and highlight mandatory items). If this has been done, it should be reported. All items should provide a non-response option such as “not applicable” or “rather not say”, and selection of one response option should be enforced.	Yes, completeness was assessed at data analysis
Review step	State whether respondents were able to review and change their answers (eg, through a Back button or a Review step which displays a summary of the responses and asks the respondents if they are correct).	Participants could go back to view responses prior to submitting the final survey.
Unique site visitor	If you provide view rates or participation rates, you need to define how you determined a unique visitor. There are different techniques available, based on IP addresses or cookies or both.	Unique codes applied by RedCap linked the email addresses to the participants’ study identifier and

		ensured survey access was per protocol.
View rate (Ratio of unique survey visitors/unique site visitors)	Requires counting unique visitors to the first page of the survey, divided by the number of unique site visitors (not page views!). It is not unusual to have view rates of less than 0.1 % if the survey is voluntary.	N/A
Participation rate (Ratio of unique visitors who agreed to participate/unique first survey page visitors)	Count the unique number of people who filled in the first survey page (or agreed to participate, for example by checking a checkbox), divided by visitors who visit the first page of the survey (or the informed consents page, if present). This can also be called “recruitment” rate.	N/A
Completion rate (Ratio of users who finished the survey/users who agreed to participate)	The number of people submitting the last questionnaire page, divided by the number of people who agreed to participate (or submitted the first survey page). This is only relevant if there is a separate “informed consent” page or if the survey goes over several pages. This is a measure for attrition. Note that “completion” can involve leaving questionnaire items blank. This is not a measure for how completely questionnaires were filled in. (If you need a measure for this, use the word “completeness rate”.)	Attrition was tracked throughout the study because the sample was known.
Cookies used	Indicate whether cookies were used to assign a unique user identifier to each client computer. If so, mention the page on which the cookie was set and read, and how long the cookie was valid. Were duplicate entries avoided by preventing users access to the survey twice; or were duplicate database entries having the same user ID eliminated before analysis? In the latter case, which entries were kept for analysis (eg, the first entry or the most recent)?	No
IP check	Indicate whether the IP address of the client computer was used to identify potential duplicate entries from the same user. If so, mention the period of time for which no two entries from the same IP address were allowed (eg, 24 hours). Were duplicate entries avoided by preventing users with the same IP address access to the survey twice; or were duplicate database entries having the same IP address within a given period of time eliminated before analysis? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	No

Log file analysis	Indicate whether other techniques to analyze the log file for identification of multiple entries were used. If so, please describe.	No
Registration	In "closed" (non-open) surveys, users need to login first and it is easier to prevent duplicate entries from the same user. Describe how this was done. For example, was the survey never displayed a second time once the user had filled it in, or was the username stored together with the survey results and later eliminated? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	Surveys were only available if the respondent used the link embedded in the invitation email and were unavailable after completion.
Handling of incomplete questionnaires	Were only completed questionnaires analyzed? Were questionnaires which terminated early (where, for example, users did not go through all questionnaire pages) also analyzed?	No, all data were included in analyses.
Questionnaires submitted with an atypical timestamp	Some investigators may measure the time people needed to fill in a questionnaire and exclude questionnaires that were submitted too soon. Specify the timeframe that was used as a cut-off point, and describe how this point was determined.	N/A
Statistical correction	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for the non-representative sample; if so, please describe the methods.	No