STAPP@Work: A Mobile Self-Management Application for Reducing Work Stress and Preventing Burnout: Single-Case Experimental Design Study

Sevda Demirel, Yvette Roke, Adriaan W Hoogendoorn, Jamie Hoefakker, Kirsten Hoeberichts, Peter N van Harten

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Sevda Demirel[1] MSc; Yvette Roke[1] MD, PhD; Adriaan W Hoogendoorn[2] PhD; Jamie Hoefakker[1] MSc; Kirsten Hoeberichts[1] MD, PhD; Peter N van Harten[3, 4] MD, PhD

[1]Expertise Center Specialized in Autism Spectrum Disorder GGz Centraal Almere NL
[2]Department of Psychiatry Amsterdam UMC Amsterdam NL
[3]Department of Psychiatry GGz Centraal Amersfoort NL
[4]Department of Psychiatry and Neuropsychology School of Mental Health and Neuroscience Maastricht University Maastricht NL

Corresponding Author:
Sevda Demirel MSc
Expertise Center Specialized in Autism Spectrum Disorder
GGz Centraal
Randstad 20, 27C
Almere
NL

Abstract

Background: Work-related stress and burnout remain a common problem among employees leading to impaired health and higher absenteeism. Use of mobile health apps to promote well-being has grown substantially, however, the impact of such apps on reducing stress and preventing burnout is limited.

Objective: This study aimed to assess the effectiveness of STAPP@Work, a mobile based stress management intervention, on perceived stress, coping self-efficacy and the level of burnout among mental health employees.

Methods: A study using a single-case experimental design was conducted among mental health employees without a known diagnosis of burnout (n=63). Participants have used the app one week per month repeatedly for a period of six months. Using a reversal design, the intervention was applied for a total of six times to assess replicated immediate (1-weeks post-use) and lasting (3-weeks post-use) effects. The Perceived Stress Scale, Coping Self-Efficacy Scale and Burnout Assessment Tool were used to measure outcomes. Linear mixed models were used to analyze the data.

Results: After six months of app use for one week per month the participants showed a statistically significant decrease in perceived stress (b=-0.38, 95% CI -0.67 to -0.09; P=.01, d=0.50) and burnout symptoms (b=-0.31, 95% CI -0.51 to -0.08; P=.002, d=0.63) as well as a statistically significant improvement in problem-focused coping self-efficacy (b=0.42, 95% CI 0.00 to 0.85; P=.049, d=0.42). Long-term use of the app provided consistent and sustained reductions in burnout symptoms including the level of exhaustion and emotional impairment.

Conclusions: The findings indicate that introducing an app-based stress management intervention can be feasible and successfully implemented to reduce burnout symptoms and enhance coping self-efficacy.

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[1]Expertise Center Specialized in Autism Spectrum Disorder, GGz Centraal, Almere, The Netherlands
[2] Department of Psychiatry, Amsterdam UMC, Amsterdam, The Netherlands
[3] Department of Psychiatry, GGz Centraal, Amersfoort, The Netherlands
[4] Department of Psychiatry and Neuropsychology, School of Mental Health and Neuroscience, Maastricht University, Maastricht, The Netherlands

Corresponding Author:
Sevda Demirel, MSc
Expertise Center Specialized in Autism Spectrum Disorder
GGz Centraal
Randstad 20-27c
Almere, 1314 BC
Netherlands
Phone: +31 41 80 73 29
Email: s.demirel@ggzcentraal.nl

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Results: After six months of app use for one week per month the participants showed a statistically significant decrease in perceived stress (*b*=-0.38, 95% CI -0.67 to -0.09; *P*=.01,

d=0.50) and burnout symptoms (*b*=-0.31, 95% CI -0.51 to -0.12; *P*=.002, *d*=0.63) as well as a statistically significant improvement in problem-focused coping self-efficacy (*b*=0.42, 95% CI 0.00 to 0.85; *P*=.049, *d*=0.42). Long-term use of the app provided consistent reductions in burnout symptoms over time, including the level of exhaustion and emotional impairment.

Conclusions: The use of an app-based stress management intervention has been shown to reduce burnout symptoms and enhance coping self-efficacy among mental health workers. Prevention of burnout and minimizing suffering from work-related stress is of utmost importance to protect employee health and reduce absenteeism.
Keywords: mental health; stress; coping; burn-out; stress management; digital intervention; health promotion; mobile apps; mHealth; mental health professionals

Introduction

Work-related stress continues to be a burden among employees and organizations by negatively impacting health outcomes and reducing job performance [1]. Stress is often defined as a condition in which an environmental demand exceeds the natural regulatory capacity of an organism, in particular in situations that are unpredictable and uncontrollable [2]. Numerous studies over the last several decades have demonstrated that psychosocial stress adversely affects hormonal processes and organ systems in the body [3–6]. Excessive stress has a detrimental effect on mental health by causing emotional distress as well as increasing the risk of mental illnesses such as depression, anxiety and burnout [7].

Burnout is defined as a psychological syndrome primarily caused by a prolonged period of stress and the inability or unwillingness to cope effectively, resulting in both physical and mental exhaustion [8]. The term burnout is often used in occupational context in which stress originates from the work environment. Such job stressors include heavy workload, long working hours, job insecurity, conflicts, low support, role ambiguity and lack of autonomy [9]. When work stress is of long duration without applying effective coping strategies, job demands exceed the capacities leading to depletion of one's emotional, physical and cognitive resources [9]. Individual consequences further include job dissatisfaction, depersonalization, cynicism and low fulfilment [10]. Organizational consequences include absenteeism, reduced productivity levels, a higher turnover rate and an increase in healthcare costs [9,11]. Organizations may incur financial costs not only from losing and replacing experienced staff, but also by providing employee burnout support, implementing employee assistance programs and the facilitation of reintegration processes [11-14]. Having a burnout causes significant suffering due to symptoms such as chronic fatigue, trouble sleeping, depressive symptoms and difficulties with concentration and memory [9]. In 2021, around 17% of Dutch employees reported being mentally fatigued by their work, 16% emotionally exhausted and 15% completely exhausted after work [15]. Moreover, the Dutch healthcare sector had one of the highest proportion of employees experiencing work-related mental exhaustion being 20% [16].

Effective interventions in preventing work-related stress and burnout are of high importance. The use of digital health, including mobile apps, as behavioral interventions to promote positive mental health is rapidly growing. The benefits of mobile mental health interventions include, but are not limited to, high accessibility, low costs, less time consuming, no clinician involvement, timely support and promoting autonomy [17]. A recent systematic review found that mindfulness was the most common applied theory-based stress management strategy in apps [18]. They further concluded that such apps implemented stress prevention strategies

less often than stress management strategies for stress recovery [18]. However, stressor identification and reduction, as primary prevention, is a crucial element in effective stress management [19]. Moreover, another review found that only a few stress management apps combined both stress monitoring and intervention based on detecting users' stress levels [20].

Previous studies examining the effectiveness of web- and app-based interventions among employees provided evidence of effectiveness on stress reduction [21]. Improvements regarding emotional exhaustion and perceived stress in healthcare professionals using digital interventions were reported earlier as well [22,23]. However, the few available studies on apps for healthcare workers yielded mixed findings on stress and were often based on mindfulness practices or psychoeducation. For instance, two randomized controlled trials (RCT) assessing an app among healthcare workers found no significant improvements in stress [24,25]. Whereas, other mindfulness-based apps did find improvements in stress among physicians, nurses and therapists [26], hospital nurses [27] and employees within the general practitioner practice [28]. Little is known regarding the effectiveness of app-based interventions aimed at stress management and burnout symptoms among employees and specifically healthcare professionals. Moreover, there is a lack of evidence in the sustained effects of long-term use of such app-based interventions [29].

Mobile-based ecological momentary interventions (EMIs) comprise an emerging area of research. These interventions are based on the ecological momentary assessment (EMA), a widely used tool within psychiatry to collect repeated daily assessments of individual's behaviors, emotions, experiences, or thoughts as they occur in their own 'real-world' settings [30]. EMA is seen as a promising method that provides insight into variations in symptoms and behavior over time and its underlying person-environment interactions. EMIs offer interventions in the moment of an individual's daily life, usually based on the assessment [31]. Previous studies on the effects of EMIs showed a positive overall medium effect on stress in clinical populations [32]. No study to date has assessed the effectiveness of a mobile stress management intervention based on stress monitoring among healthcare workers.

In order to bridge this gap, our group developed a self-management stress-signaling app in co-creation with employees, called STAPP@Work. The app is developed to monitor daily stress levels and track the daily activities in employees' natural settings, including work settings, based on the principles of EMA. STAPP@Work is a tool to manage stress at work, by providing the employee feedback regarding their tracked stress levels and associated activities and creates a visual overview to make stress patterns during workdays and weeks visible. Furthermore, the app provides real-time suggestions for coping strategies specified for both the work environment and at home. The aim of this study was to evaluate the effectiveness of the STAPP@Work app by examining perceived stress, coping self-efficacy and burnout symptoms. Based on the research outlined above, we hypothesized that after six months of using the STAPP@Work app for one week per month, perceived stress and coping self-efficacy would be improved and burnout symptoms would be reduced in mental health workers. Additionally, we explored the progression of perceived stress, coping self-efficacy and burnout scores over time to examine lasting effects.

Methods

Study Design

This study adopted a single-case experimental design (SCED), a within-subjects design measuring the effectiveness of interventions [33]. Using a SCED, it became possible to focus on individual changes in outcomes (perceived stress, coping self-efficacy and burnout symptoms) over time. This design was considered to be a good fit as it enabled the assessment of behavior change over time in "real-world" settings using heterogeneous samples [33]. Moreover, SCEDs are often used to capture small but meaningful differences in behavior and to examine behavior that may change gradually over time, which is not feasible to assess in RCTs with a high number of successive measurements [34]. Additionally, SCEDs are suitable for being able to evaluate the effectiveness of novel innovative interventions before they are evaluated in time-consuming and costly RCTs [35]. The results of the current SCED study will provide an indication of whether it is worthwhile to conduct a large-scale RCT to further assess the effectiveness of the app [36]. Given that STAPP@Work is a novel behavioral intervention, using a SCED constituted a useful first step to measure its effectiveness.

Furthermore, an A1-B1-A2-B2 reversal design was used, in which A1 represents the baseline period, B1 the introduction of an intervention, A2 the withdrawal of the intervention and B2 the re-introduction of the intervention [36]. In the current study, this translated to the participants having used the STAPP@Work app for one week after the baseline period, followed by three weeks of non-use after which they used the app again for the second time for a week-long. Withdrawing the intervention allowed for an assessment of whether the effects of the app were lasting.

Sample Size

Due to the complexity and practical unfeasibility of sample size calculation for the current single-case experimental design, the sample size for this study was based on the traditional paired sample t-test design. Similar studies on stress management apps among healthcare employees are limited. Instead, we relied on a meta-analysis on the effectiveness of web- and app-based interventions on stress among employees, which found moderate-to-large effect sizes for mindfulness-based interventions and small-to-moderate effect sized for stress management interventions [37]. A medium effect size (d=0.5) was considered for the current sample size calculation. For the paired sample t-test, the sample size needed to detect a medium effect of d=0.5, assuming a low internal correlation r=0.1, resulted in 59 participants. Considering potential dropout of 7.5%, the required sample size was set at 63 participants.

Participants

Subjects were eligible to participate in the study when they were employed within GGz Centraal, the fourth largest mental healthcare institution in the Netherlands. No further in- or exclusion criteria were maintained. Recruitment strategies included the promotion of the study through flyers, digital media and approaching teams or staff in various departments.

The STAPP@Work app

STAPP@Work is a self-management app designed to manage stress and improve well-being through (1) measuring daily stress levels, (2) providing personal coping advice and (3) visualizing stress patterns. The app is based on a stresssignalingplan, a widely used tool in Dutch mental health institutions to monitor client's stress levels in relation to their mental health [38]. This allows for recognizing and dealing with early warning signs of distress. A

stresssignalingplan often consists of four phases: green, yellow, orange and red. Each phase characterizes how a person is feeling and what symptoms are associated, with the colors increasing from green (no stress) to red (very high stress) [38]. Furthermore, the plan describes both stress-inducing and protective factors as well as personal coping strategies to encourage the clients' self-management [38]. STAPP@Work includes the concept of a stresssignalingplan and the EMA method by assessing stress levels in daily life and ensuring that these are linked to specific moments and activities in a day. The app was designed in co-creation with mental health employees and based on their needs, ideas and experiences which were explored during focus group discussions. The ongoing iterative development of prototypes continued until the desired version of the STAPP@Work app was achieved.

Measuring Daily Stress

The app calculated daily stress levels by preparing a questionnaire. The employee could specify whether to complete two, three or four questionnaires per day via the settings of the app. The app required a minimum of two questionnaires, as there were four hours between each questionnaire and filling in two questionnaires would cover a working day of eight hours. If the employee chose to fill in three or four questionnaires a day, the app would cover a 12-hour or 16-hour period out of one day. On the homepage the user could see if a questionnaire was available to fill in as well as the results of the previous stress measurement as shown in Figure 1.

Each questionnaire became available for the user to complete within a 1-hour timeframe, probing activities that were performed in the past 4 hours and how one felt while doing so. Then it followed with seven stress signaling questions (eg, “Did you feel irritable?”, "Were you able to take good care of yourself?") to derive a stress level. The app calculates stress levels based on the answers of the seven stress questions. The stress questions were formulated and validated by focus group discussions and individual interviews with employees, following the design thinking method. The questions were not derived from an existing stress scale. The answer options for each stress question are as follows: 'no', 'yes, but not more than normal', ‘yes, more than normal' and 'yes, much more than normal'. A score is assigned to each answer option and from there the app computes a total stress score based on the answers of all seven stress questions. The app then assigns the user’s perceived stress to one of four categories: no stress, little stress, stress or a lot of stress, based on the total score from the stress-related questions. The app also asked for the user’s feedback on the assigned stress categories and gave personal coping advice.

Visual Overview

The app includes a visual overview of the assigned stress levels at both day and week level, helping the users to recognize their own stress patterns (Figure 1). The overview also showed which activities were associated with (a lot of) stress and no stress during the week.

Personal Coping Advice

During the exploratory focus groups and interviews, employees were also asked how they cope with stress at work and at home. Together with desk research and practitioner experience, a list of different effective approaches to coping with stress was formed referred to as coping strategies. This list forms the general list of predefined suggestions for coping in the app. Suggestions for coping at work included the following: contact or discuss the situation with a colleague, get moving, go walking, plan or make an overview, do breathing exercises, take a break, do something else and take care of yourself such as eating and drinking enough. However, the participants could add their own suggestions for coping to the list and remove existing suggestions. After each stress assessment, the app suggests a coping strategy displayed in text, which the app randomly selects from the personalized coping list of the user.

Personalization

The app was highly customizable as the users could choose how many questionnaires they wanted to fill out a day and at what times, to fit their working days. The app consisted of a list of activities created by mental health employees that fit within a workday, but users could add or remove activities as they wished. The same was true for coping advice of which the app provided a list of coping strategies which the user could have changed at any time.

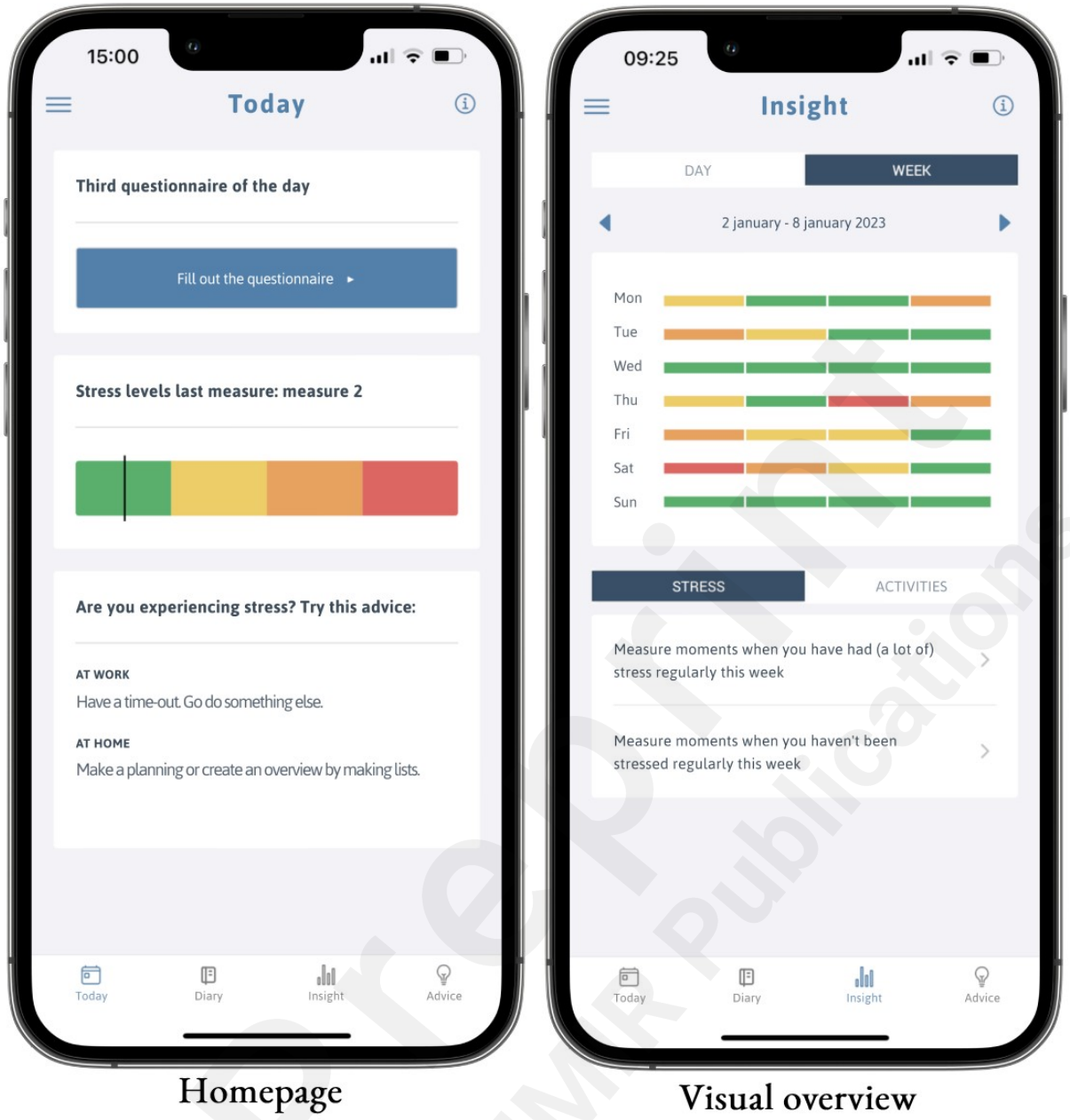


Figure 1. Screenshots of the homepage and the visual overview page of the STAPP@Work app (translated from Dutch).

Measures

Perceived Stress

The Perceived Stress Scale (PSS) is a 10-item self-report questionnaire that was used to measure how stressful certain situations were perceived in the past month (eg, “How often have you felt that you were in control of things”) with items rated on a 5-point scale ranging from 0 (never) to 4 (very often) [39]. The PSS has shown a good internal consistency (10 items; alpha=.84) [40].

Coping Self-efficacy

The 13-item version of the Coping Self-Efficacy Scale (CSES) measures one’s confidence in

various coping behaviors [41]. The CSES consists of three subscales which are problem-focused coping (6 items; alpha=.91), emotion-focused coping (4 items; alpha=.91), and social-support coping (3 items; alpha=.80) [41]. Items have a 10-point scale ranging from 0 (cannot do at all) to 10 (certain can do).

Burnout Symptoms

The shorter version of the Burnout Assessment Tool (BAT), which consists of a 12-item self-report questionnaire, determines the extent of which burnout symptoms are experienced (eg, “I do not recognize myself in the way I react emotionally at work”) rated from 0 (never) to 4 (always) [42]. Cronbach alpha has been shown to be similar to the full version of the BAT (23 items) [43]. The BAT (23 items; alpha=.90) is subdivided into four validated core dimensions which are exhaustion (8 items; alpha=.92), mental distance (5 items; alpha=.91), cognitive impairment (5 items; alpha=.92) and emotional impairment (5 items; alpha=.90) [42].

Procedure

A measurement involved filling out the questionnaire which was composed of the PSS, CSES and BAT items. The researchers sent the online questionnaire to all participants at each time of measurement, regardless of whether they had completed the previous questionnaire or not. A total of 17 measurements were obtained from the participants in a period of nine months. Of these, four were conducted during the baseline period and 12 during the intervention phase ending with one follow-up measurement. We chose to include four baseline measurements to account for possible learning effects by merely participating in the study. Being introduced to the study and responding to the questionnaires on stress could have possibly contributed to increased awareness of one’s own stress. During the 7-week baseline phase, participants completed the questionnaire every two weeks. After the baseline measurement, the research team provided individual explanatory sessions on installing, setting up and using the STAPP@Work app, and the proceedings of the experiment. Participants could communicate their comments and questions regarding the study as well as make inquiries about app functionalities to the available help desk.

The intervention concerns a daily use of the STAPP@Work app for one week, called the intervention week. After the withdrawal of the intervention, a questionnaire was completed in the week after use (1-week post-use) and 3 weeks after use (3-weeks post-use) in order to examine the immediate and lasting effects, respectively. The introduction and withdrawal of the intervention was repeated six times throughout the intervention phase. A follow-up measurement took place six weeks after the last time the app was used. Figure 2 describes the order of events.

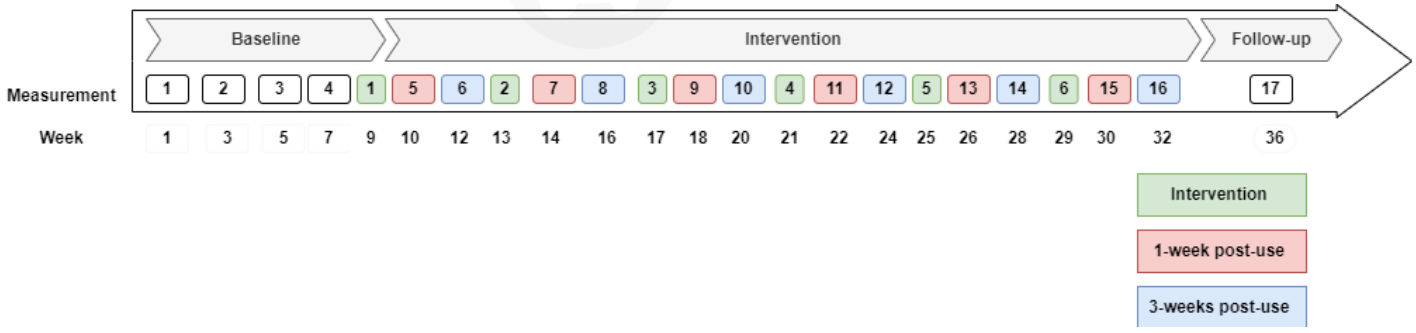


Figure 2. Schematic overview of the study design including timeline.

Statistical Analysis

All analyses were performed using SPSS (version 28.0). For the purpose of data analysis, mean scores were calculated from the total scores of the PSS, CSES and BAT including the subscales. Subscales of the CSES and BAT were included as separate outcome variables to gain more insights into the subdomains. Descriptive statistics were used to describe participant characteristics and to determine response rates over time. We assigned participants as early dropouts when they had failed to use the app for at least three times and definitively stopped participating Early dropouts were not included for data analysis. Linear mixed model (LMM) analysis was used to analyze the data [44]. LMMs are well suited for longitudinal intervention studies as they allow the measurement of change in the response variables across units of time and within subjects [45,46] as well as they account for missing values [47]. Change scores between baseline and all consecutive intervention measurements were modelled for all outcome variables. We chose the fourth and last baseline measurement (week 7) as a reference, to correct for learning effects during the baseline period [36].

When conducting the LMM, assumptions of normality and equal variance of residuals were checked using graphic representations. As the data were collected over time, the presence of autocorrelation was evaluated both visually by means of the partial autocorrelation function plot and by the Durbin–Watson statistic test. Accordingly, the appropriate covariance structure was chosen for the models for each outcome variable. Time was represented by (binary) week indicators that were included in the LMM as fixed effects, enabling the assessment of mean scores at each week of app use. For each outcome, Cohen d effect sizes were calculated for the mean change score from baseline to 6 months, standardized by baseline standard deviation. Using the LMM results, graphs were created to visually present the estimated mean scores of the outcomes, and thereby the progression over time. The significance level was set at alpha=0.05.

Ethical Considerations

In order to ensure data confidentiality, consideration has been given to secure data collection and storage. Data were collected via online questionnaires and stored in a folder of which the responses were only viewable by the researchers within the team who had access. Data were then anonymized and stored to a protected folder on a secure server of GGz Centraal of which access for a single researcher was protected by password and soft token-based authentication. This study was conducted in accordance with the Declaration of Helsinki, and approved by the Medical Ethics Committee of Isala Zwolle (211006211006) on November 11, 2021. Informed consent was obtained from all subjects involved in the study. The informed consent form included extensive information regarding the purpose of the study, procedures, data security and the participant's rights. Participation in the study was completely voluntary and without any compensation. Furthermore, use of the STAPP@work app is in accordance with the General Data Protection Regulation of the European Union.

Results

A total of 63 mental health employees were included in the study with 10 early dropouts, resulting in 53 participants. Of these, 74% (39/53) were female and the average age was 41 (SD 11.7) years (Table 1). Various mental health professions were included with the majority represented by nurses (22/53, 42%). The response rates of the participants ranged from 45% (24/53, by the end of the study) to 100% (53/53, at the start of the study) as presented in Table 2.

Table 1. Characteristics of the participants (N=53).

Variable		Value
Age in years, mean (SD)		41 (11.7)
Gender, n (%)		
	Female	39 (74%)
	Male	14 (26%)
Profession, n (%)		
	Nurse	22 (42%)
	Psychologist	7 (14%)
	Management function	7 (14%)
	Counselor	6 (12%)
	Staff member/advisor	4 (8%)
	Administration/IT function	3 (6%)
	Psychiatrist	2 (4%)

Table 2. Response rates among participants.

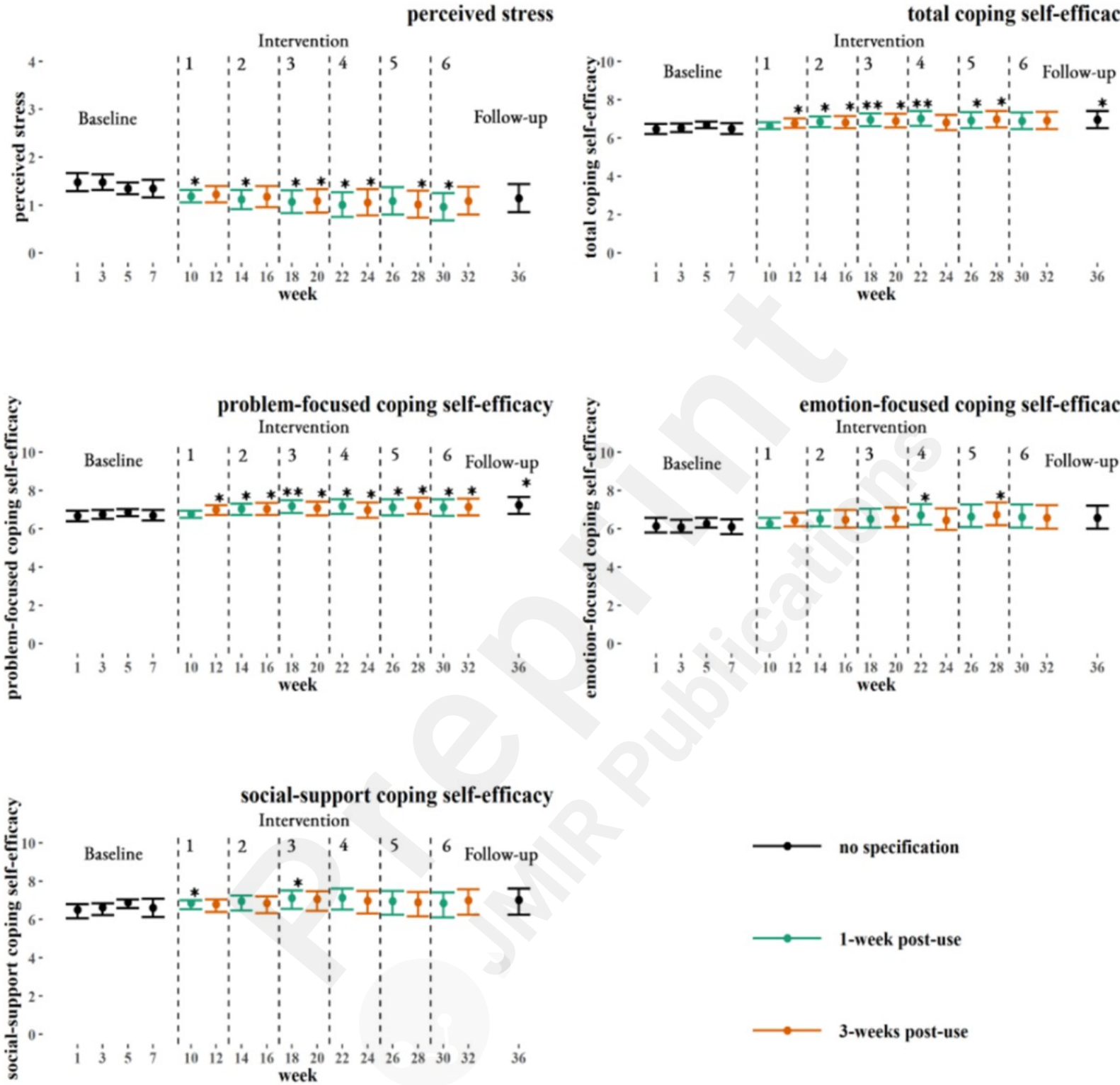
	Baseline				**Intervention**												**Follow-up**
ureme	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
nse	100 %	98 %	98 %	96 %	87 %	79 %	77 %	77 %	70 %	72 %	66 %	55 %	45 %	51 %	53 %	49 %	57 %

Perceived stress

The perceived stress score significantly improved after six months (*b*=-0.38, 95% CI -0.67 to -0.09; *P*=.01) compared to baseline, with a medium effect size (*d*=0.50) as presented in Table 3. Figure 3 shows a lower stress score after each intervention week for 1-week post-use except for the fifth intervention week. A significant decrease in stress score was not found at follow-up.

Table 3. Results of linear mixed model for all outcome variables: perceived stress, coping self-efficacy with subscales and burnout symptoms with subscales after 6 months of monthly 1-week app use.

Variable	*b* (95% CI)	SE	*P* value	*d*
Perceived stress	-0.38 (-0.67 to -0.09)	0.15	.01	0.50
Total coping self-efficacy[a]	0.40 (-0.03 to 0.83)	0.22	.07	0.37



b: Unstandardized beta coefficient, CI: Confidence Interval, SE: Standard Error, *d*: Cohen *d*, the standardized mean difference. [a] Total score of all 13 items on the CSES, [b] Total score of all 12 items on the BAT.

Figure 3. Graphs showing the progression of the estimated means from LMMs of perceived stress, total coping self-efficacy, problem-focused coping self-efficacy, emotion-focused coping self-efficacy and social-support coping self-efficacy over a 36-week period. The baseline, intervention and follow-up phase are presented. Each intervention week is indicated by the corresponding number. Error bars represent confidence intervals. **P*<.05, ***P*<.01 significant change from baseline (week 7).

Coping Self-efficacy

Coping self-efficacy did not significantly improve after six months of app use for one week per month (*b*=0.40, 95% CI -0.03 to 0.83; *P*=.07) as shown in Table 3. Focusing on the subscales, problem-focused coping abilities significantly improved after six months (*b*=0.42, 95% CI 0.00 to 0.85; *P*=.049) with a small to medium effect size (*d*=0.42) Emotion-focused coping (*b*=0.52, 95% CI -0.08 to 1.11; *P*=.09) and social-support coping (*b*=0.24, 95% CI -0.41 to 0.89; *P*=.47) were not significantly improved. Figure 3 shows significant consistent improvements in problem-focused coping starting from the second intervention week for both 1-week and 3-weeks post-use until follow-up. No significant consistent improvements were found regarding emotion-focused and social-support coping self-efficacy scores (Figure 3).

Burnout Symptoms

Table 3 shows a significant improvement in the measure of burnout symptoms after six months of app use for one week per month (*b* = -0.31, 95% CI = -0.51 to -0.12; *P*=.002) compared to baseline with a medium effect size (*d*=0.63). With regard to the subscales, a significant decrease was found for exhaustion (*b*=-0.38, 95% CI -0.68 to -0.08; *P*=.02) and emotional impairment (*b*=-0.42, 95% CI -0.68 to -0.16; *P*=.002). The effect sizes were found to be medium which were (*d*=0.50) and (*d*=0.69) respectively.

When examining the progression over time, a significant decrease in emotional impairment was found after the first week of app use and was sustained, for both 1-week post use and 3-weeks post-use, until follow-up (Figure 4). Consistent improvements following initial app use were found for exhaustion as well with no significant change at follow-up (Figure 4). No consistent and sustained improvements were found for the level of mental distance and cognitive impairment (Figure 4).

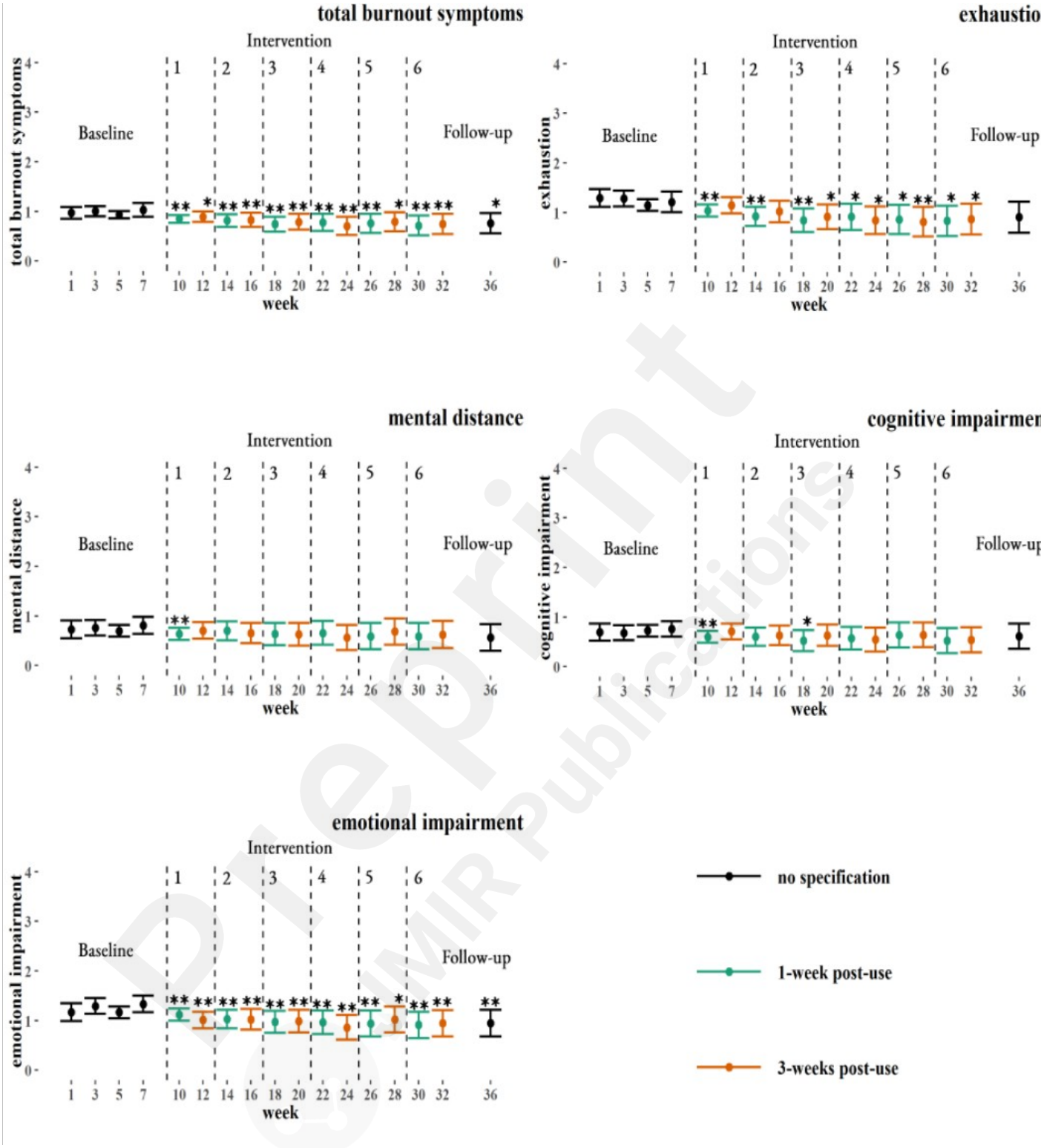


Figure 4. Graphs showing the progression of the estimated means from LMMs of total burnout symptoms, exhaustion, mental distance, cognitive impairment and emotional impairment over a 36-week period. The baseline, intervention and follow-up phase are presented. Each intervention week is indicated by the corresponding number. Error bars represent confidence intervals. *P<.05, **P<.01 significant change from baseline (week 7).

Discussion

Main Findings

The current effectiveness study showed that the participants using STAPP@Work were able to

consistently reduce their measure of burnout symptoms over time. Specifically, the findings yielded consistent improvements in exhaustion and emotional impairment of which a sustained improvement was found for emotional impairment. Simultaneously, the participants showed lasting improvements in their confidence of problem-focused coping abilities. Perceived stress levels were reduced after six months of monthly 1-week app use. Following the findings, the app provides a means for improving problem-focused coping strategies to cope effectively with job stressors and in reducing burnout complaints.

This study found lasting improvements in burnout symptoms. Although each participant scored a measure of burnout symptoms, it is important to emphasize that they did not have a known burnout diagnosis. All participants were working during the time of this study. From the findings it became apparent that particularly two core dimensions - exhaustion and emotional impairment - were consistently reduced. Improvements in exhaustion indicate that the employees felt less tired and experienced higher physical and mental energy levels at work [42]. A decrease in emotional impairment implies that the participants were able to improve their abilities to adequately control their own emotions at work [42]. The app providing insights into one's stress patterns and work-related stressors may have contributed to higher awareness and control over one's stress levels at work. This study's results showed reductions in perceived stress among the employees. The employees may have been able to reduce their stress as the app assessed their perceived stress several times a day, allowing to intervene early when stress levels were rising to prevent worse, similar to how a stresssignalingplan functions [38].

Moreover, they improved their problem-focused coping self-efficacy indicating an increased confidence of coping effectively by resolving the stressful situation or altering the source of the stress [41]. This suggests that the participants were more able to cope effectively with work-related stressors and demands resulting in lower exhaustion and higher control of emotional processes. Stress assessment and surveillance are crucial to determine the causal and contributing factors of stress according to the theory of preventive stress management (PSM) [19]. The PSM framework further encourages individual stress assessment assuming a transactional relationship between an individual and work-related stress due to individual differences [19]. STAPP@work calculated daily stress levels and created a personal overview in which one could see the moments and activities that were connected to high stress. This allowed the employee to recognize moments of high stress during the day and week as well as the associated activities to identify stress-inducing factors. This might have enabled employees to reduce, modify or manage the known work stressor to decrease or prevent the stress response, as primary prevention [19]. Addressing work stressors reduces high job demands leading to less fatigue and more energy as the job demands-resources model assumes that high job demands and low resources are important predictors for the exhaustion component of burnout [48].

The PSM theory argues that chronic stress that remains unaddressed and builds over time is manageable by providing interventions focused on both primary and secondary prevention [19]. The app touches upon secondary prevention by providing real-time suggestions for coping strategies to manage work stress. Stressful situations become more manageable and less threatening due to such effective coping strategies which act as a protective factor for the development of burnout [9]. Improvements in problem-focused coping self-efficacy were both immediate and lasting, suggesting that app use has led to the learning of problem-focused coping skills. In contrast, emotion-focused and social-support coping abilities did not

significantly improve and therefore, our hypothesis only supports problem-focused coping self-efficacy. The features of the app may have been especially profitable for problem-focused coping. Insights into stress patterns and daily stress levels through app use may have caused participants to be more proactive in identifying and resolving the cause of stress. Previous research has shown that individuals engaged more in problem-focused coping instead of emotion-focused coping when they were clearer and more communicative about their own emotions [49]. Therefore, participants gaining insights and self-reflection regarding their stress level may had little to gain by engaging in emotion-focused coping.

Indeed, the perceived stress level significantly reduced after six months, how-ever, when examining the effects over time, these were often to be found immediate instead of lasting with no significant change at follow-up. This suggests that the app is most effective by increasing awareness and control through app engagement whereas when the app is not being used and thus no feedback on stress level is provided, the effects wear off until the app is being used again.

The few studies examining mental health apps in relation to burnout have shown similar results in the improvement of burnout symptoms among employees [50] and specifically in reducing emotional exhaustion among healthcare professionals [23,51]. Furthermore, findings from a RCT assessing a self-management app among employees showed medium effects for reduction in perceived stress, lower emotional exhaustion and higher emotion regulation, which are consistent with our findings [52]. Most of the scientifically studied mental health apps were based on the theories of mindfulness, psychoeducation or cognitive behavioral therapy and were studied in RCTs [22,53]. The current findings add to the existing body of research by providing evidence that a stress-management app, aligned to the work environment and assessed in a naturalistic context, can reduce symptoms that are indicative of burnout and therefore has the potential to preventively avert the risk of burnout. Furthermore, this study provides insights into the sustained effects of mental health apps, which were often lacking in previous studies [29].

Strengths and Limitations

One of the strengths of this study includes the use of a SCED, which made it possible to offer the intervention to all participants as they were their own control [20] and enabled to measure the changes of each participant in “real-life” conditions rather than comparing it between two groups in a highly controlled setting [54]. Furthermore, the relatively long length of the experiment allowed for close observation of how stress, coping and burnout symptoms progressed separately over a 9-month period and whether these were learned over time, such as coping [33]. In addition, STAPP@Work involves an innovative design in which an app incorporates a stress signaling intervention and is of potential value in terms of reducing absenteeism.

There are several limitations to consider when interpreting this study. First, the participants may have induced social desirability bias. However, it is unlikely that such bias persisted several months after the intervention. Second, we observed that the number of missing values increased as the study progressed. Participants may have failed adherence due to loss of interest or other external circumstances. Though, LMMs can deal with dropout if the missing data mechanism is missing at random, which is the case if dropout depends on observed characteristics such as stress in the baseline period [47].

Third, each participant received the intervention at the same time following the baseline

period, as it was not feasible to measure baseline stability at individual level. Such stability is valuable to ensure that results are accountable to the intervention rather than to contextual influences [55]. This study did apply a reversal design contributing to a higher degree of experimental control by repeatedly introducing and withdrawing the intervention leading to a more robust demonstration of replicated effects resulting in higher internal validity [56]. Fourth, the small sample size and disproportionate representation of females limited the generalizability of the findings to a broader and more diverse population. However, the distribution of gender in the current study population corresponds to the distributions reported for Dutch mental health institutions [57]. Moreover, potential knowledge on stress management by mental health professionals restricts the generalizability to other industries or work settings as well. Lastly, as this study followed a within-subjects design it became more difficult to assess if changes occurring over time were a result of repeated use of the app or rather the cumulative effects of previous app use [36]. Yet, this did not limit the interpretation of whether such previous effects of the app were lasting.

Implications and Future Research

The preliminary results provided promising evidence that STAPP@Work is effective in reducing burnout symptoms and improving problem-focused coping. These findings build upon existing research by showing that a mobile health app can lead to sustainable effects and is able to address burnout-related symptoms. This is in particular of relevance for preventive implementation in organizations to prevent burnout. This self-management app may have the potential to offer support in occupational contexts to promote less absenteeism and a healthier workforce which are important for well-functioning and successful organizations. Also, the app has the potential to integrate into daily life to support employees during their workday or challenging periods. As the app helps to identify job stressors and provides coping advice suited for work environments, it can be implemented in any workplace to protect the health of employees and enhance job satisfaction.

Due to the high accessibility and autonomy, mobile interventions can be a more convenient and resource-saving way to prevent the onset of aggravated stress symptoms from within the workplace. This is especially relevant as recent challenges in the healthcare workforce include high-pressure working conditions and a shortage of workers, even though the number of employees increased in the last years [58]. It is of utmost importance to focus on the health of these employees who are putting effort to provide the best care for clients.

A SCED study is typically characterized as a within-subjects design. Hence, this design does not include a control group but instead employs longer baseline periods and multiple measures over time. This impeded the ability to draw firm conclusions on the effects of the app, especially to a larger group, and therefore highlights the need of future experimentally controlled studies investigating larger and more heterogeneous samples. Further qualitative research is necessary to complement the current findings, as it remains unclear how the app contributes to perceived stress, coping skills, and burnout symptoms. By exploring this context and examining the underlying mechanisms and motivations for employees' behavior, a richer understanding of users' experiences and more insight into the meaning of the app in everyday work life is created [59,60].

While the intervention resulted in a significant reduction in perceived stress immediately after using STAPP@work, this study found no significant change in stress levels at follow-up. This suggests that the effectiveness of the app in reducing stress on the short term did not persist on the long-term. This underscores the importance of conducting future research studies to investigate this specific aspect further. In addition, it would be beneficial to conduct further research on longer-term follow-up assessment to gain more insight into the lasting impact of

the app. Since the app shows to be promising in reducing burnout symptoms, it would be clinically relevant to explore the effect of the app on specific groups of individuals, for instance those with a history of burnout or absenteeism. Due to the accessibility of the app, it can offer solutions to those individuals who are in immediate need of support in managing their stress, such as clients who are on the waiting list for psychological help, which prompts further research ideas.

Conclusions

This intervention study showed that STAPP@Work, as a stress management app, is effective in reducing burnout symptoms and improving problem-focused skills among mental health workers. The preliminary findings specifically showed reductions in exhaustion levels and emotional impairment. Moreover, the effects of the app emerged consistently and sustainably over more than six months. This offers great opportunities for implementation at the workplace, as the app has the potential to prevent burnout and promote less suffering of stress-related complaints as well as a reduction in absenteeism.

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Data Availability

The data sets generated and analyzed during this study are available from the corresponding author on reasonable request.

Authors' Contributions

JH, KH and YR contributed to conceptualization, investigation, and project administration. AWH and SD contributed to data curation, formal analysis, methodology, validation, and visualization. SD contributed to writing of the original draft and review and editing of the manuscript. AWH contributed to review and editing of the manuscript. YR and PNVH contributed to supervision and review and editing of the manuscript.

Conflicts of Interest

None declared.

Abbreviations

EMA: Ecological Momentary Assessment
EMI: Ecological Momentary Intervention
BAT: Burnout Assessment Tool
CSES: Coping Self-Efficacy Scale
LMM: Linear Mixed Model
PSM: Preventive Stress Management
PSS: Perceived Stress Scale
RCT: Randomized Controlled Trial
SCED: Single-Case Experimental Design

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Supplementary Files

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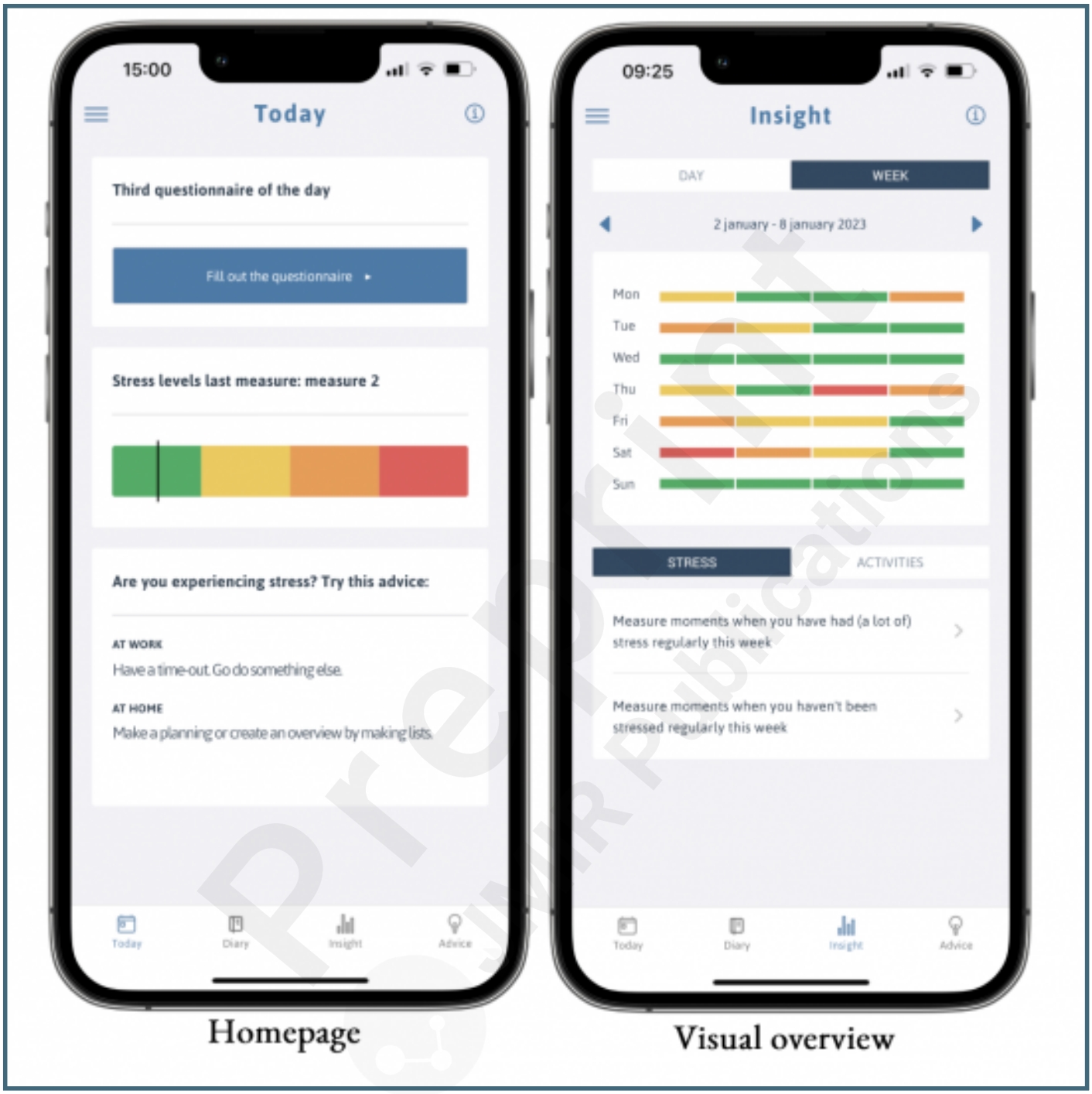
Figures

Screenshots of the homepage and the visual overview page of the STAPP@Work app.



Schematic overview of the study design including timeline.