

Feasibility, Acceptability, and Potential Efficacy of the PTSD Coach App: A Pilot Randomized Controlled Trial With Community Trauma Survivors

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Objective: Posttraumatic stress disorder (PTSD) is a major public health concern. Although effective treatments exist, affected individuals face many barriers to receiving traditional care. Smartphones are carried by nearly 2 thirds of the U.S. population, offering a promising new option to overcome many of these barriers by delivering self-help interventions through applications (apps). As there is limited research on apps for trauma survivors with PTSD symptoms, we conducted a pilot feasibility, acceptability, and potential efficacy trial of PTSD Coach, a self-management smartphone app for PTSD. **Method:** A community sample of trauma survivors with PTSD symptoms ($N = 49$) were randomized to 1 month using PTSD Coach or a waitlist condition. Self-report assessments were completed at baseline, postcondition, and 1-month follow-up. Following the postcondition assessment, waitlist participants were crossed-over to receive PTSD Coach. **Results:** Participants reported using the app several times per week, throughout the day across multiple contexts, and endorsed few barriers to use. Participants also reported that PTSD Coach components were moderately helpful and that they had learned tools and skills from the app to manage their symptoms. Between conditions effect size estimates were modest ($d = -0.25$ to -0.33) for PTSD symptom improvement, but not statistically significant. **Conclusions:** Findings suggest that PTSD Coach is a feasible and acceptable intervention. Findings regarding efficacy are less clear as the study suffered from low statistical power; however, effect size estimates, patterns of within group findings, and secondary analyses suggest that further development and research on PTSD Coach is warranted.

Keywords: mobile apps, mobile phone intervention, posttraumatic stress disorder, PTSD

Posttraumatic Stress Disorder (PTSD) is a potentially disabling mental health condition that causes long term problems for individuals, families, and society in terms of compromised emotional well-being, interpersonal challenges, productivity loss, and cost of treatment (Kessler, 2000). PTSD is estimated to affect about 7% of the U.S. population (Kessler et al., 2005). In addition, subthreshold

or partial PTSD—defined as having significant PTSD symptoms without meeting diagnostic criteria—affects about 10% of trauma survivors, a quarter of whom maintain or experience symptom worsening over time (Cukor, Wyka, Jayasinghe, & Difede, 2010). Thus, PTSD and partial PTSD represent considerable public health concerns.

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Evidence-based treatments are available for PTSD (Foa, Keane, Friedman, & Cohen, 2009), but many affected individuals go untreated (Kessler, 2000). Barriers to receiving treatment include logistical issues, privacy and stigma-related concerns, insufficient motivation, negative beliefs about the effectiveness of treatment, and a desire to resolve symptoms on one's own (Hoge et al., 2004; Shalev, Ankri, Peleg, Israeli-Shalev, & Freedman, 2011). Additionally, in many areas there is a shortage of qualified mental health care providers for individuals in need of care (Kazdin & Rabbitt, 2013).

Technology, including mobile device applications (or apps), offers a possible solution to help expand access to mental health services (Free et al., 2013). For example, mobile apps can facilitate access to high-quality psychoeducational information and self-management tools independent of professional involvement, allow for real-time in vivo interventions, and may reduce provider time and overcome geographical limitations (Mohr, Burns, Schueller, Clarke, & Klinkman, 2013). Mobile apps are also readily scalable as smartphone ownership continues to rise, with nearly two thirds (64%) of American adults currently owning smartphones, with a majority of them (62%) using their smartphone to obtain health information (Pew Research Center, 2015). Moreover, this technology may be a viable means of reaching minority populations who experience disparities in access to health care (López, Barrio, Kopelowicz, & Vega, 2012; U.S. Department of Health & Human Services, 2001), as rates of mobile phone usage in the U.S. are higher for some ethnic minorities, including Hispanics and African Americans, than for Whites (Pew Research Center, 2015).

Given the potential of this technology to help address the unmet need for PTSD care, the PTSD Coach mobile app (Hoffman et al., 2011) was developed by the Veterans Affairs' (VA) National Center for PTSD in partnership with the Department of Defense National Center for Telehealth and Technology. It was designed by PTSD experts and clinicians to offer trauma survivors high quality psychoeducation about trauma and PTSD, sound PTSD symptom assessment and monitoring (PTSD Checklist [PCL]; Weathers, Litz, Herman, Huska, & Keane, 1993), evidence-informed cognitive-behavioral therapy (CBT)-based self-management tools, and easy access to crisis support. It is available for free for both iOS (Apple) and Android mobile devices, and since its release in April of 2011 it has been downloaded more than 200,000 times in 92 countries (as of July 1, 2015). In a preliminary study, veterans being treated for PTSD reported high satisfaction with PTSD Coach and reported that it was helpful for managing their PTSD symptoms (Kuhn et al., 2014).

Although Web-based interventions for PTSD have shown promise at reducing PTSD symptoms (Amstadter, Broman-Fulks, Zinzow, Ruggiero, & Cercone, 2009; Spence et al., 2011) and emerging evidence suggests that smartphone apps can improve depression and anxiety symptoms (Donker et al., 2013), there are no controlled studies to our awareness that have evaluated the effect of a mobile app on PTSD symptoms nor have there been studies assessing the feasibility and acceptability of a mobile app for self-management of PTSD symptoms with a community sample of trauma survivors. Therefore, the primary aims of the current study were to explore the feasibility, acceptability, and potential efficacy of PTSD Coach in reducing PTSD symptom severity in a small-scale, randomized pilot study. Feasibility was assessed by how much PTSD Coach was used, when and where it was used,

and barriers to its use. Acceptability was evaluated in terms of whether participants found it useful and what in particular they found helpful about it. Potential efficacy was assessed by evaluating changes in self-reported PTSD symptoms after one month of use in terms of both statistically significant changes as well as effect size estimates to inform future development and research. Lastly, we also explored whether baseline PTSD symptom severity related to how much the app was used and whether symptom improvement related to use.

Method

Participants

Eligibility criteria included being at least 18 years old, fluency in English, not currently receiving treatment for PTSD, having an active e-mail address, and scoring ≥ 25 on the PCL-C. This liberal cut score was used to allow inclusion of trauma survivors who may have had partial PTSD. However, despite such an inclusive cut score, no participant had a PCL score lower than the recommended range (i.e., 30–35) for PTSD screening in general population (National Center for PTSD, 2015). As the primary aims of the study were to assess feasibility, acceptability, and explore potential efficacy (i.e., obtain an estimate of a between group effect size) to inform a larger-scale trial, a power analysis was not conducted a priori.

Measures

Demographics. A series of items gathered information regarding age, gender, ethnicity, education, and smartphone ownership.

Feasibility of PTSD Coach. Participants reported PTSD Coach use with the following question: *On average, how often each week did you open the app?* using a 5-point scale ranging from 1 (*0 times*) to 5 (*10 or more times*). Similar questions assessed use of the psychoeducational (Learn) and the self-management tools (Manage Symptoms) sections of the app. Participants were also asked how many assessments (i.e., PCLs) they completed (*0–4*), typical times and places/situation they used the app, and barriers to app use, including limited time, difficulty using, not getting much from the app, and not being able to find what they needed on a 4-point scale: 0 (*not a barrier*) to 3 (*extreme barrier*). Finally, participants reported if they personalized the app with their own music, photos, or personal contacts (*yes/no*).

Acceptability of PTSD Coach. Participants rated how helpful the information was in both the Learn and Manage Symptoms sections of the app on a 5-point scale (1 = *not at all*, 2 = *slightly*, 3 = *moderately*, 4 = *very*, 5 = *extremely*). They were also asked whether they could use skills from PTSD Coach to manage emotions (1 = *strongly disagree* to 5 = *strongly agree*) and had learned new tools from the app that were useful (*yes/no*). Participants rated how convenient using the app to get information was relative to paper-based materials using a 5-point scale (1 = *not at all* to 5 = *extremely*). Finally, an open-ended question inquired about how the app was most useful to them. Responses to this question were qualitatively categorized based on specific themes associated with use of the app (e.g., for self-management of symptoms, psychoeducation).

PTSD. The PTSD Checklist – Civilian (PCL-C; Weathers et al., 1993) is a widely used 17-item self-report measure of PTSD that has strong psychometric properties (Wilkins, Lang, & Norman, 2011) and has shown measurement equivalence between paper-and-pencil and web-based administrations (Read, Farrow, Jaanimagi, & Ouimette, 2009). PCL items correspond to *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV) PTSD symptoms and are rated on how much the symptom bothered the respondent in the past month on a scale ranging from 1 (*not at all*) to 5 (*extremely*). Total scores can range from 17 to 85. Cronbach's alpha for the PCL administered at baseline was .84, demonstrating adequate internal consistency.

Intervention

PTSD Coach provides evidence-supported tools, assessments, and psychoeducation about PTSD symptoms and was designed to be applicable across a broad range of trauma types (Kuhn et al., 2014). The app does not deliver a structured program of use; instead it allows users to determine how they wish to use the app. It has four main goals that correspond with the major sections of the app found on the home screen. The “Learn” section provides psychoeducational information about trauma, PTSD, and professional treatment options. The “Manage Symptoms” section offers CBT-based self-management tools for common PTSD-related symptoms (e.g., interactive relaxation tools, stress inoculation training, and grounding). The “Self Assessment” section allows users to take, schedule, and view assessments of their PTSD symptoms using the PCL-C (Weathers et al., 1993). The “Find Support” section allows users to conveniently contact personal contacts and crisis (e.g., national suicide prevention hotline) and emergency services (911). Users can personalize the app by selecting their own music, photos, and contacts stored on their smartphone to be used in tools in the app (e.g., soothing pictures or audio).

Procedure

Study procedures were approved by Stanford University's Institutional Review Board. All participants provided signed informed consent. Enrollment began March 1, 2012 and data collection ended September 30, 2013. Participants were recruited using fliers posted throughout the San Francisco Bay Area as well as through websites (i.e., med.stanford.edu/clinicaltrials, Craigslist.com) seeking volunteers who had experienced trauma, had PTSD symptoms from it, and were willing to use a mobile app. Interested individuals were screened for eligibility via an online questionnaire or by phone. Eligible individuals were scheduled for the baseline assessment during which they provided informed consent and completed the assessment. After completing the baseline measures, participants were randomly assigned with an equal chance to either the PTSD Coach or waitlist condition. All self-report assessments were completed online using a Web-based survey tool (Qualtrics). Those assigned to the PTSD Coach condition were given the app and instructed to use it however they would like for the following month. No specific training, instructions for use, or suggestions of how PTSD Coach might be helpful were provided in attempt to represent real world use. If the participant did not have an Android or iOS compatible smartphone

or mobile device, an iPod Touch (model A1367, iOS 4.3) was loaned to them ($n = 10$) for the month. Those assigned to the waitlist condition received no intervention over the ensuing month. Participants completed the postcondition assessment one month later. Upon completion of the postcondition assessment, participants in the waitlist condition were given PTSD Coach (and loaned an iPod Touch if necessary [$n = 7$]) to use for the following month. Those in the PTSD Coach condition received no further instructions on app use. One month later, participants in both conditions completed the follow-up assessment and received \$50 in major retail store gift cards for completing the three assessments (i.e., baseline, postcondition, and 1-month follow-up).

Statistical Analyses

All analyses were conducted using PASW Statistics version 21. Descriptive statistics, including means, standard deviation, numbers, and percentages, were used to summarize feasibility and acceptability variables. Between groups repeated measures ANOVAs were conducted to evaluate the potential efficacy of PTSD Coach. The condition (PTSD Coach vs. waitlist) by time (baseline and postcondition) interaction was used to estimate an effect size and assess if there was significant differential change in PCL scores using intention-to-treat (ITT) and completer analyses. For the ITT analysis multiple imputation with 10 imputed data sets was used to replace missing PCL values at the postcondition ($n = 5$; 10.2%) and follow-up ($n = 9$; 18.4%) assessments and ranges and averages of statistics across these imputed datasets are presented. Cohen's d s were calculated for the between-condition effect size (ES) using the following formula: $((\text{PTSD Coach postcondition } M - \text{baseline } M) - (\text{waitlist control postcondition } M - \text{baseline } M)) / SD$ of the pooled change scores. A paired sample t test evaluated mean changes from the postcondition to the 1-month follow-up assessment for the waitlist control condition after being crossed-over to receive PTSD Coach. A Cohen's d for the within Condition ES change was calculated by subtracting the postcondition M from the 1-month follow-up M and dividing by the SD of postcondition M . Three exploratory follow-up paired sample t tests were conducted to evaluate within condition changes in mean PCL scores for the PTSD Coach condition (baseline to postcondition, baseline to 1-month follow-up) and waitlist condition (baseline to postcondition). Cohen's d s for these within Condition ES changes were calculated by subtracting the baseline M from the postcondition M and dividing by the SD of that condition's baseline M . This formula was also used for change from baseline to follow-up. A 10-point decrease in PCL score is considered clinically significant (Monson et al., 2008). A chi-square test evaluated whether there was a significant difference in the proportion of participants achieving this level of change across conditions. To examine whether baseline characteristics (i.e., gender, ethnicity, education, and smartphone ownership) and PTSD symptom severity related to improvements in PTSD symptoms in the PTSD Coach condition from baseline to the postcondition assessment, we used independent samples t tests. Finally, to assess whether baseline PTSD symptoms and change in symptoms related to app use, Pearson correlations were conducted.

Results

A total of 49 adults (40 women, 9 men) met eligibility criteria and consented to participate and completed the baseline assessment. Participants were an average of 45.7 years old ($SD = 13.9$), more than half identified as being White (55.1%, $n = 27$), and most had at least attended some college (77.6%, $n = 38$). Table 1 provides other demographic characteristics of the full sample and both study conditions.

There were no significant differences between the PTSD Coach and waitlist conditions on gender, $\chi^2(1, N = 49) = .191, p = .662$, age, $t(47) = 1.412, p = .164$, ethnicity (White vs. other; $\chi^2(1, N = 42) = 0.000, p = 1.000$), education (less than college degree vs. college degree or higher; $\chi^2(1, N = 42) = 2.97, p = .085$), smartphone ownership, $\chi^2(1, N = 48) = .022, p = 1.000$, and baseline PCL scores, $t(47) = 1.134, p = .262$. Participants who dropped out at the postcondition assessment ($n = 5$) did not significantly differ, $t(47) = .663, p = .511$ in terms of baseline mean PCL scores (58.00; $SD = 14.40$) compared with completers (61.57; $SD = 11.09$). Figure 1 presents a flowchart of participants through the study.

Feasibility

Participants in the PTSD Coach condition reported mean weekly usage of 2.65 ($SD = 1.03$) (i.e., falling between 1–3 times and 4–6 times) between the baseline and postcondition assessments with no participant reporting not having used it at all. The waitlist condition (when assigned to use the app) reported a similar amount of weekly use ($M = 2.50$; $SD = 0.83$) between the postcondition and follow-up assessments, and 1 participant reported he or she had not used it at all. The two

major intervention sections of the app (i.e., Learn and Manage Symptoms), showed similar levels of use. Table 2 presents descriptive statistics for the entire list of feasibility variables based on study condition.

Acceptability

Table 3 presents the acceptability variables based on study condition. To summarize, participants in both conditions endorsed that the Learn and Manage Symptoms sections of the app were “moderately helpful.” Participants also agreed that they could use skills from PTSD Coach to manage emotions, and nearly 83% of those in the PTSD Coach condition reported that they had learned new tools to cope with their PTSD symptoms. Participants also rated that getting information from the app was moderately to very convenient relative to getting such information from paper materials. Finally, responses to the open-ended question about how the app was most useful to them ($n = 38$) showed that about half of the app users reported that the self-management of symptoms was most useful, whereas 5 (13.2%) participants reported that the app was not useful to them.

Potential Efficacy

For the ITT sample, the condition by time interaction effect size from the baseline to the postcondition assessment was modest for both the ITT (average $d = -0.25$) and completer ($d = -0.33$) analyses from the between groups repeated measures ANOVAs, and neither was statistically significant (range of $F(1, 47) = 0.218$ to $1.56, p = .218$ to $.597, F(1, 42) = 1.22, p = .276$, respectively; see Table 4). Across both the ITT and completer samples, the exploratory paired sample t tests showed that the PTSD Coach condition had a statistically significant improvement on the PCL between the baseline and the postcondition assessments (ITT: $t(24) = -2.06, p = .040, d = -0.59$; completers: $t(22) = -2.35, p = .028, d = -0.78$), whereas the waitlist condition did not (ITT: $t(23) = -1.70, p = .093, d = -0.31$; completers: $t(20) = -1.81, p = .086, d = -0.29$). PTSD Coach participants showed a significant and large effect in PTSD symptom reduction from baseline to the follow-up assessment (ITT: $t(24) = -2.89, p = .004, d = -0.97$; completers: $t(19) = -2.31, p = .031, d = -1.06$). Paired sample t tests evaluating within Condition PCL mean change from the postcondition assessment to the follow-up assessment showed that the waitlist condition (which was assigned to use PTSD Coach) also evidenced a statistically significant decrease (ITT: $t(23) = -2.80, p = .006, d = -0.61$; completers: $t(18) = -2.92, p = .009, d = -0.68$).

Regarding clinically significant change on the PCL (i.e., ≥ 10 point decrease; Monson et al., 2008), for completers, 9 participants (39.1%) in the PTSD Coach condition had this amount of improvement from the baseline to the postcondition assessment, whereas 4 participants (19.0%) in the waitlist condition had this degree of improvement, which was not significantly different, $\chi^2(1, N = 44) = 2.13, p = .145$. From the postcondition to the follow-up assessment, 9 participants (47.4%) in the waitlist condition who were crossed over to PTSD Coach had a clinically significant improvement.

In the PTSD Coach condition, PCL improvement from baseline to the postcondition assessment was unrelated to gender,

Table 1
Demographics Characteristics

Characteristic	PTSD Coach ($n = 25$)		Waitlist ($n = 24$)		Total ($N = 49$)	
	n	%	n	%	n	%
Female	21	84.0	19	79.2	40	82.0
Ethnicity ^a						
White	16	64.0	12	50.0	28	57.1
African American/Black	4	16.0	0	.0	4	8.2
Asian	3	12.0	1	4.2	4	8.2
Hispanic	4	16.0	6	25.0	10	20.4
American Indian/Alaskan						
Native	1	4.0	1	4.2	2	4.1
Asian Indian	1	4.0	0	.0	1	2.0
Pacific Islander	1	4.0	0	.0	1	2.0
Multi-ethnic	6	24.0	1	4.2	7	14.3
Missing	1	4.0	6	25.0	7	14.3
Education						
Less than high school diploma	0	.0	1	4.2	1	2.0
High school diploma	2	8.0	0	.0	2	4.1
Some college	5	20.0	9	37.5	14	28.6
College degree	6	24.0	5	20.8	11	22.4
Graduate degree	11	44.0	3	12.5	14	28.6
Missing	1	4.0	6	25.0	7	14.3
Smartphone/mobile device owner	18	72.0	18	75.0	36	73.5
Missing	—		1	4.2	1	2.0

^a Ethnicity categories are not mutually exclusive.

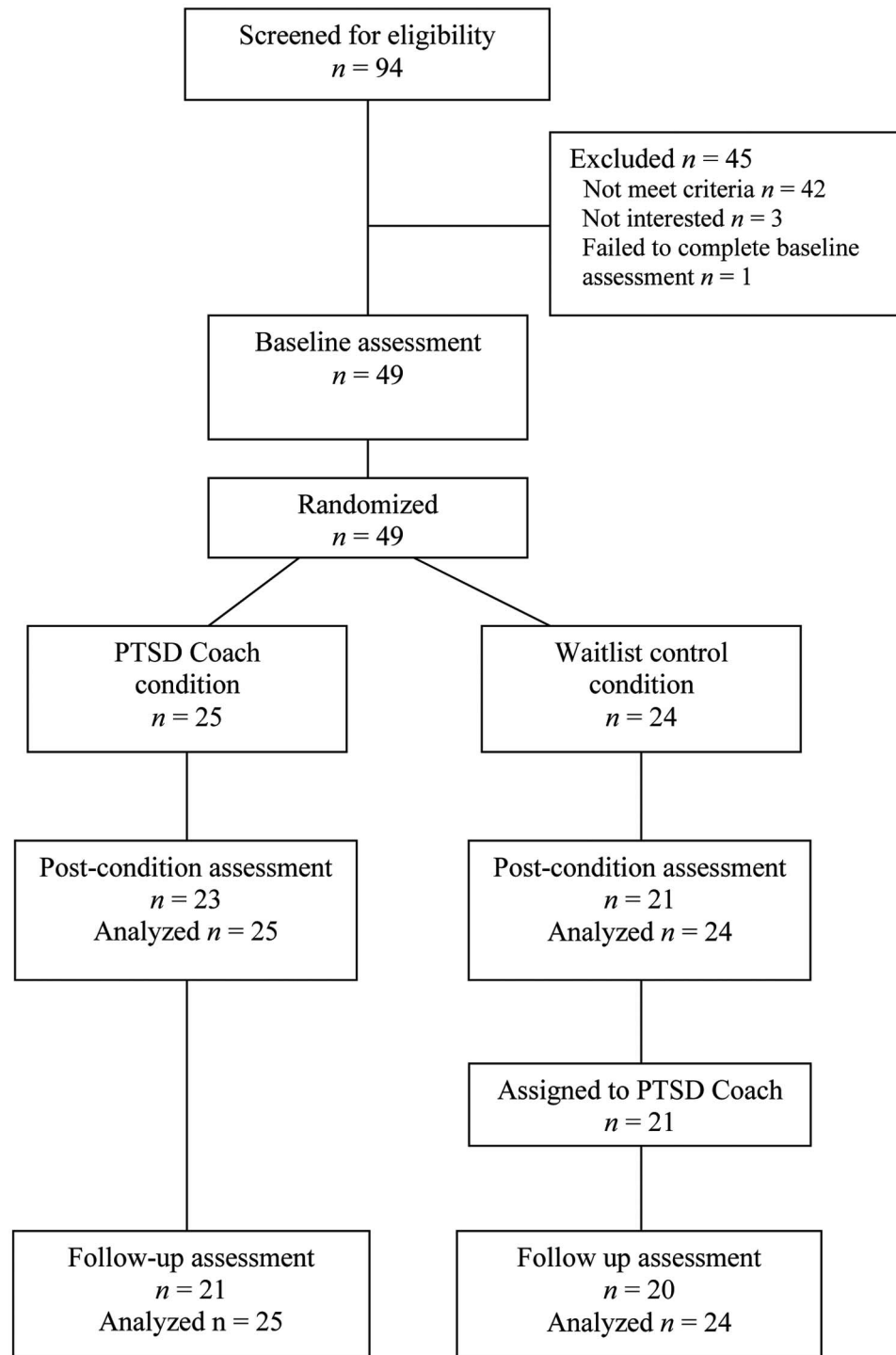


Figure 1. Flowchart of participants through the study.

$t(21) = 1.01, p = .285$, ethnicity, $t(21) = 0.79, p = .436$, and education, $t(20) = 1.03, p = .206$. However, those who used their own smartphone appeared to improve more than those who borrowed a study iPod Touch (PCL mean change of -12.23 vs. -2.10 , respectively), although this was not statistically significant, $t(21) = 1.56, p = .134$. An exploratory post hoc

repeated measures ANOVA comparing PCL changes for PTSD Coach smartphone users versus the waitlist control condition completers produced a significant, large between group effect, $F(1, 32) = 4.41, p = .044, d = -0.74$. Baseline PCL scores were found to be significantly related to PTSD symptom improvement from baseline to postcondition ($r[22] = -.76, p <$

Table 2
Feasibility of PTSD Coach

Variable	PTSD Coach (<i>n</i> = 23)		Waitlist with PTSD Coach (<i>n</i> = 20)	
	<i>M/n</i>	<i>SD/%</i>	<i>M/n</i>	<i>SD/%</i>
Times per week opened ^a				
PTSD Coach	2.65	1.03	2.50	.83
Learn section	2.22	.85	2.20	.52
Manage symptoms section	2.52	1.08	2.55	.83
Number of assessments taken	2.04	1.46	2.05	.85
Typical times of day used				
Morning	12	52.2%	5	26.3%
Lunch time	8	34.8%	9	47.4%
Evening	16	69.6%	17	89.5%
Late night	7	30.4%	7	36.8%
Typical places and situations used				
Home	15	65.2%	15	78.9%
Work or school	9	39.1%	5	26.3%
Between tasks	6	26.1%	8	42.1%
Getting to sleep	8	34.8%	8	42.1%
Other ^b	4	17.4%	6	31.6%
Barrier to use ^c				
Not enough time	1.04	1.11	1.05	.97
Hard to use	.57	1.08	.68	.89
Didn't get much out of the app	.65	1.07	1.58	1.07
Couldn't find what I needed	.74	1.01	.79	1.13
Personalized the app with:				
Music	6	26.1%	5	26.3%
Photos	10	43.5%	4	21.1%
Personal contacts	8	34.8%	4	21.1%

^a 1 = 0 times, 2 = 1–3 times, 3 = 4–6 times, 4 = 7–9 times, 5 = 10 or more times.

^b Responses included: the beach and the park, in large social situations, family visits, everywhere, out in public, clinic appointment waiting rooms, and friend's house.

^c 0 = not a barrier to 3 = extreme barrier.

.001) for the PTSD Coach condition, but not for the waitlist condition ($r[21] = -.21, p = .357$).

For both conditions, self-reported weekly app use was not statistically significantly correlated with baseline PCL scores

(PTSD Coach condition: $r[22] = .12, p = .58$; waitlist condition: $r[19] = .34, p = .14$) or PCL change scores (PTSD Coach condition: $r[22] = .13, p = .56$; waitlist condition: $r[18] = .04, p = .86$).

Discussion

This is the first study that we are aware of to evaluate a mobile app for PTSD symptoms with trauma survivors from the community. Our findings suggest that PTSD Coach is a feasible intervention for this group, with participants reporting using the app multiple times per week to learn about PTSD, self-manage symptoms, and engage in symptom self-monitoring. Participants also reported using the app throughout the day (including times outside of typical clinic hours) across multiple contexts and endorsed few barriers to use. Likewise, there was clear support for the acceptability of PTSD Coach. Participants reported that the major intervention components (i.e., psychoeducation and self-management) were moderately helpful and they had learned new tools to manage symptoms and could use skills from the app to manage emotions. In terms of convenience, participants clearly favored app-delivered information over paper materials. Finally, open-ended feedback supported these findings, with more than half of the responses mentioning symptom self-management as the most useful function of the app. However, a handful of participants reported that they did not find the app useful.

Regarding the potential efficacy of PTSD Coach, findings were less clear, as a significant effect of PTSD Coach over the waitlist control condition was not apparent. However, there are reasons to encourage further development and study. First, the between group effect sizes were modest for both the ITT sample ($d = -0.25$) and the completer sample ($d = -0.33$), suggesting that failure to detect a statistical effect may have been due to low statistical power. Second, the pattern of within group changes showed that the PTSD Coach condition had a significant reduction in symptoms, whereas the waitlist did not; however, these were exploratory findings and so should be interpreted cautiously. Third, when the waitlist participants finished serving as controls and were provided the PTSD

Table 3
Acceptability of PTSD Coach

Variable	PTSD Coach (<i>n</i> = 23)		Waitlist with PTSD Coach (<i>n</i> = 20)	
	<i>M/n</i>	<i>SD/%</i>	<i>M/n</i>	<i>SD/%</i>
How helpful was the information in the:				
Learn section	3.32	1.17	2.50	.83
Manage symptoms section	3.22	1.35	3.05	1.12
I can use skills from PTSD Coach to manage my emotions.	4.00	.95	3.70	1.08
I've learned new tools to cope with my symptoms from the app. (yes)	19	82.6%	12	63.2%
How convenient was using the app compared to getting information on paper materials?	3.70	1.26	3.42	1.02
How was the app most useful to you? ^a				
Symptom self-management	11	47.8%	12	60.0%
Accessibility	3	13.0%	2	10.0%
Education	2	8.7%	2	10.0%
Other	9	39.1%	4	20.0%
Not useful	1	4.3%	4	20.0%
No response	4	17.4%	1	5.0%

^a Responses could be in more than one category.

Table 4
Between- and Within-Condition Comparisons of PCL Scores

Condition	PTSD Coach									Waitlist ^a							Condition × Time interaction ^b
									Crossed over to PTSD Coach								
	Baseline		Post-condition			1-month follow-up			Baseline		Post-condition			1-month follow-up			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>M</i>	<i>SD</i>	<i>d</i> ^c	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>M</i>	<i>SD</i>	<i>d</i> ^d	
ITT	63.00	11.28	56.31	10.51	−.59*	52.01	14.56	−.97*	59.33	11.34	55.77	12.99	−.31	47.87	13.99	−.61**	−.25
Completers	63.65	9.94	55.83	10.66	−.78*	51.90	15.03	−1.06**	59.29	12.06	55.81	13.34	−.29	48.21	13.41	−.68**	−.33

Note. PCL = PTSD Checklist; ITT = Intent to treat. ITT analyses imputed missing values using multiple imputation. Between-condition comparisons evaluated using repeated measures ANOVAs. Within-condition comparisons evaluated using paired sample *t* tests. Sample size for ITT: PTSD Coach *n* = 25, Waitlist *n* = 24. Sample size for Completers: Baseline: PTSD Coach *n* = 25, Waitlist *n* = 24; Post-condition: PTSD Coach *n* = 23, Waitlist *n* = 21; 1-month follow-up: PTSD Coach *n* = 20, Waitlist *n* = 19.

^a Waitlist participants were crossed over to PTSD Coach condition after the post-condition assessment. ^b For Baseline to Post-condition. ^c Effect size change from Baseline to 1-month follow-up. ^d Effect size change from Post-condition to 1-month follow-up.

* *p* < .05. ** *p* < .01.

Coach, they showed a significant improvement in PTSD symptoms similar to the improvement witnessed in the PTSD Coach condition, essentially replicating those findings (Kazdin, 2003). Fourth, for the PTSD Coach condition it appears that symptom reduction persisted at follow-up. Finally, twice as many people using PTSD Coach reported a clinically significant improvement in PTSD symptoms compared to those not assigned to use it, but these results were not significant.

Although the findings are promising, especially from a public health perspective, they suggest that PTSD Coach may only have a modest impact on PTSD symptoms. PTSD Coach includes interventions (e.g., relaxation training, coping self-statements) found in evidence-based psychotherapies for PTSD, particularly stress inoculation training, and not surprisingly, does not result in nearly as large as the effects evidenced in trials of this psychotherapy (Foa et al., 2009). Likewise, more intensive-Web based self-management interventions that typically include some degree of therapist assistance also appear to provide stronger effects (Amstadter et al., 2009). The findings also suggest that PTSD Coach may not be the optimal intervention for all affected trauma survivors. For example, given that the app provides basic and widely available psychoeducation and self-management tools, individuals who have had extensive exposure to these types of materials or CBT might not find the app as useful as individuals without such exposure.

There is also suggestion that participants who borrowed an iPod Touch did not benefit to the same extent as those who used their own smartphone. Why this is the case is unclear, but others (e.g., Smith et al., 2012) have suggested that providing a mobile device to individuals already carrying one may result in differential use as a result of the burden imposed by having to carry the additional device. However, no difference in self-reported weekly use was evidenced between iPod Touch borrowers and smartphone owners. In addition, having to learn how to use a new mobile device for individuals who are not routinely using smartphones may result in a different experience using the app, which is not captured in usage data. Although iPod Touch borrowers and smartphone owners did not significantly differ on baseline PCL scores or demographic variables, it may be that unmeasured factors related to owning a smartphone could be responsible for the observed differential effects.

The current study has a number of limitations requiring mention. Foremost among these are artifacts related to the pilot nature of this study. These include those impacting statistical power, such as the use of a small sample and brief intervention period, which may not have afforded ample opportunity for accrual of the maximum benefit from the app. In fact, the PCL decline for the PTSD Coach participants over the 2 months between the baseline and follow-up assessments was large (i.e., *ds* = -0.97 for ITT and -1.06 for completers). In addition, the retrospective, single-item global measure of app use may not have been sensitive to variability in actual use resulting in a failure to detect a relationship with baseline PTSD symptoms and symptom change. Failure to establish relationships between measures of use and outcomes is common in studies of Web-based interventions leading to a recommendation that composite measures of use may need to be developed to capture the most important dimensions of program use (Donkin et al., 2011). Finally, our measures of PTSD Coach acceptability and feasibility were developed specifically for this project so lack psychometric evidence; thus, results should be interpreted with caution.

It is unknown how well these findings would generalize to other populations of trauma survivors with PTSD symptoms. The current sample was predominantly composed of women (>80%), which may reflect that women are estimated to be twice as likely to have PTSD as are men (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995) and are also more likely to seek help for it (Roberts, Gilman, Breslau, Breslau, & Koenen, 2011). The sample also had a relatively high level of education and recruitment took place in the Silicon Valley, where the population may be more comfortable using technology than in other areas. Given that the follow-up assessment was conducted only a month after conclusion of the intervention period and after the control participants had been given the intervention, it cannot be discerned whether results would generalize to time points further out.

Given these limitations, future research should employ larger samples to ensure adequate statistical power to evaluate the efficacy of PTSD Coach. In fact, if the true between-group effect size for PTSD Coach is of the magnitude estimated in the current study, the observed power to detect it was less than 20%. The current findings suggest that extending the period of app use and limiting participation to only smartphone owners would increase the be-

tween group effect size to a medium magnitude or greater, requiring a sample size of roughly 120 participants to achieve adequate statistical power. Future studies should also include other indicators of app use, which could be achieved by objective, prospective measures, such as clickstream data collected passively from the app. Likewise, they should also not rely exclusively on self-report measures and include assessment of traumatic events as well as more comprehensive measures (e.g., structured interviews) of PTSD and related clinical issues (e.g., depression), and other outcomes the app targets (e.g., willingness to seek treatment) to assess for potential broader effects of the app. In addition, measures of other possible mechanisms that may affect outcomes (e.g., coping self-efficacy) and moderators of treatment (e.g., PTSD symptom severity) should also be evaluated. Lastly, to address issues of external validity, future research should include more diverse samples (e.g., those with a broader range of educational achievement, men, and other trauma samples, such as combat veterans). Such research should also consider including longer-term follow-up assessments to assess the durability of effects of PTSD Coach.

Regardless, the current findings contribute to the scant but emerging literature on the potential of mobile apps for addressing mental health related issues (Donker et al., 2013). Although more empirical scrutiny is clearly required, these findings could have implications for how PTSD symptoms may be addressed especially from a public health perspective. Although the potential effect of PTSD Coach appears to be modest, given that smartphones are now used by nearly two thirds of U.S. adults (Pew Research Center, 2015), the app offers an easily accessible, no cost psychoeducational and self-management tool that can reach large numbers of affected trauma survivors who may not be receiving traditional care. Thus, if future research provides more convincing support for the efficacy of PTSD Coach, it could provide a significant benefit to society. Although the current study evaluated PTSD Coach as a stand-alone intervention, the app could have many other uses as well that would also be worthy of future investigation. These include use as a first-line intervention following formal PTSD screening (e.g., in primary care settings or for those waiting to enter specialty treatment), with minimal professional assistance (e.g., telephone coaching), as well as an augment to traditional care, including for patients receiving pharmacotherapy only and those in psychotherapy to possibly increase engagement.

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