



The digital MySteps intervention for abused women at risk for firearm-related injuries and homicides: Findings from the feasibility, acceptability and preliminary efficacy trial

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ABSTRACT

Background: Firearms are the leading cause of victimization of abused women by intimate partner homicide and intimate partner homicide-suicides in the US. This calls for evidence-based intervention strategies to prevent firearm-related injuries or mortality and address the firearms-related safety needs of women in abusive relationships. My Safety Steps (MySteps) was designed to comprehensively assess women's firearm-related risks, and current safety needs and to prevent women's harm from their abuser's access or ownership of a firearm through a digitally delivered firearm-focused safety planning intervention. This paper describes the development, feasibility, acceptability, and preliminary evaluation of the digital BSHAPE intervention among women survivors of intimate partner violence (IPV).

Methods: Using a pretest post-test control group design, the study was conducted with 103 participants with 55 women randomly assigned to the MySteps arm and 48 women to the standard of care control arm. The feasibility and acceptability outcomes assessed were enrollment, adherence, and perceptions of the intervention. Preliminary evaluation outcomes included the partner's access to a firearm, women's self-efficacy beliefs, and empowerment. Further, qualitative follow-up interviews were conducted with 30 survivors of IPV in the MySteps arm to follow up on the use and helpfulness of safety strategies provided in MySteps.

Results and conclusion: The intervention was found to be feasible, and acceptable and demonstrated improved outcomes for survivors of IPV at risk from their partner's firearm. Women provided feedback for further refinement. The findings of this study will be useful in further refining MySteps and testing it in a full-scale randomized controlled trial.

1. Background

Access to a firearm in abusive relationships has been found to be a significant risk factor for intimate partner homicides (IPHs) in the United States [1], with over half of all IPHs committed with firearms [2, 3]. Intimate partner violence (IPV) has also been found to be a factor in more than half (59.1 %) of the fatal mass shootings in the US from 2014 to 2019 [4]. Women are disproportionately affected by firearm-related IPV and IPHs. About 4.5 million women have had a partner threaten them with a firearm, with nearly 1 million shot or shot at by their partners [5]. Between 2011 and 2020, there was a 6 % increase in IPH of women, driven by a 15 % increase in IPH by firearms [6]. Firearm-related IPHs are found to disproportionately affect women from

minority racial/ethnic backgrounds, such as Black women [6,7]. Foreign-born women also face significant risks. Firearms have been the most frequently used method of killing among foreign-born IPH victims, with 41.4 % of these homicides committed with firearms [8].

Abused women living with firearm owners are at increased risk of victimization by a firearm-related homicide [9]. In a study, IPH involving firearms was sevenfold higher for those cohabitating with a firearm owner, with 84 % of these being women [10]. In a meta-analysis of IPH-related risk factors, perpetrators' access to a firearm increased IPH likelihood by 11 times and was the single greatest risk factor for IPH [11]. Similarly, in another study, access to a firearm was one of the most common precipitants for IPH offenders [12]. Access to firearms and threats to kill exacerbate the power and control dynamic in abusive

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relationships [6], creating an environment of fear and chronic stress for abused women. This risk persists even in the absence of explicit threats or expressed fear, as the presence of a firearm can still exert a coercive control dynamic. Thus, an abusive partner's firearm ownership can result in both non-fatal mental and physical harm as well as fatal harm, such as IPH. This calls for evidence-based strategies to prevent firearm-related mental and physical harm including mortality and address the safety needs of women in abusive relationships.

Abused women from diverse racial and ethnic backgrounds face common and unique barriers to addressing abuse including threats posed by firearms within their homes. For instance, some of the unique barriers to addressing abuse among ethnic minority women include institutional racism, patriarchal gender norms, and lack of diversity within frontline services [13]. Immigrant women encounter additional barriers such as cultural emphasis on keeping family problems private [14] and a lack of knowledge of available resources [15,16]. Specifically, barriers to reporting firearm-related threats include gender and social norms, lack of knowledge of firearm-related risks, and lack of awareness about firearm-related laws, and resources [17]. To address these barriers, there is a need for evidence-based approaches that can build knowledge and awareness about firearm-related risks and intervene with women at high risk of harm from their partner's firearm on a private and anonymous platform.

A firearm safety intervention has been developed and is being evaluated for children and adolescents [18–20]. However, no rigorously evaluated intervention exists for abused women with a partner who possesses a firearm. Although women who can access domestic violence (DV) services are provided with a broad safety plan by advocates (i.e., made aware of IPV-related risks and necessary information) [21,22], most women whose partners own firearms do not receive adequate and tailored support and evidence-based strategies that enhance their safety from firearms [23]. This is evident from firearm-related IPHs being a growing and continued significant public health problem in the US. The most common safety advice given to women for IPV-related threats including threats from abusers who own firearms is to contact the criminal justice system via police or courts [23,24]. However, not many women feel comfortable contacting the criminal justice system, and many do not find it helpful [23–25]. Further, many IPH victims do not seek help before being killed [23,26]. Thus, there is a critical need for an evidence-based intervention that is designed to protect abused women and their children from firearm-related injuries and IPHs.

Further, there is a need for an evidence-based digital intervention, that women can access on their smartphone or computer, eliminating the need for in-person services. This can help circumvent the many barriers that women face in accessing resources, including stigma, poverty, transportation barriers, and social isolation. Existing evidence-based digital IPV interventions [27,28] are not specifically designed for safety from an abusive partner's firearm. *My Safety Steps* (MySteps) is a digital firearm safety promotion intervention for women living with an abusive partner who possesses a firearm. It conducts a comprehensive firearm risk assessment and supports women's safety through knowledge, skills, and resources. The purpose of this study was to evaluate the feasibility, acceptability, and preliminary efficacy of MySteps, identifying areas for further refinement. The intervention was designed to be inclusive, aiming to meet the needs of all women facing firearm-related threats in abusive relationships, regardless of their cultural background. The role of culture in shaping safety strategies and perceptions of risk was carefully considered throughout its development and preliminary evaluation. These insights will inform the refinement and evaluation of MySteps in a larger-scale trial, ensuring its effectiveness in protecting and supporting vulnerable women from diverse backgrounds.

2. Methods

MySteps was developed using research findings from qualitative semi-structured in-depth interviews with 17 service providers and 45

immigrant survivors of IPV [17]. Participants were recruited from multiple US states using purposive and snowball sampling techniques, which included email outreach, posting flyers, and verbal invitations facilitated by staff at partner organizations. The selection of participants was carefully conducted to ensure cultural sensitivity and relevance to diverse populations. Chosen service providers had extensive experience supporting both immigrant and non-immigrant IPV survivors, providing a comprehensive perspective on safety needs across various cultural backgrounds. Similarly, immigrant survivors of IPV interviewed represented a broad spectrum of cultural identities and experiences, encompassing regions such as Asia, Africa, Latin America, and the Caribbean. This deliberate selection process aimed to capture diverse perspectives on effective strategies for risk assessments and safety planning in cases involving abusive partners with firearms. In addition to exploring approaches specific to firearm-related risk assessment and safety planning, participants were also asked about cultural nuances influencing these approaches for women vulnerable to firearm-related harm from their abusive partners. Some participants noted differences between their countries of origin and US gun culture, expressing heightened concerns about firearm-related violence in the US. Unique risks identified for immigrant women included dependency on an abusive partner for immigration status, lack of awareness about US laws, resources, and rights, as well as unfamiliarity with firearm-related risks prevalent in cultures where firearms are less common. Feedback also underscored common concerns and needs related to firearm-related violence in abusive relationships, emphasizing universally applicable strategies such as safe gun storage. This inclusive approach to gathering input directly shaped the development of MySteps. Subsequently, MySteps was refined through feedback from two domestic violence service providers of African and Asian descent, three academic experts specializing in gun violence, from White racial/ethnic backgrounds, and eight survivors of IPV from women's shelters in Texas, New Jersey, and Maryland, representing diverse immigrant and non-immigrant backgrounds. Feedback focused on overall thoughts about the modules, identifying missing content that could be added to enhance women's safety, and suggestions for improving clarity and comprehension. Participants were also asked about any concerns regarding the strategies presented in the protocol. Based on this input, MySteps was further refined and subsequently pilot-tested.

The MySteps intervention components include knowledge and awareness of the dangers of the abuser's access to a firearm, strategies for protection, and collaborative and individualized safety planning). Drawing from the empowerment framework [29], MySteps components are designed to empower women to take steps towards their safety and enhance their coping self-efficacy or beliefs about their capability to deal with barriers that arise in their efforts towards safety. Drawing from the Capability, Opportunity, Motivation, Behavior (COM-B) model [30], women's engagement in safety behaviors is supported through the enhancement of women's capabilities (e.g., understanding of their level of risk, knowledge of safety strategies), motivation (development of safety goals and intentions to implement their safety plans), and opportunity (information about the resources for protection).

The intervention includes items from the danger assessment (DA) [31] with follow-up questions specific to firearm-related risks, a psychoeducation component (knowledge and awareness of dangers of abuser's access to a firearm, strategies for protection), a safety-planning component for overall IPV [32,33] and a collaborative firearm-related tailored safety planning support. An algorithm within the online system is designed to analyze women's responses to risk assessment questions to assess imminent danger or their level of risk. For example, women's responses to the questions are used to score the danger assessment and provide feedback on their level of risk. The electronic safety plan, tailored for overall IPV includes specific resources aligned with national and state-level domestic violence guidelines. For example, women access information such as shelters, counseling services, and legal options through this platform. Following this, women complete

online modules covering firearm safety strategies ordered by situational timeline ranging from pre-incident to escalation toward or active firearm violence, and separation from an abusive partner. Subsequently, a phone-based session with a trained facilitator includes a follow-up discussion on the firearm-specific safety strategies received in the modules, as well as personalized firearm-specific safety planning support. During the personalized and tailored phone-based firearm-specific safety plan, women receive customized safety measures based on their responses to structured questions covering various aspects of safety and risk factors, considering their unique circumstances, readiness, and comfort levels for implementation.

2.1. Research design and participants

A pretest-posttest control group randomized controlled trial was conducted among 103 survivors of IPV. This study was conducted under the umbrella of a larger clinical trial (NCT04098276) focusing on evaluating a digital intervention for immigrant women in abusive relationships. To be eligible to participate in the parent study, women had to be 18–64 years of age, be foreign-born, be currently in an intimate relationship, have experienced IPV in the past 12 months, and have access to a safe computer or smartphone. Women were eligible to participate if they reported experiencing any of the following forms of IPV within the last 12 months: physical abuse (hit, slapped, kicked, or otherwise physically hurt), emotional abuse (threatened, frightened, insulted, or treated badly), or sexual coercion (forced to participate in uncomfortable sexual activities). This pilot study enrolled women from the parent study who reported their partner’s possession of a firearm.

The preliminary efficacy outcomes for the pilot study were the partner’s access to a firearm, women’s self-efficacy, their use of safety strategies, safety-related empowerment, and general empowerment. In addition, 30 semi-structured follow-up interviews were conducted with MySteps recipients to obtain feedback on their experiences with the information provided in MySteps. The average length of the interview was 1 h.

2.2. Recruitment and data collection procedures

Women were recruited from multiple regions across the US via flyers posted by partner organizations, sharing of study information via emails, listservs, and social media platforms, in-person recruitment events, and peer-to-peer referrals. Women were directed to the study website to determine eligibility. Women voluntarily completed the on-line screening survey on the website and entered their contact information for the research team to contact them. The study team members reviewed the eligible women’s information, validated their identity over the phone, obtained oral informed consent, and enrolled them in the study. Women would begin by completing electronic written consent and then proceed to the baseline survey through a Clinical Trial Management System platform on their preferred device. After completing the baseline survey, women were randomized to either the MySteps arm or the standard of care control arm.

2.3. Randomization and blinding

Fig. 1 presents the CONSORT diagram. Out of the 710 women who completed screening, 600 were excluded due to their partners not

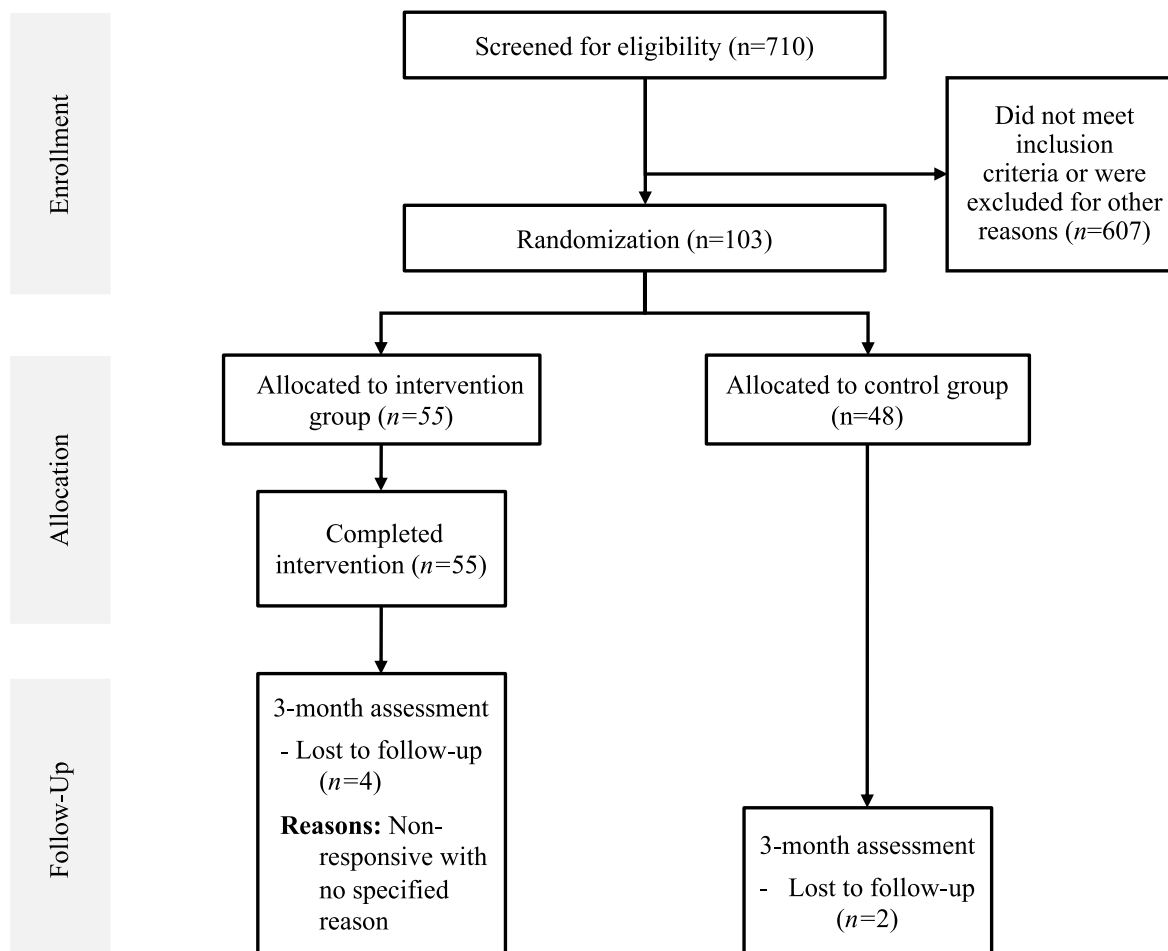


Fig. 1. The CONSORT Diagram of the MySteps Trial

owning or having access to a firearm. Additionally, five women were excluded for non-responsiveness without specified reasons, and two refused to participate due to mental health issues and the need for additional incentives. A total of 103 eligible and interested women were randomized into the study, with 55 assigned to the MySteps arm and the remaining to a standard-of-care control arm. Participants were not blinded to the arm to which they were randomized. Women in the MySteps arm, after completing the baseline survey, participated in the MySteps risk assessment, psychoeducation, and safety planning components. The control arm received usual safety planning resources modeled on national and state DV online resources. Women in the control arm did not receive the tailored MySteps safety planning intervention. The impact of MySteps was evaluated at 3 months follow-up using online surveys and follow-up interviews with participants in the MySteps arm. Women received \$40 for completing the surveys at each time point. Those who completed the follow-up interviews providing feedback received an additional \$35. All study procedures were approved by the institutional review board of the home institution of the study's principal investigator.

2.4. Measures

2.4.1. Feasibility and acceptability outcomes

The feasibility and acceptability outcomes were measured by enrollments and loss to follow-up, adherence to completion of the intervention protocol, and women's perceptions and feedback regarding MySteps. *Adherence to the MySteps protocol* was measured by: (1) A complete review of the online education/psychoeducation component, and (2) Participation in the phone-based safety planning. For *perceptions and feedback*, feedback was gathered from participants throughout their completion of the online modules and noted by the facilitator. Following the review of each section of the modules, the facilitator inquired about any unclear aspects, their potential application of the strategies in their situations, anticipated challenges in implementation and proposed solutions, and any reservations regarding the strategies. Final feedback was obtained in the follow-up interviews.

2.4.2. Preliminary evaluation quantitative outcomes

Self-Efficacy: The adapted *Trauma-related Coping Self-Efficacy* (7 items; $\alpha = 0.86-0.94$) [34] was used to evaluate women's confidence in their ability to handle and cope with abuse and traumatic experiences, with responses rated on a 7-point scale ranging from 1 (Not at all capable) to 7 (Perfectly capable). The items were summed for a high score of 49. Higher scores indicated greater trauma-coping self-efficacy.

Safety Empowerment: *The Measure of Victim Empowerment Related to Safety (MOVERS)* (13 items; $\alpha = 0.74-0.88$) [35] was utilized to assess survivor empowerment within the safety domain, with response options ranging from "never true" to "always true." Higher scores on the MOVERS indicated greater levels of empowerment.

Overall Empowerment: *The Personal Progress Scale-Revised (PPS-R)* (28 items; $\alpha = 0.88$) [36] was used to assess multiple areas associated with overall empowerment such as positive self-evaluation, self-esteem, ability to regulate emotional distress, gender-role and cultural identity awareness, self-efficacy, self-care, problem-solving, assertiveness skills, and access to resources. Item responses were rated on a 7-point scale ranging from 1 (Almost Never) to 7 (Almost Always), with a total maximum composite score of 196. Higher scores indicated a higher level of empowerment.

Partner's Access to a Gun: Participants were asked if their partner had access to a gun using a dichotomous item (0 = No; 1 = Yes).

2.4.3. Qualitative outcome

Use of Safety Strategies for Protection from Firearms. The semi-structured qualitative interview guide included questions related to participants' overall experiences with MySteps, including the effectiveness of strategies used and any encountered barriers.

2.5. Data analysis

2.5.1. Quantitative data analysis

The comparability of baseline demographic data between the intervention and control groups was assessed using t-tests for continuous variables, and chi-squared tests for categorical variables (Table 1). For evaluation, the Generalized Estimating Equations (GEE) approach estimated group differences in outcomes from baseline to three months, including time (three-month follow-ups and baseline [reference]), study group (intervention and control [reference]), and a time \times group interaction (Table 2). All the participants ($n = 103$) who completed the baseline survey were included in the analysis. Since less than 5% of the data were missing, multiple imputation was not appropriate [37]. Cohen's d (for continuous data) and Cohen's h (for categorical data) were employed to calculate effect sizes for the group differences in change from baseline to three months. The effect sizes for both of them could be categorized as small (≈ 0.2), medium (≈ 0.5), and large (≈ 0.8) [38,39]. All statistical analyses were performed using SPSS, version 27, and R Studio.

The pilot studies do not necessitate a formal sample size calculation because of the focus on feasibility, protocol refinement, and procedural testing, rather than on hypothesis testing or generating generalizable results. In the design of a main trial with 90% power and two-sided 5% significance, the recommended sample sizes per treatment arm in pilot studies are 75, 25, 15, and 10 for standardized effect sizes, which are extra small (≤ 0.1), small (0.2), medium (0.5) or large (0.8), respectively [40]. Therefore, our sample size was sufficient to assess the preliminary efficacy of the MySteps intervention.

2.5.2. Qualitative data analysis

Data for this paper were analyzed using content analysis employing a deductive approach [41]. First, two members of the research team familiarized themselves with the interview guide and thoroughly reviewed all the transcripts to grasp the scope of the data. Next, they constructed a structured set of codes derived from the framework of the interview guide and independently applied these codes. Subsequently, the team members discussed and compared their respective findings and collaboratively added and refined codes and subcategories. This iterative process led to a second coding review where the authors compared findings together, reconciling any inconsistencies until a consensus was reached. Finally, the findings were organized and presented based on

Table 1
Participants' baseline characteristics by study group.

	Intervention ($n = 55$)	Control ($n = 48$)	p -values ^c	Total Sample ($N = 103$)
Age [Mean (SD)]	36.0 (10.9)	35.6 (8.9)	0.83 ^a	35.8 (10.0)
Race (N, %)			0.48 ^b	28 (27.2)
White or Caucasian	17 (30.9)	11 (22.9)		
Black	8 (14.5)	11 (22.9)		19 (18.5)
Asian	21 (38.2)	15 (31.3)		36 (35.0)
Other	9 (16.4)	11 (22.9)		20 (19.3)
Ethnicity (N, %)			1.00 ^b	73 (70.9)
Non-Hispanic	39 (70.9)	34 (70.8)		73 (70.9)
Hispanic	16 (29.1)	14 (29.2)		30 (29.1)
Living Situation (N, %)			0.29 ^b	44 (42.7)
Urban	24 (43.6)	20 (41.7)		44 (42.7)
Rural	4 (7.3)	1 (2.1)		5 (4.9)
Suburban	25 (45.5)	27 (56.3)		52 (50.5)
Other	2 (3.6)	0 (0.0)		2 (1.9)

Notes. Percentages represented are within column percentages.

^a T-test was conducted on continuous variables.

^b Chi-squared test was conducted on categorical variables.

^c p values presented a significant difference between intervention and control arms

Table 2
Generalized Estimating Equations (GEE) analysis of outcome variables from baseline to 3 Months.

Outcome Variables	Intervention Arm (n = 55)	Control Arm (n = 48)	Group Difference in Change from Baseline			
	Mean (SD)	Mean (SD)	b	95 % CI	p-values ^c	Effect Size
Access to gun						
Baseline	52 (94.6 %)	45 (93.7 %)				
3 months	18 (32.5 %)	18 (37.5 %)	-0.56	-0.71 to -0.44	<0.001	0.10 ^a
Overall Effect (Group x Time)					0.583	
Self-efficacy						
Baseline	31.1 (8.6)	34.6 (8.2)				
3 months	34.9 (9.0)	34.1 (9.2)	-0.03	-2.00 to 1.95	0.979	0.51 ^b
Overall Effect (Group x Time)					0.010	
Safety Empowerment						
Baseline	3.3 (0.7)	3.4 (0.7)				
3 months	3.6 (0.7)	3.5 (0.7)	0.04	-0.13 to 0.22	0.604	0.29 ^b
Overall Effect (Group x Time)					0.012	
Overall Empowerment						
Baseline	112.9 (20.6)	116.3 (24.2)				
3 months	117.9 (20.2)	114.5 (21.9)	-1.57	-6.94 to 0.32	0.571	0.30 ^b
Overall Effect (Group x Time)					0.035	

^a Cohen's *h*.

^b Cohen's *d*.

^c *p*-value for each time point assessed whether there was a statistically significant change in each time point; the *p*-value for overall effect (Group * Time) suggested that whether outcome variables changed over time was different between the intervention arm and control arm.

their frequency of occurrence and their relevance to the research objectives. Dedoose software [42] was used for analysis.

3. Results

3.1. Sample characteristics

The average age of participants was 36 years. Most women in the study were non-Hispanic (71 %), Asian (35.0 %), followed by White or Caucasian (27.2 %), Other (19.4 %), and Black (18.5 %). The most represented regions of origin of women were Asia (41 %) and Latin America (30.1 %), followed by Africa (12 %), Europe and the Middle East (10 %), and nearby regions of the US (8 %). About 51 % resided in suburban areas, followed by those living in urban (43 %) and rural (4.9 %) areas. Most women reported experiencing psychological abuse (93.2 %), followed by those with experiences of physical (77.7 %) and sexual abuse (71.7 %). About 58.3 % reported experiencing all these 3 types of abuse. The baseline characteristics revealed a well-balanced distribution between the intervention and control groups (Table 1).

3.2. Feasibility and acceptability outcomes

3.2.1. Enrollment, adherence to the MySteps protocol, and loss to follow-ups

All 55 women randomized to the MySteps arm completed the MySteps protocol, including the risk assessment and safety planning. The attrition analysis revealed a retention rate of 93 % (*n* = 51) in the MySteps arm at three-month follow-up and a slightly higher retention rate of 96 % (*n* = 48) in the control arm.

3.2.2. Perceptions of MySteps

Overall, women reported that their experience with MySteps provided them with new, important, and helpful information presented clearly and comprehensively. Feedback was highly positive with many women expressing gratitude for the resource with a participant remarking that “*knowing these [safety strategies] would give confidence to any woman (Survivor, Age 39, Kazakhstani).*” Strategies relating to safety and escape planning (*n* = 18) were reported as the most helpful followed by safe gun storage (*n* = 16), strategies for avoiding an active shooter (*n* = 15), remaining calm and using verbal de-escalation (*n* = 14), packing a safe bag (*n* = 10), taking self-defense training (*n* = 9), discussing safe gun storage with the partner (*n* = 9), taking gun safety classes (*n* = 8), calling authorities (*n* = 6), and using a trigger lock (*n* = 6).

3.3. Preliminary evaluation outcomes

3.3.1. Quantitative outcomes: assessment of change over time

The findings (Table 2) indicate significant improvement in outcomes at 3 months follow-up in the MySteps arm compared to the control arm. The reduction in the partner's access to a firearm was larger in the MySteps arm (from 95 % at baseline to 32.5 % at 3 months) when compared to the partner's access to a firearm in the control arm (from 94 % to 37.5 %). At the 3-month follow-up, the odds of the partner's access to a firearm in the MySteps arm was 20 % lower than the odds of the partner's firearm access in the control arm (*OR* = 0.80). The group differences, however, were not statistically significant (*p* = .583, *Cohen's h* = 0.10). Similarly, at 3 months follow-up, women in the MySteps arm showed significantly greater improvement in self-efficacy (*p* = .010, *Cohen's d* = 0.51) than participants in the control arm. The mean change in self-efficacy was +3.8 (31.1–34.9) among the MySteps participants versus a decline in scores on self-efficacy (–0.5) among women in the control arm (34.6–34.1). Additionally, women in the MySteps arm showed a significantly greater improvement in safety-related empowerment (*p* = .012, *Cohen's d* = 0.29), with a mean change of +0.3 (from 3.3 to 3.6) compared to the control Arm, which showed a smaller mean change of +0.1 (from 3.4 to 3.5). The overall general empowerment improved significantly (*p* = .035, *d* = 0.30) among women in the MySteps arm (Mean Change = +5) when compared to women in the control arm, who showed a decline in scores on general empowerment (Mean Change = –1.8). The overall group-by-time interaction was statistically significant for women's coping self-efficacy, safety-related empowerment, and general empowerment.

3.3.2. Qualitative outcome: Reported use of Safety Strategies for Protection from firearms

In the follow-up interviews, most women engaged with the safety strategies provided by the intervention. Most frequently used reported strategies for protection included discussing gun storage with their partner (*n* = 8) and safe gun storage (*n* = 8) along with increased use of the more standard IPV strategies of safety planning (*n* = 10), packing a safe bag (*n* = 8), and remaining calm and using verbal de-escalation (*n* = 7). Some women shared stories of success in using these strategies: “*With the information I read from the handout I was able to figure out how to have a productive conversation with my partner about these are my concerns with the weapons and then these are the specific things that I think if you did, I would feel safer (Survivor, Age 27, Pakistani).*” Another woman shared:

The tips were very helpful because they gave me a sense that I do have something that's in my control. I can look for classes to educate myself on this, and learn more, and feel a little bit more powerful and more in control of the situation (Survivor, Age 26, Bahamian)."

Women reported no adverse events associated with their use of safety strategies. Among the strategies reported, most women reported successful utilization. The strategies with the most mixed results were calling authorities and discussing safe gun storage with their partner, each reported by four women. Some women found contacting authorities ineffective due to a lack of meaningful support and instances where authorities did not follow up as expected. *"I just stopped calling. Why keep calling the police? They are supposed to protect me. Then when I call them, they don't even try [calling back] (Survivor, Age 41, South African)."* Similarly, discussions about safe gun storage with their partner were often unproductive, as partners were either uncooperative or unwilling to disclose how the firearm was stored. A recurring challenge was the inability to determine where or how the firearm was stored. For instance, a woman stated: *"If my partner was open about where they keep their gun, I probably would have brought up a conversation about storing it properly or storing it separately from the ammunition. But at that point, I did not have access to it and I wasn't probably entitled to have an opinion on that either (Survivor, Age 30, Pakistani)."* Additionally, mistrust of or negative experiences with authorities or services was a significant barrier. The most frequently reported barrier to attempting strategies overall was fear of retaliation by their partner ($n = 20$).

Only six women did not report using any strategies post-intervention. However, these women still valued the information, expressing that it was beneficial to know about the strategies for potential future use: *Just being aware of all the things that I could do if needed made me feel ready or a bit more prepared instead of freezing up (Survivor, Age 35, Mexican)."* Among the 24 women who did implement the strategies, 13 found them particularly useful because they were either currently in a relationship with or in the process of separating from a firearm-owning partner. These women actively applied the strategies to enhance their safety. Eleven women, who were no longer in relationships with partners who had access to firearms at the post-intervention follow-up, still found the information helpful for general firearm safety and future preparedness. For instance, one woman stated: *"If I encounter a similar situation again, at least I have a backup [safe bag] in that safety room (Survivor, Age 41, Chinese)."* Another woman shared: *When I first spoke about guns, I was scared because I didn't know much. Then I got more confident, I know how to protect myself when a bad thing happens ... and I feel more in control about what I can do. It's less scary (Survivor, Age 27, Vietnamese)."* These responses highlight that the strategies were not only utilized by those in immediate need but were also valued as useful knowledge for future situations. This indicates the dual benefit of the intervention—offering immediate safety solutions while also empowering women with information for ongoing and future safety.

4. Discussion

This study offers support for the usefulness of digital MySteps in improving outcomes for survivors of IPV, in relationship with a partner who possesses a firearm. Compared to the control arm, women randomized to MySteps showed significant improvement over time in self-efficacy, safety-related empowerment, and general empowerment. Women in the MySteps arm also showed a reduction in their partner's access to a firearm than women in the control arm. Further, in the follow-up interviews, women provided positive feedback on their experiences with MySteps and the helpfulness of firearm-specific safety strategies such as escape planning, safe gun storage, avoiding an active shooter, verbal de-escalation, self-defense training, discussing safe gun storage with the partner and gun safety classes. With the growing emphasis on digital health technologies [43] and providing round-the-clock access to support survivors of IPV in an anonymous and private setting [27], there is a need for an evidence-based digital

intervention that could protect survivors at high risk of being harmed by their abusive partner's firearm. Prior evidence-based digital IPV interventions have not been specifically designed to protect IPV survivors from abusive partners' possession of a firearm but rather focused on general safety planning and directing them to support services [27,28]. Our study adds to the growing body of literature on digital IPV interventions [27,28,43], with its unique focus on a tailored firearm safety promotion intervention to protect abused women from their partner's firearm.

The psychological consequences of IPV often include disempowerment and low self-efficacy among women, leading them to feel helpless and powerless within their abusive relationships [44,45]. Consequently, many remain in these situations, which exacerbates their feelings of helplessness and powerlessness, distorts their self-perceptions, and diminishes their confidence in addressing abuse [44–46]. As a result, abused women with low self-efficacy may struggle to take necessary safety measures against threats such as a partner's firearm, further compromising their ability to protect themselves. Research shows a clear link between coping efficacy and fear; as self-perceived efficacy in coping increases, fear tends to decrease [47]. Strengthening coping self-efficacy can therefore empower women to feel less fearful and more capable of managing threats associated with firearms. Empowering approaches can enhance abused women's self-efficacy and facilitate access to necessary skills and resources [36,48] to effectively address safety concerns. Empowerment has been associated with a reduced likelihood of revictimization by IPV in prior research [48]. Further, research shows that effective interventions with IPV survivors empower them with the necessary skills to enhance safety [21,22]. Using a collaborative approach to ensure that women have the information and skills they need to keep themselves safe while accounting for their choice and self-determination, can enhance their self-efficacy and empower them to take steps towards their safety. An increase in self-efficacy perceptions or optimistic beliefs in their capability to handle the threat from their partner's firearm can lead to enhanced use of safety strategies to keep themselves safe. Our preliminary findings on enhanced self-efficacy beliefs, safety-related empowerment, and overall empowerment among abused women in the MySteps arm, show that MySteps intervention is promising for abused women with partners who possess a firearm.

We also found a reduction in the partner's access to a firearm from the baseline to the three-month follow-up point. This could be attributed to increased awareness of firearm-related risks among women and their proactive steps, such as safe storage and anonymous reporting of their partner's firearm. MySteps provided information on legal provisions for DV and firearms, encouraging women to learn about firearm laws in their state. In cases where a partner was not legally allowed to own a firearm, the resource suggested anonymously reporting the partner's firearm ownership to the police. During follow-up interviews, participants reported using various methods to reduce gun access, such as safe gun storage, trigger locks, and reporting their partner's gun ownership. While we did not directly investigate the causal relationship between these safety strategies and the reduction in gun access, the use of these safety measures could have contributed to the decline. The implementation of these strategies likely played a role in limiting the availability and accessibility of firearms, thereby enhancing the overall safety of the participants.

The study limitations include the use of self-report data, which is subject to potential biases inherent in self-reporting, such as recall bias, social desirability bias, and subjective interpretation of questions and experiences [49–51]. Despite these potential biases, self-reporting is critical for capturing the nuanced and personal experiences of survivors of IPV, providing insights that might not be accessible through other means [52]. Further, the pilot trial was conducted among immigrant women since the sample was drawn from a parent study focused on immigrant IPV survivors. However, the development of MySteps involved experts and providers who worked with non-immigrant

survivors. In the preliminary work, participants highlighted that firearms can be a threat to abused women regardless of their cultural background, with some unique challenges for immigrant women in reporting their partner's firearm (e.g., deportation threat). Thus, MySteps was designed to apply to women from diverse backgrounds, not just those from immigrant backgrounds. The intervention considered cultural considerations during its development to ensure its relevance and effectiveness for women from various cultural backgrounds. Despite pilot participants being immigrants and concerns about immigrant women being less likely to report, we saw positive outcomes, such as reduced access to firearms by perpetrators among women in the MySteps arm at the follow-up point. These positive outcomes demonstrate the intervention's potential effectiveness for women from diverse cultural backgrounds. The lessons learned from the pilot trial will be used to further improve MySteps and test it with diverse groups of women in the US. This work will ensure that MySteps remains responsive and effective for women from various cultural backgrounds. The study shows promising evidence for digitally delivered MySteps for women in abusive relationships with a partner who possesses a firearm. By continuously refining MySteps based on feedback and outcomes, we aim to create an evidence-based inclusive, and culturally sensitive intervention that addresses the safety needs of all women facing firearm-related threats in abusive relationships.

CRedit authorship contribution statement

Bushra Sabri: Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Theresa Mata:** Writing – review & editing, Formal analysis. **Jian Li:** Writing – review & editing, Formal analysis. **Sara Butter:** Formal analysis. **Jacquelyn C. Campbell:** Methodology. **Chakra Budhathoki:** Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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