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An Evaluation of the Efficacy, Feasibility and Acceptability of Mobile Health Technologies for

Violence Prevention and Control in Low- and Middle-Income Countries: A Systematic Review

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Abstract

An Evaluation of the Efficacy, Feasibility and Acceptability of Mobile Health Technologies for

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By Madeline Anscombe

In Low- and Middle-Income Countries (LMICs), the increasing availability of technology has

allowed for significant development in the field of mobile health (mHealth) interventions. Of

these interventions, ten have published results on the efficacy, feasibility, and acceptability of

mHealth technology for the purposes of violence prevention and control. This systematic review

examines published literature to provide a comprehensive analysis of mHealth violence

programming in LMIC contexts and draws conclusions regarding specific program constructs,

modalities, and testing instruments.

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ACRONYMS:

ACLED: Armed Conflict Location & Event Data Project

CSE: Coping Self-Efficacy

CTS-2: Revised Conflicts and Tactics Scale

DALY: Disability-Adjusted Life Years

GDP: Gross Domestic Product

GTD: Global Terrorism Database

HICs: High-Income Countries

IISS: International Institute for Strategic Studies

IPV: Intimate Partner Violence

LMICs: Low- and Middle-Income Countries

MeSH: Medical Subject Headings

mHealth: Mobile health

PCC: Post-traumatic Cognitive Changes

PCL: PTSD checklist for DSM-5

PDS: Post-Traumatic Diagnostic Scale

SCL-D: Symptom Checklist for Depression

SFI: Social Functioning Impairment

SV: Sexual Violence

UCDP: Uppsala Conflict Data Program

UEQ-s: User Experience Questionnaire

WHO: World Health Organization

YLD: Years Lived with Disability

YLL: Years of Life Lost

Introduction

Background and Rationale

As one of the largest determinants of morbidity and mortality, experiences of violence impact every population in every culture, and shape the economic, physical, and interpersonal abilities of individuals, families, and communities. It is estimated that at least one in every three women is the victim of intimate partner violence or sexual violence over the course of her lifetime, while suicide is one of the leading causes of death amongst men globally. These figures represent only a fraction of the burden of violence in high-income countries (HICs), and an even smaller fraction of the burden of violence in low- and middle-income countries (LMICs), where violence estimates are considered extremely conservative due to insufficient surveillance systems, underreporting, and overburdened healthcare systems. Still, based on what is known, it is estimated that over 90% of violence occurs in the 53 countries meeting the World Bank's LMIC classification, placing significant strain on already vulnerable populations, causing significant detriment to the financial wellness and physical health of victims and their communities. While most of the global burden of violence occurs in these settings, there is a shortage of interventions targeting violence prevention and control, and violence is often not adequately prioritized. In many cases, scaling up violence interventions requires a long-term improvement in infrastructure and surveillance, much of which does not address the dire situations of those currently impacted or is improbable given cultural and financial constraints.

Mobile Health (mHealth) technology, which utilizes cellular phones, computers, and Wi-Fi-enabled devices to connect hard-to-reach populations with accessible care, offers a potential solution to this gap through the provision of cost-efficient programming. This technology has grown increasingly prevalent in LMIC settings, offering the traditionally under-resourced with

interventions that they might not otherwise receive. A vast majority of these interventions have sought to address behavior change, chromic disease, physical disease, and physical activity. [1] In recent years, governments and public health officials have sought to create solutions to issues of violence through mHealth technology. While a few programs have been funded in LMICs, they have not been systematically reviewed or assessed collectively to determine if such technologies improve violence programming.

Problem Statement

Of the interventions targeting LMICs, only ten have published results on the efficacy, feasibility, and acceptability of mHealth for the purposes of violence prevention and control. Assessment of mHealth interventions in this context is critical, as many of the constructs that shape these measurements differentiate significantly between LMICs and HICs.

Purpose Statement

Given the novelty of such interventions, there have been few literature reviews assessing the efficacy, feasibility, and acceptability of mHealth for violence prevention purposes, none of which have encompassed multiple violence topics or have been conducted in LMIC settings. Perhaps even more than in HICs, mHealth has the potential to transform communities without access to adequate healthcare resources at an attainable price point. For this innovation to exist and make a meaningful impact, however, research must be conducted to evaluate the efficacy, feasibility, and acceptability of mHealth for the purposes of violence interventions in LMICs. The implications of this review should be used to inform future program development and study design so that reach and impact are maximized in these contexts.

Research Questions

Question One: Are mHealth interventions for violence prevention efficacious in LMICs?

Question Two: Are mHealth interventions for violence prevention feasible in LMICs?

Question Three: Are mHealth interventions for violence prevention acceptable in LMICs?

Significance Statement

In both HIC and LMIC settings, violence prevention interventions have struggled to sustain funding and are often not prioritized due to limited results on the efficacy, feasibility, and acceptability of programming. By centralizing these results, this review can help inform the development of efficacious, feasible and acceptable violence technologies in LMICs.

Literature Review

Mobile Health Technology in Low- and Middle-Income Countries

The first cellular phone was developed by Motorola in 1973 and allowed individuals to use handheld, mobile devices to communicate for up to thirty minutes of battery life. [2] In the decades following this invention, mobile technologies have evolved in several ways, and now facilitate communication through SMS messaging, video chatting, instant messaging, social media, and internet access, and offer improved battery life that allows for longer call time. [2] These technologies have also grown to encompass mobile tablets and mobile laptop computers. As this technology has evolved and improved, so have methods for using mobile devices for healthcare and behavior change purposes.

Access to these technologies in LMICs has grown significantly in the decades following the advent of the smartphone in 2001, and in some low-income countries, connection to smartphones, which are cell phones with internet and additional software capabilities, is more

reliable than access to electricity and clean water. [3] By 2025, an estimated 5.6 billion mobile devices are expected to be in the hands of two-thirds of the global population, with growth rates in LMICs being the largest-growing demographic impacted. [4] Mobile data subscribership is estimated at 73% global penetration, 63% of which is sourced from smartphone ownership. [5] Irrespective of subject, mobile health (mHealth) programming in LMICs has historically utilized SMS messaging as the modality of intervention, however as smartphone ownership has grown, so has the population of technologically literate populations in LMICs who are equipped to engage in a diverse range of intervention modalities. [6] While this is promising for increasing the reach of mHealth technologies, concerns for equity can be made for populations with less access to resources, and higher-income populations are still favored in the scaling up of mHealth interventions. [7]

The Burden of Violence in Low- and Middle-Income Countries

The impact of violence on individuals and populations is often measured using a few key metrics and corresponding data sources. The most utilized types of data include mortality records, morbidity data, self-reported accounts, community records, crime records and economic impacts. When used together, these sources can provide insight into the burden of disease, mortality and overall impact of experiences of violence. [8]

Mortality

The most recent estimates of the global distribution of violence estimate that more than 90% of violence related deaths occur in LMICs, resulting in a violence-related mortality rate that is 2.5 times higher than that in HICs. [9]

Global estimates on violence rates leading to mortality have been most recently calculated in the 2019 World Health Organization (WHO) Global Health Estimates Death by Cause, Age and Sex, By World Bank Income Group. This data has been collected by the WHO and United Nations (UN) partner agencies, who receive cause-of-death statistics annually. [10] Inclusion criteria for countries included in this set require medium or high-quality data, which is calculated using a usability score that takes a completeness percentage (the percentage of deaths that are registered with a medical certificate), which is multiplied by a proportion of deaths that are assigned a meaningful cause of death. [10] Estimates from countries that did not meet this standard, many of which are classified as LMICs, were assigned using covariate-based estimation models developed by The Institute for Health Metrics and Evaluation (IHME), which provides estimates by country, age, cause, and sex.[10]

Violence-specific methods were included in the development of this data. The WHO used their Member States' report on homicide for 2000-2012 alongside recent trends to project new estimates, and conflict data from Uppsala Conflict Data Program (UCDP), International Institute for Strategic Studies (IISS), Armed Conflict Location & Event Data Project (ACLED) and Global Terrorism Database (GTD) was used to estimate deaths due to collective violence, with assigned deaths per-event. [10]

In countries that fit the low-income categorization, interpersonal violence accounts for 1.2% of total deaths, with an estimated cumulative death rate of 8.6 per 100,000. In lower-middle income countries, self-harm accounts for 1.4% of total deaths, with an estimated cumulative death rate of 9.2 per 100,000 individuals. [11] High-Income Countries have high rates of self-harm, which accounts for 1.5% of total mortality, and can be attributed to 13 cumulative deaths per 100,000. [11]

The breakdown of violence-related mortality shows large differences between men and women. Men account for 60% of suicide related deaths [12] and 81% of homicide-related deaths, however comprise only 44% of mortality caused within the context of an intimate relationship. Estimates on female homicide are influenced by a lack of contextual data available, which leaves 4 in 10 homicides unclassified. [13] From what is known, 56% of homicides committed against women are committed within the context of an intimate partner or familial relationship. [13]

The burden of violence-related mortality still falls largely on lower- and lower-middle income countries which also bear a larger burden of overall mortality, thus driving down violence-specific deaths using rate-based metrics, but not death totals. [11]

Violence-Related Disease and Disability

These findings do not encompass the totality of violence, as the measurement of violence is difficult to quantify using one singular metric. While mortality reflects a partial picture of victimization rates, not all violence related deaths are recorded as such, and further, not all acts of violence result in mortality. Higher rates of diseases such as cardiovascular disease, HIV/AIDS and substance misuse exist amongst victims of violence and lead to disability, death, and disease, yet may not be captured in mortality data. [9]

Calculations quantifying burdens of disease, such as potential Years of Life Lost (YLL), Years Lived with Disability (YLD) and disability-adjusted life years (DALY) allow further insight into the populations burdened by violence. [14] The DALY is calculated by the WHO in their Global Disease Burden data set, which was most recently captured in 2019 and measures "disability" as time lost through premature death or time spent in suboptimal health states, with one DALY

representing one lost year of healthy life. [14] The calculation used by the WHO to calculate this data calls for the sum of YLL measurements and YLD.

Estimates for YLL are calculated using age, cause, sex, and time specific estimates of mortality multiplied by a loss function for years of life lost at a particular age by sex. [10] The calculation to determine YLDs uses an incidence perspective, multiplying the number of incident cases in a given period by the average duration of a given disease and a weighted factor that measures severity on a scale from perfect health (0) to death (1). [14] Globally, DALY estimates have been estimated with 95% uncertainty ranges, which estimates average global uncertainty for violence topics such as suicide ($\pm$ 36.9%), conflict ($\pm$60%) and homicide ($\pm$34.9%). [14]

Non-fatal estimates for violence often rely on self-reported and crime data, which likely leads to underreporting in a population. [12] In LMIC settings, poor quality death registration data causes YLL and YLD estimates trend towards greater uncertainty. [14]

In the 2019 data, violence topics are covered in the intentional injuries categorization, with estimates for self-harm, interpersonal violence, and collective violence, as well as a total estimate. [14] In the top 20 DALY causes, collective violence and interpersonal violence ranked 14th and 20th respectively in low-income countries. [15] Collective violence accounts for 4,507 average DALYs, which represents 1.4% of recorded causes and 674 DALYs per 100,000 individuals in a population. [15] Interpersonal violence accounts for 3,670 average DALYS, which represents 1.2% of DALY causes recorded and 579 DALYs per 100,000 individuals in a population. [15] In lower middle-income contexts, self-harm is listed as the 19th leading cause of DALYs, which accounts for 13,786 average DALYs, 1.3% of the causal burden, and 473 DALYs per 100,000 in a population.[15] In high-income countries, self-harm is ranked 13th, with 6,510 average DALYs, which represents 1.9% of the causal burden, and 532 DALYs per

100,000 individuals. [15] The disparity between DALY burdens in HIC and LMIC reflects higher rates of disease and disability in poorer countries.

Further, the burden of mental health outcomes associated with violence exposure may be difficult to track on a nationwide population level but provide relevant insight into the burden of violence. [9]

The Economic Impact of Violence

The economic implications of violence are vast, not only for the individuals directly exposed, but also for the local and national contexts in which they exist. The sum of these costs is estimated to cost $14.4 trillion globally, much of which falls upon conflict-burdened areas which are largely in LMICs. [16] There is a gap in the literature for exactly how much of this burden falls upon countries fitting this classification, but existing literature has connected the disproportionate burden of violence that occurs in LMICs to a lack of economic development on a national scale. The economic burden of violence is often split into two different categorizations, direct costs and indirect costs. A 2019 study conducted by the Institute for Economics & Peace provides the most current, standardized data on this topic. To determine the global economic burden, researchers used 18 indicators covering both indirect and direct costs associated with violence, as well as costs for expenditures used to contain and prevent violence. [16] The estimates captured in this study can be further categorized by costs associated with violence containment, armed conflict related costs, and consequential costs of interpersonal and self-inflicted violence. The third categorization contains both direct and indirect costs associated with experiences with violence. The indirect costs captured are described as those resulting in economic losses, such as decreased productivity following injury, lost economic output of a homicide victim, and reduced economic growth in high-conflict areas. Of the categorized

domains, interpersonal and self-inflicted violence was estimated to cost $2.25 trillion in 2019, which costs an estimated 1.6 percent of the global Gross Domestic Product (GDP). [16] The economic burden of armed conflict amounted to $519 billion in 2019, much of which occurs in authoritarian regimes unlikely to provide accurate and comprehensive data on mortality and morbidity due to violence. [16] The findings of this research quantify the economic cost of violence to equate to 10.5 percent of the GDP globally. This number was derived from a wide range of economic impacts, ranging from 3.9 percent GDP in the ten most peaceful countries, which are all listed as HICs, to 36.4 percent GDP in the ten most violent countries, which are all listed as LMICs. [16]

Small improvements in violence reduction have been demonstrated to have significant impact on the economic stature of a country, which in turn, provides conditions less restricted by income inequality, which can improve nation-wide health outcomes and contribute to further reduction in violence. [16] If all countries improved their violence rates to the standard met by the 40 most peaceful countries, the reduction in violence would result in $3.6 trillion in savings over the next decade, much of which would occur in countries and regions comprised of LMICs. [16]

The estimates explored in this section are all considered conservative given limited data, which could potentially be improved through increased access to mHealth surveillance developed through intervention programs. Further, access to cost-effective mHealth technologies, if determined to be efficacious, feasible, and acceptable, could potentially lessen the burden of disabilities, illness, and economic limitations that are disproportionately incurred on LMICs experiencing high rates of violence.

Global Distribution of Violence

The variance in violence rates globally can also be broken up regionally, by violence topic, and by country. Violence, as previously defined, can be organized into one of three directed targets; self-directed, interpersonal, and collective. [12] These categorizations can then be broken into one or several categorizations: child abuse and neglect, youth violence, intimate partner violence, sexual violence, abuse of the elderly, self-directed violence, and collective violence. [9] Overlap of these violence subjects exists, for example, high rates of sexual violence are often captured in collective violence settings, and domestic violence often coexists with abuse directed towards children.

The types of violence targeted by existing mHealth technology, and their corresponding burdens of violence in LMICs can be summarized as follows.

Intimate Partner Violence (IPV)

In the 2018 update of the WHO Violence Against Women Prevalence Estimates, data suggested that the highest rates of lifetime prevalence of IPV occurs in women aged 15-49 living in the least developed countries, which also fit LMIC classification. The estimated 37% lifetime prevalence of IPV in this population can be further dissected, and the study estimates a 22% prevalence over the course of the past year. [17] Regionally, prevalence is highest in Southern Asia and Sub-Saharan Africa. [17]

A 2019 review of IPV in LMICs compiled relevant findings regarding the causation and prevalence of this form of violence. The review utilized data compiled from Demographic and Health Surveys conducted between 2010 and 2017 in LMICs, which estimated prevalence using questions detailing experiences of IPV that occurred within the previous year, with specific estimates pertaining to experiences of physical, sexual, and psychological IPV, all of which

ranged significantly. [18] The range of psychological IPV ranged from 6.2% in Cosmoros to 34.4% in Afghanistan, and physical/sexual IPV ranged from 3.5% in Armenia to 46% in Afghanistan. [18] The WHO estimates that IPV violence against women in low-income countries impacts around 36% of women, and 32% of women in lower-middle-income countries, compared to 27% globally. [19]

While high levels of wealth inequality were unassociated with psychological violence, wealth inequality was associated with high levels of sexually violent IPV. [18] Within LMICs, richer and more empowered women reported lower risks of IPV, while younger women, women in polygynous relationships and women living in rural areas have reported higher levels of IPV. [18] Victims of IPV have been found to have higher rates of depressive symptoms, drug use, unwanted pregnancies, post-traumatic stress, and unsafe sexual behavior, all of which can lead to death and higher burdens of disease and DALYs. [18] [9] The WHO DALY and mortality datasets do not yet specifically include estimates on IPV, but the burden is partially represented in interpersonal violence estimates.

Mortality due to IPV largely falls upon women, with 40-60% of female homicide being at the hands of an abusive relationship. [13] Further, experiences of IPV increase the likelihood of suicide-related mortality. [13]

A systematic review looking at the economic cost of IPV in LMICs was conducted in 2021, and selected articles based on the presence of cost-related metrics pertaining to both indirect and direct costs, as well as classification as occurring in a LMIC. [20] Costs were then inflated to create metrics standardized by GDP and then converted to US dollars. This study reported a wide range of direct expenditure costs to victims, largely considering expenses such as hospital bills, travel, and treatment, ranging from US $29.72 per-incident in Romania to US $156.11 in South

Africa. [20] Direct costs to service providers also yielded a significant range, with an average annual cost of US $115,971 to providers in Senegal, to US $599,563 to hospitals in Kenya. [20] Indirect cost estimates ranged in methodologies, even within singular countries. Two studies in South Africa ranged in estimates from US$73.84 to US$2,151.48 per-incident, with no clear reasoning as to why that variance occurred. [20] Given a wide range of methods, aggregate data were difficult to compile regarding total costs to individuals and households, and the three collected averages of lost earnings amounted to over US $73 million in Vietnam, US $18.4 million in Ecuador, and US $4.4 million in Thailand. [20] Similar to other forms of interpersonal violence, IPV estimates are considered conservative due to underreporting. [21]

Sexual Violence (SV)

Globally, sexual violence is significantly underreported, which makes it difficult to estimate the prevalence and impact of at all levels. In the 2013 World Health Organization Violence Against Women Prevalence Estimates, SV was defined as a forced sexual act that an individual does not want to perform as perpetrated by someone other than a significant other. This report estimated that 7.2% of women globally have an experience of SV during their lifetime, with a higher prevalence reported in high-income countries (12.6%). [22] The reported differences between HICs and LMICs is likely not due to higher incidence, but rather issues with data quality.

In the 2018 update of this report, a global prevalence of 6% was determined amongst women aged 15-49. [17] Of the countries with the highest prevalence of sexual violence, high-income regions including Oceania and North America (19% and 15% respectively) report the highest numbers, followed by Polynesia (12%), Micronesia (12%), and Latin America (11%). These figures raise the same concerns about data quality as expressed in the 2013 data, with the authors

noting that higher estimates in high income countries are likely not reflective of higher incidence rates, rather a reflection of the stigmatizing and dangerous repercussions that exist for those who report sexual violence. [17] Varying levels of underreporting, stigmatizing climates, and retaliatory repercussions following disclosure influence SV statistics, making analysis difficult on both national and international levels. [17] While data concerns exist for the underreporting of SV, they are considered to be validly reflective of higher IPV rates in comparison to SV. [22]

While the Violence Against Women dataset focuses on women, the Global Burden of Disease provides insight into the breakdown of SV by sex and Human Development Indexes (HDI), which is a summary of achievements that are critical dimensions of a decent standard of living, which largely captures income status. [23] In low-development countries, estimates range from 1221.2 incidents per 100,000 men in a population to 2915.1 incidents per 100,000 females in a population. [23] By contrast, high-development countries estimate 1097.8 incidents per 100,000 men in a population and 2602.1 per 100,000 females in a population. [23] The study notes that this disparity is likely in part due to the presence of programming in high HDI countries, while low HDI, resource-limited countries still lack comprehensive intervention programs. [23]

The 2013 WHO data included a systematic review for health effects associated with SV and concluded higher rates of depression, anxiety and substance use amongst victims. [22] A systematic review of health consequences associated with SV further confirmed associations with conditions such as fibromyalgia, chronic pain syndrome, HIV/AIDS, suicidal tendencies, risky behavior, sexual dysfunction, eating disorders, and maternal deaths. [24] Given the limitations outlined with prevalence estimates, DALY totals have not yet been made available on a population level or amongst LMICs. [17] In a study conducted in the United States, it was

found that victims of SV were 5.3 times more likely to attempt suicide, which leads to SV-related disability and mortality. [24 25]

The total economic impact of SV is impossible to assess without better data and scaled-up research. A UN Session of the Commission on the Status of Women noted that in the developing world, lost wages, lower earnings, and underemployment causes devastating impacts to a victim's economic health. [26]

Self-Directed Violence

Globally, more than 77% of deaths due to suicide occur in LMICs. These data are not considered to be of high-quality, given the illegality and stigma surrounding suicide world-wide. [27]

The WHO estimates that only 80 countries have reliable surveillance data on suicide, many of which are HICs. [27] Suicide is the leading cause of death due to violence in LMICs, but accounts for a smaller percentage of deaths due to violence than in HICs, statistics that are influenced by a higher burden of conflict in LMICs. Additionally, self-directed violence and non-fatal suicidal behavior are 20-30 times more common than completed suicidal behavior, which includes acts such as cutting, burning, and intentional injury, which can impact both potential years of life lost and DALYs. [27] Further, in LMICs, there are an estimated <0.5 psychiatrists per 100,000 in a population, which limits intervention capabilities on self-harm activities. [28]

The 2019 WHO data estimated 1,800,556 deaths in countries fitting the low-income classification, and 268,720 deaths in countries fitting the lower middle-income classification. [11] WHO further estimates a 9.91 [5.84-15.85] suicide rate per 100,000 in a population in low-

income countries, and a 10.07 [6.75-14.32] suicide rate per 100,000 in a population in lower-middle income countries. [11] The dataset for DALYs further estimates 1,880,556 DALYs in lower-income countries, and 13,786,353 in lower-middle income countries. [15]

Little is known about the economic costs of suicide in LMICs, but estimates from the US, where suicide is less prevalent than in many LMICs, estimate that the annual cost of suicidal behavior is $93.5 billion when considering under reporting. [28] In a 2016 systematic review, data was compiled on the association between income inequality and suicidal behaviors, showing that on the individual level, poverty indicators such as unemployment, economic bankruptcy, and economic status may impact suicidal behavior in LMIC, but more data are needed for comprehensive results. [28]

Collective Violence

Collective violence can be categorized into three types of violence, including war, terrorism and political conflicts between or within states, state-perpetrated violence such as genocide or repression, and organized violent crime. The global burden of war disproportionately falls on LMICs, and 81% of casualties occur in countries fitting this categorization.[29]

Collective violence in LMIC is estimated to be ten times higher than in HICs. Of the countries on the World Bank's 2023 List of Fragile and Conflict-affected Situations, 36 of the 37 listed fit their definition for LMIC contexts. [29] This disproportionate burden may be further parsed by the 2019 WHO DALY data, which ranked collective violence as the 14th top cause in low-income countries, contributing 674 DALYS per 100,000 in a population, and accounting for 1% percent of DALY causes. [15] In middle-income countries, this rate drops to .038 DALYS per 100,000 in a population, which does not account for a percentage of total DALY causes. [15]

The burden of mortality due to collective violence in LMIC ranges, with an estimated 54,068 annual deaths occurring in low-income countries, and 8,769 annual deaths in lower-middle-income countries.[11] It is difficult to assess the economic impact of collective violence given the nature and span of what is covered in collective violence settings, including property damage, increased sexual violence, and reduced healthcare capacity.

The Use of mHealth Technology for Violence Prevention and Response in LMIC Settings

Despite bearing a significant burden of violence worldwide, interventions targeting violence still disproportionately serve HICs. [30] This is likely in part due to resource shortages in LMIC settings, which limits the reach and implementation of traditional healthcare programs.[31] Given the novelty of mobile technology in LMICs, this disparity also exists with respect to mHealth technologies targeting violence prevention and control. From what little evidence is available regarding the prospect of mHealth implementation in LMICs, it can be inferred that this technology may provide efficacious, low-cost interventions on violence subjects, yet comprehensive analysis of this has yet to be conducted. [31]

In a 2016 systematic review, a baseline measure of mHealth efficacy in LMIC settings found statistically significant differences in results between intervention and control groups in five of seven reported studies. Further, this review identified that the scarcity of resources in these settings led to a lack of measured outcomes following program implementation, leaving a gap in the literature for comprehensive analysis and evaluation of mHealth technologies. [31] A 2020 systematic review of mHealth technologies addressed part of this gap, adding that the prospect of mHealth technology in LMIC is an important subject to further explore in efforts to provide convenient, low-cost, and transparent healthcare services. [32] Of the 31 studies synthesized in this review, feasibility and acceptability were additionally mentioned as potential measures for

analysis. [32] While the study did not specifically apply to violence technologies or provide insight into evaluation, it did further discuss the need for quality mHealth data before scaling up programs or applying them in LMIC contexts.

The measurement of the efficacy, feasibility, and acceptability of mHealth technologies has not yet been conducted or specifically applied to violence-related technologies in LMICs, and the results of this review will provide insight into these topics as well as the potential uses of this technology for violence prevention and response.

Methods

General Cochrane methods were used to develop this systematic review, which included developing a research question with the assistance of Emory University Library services.[33] The criteria for this review were developed through preliminary research on mobile health (mHealth) technologies used in violence settings. Search terms were then derived from standard definitions developed by the World Health Organization (WHO) and World Bank. The resulting research topic looks at the efficacy, feasibility, and acceptability of mHealth technologies used for violence prevention and control in Low and Middle-Income Countries (LMICs). Comparison and intervention groups were applicable to the research question.

Given the novelty of mobile health technology, results were limited to research conducted after the advent of the flip phone in 1996 to October 2022. English language and Emory Library requisites were set given the available resources and language abilities of the researcher.

Initial search terms were derived from the key terms "efficacy," "feasibility," and "acceptability" among mHealth tools. Following an initial evaluation of relevant literature, inclusion and exclusion criteria were developed and applied to published peer-reviewed literature accessible

through the University's library. All searches contained three key criteria detailing the key components of the research question. To capture studies conducted in LMICs, all searches included the names of countries fitting this categorization by The World Bank, which defines low- and middle-income countries as ones where the gross national income (GNI) is less than $4,095. As of 2022, 53 countries fit within these parameters. [34] These terms were then connected by the word "OR", which links each set of terms to include at least one of the words listed. Mobile health (mHealth) technologies were defined using the World Health Organization's definition of interventions that, "utilizes mobile technologies such as tablets, cell phones and tablets to provide a health service." [35] Terms in the mHealth portion of the search included: ("Mobile Applications"[tiab] OR "Telemedicine"[tiab] OR "Smartphone"[tiab] OR "Cell Phone"[tiab] OR "Electronic Mail"[tiab]) OR "Online Systems"[tiab]) OR "Online Social Networking"[tiab] OR "Internet-Based Intervention"[tiab] OR "Patient Portals"[tiab] OR "Internet"[tiab] OR "Text Messaging"[tiab] OR "Social Media"[tiab]). Additional coding using "tiab" tags were added to mHealth terms to limit search results to articles that had mHealth technology components named in their title (ti) or abstract (ab). Doing so ensured that mHealth technology was central to the interventions being described. The definition for violence used for the search was sourced from the WHO, "the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation." [36]. The resulting medically defined violence topics included child abuse, elder abuse, spouse abuse, gender-based violence, intimate partner violence, physical abuse, rape, terrorism, workplace violence, domestic violence, adverse childhood experiences and gun violence. Terms used encompassed MeSH terms listed for each of these

subjects, with terms such as "homicide," "molestation," "femicide" and "dating violence." Resulting searches were then assessed by whether an intervention provided victims or potential victims with an intervention for the prevention or control of experiences of violence.

Next, the search terms were applied to the following bibliographic databases: PubMed, PyschInfo, CINAHL, MEDLINE, CABGlobal Health, Google Scholar and EmBase. Articles were initially limited to those published between January 1996 and October 2022, with the search occurring on October 31, 2022. These dates were selected to reflect this technology since the development of the cell phone.

Inclusion criteria were:

- Studies occurred in a LMIC;

- Violence prevention or control was an aim of selected technologies;

- Population includes victims or potential victims of violence;

- Intervention utilizes mobile health technology, defined as any intervention using cell phone or internet-based technology;

- Study assesses the efficacy, feasibility, and/or acceptability of mHealth technologies;

- Published between 1996 and 2022;

- Published in English; and

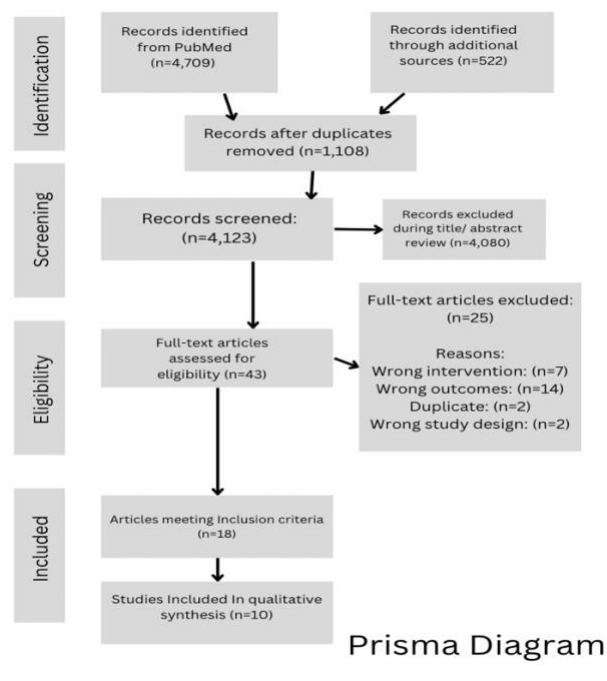- Full text available through Emory Library or other catalog systems.

Exclusion criteria were:

- Selected studies occur in a high-income country;

- Population has not been victimized nor is subject to victimization;

- Refugee populations living in high-income countries;

- Intervention does not meet the definition for mobile health technology;

- Violence prevention or control is not an aim of the intervention;

- Study does not include assessments of efficacy, feasibility, and/or acceptability;

- Study was conducted before 1996, the advent of the flip phone;

- Published in a language other than English; and

- Full-text version unavailable through Emory University Library systems.

The resulting search yielded 5,231 articles across all databases. Citations were exported to Covidence where 1,108 duplicates were detected and removed by system detection technology. Following the identification of duplicates, the 4,123 remaining studies were included in title and abstract screening. After applying inclusion and exclusion criteria, 43 articles were included for full-text review (Figure 1, Prisma Diagram). Following study identification, studies were labeled in Covidence with design type and analysis measures.

Figure 1 PRISMA Diagram

Prisma Diagram

A data collection form was then constructed to extract data from the articles included in the full-text portion of the review. Extracted data included country and regional origin, outcomes measures, mHealth intervention type, violence targeted, study design, sample size, and key findings. Relevant findings were then exported from Covidence to a Microsoft Excel spreadsheet for data analysis.

This review did not directly involve any human subjects and was reliant on existing literature, therefore no Institutional Review Board consideration was necessary.

Results

The objective of this systematic review was to assess the efficacy, feasibility and acceptability of mHealth technologies used for violence prevention in LMICs. A meta-analysis was not conducted for this review. Studies were identified in: Argentina, Brazil, Cambodia, China, Democratic Republic of the Congo, Iran, Iraq, Kenya, South Africa, and Sierra Leone. While the study in Sierra Leone met the criteria for a mHealth intervention, it has only published a protocol for its intervention and has not yet published the collected data and was therefore excluded. Kenya was the only country with more than one (n=2) mHealth intervention and the global distribution of interventions included Africa (n=4), the Middle East (n=2), Asia (n=2), and South America (n=2). Of the ten interventions represented in this study, six used Randomized Control Trial methods, one used Participatory Action Research, two used Qualitative Research, and one used a Double-Blinded Clinical Trial. Intervention outcomes included measures of efficacy (n=6), feasibility (n=4), and acceptability (n=3) (Table 1).

Table 1: mHealth Intervention Studies in LMICs by Design, Included Measures, Violence Subject, and Country

Authors	Country	Intervention Name	Study Design	Outcome Measures
Ampt et. Al. 2020	Kenya	WHISPER	Cluster Randomized Control Trial	Feasibility, acceptability
Brody et. Al. 2022	Cambodia	Mobile Link	Randomized Control Trial	Efficacy
Decker, Wood, et. Al. 2020	Kenya	MyPlan Kenya	Randomized Clinical Trial	Efficacy
Engelhard et. Al. 2018	South Africa	MomConnect Helpdesk	Qualitative Research	Feasibility
Haghnia et. Al. 2019	Iran	Imo	Double blinded clinical trial	Efficacy
Knaevelsrud1 et. Al 2015 Wagner et. Al. 2012	Iraq	Ilajnafsy	Parallel group Randomized Control Trial	Efficacy
Mishori et. Al 2017	Democratic Republic of the Congo	MediCapt	Qualitative Research	Feasibility, acceptability
Rodante et. Al. 2022	Argentina	CALMA	Cluster Randomized Control Trial	Efficacy, acceptability
Signorelli et. Al 2022	Brazil	Eu-Decido	Qualitative Participatory-action research (PAR)	Feasibility
Wang et. Al. 2013	China	Chinese My Trauma Recovery	Parallel Randomized Control Trial	Efficacy

Studies varied in terms of in mHealth intervention type (e.g., mobile applications and SMS messaging), violence topic, target population, and setting (Table 2). Mobile applications (n=3)

and SMS (n=3) were the most widely used intervention types. The most prevalent violence topics were SV (n=4), Collective Violence (n=2), with IPV (n=2), Self-Directed Violence (n=1), and an intervention across topics for individuals experiencing post-traumatic stress (n=1). All studies included used a unique set of outcome measures, namely measures of efficacy, feasibility, and acceptability.

Table 2: mHealth Intervention Studies in LMICs by Population, Subject and Modality

Authors	Intervention	mHealth type	Violence Subject	Target Population	Intervention Location
Ampt et. Al. 2020	WHISPER	SMS	Sexual Violence	Female Sex Workers	Mombasa, Kenya
Brody et. Al. 2022	Mobile Link	SMS and Voice Messaging (VM)	Sexual Violence	Female Entertainment Workers (FEW)	2 sites in Phnom Penh and 1 site in each Banteay Meanchey, Battambang, and Siem Reap, each has a high burden of FEW
Decker, Wood, et. Al. 2020	MyPlan Kenya	Mobile Application	IPV	Women/ Victims of IPV	Three informal settlements in Nairobi, Kenya: Korogocho/ Kariobangi, Dandora, and Huruma/Mathare
Engelhard et. Al. 2018	MomConnect Help Desk	Short Message Services (SMS)	Sexual Violence	Women	Messages sent from all provinces in South Africa
Haghnia et. Al. 2019	Imo	Telepsychiatry (website)	Collective Violence	Veterans of the so-called "8 year-imposed war"	Tabriz, Iran
Knaevelsrud1 et. Al 2015 Wagner et. Al. 2012	Ilajnafsy	Website	Collective Violence	Victims of different forms of violence in Collective Violence settings	One study across Arabic speaking countries, one specifically in Iraq, therapists located across the world

Mishori et. Al 2017	MediCapt	Mobile Application	Sexual Violence	Victims of SV as treated through healthcare providers	Democratic Republic of the Congo
Rodante et. Al. 2022	CALMA	Mobile Application	Self-Directed Violence	Individuals with self-harm tendencies or ideations	Buenos Aires, Argentina
Wang et. Al. 2013	Chinese My Trauma Recovery	Website	All violence subjects	People living in China who have experienced trauma	Urban sample recruited through email, and a rural sample in Beichuan in the Sichuan province
Signorelli et. Al. 2022	Eu-Decido	Mobile Application	IPV	Women/Victims of IPV	Curitiba, Brazil

Aim 1: Efficacy Measures

Six studies included measurements of efficacy, each of which defined efficacious intervention differently. Across the selected interventions, 22 unique instruments were used, with the Post-Traumatic Diagnostic Scale (PDS) being the only intervention used in multiple (n=2) studies. For an outcome to be considered demonstrative of efficacy, the instrument must be described by positive outcomes. Outcomes identified as "null" are outcomes that show no change post-intervention or non-significant change. There was a range of how efficacious outcomes were, with two studies (CALMA and Ilajnafsy) scoring a 100% improvement in efficacy measurements and MyPlan Kenya scoring an improvement in 11% of efficacy measurements in the intervention. All but MyPlan Kenya scored 50% or above on positive outcomes, and no reports included concerns regarding worsening symptoms. Across interventions, all scores detailing PTSD symptoms showed improvement in the intervention group. Depression scores improved in two of the three studies measuring differences in depression symptoms (MyTrauma Recovery and Iljnasfy had positive intervention effects, and MyPlan Kenya intervention

outcomes on depression were null). Self-efficacy scores were also included in three studies, two

of which were null (MyPlan Kenya and MyTrauma Recovery). The Mobile Link trial scored

50% on self-efficacy outcomes, noting increased decisional ability to not forcibly drink, but no

increase in gender-based violence acceptance. By violence subject, interventions for self-directed

violence and post-traumatic stress fared most efficacious (CALMA, My Trauma Recovery and

Ilajnafsy all scored 100% and Imo improved on 85% of efficacy outcomes) while IPV and SV

interventions were less efficacious (Mobile Link improved on 50% of outcomes, while MyPlan

Kenya showed improvement favoring the intervention in 11% of studies).

Table 3: Efficacy Instruments, Measures and Outcomes among mHealth Intervention

Studies in LMICs

Intervention	Instrument	Construct	Outcome
CALMA	• Self-injurious Thoughts and Behaviors Interview (SITBI)	Suicidal gestures, plans and ideation	• Included Confidence Intervals with the zero value, however, suggest a high probability of decreased suicidal gestures, plans, and ideation. The study concluded that there was a higher probability for decreased ideation and gestures than those who did not receive the CALMA intervention
Chinese My Trauma Recovery	• Post-Traumatic Diagnostic Scale (PDS) • Post-traumatic Cognitive Changes (PCC) • Symptom Checklist-90-Depression (SCL-90-D) • Social Functioning Impairment (SFI) • Coping Self-Efficacy (CSE)	PTSD, post-traumatic cognitive changes, depression, social functioning, coping self-efficacy	• PDS: Significant improvement in PTSD symptoms in both urban and rural samples • PCC: Significant improvement in post-traumatic cognitive change in the urban sample • SCL-D: Significant improvement in depressive symptoms in the urban group • SFI: No improvement in social functioning among either sample • CSE: No improvement in self-efficacy in either the rural or urban sample

Ilajnafsy	• Post-traumatic Diagnostic Scale (PDS) • Hopkins Checklist-25 (HSCL-25) • Quality of life (EUROHIS) • Symptom Checklist-90-revised (SCL-90-R)	Improved quality of life and PTSD symptoms, decreases in depression, somatization and anxiety	• PDS: Improvements in all measured PTSD symptoms, including intrusions, hyperarousal and avoidance • HSCL-25: Significant decreases in depression and anxiety • EUROHIS: Significant increase in quality of life • SCL-90-R: Decrease in somatization Results from pilot study validated in a larger study, and additionally concluded decreases in somatization
Imo	• Questionnaire	Access to a psychiatrist, reduction in treatment costs, waiting time, access to treatment, satisfaction, completion of follow-up and efficacy	• Significant reductions in treatment cost and waiting time • Significant positive relationship with patient satisfaction, access to PTSD treatment, completion of follow-up, and treatment efficacy. • No relationship was determined between the two groups and access to a psychiatrist
Mobile Link	• Experiences of forced drinking • GBV experiences and acceptance	GBV experiences and acceptance, forced drinking	• There was a positive intervention effect on forced drinking in the workplace for FSW • No improvements associated with GBV experiences and acceptance
MyPlan Kenya	• Decisional Conflict Scale • Revised Conflicts and Tactics Scale (CTS-2), • Women's Experiences of Abuse scale • Resilience: the Connor Davidson Scale (CDS) • Center for Epidemiologic	Decisional conflict, conflict skills, victimization, depression, abusive behaviors, self-efficacy, resilience, safety strategies	• Decisional Conflict: null overall, safety preparedness higher in intervention • CTS: null on measurements on IPV, relationship quality improvements favor the control • Women's Experiences of Abuse: decrease in emotional abuse favored the control • CDS: Non-significant trend favoring the intervention for resilience • CESD-R: Null on depression

	Studies Depression Scale (CESD-R) • The Sexual Victimization Attributions Measure (SVAM) • The Abusive Behaviors Scale • Danger Assessment Scale • Generalized Self-Efficacy Scale		• SVAM: Positive intervention favoring the control arm on emotional abuse • Abusive behaviors: Service seeking, self-blame, self-efficacy and recognition of abuse: no detected changes • DA Scale: Safety strategies had groupxtime interaction, risk for severe and lethal violence declined significantly in the intervention • Generalized Self-Efficacy Scale: Safety specific self-efficacy: null • Relationship quality: improvements favored the control

1.1 CALMA

In the CALMA intervention in Argentina, a trial compared a group receiving standard care to an intervention group receiving that care with the additional CALMA intervention. [37] Efficacy was then assessed using a self-injurious thoughts and behaviors interview (SITBI), which assessed changes in self-harm behaviors. [37] Following completion, participants were assessed on suicidal thoughts and behaviors to rate the usefulness of the app during a crisis using dichotomous answers. The CALMA intervention included Confidence Intervals with the zero value, however, suggest a high probability of decreased suicidal gestures, plans, and ideation. [37] The study concluded that there was a higher probability for decreased ideation and gestures among those who participated in the intervention compared to those who did not. [37]

1.2 Chinese My Trauma Recovery

In the Chinese My Trauma Recovery website intervention, efficacy was determined by testing if participants from treatment groups would show significant improvement in PTSD

symptoms and general mental health compared to a waiting group control group, which provided the same intervention on a delay. [38] Efficacy outcomes were assessed using a Trauma Screening Questionnaire (TSQ), an adaptation of the German Diagnostic Interview for Psychiatric Symptoms, which included a number of subscales. The primary outcome was measured using a Post-Traumatic Diagnostic Scale (PDS), which measured the frequency of trauma-related symptoms. [38] Secondary outcomes were measured using questions selected from previously validated assessments including the Post-traumatic Cognitive Changes (PCC), Social Functioning Impairment (SFI) and Coping Self-Efficacy (CSE) and Symptom Checklist for Depression (SCL-D). [38] Data were collected at four points during the intervention, beginning with a baseline measurement in both samples. Following the intervention, data were collected in the treatment group post-intervention, and then again at three months. In the waitlist control group, data were collected post-waiting period, post-treatment, and at three-month follow-up. A General Linear Model and ANOVA analysis was used to determine groupxtime (change in outcomes over the course of the intervention period) and in-group differences. [38]

There were no statistically significant differences between the urban and rural samples (pre-intervention). In the urban sample, groupxtime interactions were discovered for PTSD, depression and post-traumatic cognitive changes, but not social functioning or coping self-efficacy. In the rural sample, groupxtime interaction was only significant on PTSD[38] At the three-month measurement mark, Intend to Treat (ITT) analysis determined no significant between-group differences. [38] Improvements were sustained following intervention in the urban sample, while improvements on depression became non-significant between Time 3 and Time 4. [38]

1.3 Ilajnafsy

The Ilajnafsy intervention in Iraq defined efficacy using a Posttraumatic Diagnostic Scale

(PDS), changes in depression and anxiety levels as captured by the Hopkins Checklist-25

(HSCL-25), and quality of life as measured by EUROHIS-QOL. [39] The mean range of scores

from baseline to post-treatment were statistically significant on each measurement, with

significant decreases in PTSD symptoms such as intrusions, hyperarousal and avoidance.

Significant decreases also occurred in depression and anxiety results on the HSCL-25, and there

was a highly significant increase in quality of life. [39] Following the successes of the pilot

study, a larger sample was taken across the Middle East, which collected data at baseline,

posttreatment and 3-month follow-up using the PDS, HSCL-25, EUROHIS-QOL, an Arabic

translation of the Suicide Risk Assessment, the Symptom Checklist-90-revised (SCL-90-R) and a

Dutch Screening Device for Psychotic Disorder. [40] Analyses used ITT principles and provided

delayed intervention for the control group. [40] There were significant intervention effects in all

outcomes, confirming the decrease in avoidance, intrusion, and hyperarousal, as well as

decreases in anxiety, depression, and somatization (SCL). Results further indicated stability on

these measurements at 3-months. [40]

1.4 Imo

While other measurements of efficacy centered the improvement of violence-related

symptoms, the Imo intervention in Iran defined efficacy through comparison of cost of treatment,

access to mental health services, completion of therapy sessions, and satisfaction rate with

services. [41] The control received follow-up sessions in person, and the intervention group

received virtual follow-up. [41] A questionnaire was then issued to capture both demographic

data and questions related to efficacy. The intervention group reported significant reductions in

treatment cost and waiting time and a significant positive relationship with patient satisfaction,

access to PTSD treatment, completion of follow-up, and treatment efficacy. No between group

differences were observed regarding access to a psychiatrist. [41]

1.5 Mobile Link

In the Mobile Link trial in Cambodia, efficacy was measured by evaluating

improvements made to: (1) HIV testing, (2) STI testing when experiencing symptoms, (3)

contraceptive use, (4) always using condoms with nonpaying partners, and (5) always using

condoms with paying partners. Secondary outcome measures included: (1) contact with outreach

workers, (2) utilization of escorted referrals, (3) forced drinking at work, and (4) responses to

GBV and GBV acceptance. [42] The secondary outcomes of forced drinking and responses to

GBV and GBV acceptance were relevant to this study. Acceptance of these behaviors was

measured by self-report at baseline, midline, and endline through structured interviews. [42]

Data was analyzed using STATA, which determined statistically significant differences were

observed for not being forced to drink at work at endline, which is pertinent because alcohol

often facilitates sexual violence. [43] There were no statistically significant differences in GBV

experiences or responding to GBV.[42]

1.6 MyPlan Kenya

Primary efficacy outcomes were measured to assess MyPlan Kenya using a scale

assessing safety preparedness, a Decisional Conflict Scale (DCS) including an index of safety

strategy questions, experiences of IPV as assessed using a version of the Revised Conflicts and

Tactics Scale (CTS-2), a Women's Experiences of Abuse scale, and a reproductive coercion

scale using binary values. [44 45] Secondary efficacy outcomes included resilience as assessed

by the Connor Davidson Scale, Conflicts and Tactics Scale (CTS-2), depression as assessed

through the 10-item Center for Epidemiologic Studies Depression Scale (CESD-R), support service, self-blame as assessed by the Sexual Victimization Attributions Measure (SVAM), recognition of abuse was assessed by the Abusive Behaviors Scale, a Danger Assessment Scale, and a Generalized Self-Efficacy Scale. [44 45] Outcome measurements were collected at baseline, post-intervention, and three-months post-baseline, and compared standard IPV intervention to MyPlan Kenya. Results were null on decisional conflict overall as both groups showed decreases, however safety preparedness was higher in the intervention when controlling for baseline decisional conflict. [44] Intervention results were null on IPV measures including the CTS, with both groups reporting decreases in summary scores, sexual violence, physical violence, and reproductive coercion. Decreases in emotional abuse favored the control arm. [44] There was a non-significant trend favoring the intervention for resilience, and results were null for safety-specific self-efficacy and depression scores. [44] No changes were determined between groups in service seeking, self-blame, self-efficacy, or recognition of abuse. Improvements to relationship quality favored the control group. [44]

Aim 2: Feasibility Measures

Feasibility was measured in four selected studies, each of which utilized different outcomes (Table 4). Of the four studies, all reported promising feasibility results, sharing similar findings including time-saving capabilities (n=2) and ease of sharing (n=2) the intervention. With respect to concerns, safety (n=2) and internet connection (n=3) were both noted. The populations receiving the selected interventions reported high levels of cell phone and smart phone ownership, which increases the feasibility of mHealth interventions but potentially can leave out some of the individuals most in need. All feasibility assessments were on SV and IPV interventions.

2.1 Eu-Decido

The research team for Eu-Decido in Brazil conducted in-depth-interviews (IDI) with

healthcare workers and survivors of intimate partner violence to assess the feasibility of the

application, with data transcribed, coded, and analyzed for advantages, uncertainties, barriers,

and suggestions. [30] Of the participants, 89.3% of participants found the application feasible.

Participants found the tool advantageous for ensuring agility, security and anonymity, in the

application's ability to work as a learning tool, and as a resource for formal help-seeking. [30]

Participants noted several uncertainties, principal amongst them being confusion about how

Safety Decision Aids work. [30] Eu-Decido feasibility concerns included the safety of use for

IPV survivors being monitored by their abusers, and barriers to access for vulnerable women

who do not have access to smartphones or the internet. [30]

2.2 MediCapt

This intervention in the Democratic Republic of the Congo has been developed using a

number of formative development phases, beginning with a needs assessment, and followed with

two phases of prototype development and field testing. [46] Physicians enrolled in development

and testing were administered a questionnaire following a 2-day session with mock patient

scenarios. [46] Attitudes were captured with a Likert scale on several domains, and then

analyzed. All believed that MediCapt would be useful in the field, and 7/8 felt confident that they

could master the use of the app. [46] The largest areas for improvement were providing

additional measures for making the device usable, and barriers to Wi-Fi, the Internet, and

electricity. [46] The most favorable feasibility results were in regard to physicians believing that

they could foresee using and training colleagues at health centers on using the app, that using the

app would save time, and it would ensure that records are transferred to the correct personnel.
[46]

2.3 MomConnect

The MomConnect helpdesk evaluated the feasibility of emergency response messages
using an automated triage system by conducting a detailed inspection of messages reporting the
mistreatment of women in South Africa. [47] Responses were scored rating the appropriateness
of the helpdesk messages, with a total of 81.3% of messages being considered correct. [47] Of
reviewed responses, partner and family violence topics had a slight trend towards better message
handling at 87.2%. Median message wait time was 4.0 hours among all responses, ranging from
a median wait time of 2.1 hours among suboptimal calls, to 4.5 hours for calls graded as optimal,
and 17.2 hours among those graded as incorrect. The service was able to successfully identify
and categorize types of mistreatment, which supported the feasibility of MomConnect to flag
high-priority messages. [47] In all categories except for "question," specificity was higher than
98%. Message sensitivity and positive predictive value ranged, notably with a 93% positive
predictive value and 91% sensitivity for questions. [47] As the program stands, the helpdesk is
no better than the average response, but with the improvement of wait times and effective
message sorting, automated triage was considered highly feasible. [47]

2.4 WHISPER

This intervention in Kenya collected data in two phases, the first utilizing workshop data
to assess technical performance and create an intervention structure, and the second phase using
semi-structured interviews to refine and test messages, providing feedback to assess feasibility
and acceptability. [45] Of the demographic data collected in the FSW population, just over half

owned smartphones, with the remainder owning basic mobile phones. Nearly all used SMS daily, and 83% of participants reported sharing text messages with one another, supporting the feasibility of an intervention using SMS. [45] Some considered that sharing messages would be dangerous, however most saw the feasibility and utility of sharing information from the texts. Many reported the ease of receiving detailed information on their phones rather than needing to seek it out from healthcare workers and found that it was useful to have messages to refer back to when needed. [45] The WHISPER app was determined to be most useful when delivered later in the morning when women started work, which allowed messages to align with work and be easily shared with coworkers. [45]

Table 4: Feasibility Instruments, Measures and Outcomes among mHealth Intervention Studies in LMICs

Intervention	Instrument	Constructs	Outcome
WHISPER	Semi-structured interviews	Desire to learn more, comfort using SMS	• Feasibility demonstrated through comfort using SMS and a desire to learn more
MomConnect	Qualitative research	Wait times, message prioritization, message triage	• Long wait times and improvement needed for message prioritization • Sensitivity, specificity and positive predictive value results suggest high feasibility for message triage

MediCapt	Field testing	Usefulness in the field, mastery of the app, usability, triage	- All believed that MediCapt would be useful in the field. 7/8 felt confident that they could master the use of the app. - Needs improvement: providing additional measures for making the device usable, barriers to Wi-Fi, the Internet, and electricity make the app difficult to use. Favorable results: - Physicians believed that they could foresee using and training colleagues at health centers on using the app. - Using the app would save time, and it would ensure that records are transferred to the correct personnel.
Eu-Decido	IDI qualitative data	Agility, security, anonymity, capabilities as a learning tool, help-seeking capabilities, barriers	89.3% of participants found the app feasible

<u>Aim 3: Acceptability Measures</u>

Positive acceptability results were discovered in two of the three included studies. CALMA reported multiple positive evaluation measures, including easy navigation, supportive and interesting content, and innovative use of technology. Participants receiving the WHISPER intervention found the SMS messages easy to access and the content relatable and applicable. The MediCapt intervention was less successful in terms of acceptability, and subjects noted that special training would be necessary for people using the application.

<u>3.1 CALMA</u>

CALMA's acceptability was measured in Argentina using the User Experience Questionnaire (UEQ-s), which measured satisfaction and user experience through eight scored items, Data was collected at the end of the study and measured subscales defining pragmatic aspects and hedonic aspects. [37] Positive evaluation was measured in obstructive/ supportive, complicated/ easy, confusing/clear, not interesting/ interesting, conventional/ inventive, usual/ leading edge questions. [37] Neutral evaluation was determined in inefficient/ efficient and boring/exciting measurements. [37]

<u>3.2 MediCapt</u>

Respondents indicated a few key takeaways regarding acceptability, indicating that special training would be necessary for using the app with a patient, MediCapt would not always be useful during an exam, and existing practices for examinations might make acceptability difficult. [35]

<u>3.3 WHISPER</u>

Of the participants who completed interviews of WHISPER in Kenya, 58% found it "very easy" to access messages, 16% found it "genuinely difficult" to access the intervention, and 25% reported experiencing minor difficulties. [45] The intervention was considered highly acceptable, fostering engagement, interest, and discussion. [45] The inclusion of role model stories proved particularly acceptable, and providing women receiving the intervention with someone similar to them to relate to made the content realistic and applicable. [45]

Table 5: Acceptability Instruments, Measures and Outcomes among mHealth Intervention Studies in LMICs

Intervention	Instrument	Constructs	Outcome
CALMA	User Experience Questionnaire (UEQ-s)	Obstructive/ supportive, complicated/easy, confusing/clear, not interesting/ interesting, conventional/ inventive, usual/ leading edge questions, inefficient/ efficient, boring/ exciting	• Positive evaluation was measured in obstructive/supportive, complicated/ easy, confusing/clear, not interesting/ interesting, conventional/ inventive, usual/ leading edge questions. • Neutral evaluation was determined in inefficient/ efficient and boring/exciting measurements.
WHISPER	Semi-structured interviews	Easiness, engaging/ interesting	• 58% found the intervention very easy, women noted being engaged and interested in the format and content of the SMS intervention

MediCapt	Field testing	Training necessary, usefulness during an exam, integration with existing services	• Barriers to acceptability: special training would be necessary for using the app with a patient, MediCapt would not always be useful during an exam, and existing practices for examinations might make acceptability difficult.

Overall, results favored mHealth interventions for efficacy, feasibility and acceptability. MHealth programs targeting PTSD on collective violence and self-directed violence topics scored highest on efficacy outcomes but need further validation on feasibility and acceptability. Sexual violence and IPV scored highly on feasibility and acceptability measurements but were less efficacious when compared to PTSD interventions. Feasibility concerns largely centered safety and accessibility for individuals who lack access to phones or the internet.

Discussion

No prior analyses that have examined mHealth interventions related to violence in LMICs have been published, making the results presented here difficult to compare to previous research findings. In HICs, several systematic reviews have been used to assess the efficacy, acceptability, and feasibility of violence interventions, but given the larger quantity of interventions available, no comparisons exist across all subjects. Findings in HIC settings likely carry some implications for interventions taking place in LMIC settings, however, efficacy, feasibility, and acceptability are all impacted by a multitude of factors that differentiate between HIC and LMIC, including the availability and quality of in-person services.

Efficacy

In the selected mHealth interventions, efficacy was primarily defined as improvement in constructs such as depression, post-traumatic stress, and quality of life. However, in one intervention, Imo, efficacy was defined as improvements to treatment costs, waiting time, access to treatment, and completion of follow-up. Both definitions of efficacy share important insights and potential implications for the impact of mHealth interventions in LMICs, yet their different interpretations make cross-intervention comparison difficult. Measurements assessing treatment costs and access to treatment are particularly useful in resource-strained environments where in person care may be inaccessible, while improvement in symptomology associated with experience of trauma provides insight into the strength of an intervention. Encompassing both definitions also allows for insight in instances where an intervention is equally efficacious to in-person treatment but scores well on improvements to treatment costs. Future research should encompass both definitions of efficacy using standardized measurements such as the CTS-2 and PDS so that larger conclusions regarding efficacy can be drawn with strengthened validity. In a systematic review conducted in the United States, inclusion of the PTSD checklist for DSM-5 (PCL) as a pre-post measurement was included in the selection criteria, measuring PTSD before and after an intervention took place. [48] By selecting such a measurement, the validity of the review was increased through standardization, and cross-intervention conclusions were more likely reflective of differences in PTSD symptoms. This study, however, appeared to be the only published review able to include a standardized measure, and reviews of violence interventions in both HICs and LMICs across violence subjects were unable to standardize measurements, limiting the validity of study findings. [49] [50] When considering cross-cultural measurement, the provision of standardized measures is important as definitions for violence differentiate, and

the lack of a shared definition limits the relevance of findings outside of a study's context. Furthermore, given that study design across interventions has not been standardized, studies comparing an intervention group to a waitlist control group may elicit different results than an intervention where the experimental group receives an in-person intervention. Of the selected efficacy evaluations, two utilized waitlist controls, and the remaining four used existing treatment methods. Study design does not appear to have impacted the directionality of results; however, the selection of control groups may have had unknown impact based on the strength of existing interventions.

Five of the six studies reporting measurements on efficacy were conducted exclusively in urban settings, with Chinese My Trauma Recovery using samples in both urban and rural contexts. In this intervention, results were significantly stronger in the urban sample, suggesting better use for mHealth violence interventions in urban settings. This should be validated by further sampling and testing in rural areas, as limitations for in-person care are strongest in rural populations. The modalities covered in efficacy studies were website (n=3), mobile applications (n=2) and SMS messaging (n=1). The highest efficacy was recorded amongst website-based interventions, which all sought to address collective violence and post-traumatic stress, so there might be interaction on those variables. The most efficacious measurements were noted on depression, post-traumatic stress, and less successful measurements were noted on improvements on self-efficacy. These findings are consistent with findings established in HICs, which validate high levels of efficacy for interventions targeting self-directed violence and PTSD and lower levels of efficacy for IPV. [49] This may be in part due to the behaviors and symptoms targeted, mHealth interventions have been found to facilitate higher levels of disclosure than in-person interventions, which may allow individuals suffering from PTSD and self-directed violence a

space in which they can get symptoms treated that may otherwise go unacknowledged, while disclosure in a context where a victim is worried about being monitored may discourage that same level of disclosure, and may require additional steps outside of an intervention to make improvement.

There were few measurements that were utilized in more than one study, with both different constructs addressed (e.g., depression, post-traumatic stress) and different instruments (e.g., SCL-90D, PDS) which makes cross-study comparison difficult. When compiled, results regarding efficacy were considered successful, and of the 20 constructs of 31 were reported as being efficacious or favoring the intervention.

Feasibility

Of the four studies being evaluated for feasibility, three took place in Africa, with the WHISPER intervention taking place in Kenya, the MomConnect intervention taking place in South Africa, and the MediCapt intervention taking place in the Democratic Republic of the Congo. While the Eu-Decido intervention occurred in Brazil, the geographic locations for mHealth interventions meeting this study's criteria share only one small insight into the feasibility of violence interventions across LMICs globally. Feasibility was assessed in both application form (n=2) and SMS intervention (n=2) with no pattern for which modality is more advantageous. Amongst findings, high feasibility was determined for constructs such as shareability (n=2) and triage (n=3). Triage, which refers to the direction of messages to the appropriate parties, has promising implications for mHealth interventions in countries without adequate healthcare staffing and need messages prioritized or sorted. In the MomConnect intervention, high sensitivity, specificity and positive predictive values associated with message triage has implications for directing high-priority messages related to sexual violence to the

proper services. In the MediCapt intervention, this finding also ensured that messages would be

directed to the proper authorities. For participants using Eu-Decido, proper direction to formal

help-seeking services allows victims to be directed to the right victim services. In terms of

shareability, the WHISPER SMS intervention and the MediCapt interventions both reported

interests in sharing the intervention with their circles, with the MediCapt application-based

intervention targeting hospital employees working in post-rape care and the WHISPER

intervention targeting FSWs who are at high risk of being exposed to violence. Given that these

interventions have different modalities, these studies offer only a small insight into the different

forms of mHealth violence interventions that could be easily spread through a population. Three

of the four studies addressed concerns for safety. In the MediCapt intervention, documenting

evidence post-violence exposure using technology was of concern to the physicians surveyed,

who have used paperwork for documentation until this point. By taking photos and digitizing the

process, they concluded that this technology may scare victims. In the WHISPER and Eu-Decido

interventions, access to phones by abusers could potentially lead to compromising messages

getting into the wrong hands, causing future violence. In the Eu-Decido app, this has informed

adaptations including a dummy pin that changes the content of the app after opening. In the two

app-based interventions, Eu-Decido and MediCapt concerns regarding Wi-Fi, power and internet

access were raised. In the Eu-Decido intervention, this could potentially limit access for the most

vulnerable populations, while in the MediCapt intervention, this raises concerns for victims

seeking care at hospitals who want their experiences documented for legal purposes. In LMICs,

Wi-Fi and internet concerns must be central to development as to not limit the reach of mHealth

interventions. The results included in this study have strong, primarily positive implications for

the feasibility of mHealth technology in IPV and SV settings, and do not have any included

studies that pertain to the other forms of violence. These findings mirror those found in HICs, where high levels of feasibility have been determined for IPV and SV interventions. [49] [51] This finding is important given that efficacy evaluation on these subjects have determined that mHealth interventions are largely on-par with in person interventions, which when considered together, could potentially provide many previously inaccessible populations with adequate SV/IPV treatment.

In both high- and low-income countries, a gap in the literature exists for feasibility assessments on child abuse, self-directed violence, elder abuse and collective violence. Assessing the feasibility of collective violence interventions in LMICs should be evaluated in future studies, as high levels of feasibility could help reach some of the world's most hard to reach populations. Given high levels of efficacy across interventions for self-directed violence and PTSD, evaluation of the feasibility of mHealth interventions could have substantial implications for program funding and implementation.

Acceptability

Of the included studies, only three included measurements of acceptability. Those studies were the CALMA app-based intervention in Argentina, the WHISPER SMS intervention in Kenya, and the MediCapt app-based intervention in the Democratic Republic of the Congo. Each study included different constructs in their definition of acceptability, but similarities between evaluations illuminated acceptability trends including easiness (n=2) interesting (n=2) and engaging (n=2). Concerns for mHealth acceptability in LMICs and HICs are largely related to the usability of a selected platform. There is, however, a disparity between the availability of mobile technologies between these categorizations, which influences the baseline ability for a population to use and accept an intervention.

As access to these technologies increases through globalization, it is likely that acceptability of mHealth interventions will increase throughout the developing world. This is evidenced in interventions such as MediCapt, which took place in the country with the most restricted access to technology and reported the lowest acceptability of the selected interventions. This low acceptability was largely associated with low media literacy and limited access to Wi-Fi. Participants selected to test MediCapt reported that once trained on using the technology, that they could foresee the intervention being highly accepted amongst the intended population. The Calma intervention in Argentina was the only intervention of the three that measured the mHealth intervention in addition to traditional in-person services against traditional in-person services. The results of this intervention scored high on acceptability measures, which has implications for interventions that can provide in-person instruction on how to use mHealth technology. Future acceptability studies should consider hybrid in-person and mobile interventions and should use in-person comparison groups to fully assess the extent to which barriers to Wi-Fi and technologies influence the acceptability of mHealth interventions.

Limitations

Given the novelty of mHealth technology in LMICs, evaluation for the acceptability, feasibility and efficacy of violence interventions is based on a limited sample of countries, contexts and interventions. Of the 53 countries meeting the LMIC classification from the World Bank, only 9 countries are represented in this study, posing potential limitations of the relevance of these results for countries without an intervention meeting this study's criteria. Further, this small sample does not consider the efficacy, acceptability and feasibility of mHealth interventions in populations without access to the internet or mobile phones.

When combined with the additional layer of the range of violence forms not represented in each study, results for a PTSD intervention may not carry strong implications for an IPV intervention, with concerns on both nation-wide and international levels. Similarly, evaluation of mHealth interventions targeting violence subjects such as child abuse and neglect and elder abuse would provide a more holistic interrogation of the research question. Future research and development should encompass both a more holistic range of violence subjects and LMIC contexts, calling upon standardized measurements that allow cross-intervention comparison.

Modalities utilized in this study also each provide different insight into each component of the research question and may have impacted results. This paper was written under the assumption that all mHealth modalities elicit comparable results for efficacy, acceptability, and feasibility. Further, the selected studies represent only what was accessible to the researcher through Emory library services and within English language constraints.

Public Health Implications

While the studies included in this research provide preliminary findings regarding the efficacy, feasibility, and acceptability of mHealth technologies for the purposes of violence prevention in LMICs, they require further validation and additional studies through the provision of standardized instruments, inclusion of different LMIC contexts, and targeting of different forms of violence. The interventions included in this review suggest high levels of improvement for depression and post-traumatic stress symptoms, which should be expanded upon by future interventions.

Although self-efficacy was reported to be low in some interventions, SDAs such as Eu-Decido should be tested further, as results have shown improvements to decision making skills and self-

efficacy. Future SDA interventions should include standardized self-efficacy measurements and should target IPV, as well as other forms of violence where decisional abilities and self-efficacy play pivotal roles, including violence perpetrated against sex workers and gang violence.

Future development and adaptation should pay attention to increasing the acceptability of mHealth technologies, as many studies noted concerns regarding the inability of interventions to reach the most marginalized. Acceptability can be increased by offering offline versions of app-based interventions, offering web-based options for those without access to smart phones, and adapting interventions to SMS messaging. Further, acceptability is reliant on shareability, which can be improved through partnership with local healthcare services and through in-app sharing options. Barriers to shareability include stigma surrounding experiences of violence, which makes healthcare services an ideal point of dissemination.

The findings discussed in this review provide promising insight into the accessibility, feasibility, and efficacy of mHealth technologies for violence prevention in LMICs, with high scores on measurement instruments across each construct. The findings of each of these constructs can be used to inform development and adaptation and should be used to create standardized instruments that allow for increased insight into the strengths and shortcomings of intervention modalities and content. Violence prevention efforts in LMICs can be drastically improved by resource and cost-efficient mHealth technologies, and future research and programming should be supported via human, technological and financial resources accordingly. Doing so has the potential to reduce violence victimization and improve violence response.

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