

Mobile applications addressing violence against women: a systematic review

Katharina Eisenhut ,¹ Ela Sauerborn,¹ Claudia García-Moreno,² Verina Wild¹

To cite: Eisenhut K, Sauerborn E, García-Moreno C, et al. Mobile applications addressing violence against women: a systematic review. *BMJ Global Health* 2020;5:e001954. doi:10.1136/bmjgh-2019-001954

Handling editor Seye Abimbola

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bmjgh-2019-001954>).

KE and ES contributed equally.

Received 1 September 2019

Revised 15 December 2019

Accepted 13 January 2020

ABSTRACT

Introduction Violence against women is a pressing global health problem that is being met with a new intervention strategy—mobile applications. With this systematic review, we provide an initial analysis and functional categorisation of apps addressing violence against women.

Methods We conducted a systematic online search conforming with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to identify apps addressing violence against women in five World Bank regions (Europe and Central Asia; North America, Latin America and the Caribbean; Middle East and North Africa; South Asia; and sub-Saharan Africa). Applications with location of initiation in mentioned regions and ≥ 100 downloads were included. Data on sector, target group(s), year of release, location of initiation and implementation were extracted. By means of a structured qualitative content analysis, applications were then categorised according to their main functions.

Results Of 327 relevant applications, 171 were included into the systematic review and assigned to one of five identified categories of main functions, respectively: emergency, avoidance, education, reporting and evidence building, and supporting apps. The largest proportion (46.78%) consisted of emergency apps, followed by education, reporting and evidence building, supporting and avoidance apps in descending order. With regards to the geographical distribution of app categories, significant ($\chi^2(20)=58.172$; $p=0.000$) differences among the included regions were found.

Conclusion A vast proportion of apps addressing violence against women primarily draw on one-time emergency or avoidance solutions, as opposed to more preventative approaches. Further research is necessary, critically considering questions of data security, personal safety and efficacy of such mobile health interventions.

Key questions

What is already known?

- Violence against women is a preventable global health issue of epidemic proportions, affecting approximately one-third of the global female population.
- Recently, violence against women has been met with a new intervention of increasing global significance and scope, mobile applications (apps); despite their popularity and potential to heavily influence public health strategies such apps have not yet been systematically reviewed in the scientific literature.

What are the new findings?

- Most apps addressing violence against women (46.78% out of 171 apps included into the systematic review) primarily use short-term emergency functions.
- However, an increasing amount of apps offer education, reporting and evidence building and supporting functions as the prevailing feature.

What do the new findings imply?

- Although all mentioned app functions can be beneficial to address violence against women, the dominance of emergency apps should be critically assessed, as it indicates that the currently prevailing mobile health strategy is highly skewed towards one-time solutions for isolated events of violence against women.
- Further research on the benefits, safety, efficacy and sustainability of apps in the context of already existing traditional intervention strategies addressing violence against women is necessary.

to gain importance in the fight against such violence.^{5 6} The presumed common aim of these apps is to help victims, bystanders, and/or health workers implement different prevention or response strategies. Notably, the *United Nations Commission on the Status of Women* supports the development and use of mobile technologies as tools in the response to VAW in its general recommendation no. 35.⁷

However, to date, there has been no systematic review of such apps that is not restricted to apps concerning personal safety⁵ or rape⁶

INTRODUCTION

Violence against women (VAW) is a major global health issue and a gross violation of women's human rights that affects more than one-third of the global female population.¹ It does not spare any geographical region, ethnicity, age or social class.² Eliminating VAW is pivotal to achieve gender equality and women's empowerment globally (Sustainable Development Goal 5).^{3 4} In the past years, mobile applications have begun



© Author(s) (or their employer(s)) 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Institute of Ethics, History and Theory of Medicine, Ludwig Maximilians University Munich, Munich, Germany

²Department of Reproductive Health and Research, World Health Organization, Geneva, Switzerland

Correspondence to
Dr Verina Wild; v.wild@lmu.de

and that discusses them in the realm of global health as it has been done for other mobile applications.^{8–10} This paper aims to fill parts of this research gap in the form of a systematic review on apps addressing violence against women in five World Bank regions (Europe and Central Asia; North America, Latin America and the Caribbean; Middle East and North Africa (MENA); South Asia; and sub-Saharan Africa). It aims to contribute to the discussion on the opportunities and challenges of mobile health (mHealth)¹¹ solutions for VAW globally.

As defined by the WHO, mHealth is an area of electronic health that provides health services and information to both patient populations and healthcare providers via mobile technologies such as mobile phones, especially smartphones.¹¹ Although the definition additionally entails further instantiations of mHealth, such as personal digital assistants,^{11 12} it is to be noted that, in this review, mHealth against VAW is referred to in terms of smartphone apps against VAW.

METHODS

Overview

We used a systematic online search strategy to identify apps that addressed VAW. We first developed a review protocol based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement recommendations.¹³ Our methodology with regards to identification and categorisation was in accordance with previous systematic app reviews.¹⁴ Building on our findings, we performed a structured qualitative content analysis¹⁵ of the included app descriptions. At the point of the data

collection for the systematic review at hand, no systematic data compilation of apps addressing violence against women had been published.

Identification

Between 1 August and 23 August 2018, we carried out a systematic Google search as well as a systematic online search of two app reselling platforms (*App Store* and *Google Play*; see figure 1). For app identification on the reselling platforms, we searched apps in all group categories of the reselling platforms mentioned above, including all suggested search results for the following predetermined search items in English, German, French and Spanish: ‘Violence against women’, ‘gender-based violence’ (GBV), ‘anti gender-based violence’ (anti-GBV), ‘sexual harassment’, ‘women security’ and respective translations. For the Google search, mentioned search items were linked with the term ‘app[lications]’ by the Boolean operator ‘and’. Scientific databases (PubMed, Medline, The Cochrane Library, Google Scholar and JSTOR) were also searched but did not reveal any relevant articles. Two authors (ES and KE) conducted the structured app search independently in the same time frame (see above). Discrepancies on eligibility were resolved by iterative discussion and consensus.

Screening

In this review, apps relevant to violence against women (see figure 1) were identified per mention of our search terms (see Identification) in the title and/or description of the app. If apps found in grey literature matched with those found on reselling platforms, information was

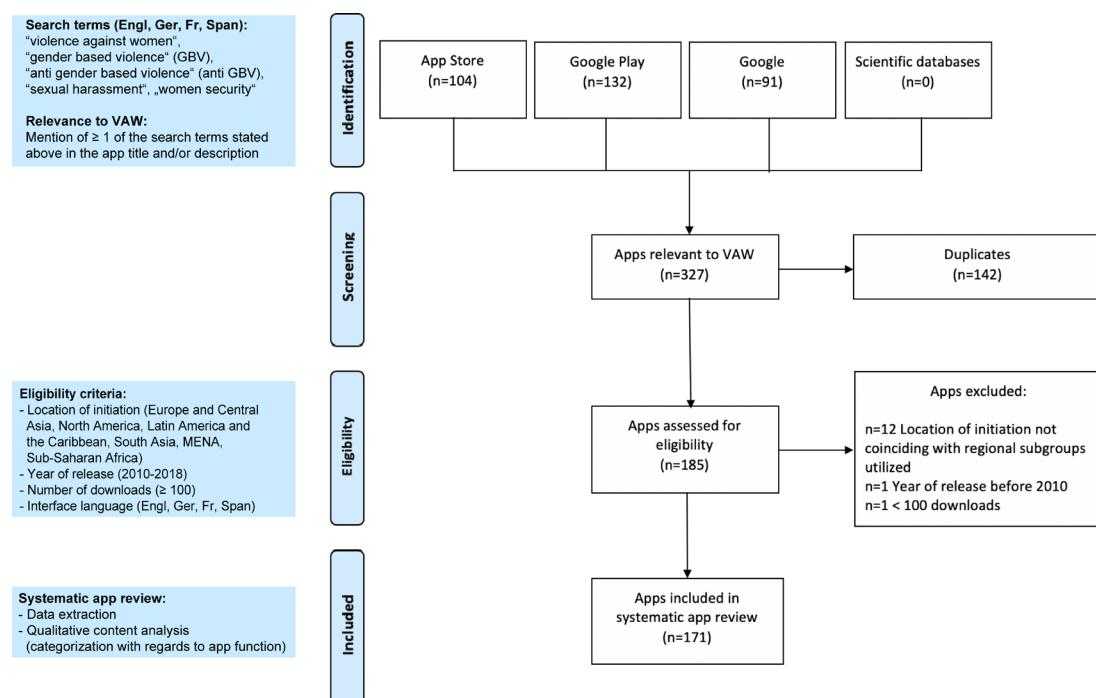


Figure 1 PRISMA 2009 flow diagram. Depiction of the screening and inclusion process. Modified from Moher et al.¹³ MENA, Middle East and North Africa; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; VAW, violence against women.

obtained from both sources. However, they were only counted once and assigned to the respective reselling platform. Identical duplicates were removed.

Eligibility

Eligibility was determined by year of release (2010 up to and including 2018), number of downloads (≥ 100), interface language (English, German, French and Spanish) and explicit location of initiation in accordance with our regional subgrouping (ie, explicit location of initiation in exactly one of the included regions, see Data extraction).

Data extraction

Data of eligible apps were extracted from app descriptions on reselling platforms, respective app websites and non-academic journals (ie, newspaper articles, press releases and blog entries). Information obtained was coded, if applicable, for the following variables:

1. App title.
2. Project affiliation.
3. Company/developer(s).
4. Sector (public, private or both).
5. Location of initiation.
6. Location of implementation.
7. Target group(s) (only victims, only non-victims, victims and non-victims).
8. Year of release.
9. Number of downloads.
10. Availability on reselling platform(s) (App Store, Google Play or both).
11. Cost.

Coding per location of initiation (ie, location of initial development; as opposed to location of implementation, ie, all regions where an application is available) was further used for grouping with regards to location. The regions of initial development were organised in accordance with the World Bank regions into: Europe and Central Asia; North America, Latin America and the Caribbean; MENA; South Asia; and sub-Saharan Africa. East Asia and Pacific was excluded due to the small number of apps identified with location of initiation in this region; furthermore, applications whose location of initiation remained elusive were excluded. In total, n=12 apps were excluded due to these two criteria (see figure 1).

Qualitative content analysis: categorisation with regards to app function

Inductive categorisation with regards to the prevailing app function was based on structured qualitative content analysis and categorisation according to Mayring.¹⁵ Two independent raters (ES and KE) conducted the grouping by main function independently in accordance with the composed coding guidelines. In total, five distinct categories of apps were identified: emergency, avoidance, education, reporting and evidence building, and supporting apps (see table 1).

Overall, 32 out of 171 apps were found to combine more than one of the functions listed in table 1. For these apps, coding rules regarding relevance of app functions were obtained from the order of listed functions and key words signifying the importance of the functions to the respective app. In coding for group affinity, a function was defined as main function as soon as it was listed as first in the order of functions and accompanied by one of the following keywords: 'Basic', 'main', 'fundamental', 'important', 'prevailing', as opposed to 'additionally', 'in addition to', 'furthermore', 'moreover', 'apart from'. In applying these coding rules, all 32 apps could be categorised to one of the mentioned groupings. The inter-rater reliability of the reviewed apps indicated strong agreement of 0.94. 8 apps out of 171 were categorised differently. This mismatch was resolved by iterative discussion and consensus.

Statistical analysis

Quantitative data were analysed with the Statistical Package for the Social Sciences (SPSS Statistics for iOS, IBM SPSS 26). For comparison of app quantities in different functional categories to sectors, target groups or geographical distribution regarding location of initiation, a χ^2 test of homogeneity was deployed, respectively.

Patient and public involvement

Patients were not involved in this systematic review.

RESULTS

Global distribution

A total of 171 applications were used for a mapping of region-specific distribution patterns of apps (see table 1). This showed that 45 apps out of 171 regionally identifiable apps (26.32%) had their location of initiation in South Asia. Other regions with large numbers of apps were Europe and Central Asia with 42 apps (25.56%) and North America with 33 apps (19.30%). The remaining three regional subcategories had relatively few apps with 23 apps in Latin America and the Caribbean (13.45%), 17 in sub-Saharan Africa (9.94%) and 11 in the MENA region (6.43%, see figure 2A).

Target group and sector distribution

82.46% of all apps reviewed were directed at (potential) victims of VAW, that is, women, only (see figure 2B). In this paper, the term 'victims' is used to refer to both survivors and 'potential victims', that is all individuals potentially at risk. Additionally, the review found that a majority of apps (77.19%) were developed in the private sector (see figure 2C). In this review, the term 'private sector' is to be understood as non-governmental institutions/organisations and includes for-profit and non-profit organisations. 'Public sector', in turn, refers to governmental institutions. In a few cases (5.26%), apps were developed in collaboration between private and public sector institutions and were therefore classified as 'both'.

Table 1 Definition of anti-VAW app categories for qualitative content analysis

| App category | Definition |
|---------------------------------------|--|
| 'Emergency app' | This function is defined by the following eight characteristics: <ul style="list-style-type: none"> ▶ Targets emergency situations only. ▶ Temporal immediacy of alert: mostly directly before, during or after an incident. ▶ Easy handling (one alarm button/shake/scream). ▶ Sends an emergency alert to selected contacts, community workers and/or to police officials. ▶ Alert may include GPS details and/or voice recording/video recording. ▶ No background-information concerning the incident is transferred. ▶ No information on VAW in general is given. ▶ No information about resources in cases of VAW is given. |
| 'Avoidance app' | This function is defined by the following four characteristics: <ul style="list-style-type: none"> ▶ No direct temporal link between usage of app and incident. ▶ Usage of function before (potential) incidents. ▶ Avoidance strategy. ▶ It also targets forms of VAW that do not specifically represent a harm to a person's physical integrity (ie, catcalling). |
| 'Education app' | This function is defined by the following five characteristics: <ul style="list-style-type: none"> ▶ No direct temporal link between usage of app and incident. ▶ Usage of function before (potential) incidents. ▶ Education strategy. ▶ Targets health workers as well. ▶ It also targets forms of VAW that do not specifically represent a harm to a person's physical integrity (ie, catcalling). |
| 'Reporting and evidence building app' | This function is defined by the following seven characteristics: <ul style="list-style-type: none"> ▶ No temporal immediacy of report needed: reporting and sharing of the incident is possible even if it has already (long) passed. ▶ During or after an incident, not before. ▶ VAW entails also non-physical and non-sexual forms of VAW (eg, catcalling), that is, without the potential to harm one's physical integrity. ▶ Entails interaction with other users/victims. ▶ Includes GPS information that is used to map incidents and is visible to all users. ▶ Specific information about the incident, the perpetrator, the victim and the context is given. ▶ Promotes public awareness and exchange of experiences with sexual harassment and other forms of VAW. |
| 'Supporting app' | This function is defined by the following five characteristics: <ul style="list-style-type: none"> ▶ Usage of app only after an (or consecutive) incident(s) of VAW. ▶ Connects users with organisations. ▶ Informs about and connects with professional resources (ie, legal, psychological and medical). ▶ Predominantly targets forms of VAW that harm the victim's physical integrity. ▶ Often aiming at intimate partner violence. |

Apps were assigned to one of the stated categories if $\geq 50\%$ of respective characteristics applied. The term 'avoidance strategy' comprises apps offering means to avoid at-risk-situations, for example, apps for all-female taxi services at night to avoid walking alone in the dark; the term 'education strategy' encompasses apps that inform users about VAW, its unacceptability, the availability of services as well as about egalitarian relationships between women and men as part of VAW prevention strategies. VAW, violence against women.

The download of most (76.61%) apps identified in this review was available free of charge (f.o.c.) and did not include any additional cost in the sense of in-app purchases (see **figure 2D**). In some cases, the individual app's cost remained unclear meaning that its actual cost could not be retrieved with the search strategies used in this review.

Global app function distribution

A proportion of 46.78% of all 171 apps addressing violence against women in our review was made up of apps whose primary function was to offer immediate help

in emergency situations, for example, by automatically alerting a nearby police station or preselected contacts if activated by the respective user. These emergency apps (app categories, see **table 1**) constituted the largest proportion of apps globally. The second largest group was composed of education apps (21.05%) followed by reporting and evidence building (14.04%), supporting (12.28%) and avoidance apps (5.85%, see **figure 3A**).

Education apps (see **table 1**) are predominantly designed to provide information on the unacceptability and, if the case, unlawfulness of VAW, as well as

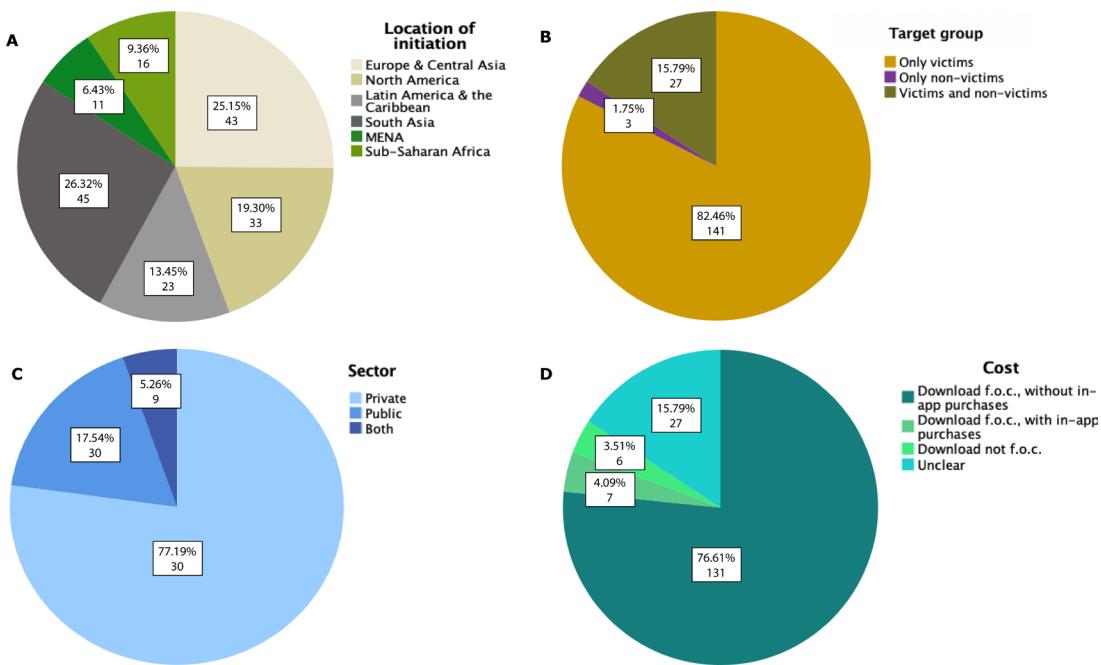


Figure 2 Distribution of apps with regards to location of initiation (A), target group (B), sector (C) and cost (D). In each chart, wedges are labelled with the percentages and absolute frequencies, that is, absolute numbers, of applications counted, respectively. MENA, Middle East and North Africa.

on the benefits of egalitarian gender roles in society and in relationships. Several apps in this category target health professionals and social workers offering training resources and information in order to deepen the expertise on how to engage with women who have been victims of violence or are at risk.

Reporting and evidence building apps allow the user to report incidents of sexual violence and/or harassment via their mobile phone. The reported information about the nature and location of respective incidents are then further aggregated into street maps of incidents. This app category focuses specifically on visualising high prevalence of acts of VAW in public spaces.

Supporting apps (see *table 1*) aim to mitigate the social, psychological and physical repercussion of for survivors of violence by mediating between survivors and local support resources. This app category specifically targets domestic violence as an essential dimension of VAW. Apps from the avoidance category help users avoid potential at-risk situations by mainly offering all-female taxi services at night.

With regards to distribution of app categories, significant ($\chi^2(20)=58.172$, $p=0.000$) differences between all regions mentioned were found, as depicted in *figure 3B*. In many regions, emergency apps represented the largest functional category (see *figure 3B*). Also, as shown by download numbers (obtained from reselling platforms, if explicitly stated there), emergency apps represented the most frequently purchased category globally (see *figure 3D*).

Significant differences were also found regarding distribution of functional app categories and sector

distribution ($\chi^2(8)=22.501$, $p=0.004$), with most emergency apps being developed by the private sector (see *figure 3E*).

Global trends with regard to app feature

An overall eightfold increase in app development rates was observed when comparing the years 2010 and 2018. Furthermore, changes in main function distribution of developed apps were identified, namely, a noticeable relative increment of the development of supporting, reporting and evidence building, and education apps (see *figure 3C*). To test whether these trends in primary app function are statistically significant, apps were aggregated to those released in the time frame 2010–2014 and 2015–2018, respectively, and compared with app function categories (see *table 1*), which showed a non-significant correlation ($\chi^2(4)=4.202$; $p=0.379$).

DISCUSSION

Principal results

In this systematic review of apps addressing violence against women, we have assessed the global distribution of apps with regards to different parameters, particularly function, location of initiation and target group. With download numbers exceeding 160 million (these numbers were obtained from explicitly stated download numbers on mentioned sources only), it is easy to see that such apps have the potential to heavily influence the field of interventions to address violence against women.

Potential benefits of mHealth solutions may, for example, include a lowered threshold to report and/or seek help in case of violence as it has been documented

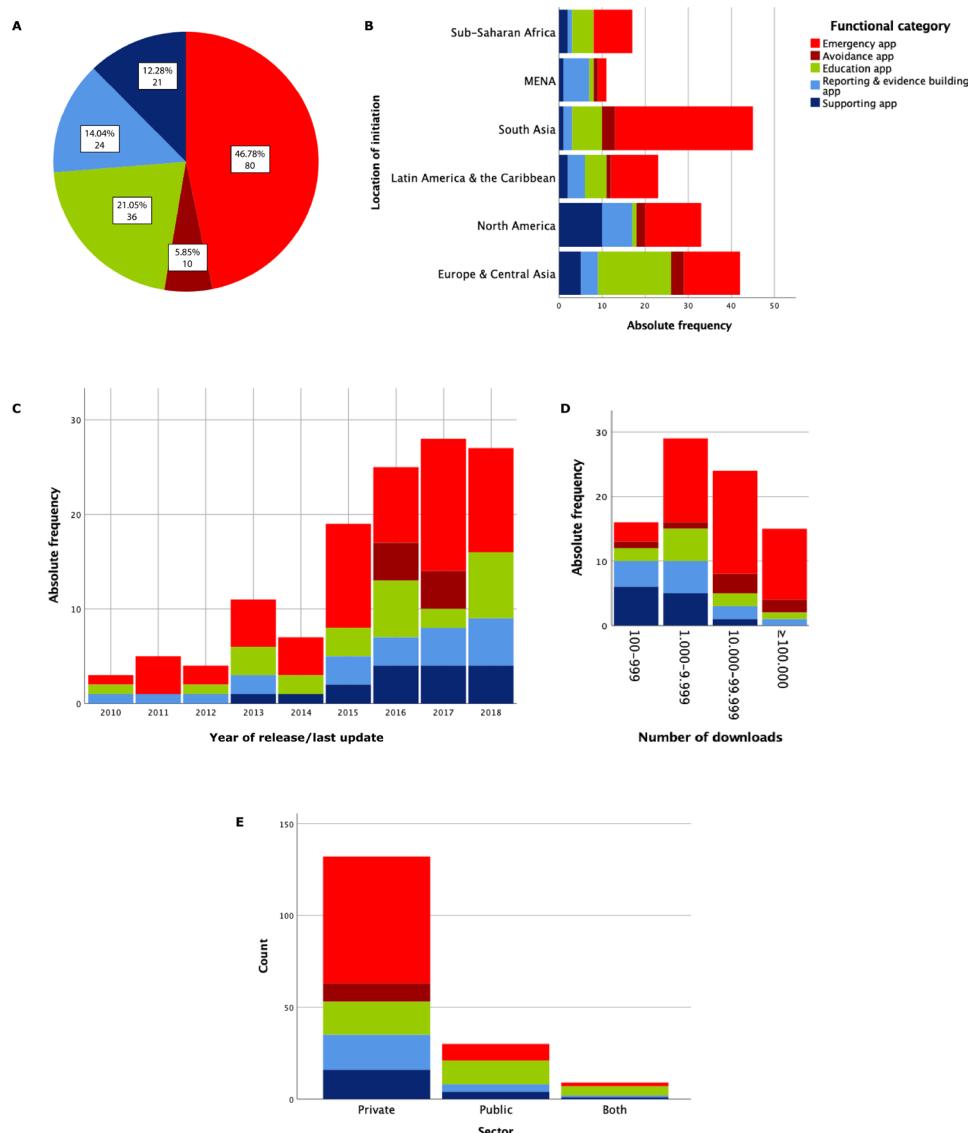


Figure 3 Global app feature distribution (A), additionally clustered by location of initiation (B), year of release/last update (C), number of downloads (D) and sector (E). In figure part A, wedges are labelled with both the percentages and absolute frequencies of applications counted in each category, respectively. In figure parts B–D, absolute frequencies of anti-VAW apps are shown with reference to their location of initiation (B), year of release/last update (C), number of downloads (D) and sector (E). MENA: Middle East and North Africa.

that even in places where non-mHealth interventions are in place, 55%–95% of women remain hesitant and fearful of reporting such incidences in person.^{16–18} The barriers for reporting might be alleviated, for example, by anonymous reporting functions that certain apps offer (ie, reporting and evidence building apps). Furthermore, interaction between survivors and existing support institutions can potentially be facilitated by means of such apps, for both survivors of violence and respective support institutions (ie, supporting apps). Also, information and communication technologies (ICT) in general,^{10 19 20} and apps in particular, offer the opportunity for comparably easy and quick access to information (ie, education and supporting apps), potentially in multiple languages.²¹ Mentioned benefits of mHealth strategies especially concerns those who do not have direct access to health

facilities where they could seek help in cases of violence but, in turn, to a smartphone—a scenario that often applies to underserved rural populations, particularly in low-income and middle-income countries (LMICs).^{9 22–24} However, in LMICs, it must be noted that while many individuals nowadays have access to a phone, access to a smartphone is relatively less common and often limited to phone-sharing between spouses, other family members or even a broader community. Although the exact prevalence of phone-sharing in LMICs remains unknown,²⁵ studies suggest that it is a common practice that has stark implications,²⁶ particularly for the safety of app-users as phone use usually requires permission of its main (commonly male) owner (see Conclusion).

Based on our findings, several important shortcomings of mHealth approaches addressing violence against

women could be identified. As shown in this review, the biggest proportion by type of app function was made up of emergency apps for women as (potential) victims of violence. This dominance of emergency apps should be critically assessed, as it indicates that the prevailing mHealth strategy emphasises individual, one-time solutions for isolated events of violence. This focus was especially pronounced in regions with higher rates of VAW (eg, South Asia, see [figure 3B](#))¹ and among those apps developed by the private sector (see [figure 3E](#)). Yet, violence against women has been established as a widespread, structurally embedded and complex global problem, which is rarely experienced as a one-time individual incident.^{1 2} However, the overall shift in focus of apps in the recent years towards more preventative and inclusive mHealth strategies against VAW (ie, education, reporting and evidence building, and supporting apps) that, among other things, broach underlying (ie, societal and structural) aetiologies of VAW as indicated by our data (see [figure 3C](#)) is a favourable development.

Factors associated with violence against women are reflected in the so-called 'socio-ecological' or 'ecological' framework, a widely used theoretical model that considers how factors across four levels (ie, individual, relationship, community and societal) interact to put individuals at increased (or decreased) risk for experiencing and/or perpetrating violence.^{18 27 28} This model is extensively used, notably by the WHO^{18 28} and the Centers for Disease Control and Prevention,²⁷ to delineate the multiple levels at which different factors operate to influence risk; in turn, evidence suggests that factors at all these levels should be addressed—separately or jointly—for successful interventions against violence against women.¹⁸ In contrast, apps oftentimes disregard the relationship, community and societal level, respectively, as our data suggest a global under-representation of education, reporting and evidence building as well as supporting apps (see [figure 3A](#)). Reporting and evidence building apps help shed light on the systematic societal level of sexual violence and harassment in public spaces as a global phenomenon. In turn, supporting apps focus on the relationship level of (mainly) domestic violence and help connect (potential) survivors of the latter to already existing 'traditional' support structures. This way, these app categories shift the focus from the individual to the relationship, community and societal level of VAW.

Too little attention is being paid still to mHealth-delivered primary prevention against violence against women, for example, in the form of education apps that explicitly highlight the relevance of gender equality, as '[t]he promotion of gender equality is an essential part of violence prevention' in public health.¹⁶ Gender inequality, more specifically female inferiority, in turn, is a socio-structural concept underlying VAW and therefore should be addressed by education apps. In general, it is paramount for mHealth intervention strategies not to be seen as an isolated solution but rather as strategy that complements the long-term public health goal of

prevention.¹⁷ Naturally, there is no need for every single app to address all factors or levels of the socioecological framework on its own; however, an overall balance of different approaches addressing all levels jointly in each region could provide better results.

In addition, the use of apps to promote change of men's attitudes and behaviours as a potentially important element in the prevention of VAW seems to be poorly developed.^{16 18}

Another important aspect is access in terms of app cost, which can be a factor limiting their effect, especially in LMICs. As described earlier (see Results, Target group, sector and cost distribution), the majority of apps can be downloaded free of charge leading to a relatively equitable access to different app-based interventions. However, it must be noted that many apps that include call or SMS sending functions, for example, emergency apps, come along with respective charges for such calls not by the application itself (through download or in-app purchases) but by the user's network provider. Consequently, access to and use of many apps with a notification function of that kind still remains inequitable.

To effectively and responsibly seize the opportunities of mHealth technology in preventing and/or addressing violence against women, the issues above should be made visible and discussed.

Limitations

Despite systematic searches, only small numbers of apps initiated in MENA, Latin America and the Caribbean and in sub-Saharan Africa could be identified, compared with South Asia, Europe and Central Asia, and North America. This limited cogent regional comparisons to South Asia, North America, and Europe and Central Asia. Mentioned misrepresentation is owing to the online availability of apps that, in many cases, is restricted to their respective location of implementation; for instance, apps available only to users in India selectively appear on the country-specific versions of app reselling platforms, for example, *App Store* – India and *Google Play* – India in this case, and are much more prone to pop up in Google searches conducted via servers in the same country. Furthermore, possible selection bias due to language restriction to English, German, French and Spanish needs to be considered as well. The language restriction as well as country-specific app selection bias is presumed to be the reason why we identified negligible numbers of apps with location of initiation in East Asia. Given the large population as well as the high density of smartphone use, especially in the densely populated areas of Central and East Asia, the low numbers of apps with location of initiation in these regions are presumably not an accurate reflection of the actual app distribution but rather are to be interpreted in the context of country-specific online search bias, as well as the language restrictions in this systematic review. However, this depicts a common limitation in systematic app reviews that are most commonly restricted to even only one language.^{29–34} The restriction of year of

release from 2010 up to and including 2018 as eligibility criterion can potentially lead to another selection bias. Nevertheless, the systematic review at hand aims to assess the recent developments in app development, for which reviewing the past 8 years is sufficient and in line with previous systematic reviews on other mHealth applications.^{29–34} Additionally, it must be mentioned that each app was assigned to the sector(s) (private/public/both) of institutions by which it was merchandised; whether other institutions were involved in actually implementing the app was not incorporated into this review. Also, download numbers as such are an imperfect proxy for the actual use of the respective application, for example, an app can be deleted right after it was downloaded or an app's privacy policy agreement may be not accepted by its user so that it cannot be put into use.

In our review, we moreover refrained from further qualitative assessment of the respective applications, as has been done before for personal safety apps,⁵ since app download was partly restricted with regard to app store as well as geographical location and activity. Selective assessment of only those applications that were accessible to us would have led to a biased app sample and thus a biased quality analysis. However, our qualitative content analysis was based on extensive app descriptions (see Methods and Qualitative content analysis: categorisation with regards to app function), and we included all apps that adhered to our inclusion criteria (see figure 1), going far beyond apps that can only be downloaded in Germany which was the location of our study. This way, we were able to include more applications than any other review on this topic—and also more than the vast majority of reviews on mHealth applications in general³²—thus leading to the first extensive review of apps addressing violence against women by which global trends may be identified.

Importantly, it should be noted that the review methodology used in this study clearly draws on the concept of categorisation. Each app was inductively categorised with regards to its prevailing function into one of five categories; as such, it is not a nuanced review of all functions an app entails. This approach was chosen due to its practicability for frontline health and social workers for whom an overview about which applications address VAW in what way in their respective region is a first step to know what kind of app(s) their patient population is using and which are available for them. This information might also be relevant for policy makers who are involved in planning and regulating both mHealth-based and non-mHealth-based interventions against violence against women.

CONCLUSION

In light of the high global prevalence of violence against women¹ and the expanding field of mHealth technologies,¹¹ as well as the high download numbers of apps (see figure 3D), this review presents a first step for further in-depth research on mobile approaches addressing VAW

globally. The overall scarcity of discussions of such apps in the scholarly literature is striking. Also, previous reviews have not captured the whole spectrum of these apps, as they solely concern applications for personal safety⁵ or against rape,⁶ while in this systematic review, a considerable amount of apps for education, reporting and evidence building, and supporting purposes addressing all aspects of violence against women, not exclusively personal safety or rape, were identified.

Based on our systematic review, the following issues need to be taken into account in further explorations of apps against VAW.

As discussed above, such apps should address individual and relationship, community and societal factors, all of which contribute to violence against women and can be modified as intervention studies on non-mHealth approaches have shown.¹⁸ App development and implementation should be based on the most up-to-date scientific evidence on interventions for the prevention of and response to VAW. For as long as there is no evidence on the efficacy of mHealth approaches against VAW, recommendations on non-mHealth strategies will provide guidance on prevention, for example, the 'RESPECT Women' Framework endorsed by twelve UN, bilateral and multilateral agencies.¹⁸

Furthermore, it is not sufficient for apps to aim to address the broader social and institutional context of violence against women without integrating their approach into this broader context, namely linking them with existing institutions (eg, self-help groups, NGOs, women organisations and so on), and taking into account the social norms and institutions that continue to uphold VAW (eg, lack of targeted training on VAW in the police force, legal and healthcare system, lack of promotion of gender equality in education and so on).^{22 35–38} Thus, collaborations between mHealth and 'traditional' approaches should be actively sought,²³ subordinating the technology to the overall aims of preventing violence against women and mitigating its impacts; and also integrating app functions into other domains that are not primarily focussed on addressing violence against women.

As an important step in the further evaluation of apps and app functions addressing violence against women, their potential purposes, risks and effects need to be assessed more thoroughly, for example, in the form of qualitative studies with users and other stakeholders, or systematic intervention studies. It will be paramount to understand potential harms such as data privacy breaches or loss of personal contact with supporters or other meaningful interventions resulting from a shift to digital technology. Furthermore, issues of safety need to be addressed as it must be ensured that women are not inadvertently put at more risk by using mHealth technology.¹⁸ This is especially the case for LMICs where mobile phones are often shared³⁵. Hence, important confidentiality as well as safety issues of the user need to be taken into account in developing apps.^{35 36} In our review, we could identify security provision for the user mainly by password-secured access

to the respective app. Many emergency app functions also included the option of placing an emergency call with a locked screen (eg, the apps Guardly mobile and Shake2alert; see online supplementary table 1). This way, the app may be accessed without anyone other than the user taking note of it. However, more research is needed on the efficacy, extent and sufficiency of such functions. For this, interviews with potential users and stakeholders of such apps as well as systematic intervention studies are needed for further evaluation. Such studies should include an assessment of risks and cultural acceptability of the mHealth intervention, as well as user satisfaction.^{39 40} Furthermore, the issues of potentially inaccurate data input, misinterpretation of the information, as well as issues regarding language and literacy problems must be taken into account when assessing mHealth intervention strategies in general^{41 42} and against VAW in particular.^{43 44} Misinterpretations can additionally occur due to lack of verbal and non-verbal cues in most apps.⁴⁵

Taken together, mHealth solutions certainly are not the panacea for violence against women and should not be viewed as replacement for existing strategies. Nevertheless, if used effectively and integrated appropriately into existing interventions, apps or app functions addressing violence against women may present a promising tool in global health. As for many mHealth interventions, available evidence on effectiveness and overall benefit is sparse³⁷ and, thus, needs to be further investigated in the future.

Contributors All authors designed the paper, read drafts and contributed written parts as well as commentaries on parts written by the coauthors. KE and ES conducted the systematic app search and categorisation, under supervision of VW and CG-M, and wrote the first draft. Equal authorship applies to KE and ES.

Funding The study was supported by the German Federal Ministry of Education and Research (BMBF); grant number: 01GP1791.

Disclaimer CG-M: The views expressed are the views of the author and do not represent policy of the WHO. VW: The funder had no role in the preparation of the manuscript or the decision to submit. The corresponding author (VW) has access to all the data in the study and final responsibility for the decision to submit for publication.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Katharina Eisenhut <http://orcid.org/0000-0001-6448-3126>

REFERENCES

- 1 World Health Organization. Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence, 2013. Available: https://www.who.int/iris/bitstream/handle/10665/85239/9789241564625_eng.pdf?sequence=1 [Accessed 26 Aug 2019].
- 2 Abrahams N, Devries K, Watts C, et al. Worldwide prevalence of non-partner sexual violence: a systematic review. *Lancet* 2014;383:1648–54.
- 3 United Nations General Assembly. Report of the open Working group of the general assembly on sustainable development goals, 2014. Available: https://www.iom.int/sites/default/files/UN_Documents/69th_Session/A_68_970.pdf [Accessed 26 Aug 2019].
- 4 Sachs JD. From millennium development goals to sustainable development goals. *The Lancet* 2012;379:2206–11.
- 5 Maxwell L, Sanders A, Skues J, et al. A content analysis of personal safety Apps: are they keeping us safe or making us more vulnerable? *Violence Against Women* 2020;26:233–248.
- 6 White D, McMillan L. Innovating the problem away? A critical study of Anti-Rape technologies. *Violence Against Women* 2019;32:107780121985611.
- 7 Freeman Met al. *Violence against women. The un convention on the elimination of all forms of discrimination against women.* Oxford University Press, 2012. <https://www.ohchr.org/Documents/ProfessionalInterest/cedaw.pdf>
- 8 Tamrat T, Kachnowski S. Special delivery: an analysis of mHealth in maternal and newborn health programs and their outcomes around the world. *Matern Child Health J* 2012;16:1092–101.
- 9 Lee SH, Nurmatov UB, Nwari BI, et al. Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle-income countries: systematic review and meta-analysis. *J Glob Health* 2016;6.
- 10 Brian RM, Ben-Zeev D. Mobile health (mHealth) for mental health in Asia: objectives, strategies, and limitations. *Asian J Psychiatr* 2014;10:96–100.
- 11 World Health Organization. Mhealth: new horizons for health through mobile technologies, 2011. Available: https://www.who.int/goe/publications/goe_mhealth_web.pdf [Accessed 26 Aug 2019].
- 12 Lindquist AM, Johansson PE, Petersson GI, et al. The use of the personal digital assistant (PDA) among personnel and students in health care: a review. *J Med Internet Res* 2008;10:e31.
- 13 Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6:e1000097.
- 14 Alyami M, Giri B, Alyami H, et al. Social anxiety apps: a systematic review and assessment of APP descriptors across mobile store platforms. *Evid Based Ment Health* 2017;20:65–70.
- 15 Mayring P. *Handbuch qualitative Forschung in der Psychologie.* 9783531920528. Wiesbaden: VS Verlag für Sozialwissenschaften, 2010ISBN.
- 16 World Health Organization. Global status report on violence prevention 2014, 2014. Available: https://www.who.int/violence_injury_prevention/violence/status_report/2014/en/ [Accessed 26 Aug 2019].
- 17 Cowan S, Baillot H, Munro V. 'Hearing the Right Gaps': Enabling and Responding to Disclosures of Sexual Violence within the UK Asylum Process' *Social and Legal Studies* 2012;21:1–28.
- 18 World Health Organization. Respect women: preventing violence against women, 2019. Available: <https://www.who.int/reproductivehealth/publications/preventing-vaw-framework-policymakers/en/> [Accessed 26 Aug 2019].
- 19 Källander K, Tibenderana JK, Akpogheneta OJ, et al. Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: a review. *J Med Internet Res* 2013;15:e17.
- 20 Feinberg L, Menon J, Smith R, et al. Potential for mobile health (mHealth) prevention of cardiovascular diseases in Kerala: a population-based survey. *Indian Heart J* 2017;69:182–99.
- 21 Whittaker R, McRobbie H, Bullen C, et al. Mobile phone-based interventions for smoking cessation. *Cochrane Database Syst Rev* 2016;17.
- 22 Mechaal PN. The case for mHealth in developing countries. *Innovations* 2009;4:103–18.
- 23 Kahn JG, Yang JS, Kahn JS. 'Mobile' Health Needs And Opportunities In Developing Countries. *Health Aff* 2010;29:252–8.
- 24 Strachan DL, Källander K, Ten Asbroek AHA, et al. Interventions to improve motivation and retention of community health workers delivering integrated community case management (iCCM): stakeholder perceptions and priorities. *Am J Trop Med Hyg* 2012;87:111–9.
- 25 The Earth Institute, Columbia University. Barriers and gaps affecting mHealth in low and middle income countries, 2010. Available: <http://cgssd.columbia.edu/files/2012/11/mHealthBarriersWhitePaperFINAL.pdf> [Accessed 26 Aug 2019].



26 Kaplan WA. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Global Health* 2006;2:9.

27 Centers for Disease Control and Prevention. The social-ecological model: a framework for prevention, 2019. Available: <https://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel> [Accessed 26 Aug 2019].

27 World Health Organization. World report on violence and health, 2002. Available: https://www.who.int/violence_injury_prevention/violence/world_report/en/ [Accessed 29 Aug 2019].

29 Huang Z, Lum E, Jimenez G, et al. Medication management support in diabetes: a systematic assessment of diabetes self-management apps. *BMC Med* 2019;17:127.

30 Knitza J, Tascilar K, Messner E-M, et al. German mobile Apps in rheumatology: review and analysis using the mobile application rating scale (MARs). *JMIR Mhealth Uhealth* 2019;7:e14991.

31 Petersen JM, Prichard I, Kemps E. A comparison of physical activity mobile Apps with and without existing web-based social networking platforms: systematic review. *J Med Internet Res* 2019;21:e12687.

32 Hamine S, Gerth-Guyette E, Faulk D, et al. Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review. *J Med Internet Res* 2015;17:e52.

33 Keogh JW, Cox A, Anderson S, et al. Reliability and validity of clinically accessible smartphone applications to measure joint range of motion: a systematic review. *PLoS One* 2019;14:e0215806.

34 Marcolino MS, Oliveira JAQ, D'Agostino M, et al. The impact of mHealth interventions: systematic review of systematic reviews. *JMIR Mhealth Uhealth* 2018;6:e23.

35 Heise L. *What works to prevent partner violence? an evidence overview*. London: STRIVE Research Consortium, London School of Hygiene and Tropical Medicine, 2011. <https://researchonline.lshtm.ac.uk/21062/>

36 Fulu E, Kerr-Wilson A, Lang J. *What works to prevent violence against women and girls. Evidence review of interventions to prevent violence against women and girls*. Pretoria: Medical Research Council, 2014. <https://www.gov.uk/dfid-research-outputs/what-works-to-prevent-violence-against-women-and-girls>

37 World Health Organization. WHO guideline: Recommendations on digital health interventions for health system strengthening, 2019. Available: <https://www.who.int/reproductivehealth/publications/digital-interventions-health-system-strengthening/en/> [Accessed 10 Dec 2019].

38 Abramsky T, Devries KM, Michau L, et al. Ecological pathways to prevention: how does the Sasa! community mobilisation model work to prevent physical intimate partner violence against women? *BMC Public Health* 2016;16:339.

38 Labrique AB, Vasudevan L, Kochi E, et al. mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. *Glob Health Sci Pract* 2013;1:160–71.

40 Free C, Phillips G, Watson L, et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. *PLoS Med* 2013;10:e1001363.

41 Lin TTC, Bautista JR. Understanding the relationships between mHealth Apps' characteristics, Trialability, and mHealth literacy. *J Health Commun* 2017;22:346–54.

42 de Jongh T, Gurol-Urganci I, Vodopivec-Jamsek V, et al. Mobile phone messaging for facilitating self-management of long-term illnesses. *Cochrane Database Syst Rev* 2012;12:CD007459.

43 García-Moreno C, Hegarty K, d'Oliveira AFL, et al. The health-systems response to violence against women. *Lancet* 2015;385:1567–79.

44 García-Moreno C, Zimmerman C, Morris-Gehring A, et al. Addressing violence against women: a call to action. *Lancet* 2015;385:1685–95.

45 Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC Public Health* 2014;14:188.