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Review Article

Digital and community-based health interventions for exercise and education in the management of musculoskeletal- and lifestyle-related health conditions in rural communities in low- and middle-income countries: a scoping review

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Abstract

Introduction: Musculoskeletal and lifestyle-related health conditions often co-occur, which presents a major physical and psychological burden on individuals and may have socioeconomic implications in society. Rural communities in low- and middle-income countries often have limited access to regular, in-person health and healthy lifestyle supportive services and facilities. As an alternative, digital and community-based interventions should be considered. A scoping review was conducted to investigate digital and community-based health interventions for exercise and education in the management of musculoskeletal and lifestyle-related health conditions in rural communities in low- and middle-income countries.

Methods: The JBI methodology for scoping reviews was utilised. A three-step search strategy was implemented to identify articles. Following an initial exploratory search, the strategy was adapted. The full search was conducted using PubMed, Scopus, Web of

Science, and EBSCOhost. Reference lists of included articles and grey literature searches were also performed. Titles and abstracts were screened followed by full-text evaluations against the eligibility criteria by two independent reviewers. Studies in the past 20 years involving digital or community-based health interventions aimed at the management of musculoskeletal and/or lifestyle-related health conditions through exercise or education for participants aged over 18 years and conducted in rural settings in low- or middle-income countries were included in the review. **Results**: The search identified 1323 articles (following removal of duplicates). Nineteen studies meeting the eligibility criteria were included. Most studies (*n*=16) focused on community-based interventions with (*n*=8) or without (*n*=8) digital components, with one study involving a digital intervention only for lifestyle-related health conditions. Only two studies focused on musculoskeletal conditions. All interventions included a health education component and some studies included screening, monitoring, and exercise components. Digital health components included mobile health messages and apps, videos, and websites to assist health practitioners and patients. Many studies relied on community health workers for the implementation of interventions. Improvements in various health parameters were reported following the interventions. Barriers related to the digital components such as technical faults and concerns related to message content were reported. Community engagement during development and implementation of interventions and finding cost-saving strategies may be important to assist with the feasibility of interventions in rural under-resourced settings. **Conclusion**: The findings of the review demonstrate that community-based health interventions with and without digital components for the management of lifestyle-related health conditions appear to have a positive impact and are feasible to implement in rural communities in low- and middle-income countries. The type of interventions utilised as well as associated facilitators and barriers should be considered during the development of future interventions to increase the likelihood of the value and feasibility thereof in rural, under-resourced settings. Community involvement should be encouraged during the development and implementation of interventions to ensure the appropriateness thereof to local communities.

Keywords

community-based interventions, digital interventions, lifestyle health conditions, musculoskeletal conditions, remote health, review.

Introduction

Musculoskeletal and lifestyle-related health conditions often co-occur, which may place major physical and psychological burdens on individuals and may have negative socioeconomic implications in society[1-4]. The health-related quality of life of individuals may be affected through chronic pain and functional limitations, which may impact on the ability to participate in both occupation and leisure-related activities[1,5,6]. Lower productivity or the inability to work and the high costs associated with standard healthcare practices add to the socioeconomic burden of these conditions[7,8]. A high prevalence of comorbid musculoskeletal and lifestyle-related health conditions have been reported in populations in low- and middle-income countries (LMICs)[4]. For example, a study conducted in an under-resourced community in South Africa reported that comorbidities such as hypertension were commonly reported alongside musculoskeletal conditions such as arthritis[9]. Risk factors such as reduced physical activity levels have also been reported to be higher in under-resourced communities[10].

Education, exercise prescription, targeted rehabilitation, and addressing risk factors form the cornerstone of prevention and treatment of many musculoskeletal and lifestyle-related health conditions[11-13]. The prevention and treatment of these conditions may involve long-term commitments to lifestyle modifications including physical activity management, a healthy diet, and avoiding smoking[3,12,14,15]. Optimal pain management, psychological support, and the facilitation of a full return to function including work following musculoskeletal conditions may be a lengthy process and relies on continuity of care[16]. These interventions often require visits to in-person facilities such as going to physiotherapy practices for lower back pain or attending training sessions at a gym to help manage type 2 diabetes[16,17]. This may be particularly challenging for individuals living in rural and under-resourced communities in LMICs where access to high-quality in-person health care and healthy lifestyle supportive services and facilities may be limited or unattainable[18]. This may be due to a combination of geographical inaccessibility, insufficient infrastructure, and resources (eg lack of health practitioner clinics and healthy food stores), along with financial constraints limiting the ability to afford high-quality services and healthier lifestyle options (eg gym memberships)[10].

Although in-person health care at established facilities remains the gold standard of management, alternative options should be considered to assist with the prevention and treatment of musculoskeletal and lifestyle-related health conditions in rural communities in LMICs[19]. Digital health platforms and community-based interventions may need to be considered as an alternative[20,21]. Digital interventions may include telehealth (eg online consultations with health practitioners such as a general medical practitioner), telerehabilitation (eg online individualised rehabilitation programs offered by a physiotherapist), pre-recorded or live exercise videos, web-based or mobile app education strategies, and telephone calls or text messages for monitoring purposes[22-24]. Systematic reviews have provided support for the effectiveness of digital health care in the management of musculoskeletal conditions with regards to pain, quality of life, and functional capacity in general populations[24,25]. Conversely, barriers such as lack of wi-fi coverage, inadequate access to digital devices, and low digital literacy may inhibit successful implementation of digital health methods[26]. Community-based interventions may include training local health practitioners, parents, or volunteers to provide certain services that would otherwise be inaccessible, the distribution of educational materials within communities, message delivery via peers, and hosting educational workshops, among other strategies[21]. In support of the efficacy of community-based health interventions, a systematic review conducted in urban areas, mostly in high income countries, found that at least one lifestyle-related health outcome improved in most studies[27]. Further research is needed to explore what digital or community-based health care interventions may be implemented for the

management of musculoskeletal and/or lifestyle-related health conditions in rural communities lacking access to sufficient, regular, and high-quality health care and healthy lifestyle supportive services and facilities.

A preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews and JBI Evidence Synthesis was conducted, and no current or underway systematic reviews or scoping reviews were identified. Related reviews (eg investigating the efficacy of digital interventions for musculoskeletal conditions in general populations) have been performed[24,25]. However, no past reviews have focused specifically on digital and community-based health interventions using exercise and education for the management of these conditions with specific consideration of the socioeconomic, geographic, infrastructure-related, resource-related, and other factors relevant to rural communities in LMICs. The barriers, facilitators, feasibility, and impact of implementation of these interventions may differ in these settings compared to those reported in well-resourced high-income countries. For example, inadequate wi-fi coverage may mean that digital interventions would be ineffective in under-resourced communities.

Aims and objectives

The review therefore aimed to identify and describe the use of digital and/or community-based health interventions for exercise and education in the management of musculoskeletal and/or lifestyle-related health conditions in rural communities in LMICs. The secondary objective involved exploring the impact, feasibility, barriers, and facilitators of these interventions in the management of musculoskeletal and/or lifestyle-related health conditions in these communities.

Methods

Inclusion criteria

Participants

Studies involving participants aged over 18 years, of any sex and occupation, were included.

Concept

Any studies investigating digital and/or community-based health interventions implemented in the prevention, treatment, and management of musculoskeletal or lifestyle-related health conditions through education or exercise (including rehabilitation) were considered. Studies describing the development without implementation of such interventions were excluded. Studies where the primary diagnosis did not include a musculoskeletal condition or a lifestyle-related health condition were excluded. Studies focused on prevention only in a healthy population without any clear risk factors were excluded. Educational interventions targeting medication compliance or pharmacological strategies only were also excluded.

Context

Rural settings in LMICs, including upper middle-income countries, were considered. The classifications as defined by the World Bank was utilised[28]. Any communities in rural regions in LMICs were considered. The definition of 'rural' may differ based on different regions and local policies[29,30]. For the present review, study locations specified as rural by the involved researchers or, where unspecified, based on geographic coordinates indicating separation from urban regions, were considered as rural regions[29,30]. Any studies conducted in LMICs combined with high-income countries where the results could not easily be extrapolated were excluded. Any studies conducted in rural and urban regions where the results for rural regions could not be extrapolated were excluded. Studies that failed to specify the location of the research were also excluded.

Types of sources

Any experimental trials, cohort, case-control studies, case series, case studies, cross-sectional observational (retrospective and prospective) designs and qualitative studies published in the past 20 years were considered. The review was limited to research published in the past two decades due to the rapid rate of technological advances impacting healthcare systems and services. Literature reviews (narrative, scoping, or systematic), single-case studies, editorials and opinion pieces were excluded. Any studies where the full text could not be obtained or that were unavailable in English or Afrikaans were excluded.

The scoping review was conducted in accordance with the JBI methodology for scoping reviews with consideration of the guidelines by PRISMA for scoping reviews[31,32]. The full protocol is registered on the Open Science Framework database[33,34].

Search strategy

A three-step search strategy was used. The first step involved an initial search of PubMed to identify articles on the topic and to assist with the development of a search strategy. The full search strategy was developed, including adjustments to the key terms, MeSH terms and Boolean operators as applicable to each database under guidance of a senior librarian at the Bongani Mayosi Health Sciences Library at the University of Cape Town. The following databases were included in the search of the literature: PubMed (MEDLINE), Scopus, Web of Science including SciELO, and EBSCOhost (with CINAHL, Africa Wide, Health Source and MEDLINE selected). To identify any further articles of relevance, the reference lists of included articles were searched. A grey literature search using Google Scholar to identify any further articles was also conducted. The search strategy for PubMed is available in Supplementary table 1.

Study/source of evidence selection

All articles identified during the search were combined and uploaded to Rayyan (Rayyan; https://new.rayyan.ai [https://new.rayyan.ai])[35]. This automated software has been recommended for use during scoping reviews, particularly for duplicate identification and screening purposes[36]. All duplicates were removed using this software. The titles and abstracts were screened by two independent reviewers (GG, TB) using blinding to determine if the eligibility criteria for assessment were met. Attempts were then made to retrieve the full texts of these studies. Full texts of available studies were evaluated against the inclusion criteria by two independent reviewers (GG, TB) using blinding. Reasons for exclusion were recorded. Any disagreements that arose between the reviewers at each stage of the selection process were resolved through discussion. No third-party consultations were needed.

Data extraction

Data were extracted from all articles using a self-developed data extraction tool based on the JBI template for data extraction[37]. The initial draft of the data extraction tool was modified and revised during the process of extracting data from each included evidence source (Supplementary table 2). The following data were captured to identify each article: authors, year of publication, and title. Study descriptors including the study design, sample size, and participant characteristic, geographic region, and socioeconomic status were extracted. Digital and community-based health methods used for exercise and/or education were described along with which musculoskeletal or lifestyle-related health conditions targeted. Where available, the impact of the method, any barriers or facilitators encountered during implementation, and any additional information regarding the feasibility of implementation were extracted.

Study selection

The initial electronic search of the four databases produced 1586 studies. Grey literature searches produced 11 additional studies. After removal of duplicates, 1323 studies remained. There was 91.0% agreement among reviewers at title screening level, with all conflicts resolved through discussion. Following title and abstract screening, 153 articles were identified for full-text review. The reviewers were 98.0% aligned at full-text screening level, with all conflicts resolved through discussion. Nineteen studies meeting the eligibility criteria were included in the review, two of which were identified by grey literature searches. The full search is presented in a PRISMA-Scoping Review (PRISMA-ScR) flowchart[31] (Fig1).

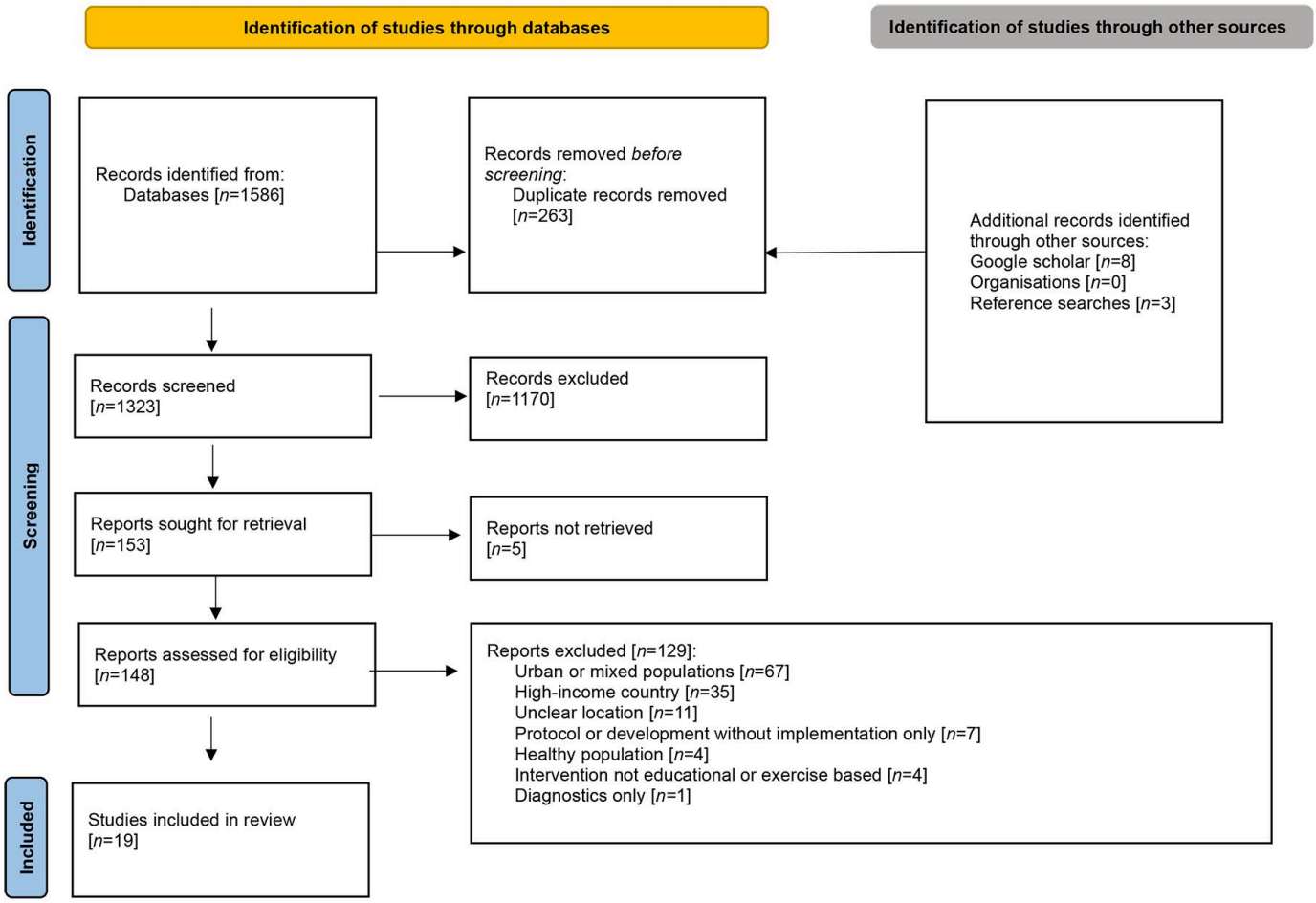

Figure 1: PRISMA-ScR flow chart for screened articles.

Results

Overview of included studies' characteristics

The final 19 studies involved a range of study designs including randomised controlled trial (RCT) (*n*=8), quasi-experimental pre-test–post-test intervention (*n*=6), mixed-methods (*n*=3), qualitative (*n*=1) and observational (*n*=1) study designs[38-56]. Three of the reports evaluated different components related to a three-arm RCT study[50,51,53]. The number of participants included ranged from 30 to 11,454 participants across studies.

Most of the studies were conducted in Asia, including seven studies in Bangladesh, five in India, three in China, as well as studies in the Philippines (*n*=1), Pakistan and Sri Lanka (*n*=1) and Vietnam (*n*=1)[38-42,44-46,48-56]. Two of these studies involved multiple Asian countries[44,55]. The only studies involving other regions included one study conducted in Nigeria, Africa and another in Brazil, South America[43,47]. All studies were conducted in rural regions, with one study by Harshitha et al (2022) comparing a rural and urban group (the rural data were extracted for the review)[42]. Most of the countries where studies were conducted are classified as LMICs (*n*=15), with the remaining two in China classified as relating to an upper middle-income country, based on

World Bank classifications[28]. Most studies (*n*=17) targeted lifestyle-related health conditions, with only two focusing on musculoskeletal conditions (namely chronic lower back pain and arthritis-related illness). The most common conditions targeted by interventions in studies were diabetes and pre-diabetes (*n*=10), followed by hypertension (*n*=6), cardiovascular disease (*n*=2), and cerebrovascular accidents (*n*=1), with some studies targeting multiple conditions. Study interventions periods and follow-up periods ranged from 6 weeks to 48 months. The details of each study are shown in Appendix I, Appendix II and Appendix III.

Types of interventions for lifestyle-related health conditions

Sixteen studies with interventions to manage lifestyle-related diseases involved community-based components[38,39,41,42,44-53,55,56], half of which also included digital health components. One study targeting diabetes involved only a digital intervention[40].

The interventions all involved a health education component[38-42,44-53,55,56]. Topics mainly covered lifestyle education such as dietary advice regarding sufficient fruit and vegetable intake, limiting salt intake, and other unhealthy food choices, performing sufficient levels of physical activity, and avoiding smoking and other forms of substance abuse[38,45,48-50,52]. Disease specific health education was also included in three studies[41,46,50].

Methods to deliver education included home visits[39,44,45,47,55], one-on-one patient sessions in various community and health facilities[38,48,49,53], group education sessions or seminars[38,41,46,52], support groups[49], and motivational sessions[39]. Some interventions included the arts, for example theatre productions and puppet shows[49,50]. One study also included cooking and yoga demonstrations in communities[38]. Printed educational materials including booklets, pamphlets, and posters were distributed as part of seven studies[38,39,41,42,45,46,52]. Five studies mentioned that advice was individualised based on identified risk factors[38-40,48,52]. A mass media campaign including broadcasting was reported in one study[52].

In addition to education, six studies included screening and monitoring of blood pressure, blood glucose, or other health parameters[39,41,44,47,49,52]. Training workshops for doctors, community health workers (CHWs), or both were also reported in six studies[41,44,47,49,55,56]. A local diabetes care centre was established as part of one study[49].

Digital interventions included mostly m-health in the form of mobile voice and text messages to patients[45,50,53,56], smartphone apps for use by health practitioners[48,55,56], with educational videos for patients based on individualised risk factors[48], as well as phone calls[46]. One study reported the development of a website for local doctors to guide patient management and to generate individualised advice to patients based on risk factors[40].

Nine of the interventions mentioned CHWs delivering various components such as screening and education[38,41,44,45,47-49,52,55]. Other studies mentioned the use of locally trained facilitators[53], doctors[56], unspecified non-healthcare staff[46], nursing students, and community nurses[39].

Impact of lifestyle-related health interventions on individuals and communities

Based on various objective and subjective parameters, a positive impact was reported in rural communities following lifestyle-related health interventions in all studies. Two studies reported a reduction in the prevalence of lifestyle-related health conditions. namely diabetes[53], hypertension, and obesity[46]. Ten studies reported improvements in blood pressure measurements[38,39,41,44-47,52,55,56], three studies reported improved blood glucose levels[38,48,53], two studies reported improvements in body weight measurements[38,45], and one study noted lowered urinary salinity[45]. Lower mortality rates were reported in two studies[44,56], along with lower recurrences of cerebrovascular accidents and fewer hospitalisations in one of these studies[56]. Improvements in self-reported lifestyle behaviours were reported in six studies[40,41,45,46,50,52], and better medication adherence was reported in four studies[39,44,55,56]. Improved health literacy with improved knowledge scores was reported in four studies[38-40,42]. Three studies reported better quality-of-life scores[44,45,56]. One study reported improved performance in function measured through the 'timed up and go test' for patients who had experienced cerebrovascular accidents[56].

The potential value of training locals and CHWs was mentioned by two research groups – the training may have resulted in enhanced skills and assisted with the creation of local employment[44,49]. Four studies also mentioned a possible reduction in healthcare costs with the interventions implemented[47,49,51,56]. Two studies reported that locals started growing their own vegetables to help support healthier dietary choices, with one mentioning that local stores also stocked healthier options due to the intervention[49,51]. However, formal objective assessments were not described to substantiate the abovementioned findings in all except a study by Morrison et al (2019), which utilised group interviews and focus groups among participants[51].

Type and impact of interventions for musculoskeletal health conditions

Only two studies investigated the use of community-based and/or digital interventions for musculoskeletal health conditions in rural communities[43,54]. A study by Rana et al (2010) involved health education provided through small groups and home visits, printed handouts, videos, and theatre productions for the management of arthritis-related illness[54]. Significant improvements in self-rated health and reduction in arthritis-related illness were reported in participants who were compliant with the intervention, compared to those who were not[54]. A study by Ibrahim et al (2018) involved a pilot RCT for the management of chronic lower back pain through exercise prescription only, education only, or exercise prescription and education respectively, provided by physiotherapists within the community[43]. All groups demonstrated improvements in pain and function, with the greatest improvements observed in the group receiving both exercise and education[43].

Barriers to implementation of interventions

Only a few studies investigated barriers related to the implementation of interventions, and these mostly related to digital health components[40,45,50]. For mobile messages, one study reported a reluctance by individuals to share mobile numbers,

which limited sign-ups, and changing mobile numbers following sign-up as barriers to sending messages[50]. For those who signed up, participants reported not listening to the messages due to a lack of interest, being too busy, not recognising the voice used, and assumptions that the messages were advertisements, unsolicited, or scams[50]. A study by Jahan et al (2020) reported that mobile messages may have been too short and generalised for some participants, although no formal assessment for obtaining participant input regarding this was reported[45]. Technological faults limiting the ability to deliver mobile messages[50] and disruptions in internet and electricity supply limiting access to a website health aid were also reported[40]. Lack of personalisation and over-standardisation were raised as concerns by some participants being managed with doctors using a web-based aid[40].

Social and environmental challenges involving disease-related stigmas and gender norms (eg restrictions on the movement of females) were reported as barriers to the ability to follow guidelines recommended during health interventions[50,51]. Insufficient funds to travel to facilities or pay for healthcare services needed were also mentioned by participants as a potential barrier to complying with suggestions made as part of the intervention[51].

Facilitators to implementation of interventions

Community engagement during development and/or implementation of interventions was mentioned by participants and researchers as a potential facilitator for the applicability and uptake of interventions[38,39,49,53]. This may have allowed for the use of more context-specific strategies, for example creating spaces for exercise, promoting access to healthier food based on community needs, and providing recipes for healthier food that were considered acceptable within the community[38,53].

Group discussions, engagement, and social support were also mentioned as valuable for the transfer of information and increasing the likelihood of following advice provided[38,51]. Community awareness regarding health conditions and healthier choices were also described as helpful since this allowed participants to feel more comfortable to follow advice[51]. The relevance and repetition of information provided during education were also mentioned as potential facilitators for the uptake of interventions[50,51]. Participants in one study indicated a preference of information provided by a doctor compared to other individuals during mobile messages[50]. Demonstrations such as in-person yoga sessions were also described as helpful to increase the chance of following the advice provided[38].

Two articles mentioned that cost savings related to the use of a group intervention and the use of a simplified approach to management may have facilitated the feasibility of the interventions[41,55]. Mohan et al (2012) mentioned that facilities could be developed due to private donations[49].

Discussion

Value of community-based and/or digital health interventions in rural communities

The studies included in the review reported positive impacts on various lifestyle-related health conditions and two musculoskeletal conditions through community-based and/or digital health intervention in rural communities in LMICs. These included reduced disease incidence and severity, improved lifestyle choices, better health literacy, improved function, and better quality of life[43,45,51-53]. The improvements observed in these rural under-resourced settings are in line with research of digital interventions and community-based interventions respectively for musculoskeletal and lifestyle-related health conditions in varied, urban, and high-income settings[25,27,57,58]. This positive trend is encouraging, although interventions for rural settings in LMICs would need to be modified based on community-specific needs and availability of resources[59].

Feasibility of community-based and/or digital health interventions in rural communities

Almost all the interventions in the reviewed studies were multimodal and community-based, with just under half including digital components[38,39,41-56]. The use of multimodal interventions may be important to help address the multifactorial causes underlying lifestyle-related and musculoskeletal health conditions[60,61]. Conversely, funding and resource constraints in rural communities in LMICs need to be considered in the development and implementation of interventions to ensure feasibility and appropriateness[62]. It was unclear from most reviewed studies if attempts were made to address possible barriers to the uptake of interventions during development. Nonetheless, some studies identified that the use of group education and screening, arrangement of transport to larger health facilities in groups, and the development of household vegetable gardens were among the potentially helpful strategies identified and implemented [38,43-46,49,51-53,55]. In support of the cost-effectiveness and value of a group-based approach, an RCT demonstrated that group education for diabetes was as effective as individual education, with improvements in glycaemic control, quality of life, and BMI among other health outcomes reported in both groups[63]. Conversely, a study conducted in an under-resourced region of South Africa found that household gardening was insufficient as a source of healthier food, partially due to cultural and spatial barriers in the community involved[64]. Promoting access to healthy food options and creating safe spaces for exercise may require collaboration between NGOs, research bodies, and local and national governmental policies[65]. Innovative plans tailored to local communities, regional, and country-specific contexts are needed to address these conditions in rural under-resourced communities. One example might be the provision of healthy food options at workplaces and schools through an NGO[65].

It has previously been reported that digital interventions appear to be cost-effective, may enhance access to information, help to streamline individualised patient care, and have been associated with improved health outcomes[57,58,66]. The present review provides support for the potential positive impact on health outcomes[46,48,54-56]; however, the relative contribution of different components (including community-based compared to digital) cannot be determined. Nonetheless, most of the barriers reported in the present review related to technological faults and a reluctance to engage with digital content, which may limit the applicability of digital components in rural under-resourced communities[40,50]. There may also be safety concerns with certain digital health interventions; for example, when utilised to promote or prescribe physical activity, an increased risk of side effects has been reported[67]. Digital components may therefore be more

helpful as an adjunct to community-based interventions rather than in isolation in these settings. This may explain why only one study in the review utilised a digital intervention in isolation[40].

The duration of interventions in reviewed studies ranged from 6 weeks to 4 years, with the repeatability and long-term impact of interventions remaining unclear. The sustainability of these interventions in rural settings should be considered in future research studies.

Critical importance of community involvement

Many studies in the present review indicated the importance of community engagement forming part of interventions, although what this entailed was not always clearly defined[38,39,49,53]. In general, community engagement may be helpful to ensure that interventions are culturally and socially sensitive, and appropriate for each unique setting, which may increase the likelihood of interest and acceptance within local communities[59]. In support of the value of community engagement, a systematic review involving 24 studies reported that community engagement utilised in under-resourced settings was associated with positive changes in access to health services, health literacy, and other health outcomes[68]. Similarly, a meta-analysis of 131 studies of public health interventions utilising community engagement for various chronic illnesses reported significant improvements in various health outcomes including lifestyle behaviours, self-efficacy, and social support[69]. Studies were grouped according to models or approaches to community engagement, including a community-independent approach, where the health-related need and response was facilitated by the community; a third-party approach, where the health need was identified by external parties who subsequently engaged with local stakeholders for the development of the intervention; and finally, a community implementation approach, where the community assisted with facilitating the intervention after development[69]. However, the use of different models of community engagement did not appear to have a significantly effect on the impact of the interventions[69]. Although the focus of these past reviews was on disadvantaged communities, most included studies were still conducted in high-income countries[68,69], with the present review providing support for the feasibility and value thereof in rural settings in LMICs.

CHWs were involved in various aspects of the implementation of interventions, such as education and health monitoring, in many of the reviewed studies[38,41,44,45,47-49,52,55]. A systematic review investigating health interventions facilitated by CHWs provided support for both the cost-effectiveness and the efficacy of these interventions for various conditions including the mitigation of cardiovascular disease risk[70]. Most studies in the systematic review were conducted in under-resourced settings, although in high-income countries[70], with the present review providing support for the potential value of CHWs in rural parts of LMICs. Regardless of the setting, CHWs may be best suited to assist with the administration of interventions due to their familiarity with local socioeconomic circumstances, and the ability to tailor communication and administration with the necessary linguistic, social, and cultural sensitivity required within their communities[70]. Consideration should also be given to the cultural competence of researchers conducting studies. This was not clearly described in reviewed studies, and should be considered in future research.

It is apparent that community involvement in various forms should be prioritised during the development and implementation of future health interventions. To assist with this, Pardoel et al (2022) developed a framework to guide the adaptation of community-based health interventions based on local cultures and contexts[71]. This included aspects such as beliefs regarding diet and physical activity, meaningfulness such as religious practices, family, and social structures, among others, all of which would need to be considered during the development of a health intervention targeting lifestyle-related and musculoskeletal health conditions[71].

Educational content for interventions

With regards to educational content forming part of interventions, information across various health conditions in reviewed studies included dietary advice, avoiding substance abuse, and performing sufficient levels of physical activity. The importance of these lifestyle interventions are well known[65], and form part of various structured guidelines such as the National Institute for Health and Clinical Excellence guidelines for the management of Type 2 Diabetes[72] and the Dietary Approaches to Stop Hypertension guidelines[73]. Since tobacco and alcohol use, physical activity, and dietary choices are among the main modifiable risk factors across many non-communicable diseases, this should be included as a minimum in future health interventions targeting lifestyle-related health conditions[65]. Health literacy, including awareness of these risk factors, and recognition of signs and symptoms requiring medical care, are also needed[74]. A systematic review has provided moderate evidence to support the association between health literacy and diabetes knowledge, and provided some support for improved lifestyle behaviours[75]. Conversely, the studies were inconclusive or of insufficient quality to demonstrate a positive impact on various health outcomes overall[75]. Studies included in the present review provide support for the value of community-based and digital interventions in promoting health literacy in rural parts of LMICs. Increased knowledge regarding when to seek medical help is also important, since early detection allowing for earlier management may also be key in reducing the severity and complications of diabetes and hypertension[76,77]. The latter conditions were the most commonly targeted by interventions in reviewed studies, which may be due to the high prevalence rates of these conditions in LMICs[78,79]. Health literacy and educational interventions should focus on the most common conditions identified in targeted communities.

Limitations and future directions

Although many of the studies were RCT designs with large numbers of participants, other study designs were insufficient to limit the potential of confounding variables impacting results rather than the intervention implemented[80]. However, commonly utilised quasi-experimental designs are often the most ethical and practical approach to evaluate health outcomes and feasibility in under-resourced rural settings in potentially vulnerable populations where access to sufficient health care may be limited[80]. Most interventions in reviewed studies were also multifactorial, making it difficult or impossible to determine the relative contribution of different components. Quality analyses and meta-analyses were beyond the scope of the current review, since the aim was to broadly describe various factors surrounding interventions in rural settings. To provide evidence-based practice guidelines regarding the efficacy, systematic reviews and meta-analysis of specific health conditions and specific interventions,

restricted to RCT designs, without limitations on the study settings, may be more appropriate. For example, systematic reviews of RCT studies provide support for digital interventions in the management of type 2 diabetes and hypertension in varied populations[57,58].

The review identified only two studies involving musculoskeletal conditions, one of which was a pilot study. Therefore, there was insufficient information available to explore the value and feasibility thereof collectively in rural parts of LMICs. Future research in rural regions where physically demanding occupations are common, such as agricultural regions and small-scale fishing communities, are recommended, since the risk of musculoskeletal conditions in these settings is high[81,82]. Interventions specifically tailored to the occupational and socioeconomic demands of target communities should be considered. Most of the reviewed studies were conducted in certain parts of Asia, therefore the findings may be most applicable to the limited number of countries included . Future research in rural areas in a broader range of LMICs is needed. For example, only one African country was included in the review, significantly limiting the applicability of findings to this region. Future reviews should also aim to compare the impact of interventions implemented in the Global South compared to in the Global North.

Only articles available in either English or Afrikaans were included based on the language proficiency of the reviewers. This may have led to the exclusion of potentially relevant studies, which may limit the generalisability of the findings.

Conclusion

Community-based health interventions with and without digital components may have a positive impact on various health outcomes related to lifestyle-related health conditions and seem to be feasible to implement in rural regions of LMICs based on reviewed studies. The types of interventions utilised, strategies to facilitate uptake and to reduce potential barriers should be considered during the development of future interventions for rural, under-resourced settings. Plans to promote sustainability of developed interventions should also be considered. This may help to increase the likelihood of the value and feasibility in these settings. Community involvement during the development and implementation of interventions is recommended to ensure the appropriateness to local sociocultural and economic settings.

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Conflicts of interest

There are no conflicts of interest to report.

AI disclosure statement

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Appendix I: Evidence source details and characteristics

Authors, year of publication	Study design	Sample size and participant demographics (age and sex)	Geographic region	Socioeconomic circumstances	Musculoskeletal and/or lifestyle-related health conditions	Incidence of musculoskeletal and/or lifestyle-related conditions in participants at baseline	Risk factors in participants at baseline
Mohan et al, 2012[49]	Mixed-methods intervention observational study	*n*=23,380 individuals out of a population of 27,104 adults were screened from 42 villages. The population included *n*=10,326 (44.2%) males and *n*=13,054 females (55.8%). Mean age: 41 years.	Kancheepuram district, India (rural)	Lower middle-income country	Lifestyle health conditions: diabetes and pre-diabetes (type unspecified)	*n*=1138 (4.9%) of participants had diabetes and *n*=3410 (14.6%) had pre-diabetes	None reported.
Pires et al, 2022[53]	Surveys to evaluate the impact of participatory learning and m-health interventions during three-arm RCT	*n*=11,454 participants completed the end-of-study survey. This included participants from 96 villages who were randomly allocated to one of two interventions or control conditions (ie 32 villages per group). The participatory learning and action intervention group were *n*=1027 (45.0%) male, *n*=1255 (55.0%) female; m-health intervention group *n*=1443 (46.3%) male, *n*=1674 (53.7%) female; control group: *n*=295 male (43.1%), and *n*=390 (56.9%) females. Age ranges from 30 to over 60 years in all groups with no sample mean.	Faridpur district, Bangladesh (rural)	Lower middle-income country	Lifestyle health conditions: type 2 diabetes, intermediate hyperglycaemia	*n*=2470 participants with intermediate hyperglycaemia at baseline with the remainer of baseline data unavailable in the report.	Hypertension, overweight/obesity (baseline numbers not provided).
Morrison et al, 2022[50]	Mixed-methods survey and qualitative evaluation of m-health messaging, which formed part of a three-arm RCT (linked to Pires et al, 2022[54])	*n*=9381 participants initially recruited with 8980 retained at the 14-month follow-up. For the first survey, *n*=49 female recipients (45.4%), *n*=59 males recipients (54.6%) and *n*=30 female non-recipients (31.3%), *n*=66 male non-recipients (68.8%) were included. Ages ranged from 18 to over 70 years across groups; mean age for sample not provided. Two focus groups with 7–11 participants each were conducted (additional information not available).	Faridpur, Bangladesh (rural)	Lower middle-income country. 45–65% of participants did not have formal education, 39–60% were involved in manual work and 33–63% were unemployed across groups and surveys.	Lifestyle health conditions: intermediate hyperglycaemia and type 2 diabetes	In baseline survey: intermediate hyperglycaemia reported in 17.2% of males and 23.4% of females; type 2 diabetes reported in 8.9% of males and 11.5% of females. (Insufficient data to calculate numbers.)	Baseline levels not reported.

Morrison et al, 2019[51]	Qualitative evaluation of participatory learning component of a three-arm cluster RCT (linked to Pires et al, 2022[54])	*n*=67 individuals from 15 villages were included in group interviews conducted among individuals with and without diabetes who attended intervention sessions, individuals who did not attend sessions and individuals who facilitated the intervention sessions as well as focus groups with individuals who attended the interventions. This involved *n*=41 males (61.2%) and *n*=26 females (38.8%). Mean age not provided.	Faridpur, Bangladesh (rural)	Lower middle-income country	Lifestyle health condition: type 2 diabetes	Not reported.	Overweight, lack of physical activity, tobacco use and unhealthy diet, hypertension (baseline numbers not available).
Jahan et al, 2020[45]	Single-centre prospective RCT	*n*=420 participants with hypertension. This involved *n*=361 females (86.0%) and *n*=59 males (14.0%). Mean age: 47.1 years (range: 35–71 years)	Bangladesh (rural)	Lower middle-income country; participants in intervention group reported to range from low income (22.0%), lower middle-income (25,4%), middle-income (27.8%), upper middle-income (21.1%) and high-income (3.8%); participants in control group reported to range from low income (28.0%), lower middle-income (25.1%), middle-income (21.8%), upper middle-income (21.3%) and high-income (3.8%).	Lifestyle health condition: hypertension	*n*=420 (all participants) diagnosed with hypertension.	Group 1: Smoking reported in *n*=117 (27.8%) participants, Group 2: smoking reported in *n*=141 (33.7%) participants.
Chen et al, 2014[40]	Quasi-experimental pilot pre-test–post-test intervention study (in preparation for RCT)	*n*=17 local doctors utilised the software on 2219 patients at risk of diabetes with the intervention tested in participants identified as having diabetes or pre-diabetes. The total population included *n*=1412 (63.6%) females and *n*=807 (36.4%) males. *n*=20 of these participants were selected for qualitative interviews. Mean age of sample not provided; age range 50–70 years across groups.	China (rural)	Upper middle-income country	Lifestyle conditions: type 2 diabetes and pre-diabetes	*n*=1022 (54.2%) of participants had pre-diabetes and *n*=103 (5.5%) of participants had diabetes.	Diet, physical activity, and body weight (baseline measurements not reported).

Jafar et al, 2020[44]	Cluster RCT	*n*=2645 participants with hypertension included out of 11510 individuals screened. The intervention group (*n*=1330) consisted of *n*=877 (65.9%) females and *n*=453 (34.1%) males, mean age: 58.5 years. The control group (*n*=1315) consisted of *n*=824 (62.7%) females and *n*=491 (37.3%) males; mean age: 59 years.	Tangail and Munshiganj in Bangladesh, Thatta in Pakistan, and Puttalam in Sri Lanka (rural)	Lower middle-income country. Over half of participants in each group had some formal education, level unspecified with *n*=834 (62.7%) in the intervention group and *n*=725 (55.1%) in the control group.	Lifestyle health condition: hypertension	In the intervention group *n*=814 (61.2%) participants were overweight/obese; *n*=177 (13.3%) reported past heart disease, *n*=165 (12.4%) reported past stroke. In the control group *n*=683 (51.9%) were overweight/obese, *n*=167 (12.7%) reported past heart disease, and 159 (12.1%) reported past stroke.	Intervention group: *n*=138 (10.4%) reported current smoking. Control group 10.0% (*n*=132) reported current smoking.
Yan et al, 2021[56]	Cluster RCT	*n*=1299 patients with cerebrovascular accidents with *n*=637 in the intervention and *n*=662 in the control group. This included *n*=553 females (42.6%) and *n*=766 males (58.4%). Mean age: 65.7 years. *n*=60 local doctors were also provided with training as part of the study.	Heibei province, China (rural)	Upper middle-income country, *n*=925 (71.2%) of participants had a primary school or lower level of education.	Lifestyle health condition: cerebrovascular accident	In the intervention group *n*=555 (87.1%) ischaemic strokes, *n*=80 (12.6%) haemorrhagic strokes and *n*=2 (0.4%) unspecified strokes reported. Co-morbidities: *n*=461 (72.4%) hypertension, *n*=248 (38.9%) dyslipidaemia and *n*=113 (17.7%) diabetes reported. In the control group *n*=564 (85.2%) ischaemic strokes, *n*=96 (14.5%) haemorrhagic strokes and *n*=2 (0.4%) unspecified strokes reported. Co-morbidities: *n*=436 (65.9%) hypertension, *n*=271 (40.9%) dyslipidaemia and *n*=216 (15.6%) diabetes reported.	Intervention group: *n*=99 (15.5%) reported current smoking. Control group: *n*=122 (18.4%) reported current smoking.
Mangal et al, 2022[48]	Prospective observational cohort study	*n*=3853 individuals screened. This included *n*=1239 (51.0%) males and *n*=1191 (49.0%) females. Age ranged from 18 to over 60 years with no mean age for total sample provided.	Jaipur District, Rajasthan, India (rural)	Lower middle-income country	Lifestyle health condition: type 2 diabetes and pre-diabetes	*n*=29 patients (1.2%) with diabetes and *n*=69 patients (2.8%) with pre-diabetes were identified.	None reported.
Kobashi et al, 2024[46]	Parallel intervention study with communities randomly allocated to intervention or control groups.	*n*=600 participants with intervention group 1 (*n*=200): *n*=93 (46.5%) females, *n*=107 (53.5%) males with mean age 48.5 years; intervention group 2 (*n*=200) *n*=97 (48.5%) females, *n*=103 (51.5%) males with mean age 45.0 years; and control group: *n*=90 (45.0%) females, *n*=110 (55.0%) males with mean age 45.0 years.	Narail district, Bangladesh (rural)	Lower middle-income country, with the majority (91.0–95.5%) of participants from all groups earning below US$400 (A$566).	Lifestyle health condition: type 2 diabetes, hypertension	Intervention group 1: *n*=56 (32.5%) participants were overweight/obese, *n*=76 (38.0%) participants had hypertension, *n*=33 (16.5%) participants had diabetes. Intervention group 2: *n*=75 (37.5%) participants were overweight/obese, *n*=74 (37.0%) participants had hypertension, *n*=28 of participants had diabetes (14.0%). Control group: *n*=69 (40.5%) of participants overweight/obese, *n*=81 (40.5%) of participants had hypertension and *n*=26 (13.0%) of participants had diabetes.	No additional risk factors reported.

Nguyen et al, 2012[52]	Quasi-experimental intervention control study	*n*=4650 individuals from a general population recruited with *n*=2352 in intervention and *n*=2298 in control group. Male and female numbers not reported. Mean age: 48.1 years for females and 51.4 years for males.	Vietnam (rural)	Lower middle-income country. At baseline, most participants had secondary or higher level of education with *n*=1842 (78.3%) in intervention and *n*=1567 (68.2%) in control group.	Lifestyle health condition: cardiovascular disease	Intervention group: 6.8% obesity in females, 7.6% in males, hypertension in 30.6% of females and 46.7% of males. Control group: 5.4% obesity in females and 5.2% in males, hypertension in 29.1% of females and 34.0% of males. (Insufficient data to calculate exact numbers.)	Intervention group: daily smoking in 0.7% of females and 47.8% of males, heavy alcohol consumption in 0.2% females and 37.9% males, physical inactivity in 6.8% of females and 10.1% of males, high-salt diet in 25.5% of females and 44.0% of males. Control group daily smoking in 0.2% of females and 47.9% of males, heavy alcohol consumption in 0.2% of females and 34.4% of males, physical inactivity in 8.8% of females and 9.0% of males and a high-salt diet in 19.9% of females and 32.1% of males.
Harshitha et al, 2022[42]	Quasi-experimental pre-test–post-test intervention comparison study	*n*=35 participants in rural areas (compared to 39 participants in urban areas). In the total sample, *n*=26 females (35.1%) and *n*=48 males (64.9%). Mean age and rural group specific could not be calculated.	South India (rural)	Lower middle-income country	Lifestyle health condition: type 2 diabetes	*n*=35 (100.0%) with diabetes	None reported.
Balagopal et al, 2012[38]	Mixed-methods community-based participatory research and quasi-experimental pre-test–post-test intervention study	*n*=1638 individuals of which *n*=404 males (46.0%) and *n*=47 females (53.0%), mean age 43.4 years in high socioeconomic status group *n*=362 males (47%) and *n*=402 females (*n*=53%), mean age 40.2 years in low socioeconomic status group.	Gujurat region, India (rural)	Lower middle-income country. Agricultural workers and business community (varied socioeconomic status within community) in included sample. 68.8% of participants in high socioeconomic group had up to a high school level of education and 50.5% of the low socioeconomic group were illiterate.	Lifestyle conditions: diabetes (7.2% of participants)	Diabetes (7.2%), pre-diabetes (19.3%), obesity (16.7%), and hypertension (28%)	Overall, 63.5% reported inadequate physical activity, 44.2% reported tobacco use, 98% did not meet fruit intake and 35% did not meet vegetable intake.
Macedo et al, 2021[47]	Quasi-experimental pre-test–post-test intervention study	*n*=638 participants. This included *n*=430 (67.4%) females and *n*=208 males (32.6%). Mean age not available, all with uncontrolled diabetes and/or hypertension.	Northeast Brazil (rural)	Higher middle-income country. 36.3% were illiterate and the remainder literate (level of education not specified).	Lifestyle conditions: diabetes and hypertension	*n*=372 (58.3%) participants had hypertension only, *n*=32 (5.0%) had diabetes only and *n*=234 (36.7%) had both diabetes and hypertension.	None reported.
Calano et al, 2019[39]	Quasi-experimental one-group pretest–post-test study	*n*=50 participants with hypertension, of which *n*=30 females (60%), *n*=20 males (40%) with mean age 48.9 years.	Bulacan, Philippines (rural)	Lower middle-income country. 40% of participants were unemployed, 38% were employed and 22% were self-employed; 62.0% had secondary level education.	Lifestyle health condition: hypertension	*n*=50 with hypertension (100) and *n*=9 (18.0%) had dyslipidaemia.	18% reported smoking, 4% were obese, and 6% were physically inactive.

Gamage et al, 2020[41]	Cluster RCT	*n*=1736 participants. Intervention group (*n*=637): *n*=373 (58.7%) females and *n*=264 (39.2%) males. Mean age: 56.6 years. Control group (*n*=1097): *n*=633 (57.9%) females, *n*=464 (42.3%) males. Mean age: 56.9 years. (Discrepancy in numbers in total and subgroups in report noted.)	Trivandrum region, Rishi Valley region and Western Godavari region, South India (rural)	Lower middle-income country	Lifestyle condition: hypertension	Intervention group: *n*=436 (39.5%) participants with coronary heart diseases, *n*=114 (10.4%) participants with stroke, *n*=147 (13.4%) participants with diabetes. Control group: *n*=316 (31.9%) participants with coronary heart disease, *n*=98 (9.9%) participants with stroke, *n*=97 (9.8%) participants with diabetes.	Intervention group: *n*=96 (15.3%) reported smoking, *n*=68 (10.8%) current alcohol use. Control group: *n*=165 (15.1%) reported smoking, *n*=145 (13.3%) reported current alcohol use.
Tian et al, 2015[55]	Cluster RCT	*n*=2086 high-risk cardiovascular individuals from 27 villages included, *n*=716 females (65.4%), *n*=379 males (34.6%), mean age 59.7 years in the intervention group; and *n*=662 females (66.8%), *n*=329 (33.2%), mean age 60.4 years in the control group.	Tibet, China and Haryana State, India (rural)	Lower- and middle-income countries. Intervention group: 59.3% illiterate. Control group: 61.9%	Lifestyle condition: cardiovascular disease	Total sample: *n*=826 (75.3%) participants with hypertension, *n*=333 (39.5%) participants with coronary heart disease, *n*=114 (10.4%) participants with stroke, *n*=147 (13.4%)	*n*=402 (36.7%) of participants reported current smoking.
Rana et al, 2010[54]	Quasi-experimental pre-test–post-test intervention-control study	*n*=839 participants with *n*=445 in intervention and *n*=414 in control group. Intervention group: *n*=182 females (42.8%), *n*=243 males (57.2%), mean age 70.6 years. Control group: *n*=192 females (46.4%), *n*=222 males (53.6%), mean age 71.3 years.	Chandpur, Bangladesh (rural)	Lower middle-income country. *n*=188 (44.2%) participants classified as low socioeconomic level in the intervention group and *n*=130 (31.4%) participants in the control group.	Musculoskeletal condition: arthritis-related illness	Intervention group: *n*=328 (77.1%) participants with arthritis-related illness. Control group: *n*=350 (84.5%) participants with arthritis-related illness in control group	None reported.
Ibrahim et al, 2018[43]	Single-blind pilot three-group RCT	*n*=30 with 10 per group; group 1: *n*=3 females (30.0%), *n*=7 males (70.0%), mean age 48.5 years; group 2: *n*=1 female (10.0%), 9 males (90.0%), mean age 50.3 years; group 3: *n*=2 females (20.0%), *n*=8 males (80.0%), mean age 49.9 years.	Tsakuwu, Northwestern Nigeria	Lower middle-income country; group 1: *n*=6 (60%) did not complete any education and *n*=9 (90%) were self-employed in farming/trading; group 2: *n*=7 (70%) did not complete any education and *n*=8 (80%) were self-employed in farming/trading; and group 3: *n*=7 (70%) did not complete any education and 80% were self-employed in the farming/trading industry.	Musculoskeletal condition: lower back pain	*n*=30 (100.0%) of participants with chronic lower back pain.	None reported.

RCT, randomised controlled trial.

Appendix II: Community-based and digital health interventions for musculoskeletal and lifestyle-related health conditions

Authors, year of publication	Digital or community-based intervention	Type and description of digital or community-based health intervention	Duration	Impact of health intervention for the individual and broader society
Mohan et al, 2012[49]	Community-based educational intervention	Screening and awareness programs followed by educational prevention strategies. A mobile unit was utilised for screening by community health workers. Community health workers received training prior to the intervention. The awareness program included family and self-help groups, peer support groups, arts, and one-on-one sessions. Topics included diet, avoiding tobacco, weight reduction, physical activity and lifestyle modification where indicated. A diabetes centre was set up to provide follow-up care for participants with diabetes. Participants in need of treatment were referred to appropriate treatment with transport provided to an hospital where indicated.	48 months intervention period	Local individuals were recruited and trained to assist with screening, which provided employment to locals. Individuals in the community were trained to grow vegetables. The researchers felt that the program raised awareness among the local community. A reduction in healthcare costs due to the new facilities created were mentioned by researchers. No formal assessment of the impact on individuals or the community are included in the report.
Pires et al, 2022[53]	Digital and community-based educational intervention	Participatory learning and action intervention involving 18-monthly group meeting on prevention and management of diabetes (group 1), an m-health intervention involving voice messages aimed at educating regarding lifestyle modifications for prevention and management through mobiles or control conditions. Locally trained individuals were utilised as facilitators for the programs.	24-month follow-up	A statistically significant reduction in the prevalence of type 2 diabetes and improvements in intermediate hyperglycaemia was observed in the participatory learning and action group. A non-statistically significant reduction in the prevalence of type 2 diabetes was reported in the m-health group except among older and higher income strata. Improvements in glycaemic outcomes in the m-health group only for the youngest strata. No impact on hypertension, quality of life, body weight/obesity, physical activity or diet reported. Reduced diabetes health burden in communities. The researchers also felt that all sectors of society benefited from the intervention despite different levels of engagement with interventions among different groups, possibly due to indirect engagement such as through other members of the community.
Morrison et al, 2022[50]	Digital and community-based educational intervention	m-health messaging and community groups performing participatory learning and action compared to control groups were performed. The mobile messages included dramatic representations, narrative fictional experiences, information given by a doctor, information by a general announcer and song formats. The content included diabetes-related information, lifestyle advice for management including diet, tobacco use, physical activity, and stress management. A research coordinator visited the areas to discuss reception of messages, and field notes were collected during the intervention period.	14-month intervention and follow-up	Just over half of participants reported behaviour changes related to the mobile messages received. Just over half of participants indicated that they shared the messages with family members or friends.
Morrison et al, 2019[51]	Digital and community-based educational intervention	Participatory learning and action intervention involving 18 monthly group meeting on prevention and management of diabetes	24-month follow-up	Promotion of health literacy such as knowledge of diabetes, risk factors and lifestyle modifications self-confidence were noted. Participants also noted feeling more positive and in 'control of their health'. Some participants also mentioned saving money due to needing to receive less medical care than previously and growing their own vegetables. Participants reported a change in societal expectations, which allowed them to perform activities they would previously have felt were against societal expectations. Healthier dietary choices were seen as more acceptable. More households reportedly started their own vegetable gardens and shops reportedly stocked healthier options.
Jahan et al, 2020[45]	Digital and community-based educational intervention	In-person health education at households and booklet along with weekly text messages focusing on lifestyle and exercise (intervention group) compared to in-person health education without the text messages (control group). The education was performed by community health workers.	5 months of intervention, 12 months of follow-up	Adherence to healthy lifestyle behaviours related to salt intake and physical activity was statistically significantly better in the control group compared to the intervention group. Significant improvements over time were reported in both groups in terms of salt intake, fruit intake, and physical activity. Systolic and diastolic blood pressure, body weight measurements, and urinary salinity measurements improved over time in both groups. Quality of life improved significantly over time in both groups.

Chen et al, 2014[40]	Digital educational intervention	Education through a newly developed web-based aid including diabetes-related information, lifestyle advice for prevention, identifying possible barriers to lifestyle changes and providing support to overcome barriers. The tool developed was used by local doctors in the management of patients.	1–6 months of the intervention	Significant increase in preventative procedures (such as assessing blood pressure, diet, and physical activity), diabetes knowledge and self-efficacy with regards to diet and exercise behaviours, improved body weight and BMI measurements were reported in pre-diabetic patients following use of intervention. A satisfaction rate of 88.0% was reported among patients using the intervention.
Jafar et al, 2020[44]	Community-based intervention	Home visits by community healthcare workers for blood pressure monitoring and health education provided every 3 months. Training of community healthcare workers and local doctors regarding blood pressure monitoring and management of hypertension and care coordination at government clinics including triaging upon arrival (intervention group). This was compared to usual care based on existing services in communities (control group).	24-month follow-up	A statistically significantly better reduction in systolic blood pressure in intervention compared to control group with both groups demonstrating improvements from baseline to the 24-month follow-up. Better quality on the EQ-5D-5L health questionnaire reported in intervention compared to control group. Better adherence to statins reported in intervention compared to control group. There were statistically significantly fewer deaths related to cardiovascular events in the intervention compared to the control group. Researchers noted that training of health professional may have improved competencies.
Yan et al, 2021[56]	Digital and community-based intervention	Participants received monthly doctors' visits and mobile based daily voice messages. Local doctors received a one-day educational workshop by physicians regarding cerebrovascular accident management and use of a mobile app to assist with management.	12-month follow-up	Significant improvement in systolic and diastolic blood pressure, health-related quality of life, performance in timed up and go test, physical activity and medication adherence reported in intervention compared to control group. Reductions in re-occurrence of cerebrovascular accidents and hospitalisations and death were also reported in the intervention group. Reduced costs associated with hospitalisations. Reduced cost of care estimated to be US$24 (A$34) per patient in the intervention group.
Mangal et al, 2022[48]	Digital and community-based intervention	E-health app developed for Android with screening questionnaire and educational videos including dietary and physical activity advice specific to risk factors or diagnosis with high blood pressure, diabetes or high BMI identified in participants. This was used by community-based health workers in communities alongside measurements performed for screening blood glucose. Specialists were arranged once a month to local communities to provide treatment and education to patients individually.	12 months	43.5% of pre-diabetic patients had normal blood glucose levels at the 8-month follow-up, presenting a statistically significant reduction. No change in incidence of diabetes detected.
Kobashi et al, 2024[46]	Digital and community-based intervention	Intervention group 1 received education through wall posters at home, phone calls, personalised advice booklets, seminar videos and in-person seminars, whereas intervention group 2 received a home poster only. The information covered information regarding the conditions as well as lifestyle advice for management and prevention delivered by non-healthcare staff who were provided with training to perform basic measurements as provide educational material to households. The control group 3 underwent screening but did not receive any educational material.	5 months	Reductions in systolic blood pressure were observed in both intervention groups, with a significantly reduction in intervention group 1 and a non-significant reduction in intervention group 2 compared to the control group. Reductions in prevalence of hypertension in all three groups, with no statistically significant differences between groups. No significant changes in blood glucose levels were reported between groups. The incidence of diabetes decreased in each group. Improvements in healthy lifestyle behaviours in intervention group 1, but not in intervention group 2. Obesity prevalence decreased in both interventions groups and increased slightly in the control group.
Nguyen et al, 2012[52]	Community-based intervention	The intervention group received education through a media campaign through broadcasting, leaflet, and meetings with risk factor and lifestyle advice (such as smoking and diet) targeted at healthy individuals, whereas individual with hypertension received monthly blood pressure check-ups along with individualised advice. This was provided by community health workers. The control group received only standard care as previously.	36 months follow-up	Significant decrease in systolic and diastolic blood pressure measurements in the intervention group as well as a significant reduction in salt intake. No impact on smoking, alcohol abuse or physical activity reported.
Harshitha et al, 2022[42]	Community-based intervention	Educational material using charts and pamphlets were provided in a rural community. This was compared to a digital intervention in an urban area (data extrapolated based on rural findings).		A statistically significant increase in knowledge regarding diabetes reported in the rural region.
Balagopal et al, 2012[38]	Community-based intervention	Lifestyle education provided by community healthcare workers through 10 in-person individual and group sessions. This included advice regarding diet and physical activity with specific advice provided as applicable in the case of diagnosed conditions including risk factor education and weight-loss advice where applicable. This was supplemented by educational handouts and demonstrations of cooking (including how to make healthier alternatives taste better).	6-month follow-up	A significant reduction in fasting blood glucose levels, and significant reductions in systolic and diastolic blood pressure, were reported in the overall population following the intervention. Improved knowledge of diabetes and cardiovascular diseases and a reduction in abdominal obesity was reported following the intervention compared to baseline levels.

Macedo et al, 2021[47]	Community-based intervention	Home visits by community healthcare workers, health worker training to improve management of hypertension and diabetes, point-of-care glycated haemoglobin (HbA1c), and blood pressure monitoring (instead of sending to laboratories) at community events such as health fairs, and health education to patients and their families.	6 months of intervention	Systolic and diastolic blood pressure reduced significantly following intervention. There was a non-significant reduction in HbA1c levels of diabetic patients. The researchers also reported overall lower medical cost despite the use of more expensive device to allow point-of-care measurements.
Calano et al, 2019[39]	Community-based intervention	The community-based health program included blood pressure monitoring, targeted health education in small groups along with printouts, motivational interviews with individualised lifestyle modification plans and home visits. This was performed by nursing students and community nurses.	2 months of intervention	Significant improvement in disease knowledge, systolic and diastolic blood pressure measurements and medication adherence was reported post-intervention.
Gamage et al, 2020[41]	Community-based intervention	2 weekly group-based education sessions delivered six times by community healthcare workers, who also received additional training prior to implementation. This included blood pressure and body mass monitoring, lifestyle advice, medication adherence, and hypertension disease education. Handouts were also provided. The educational material was developed with community engagement. The control group received usual care only.	3 months intervention with up to 2 months of follow-up	Significant improvements in blood pressure measurements, as well as significant reductions in salt intake, smoking, and alcohol use were reported in the intervention compared to control groups. No impact on body mass, weight-to-hip ratios, physical activity, or fruit consumption was reported.
Tian et al, 2015[55]	Digital and community-based intervention	A mobile app was used by community health workers monthly to provide lifestyle advice along with blood pressure measurements at homes and local clinics. Prior to the intervention, training was provided to the community healthcare workers. The interventions were adapted for applicability to local cultures; for example, education to address concerns regarding Western medication use was included. In the control group, only usual care was provided.	12 months of follow-up	Significant improvements in systolic blood pressure measurements, aspirin use, and antihypertension medication use pre- and post-intervention compared to control were reported.
Rana et al, 2010[54]	Community-based and digital intervention	Health education including advice regarding physical activity, diet, and general advice provided small-group sessions, home visits, and self-help group meetings. Additional information was provided through pamphlets, videos, and theatre productions. This group was further divided into a compliant and non-compliant group for comparison.	15 months of intervention and 18-months follow-up	A significantly higher proportion of participants in the group compliant to the intervention reported positive effects on arthritis-related illness and improvement in self-rated health.
Ibrahim et al, 2018[43]	Community-based intervention	Participants were randomly allocated to one of three groups with group 1 receiving motor control exercises, group 2 receiving education and group 3 receiving education and motor control exercises. The education sessions provided by a physiotherapist in groups with three to five participants. The motor control exercise program focused on lumbopelvic muscle strengthening and was also provided by a physiotherapist within the community. This was accompanied by stretching and advice on low-impact aerobic exercise was provided. This included supervised sessions and home exercise programs.	6-week intervention	Treatment compliance was 66% in the exercise group, 80% in the education group and 75% in the combined group. Perceived helpfulness ranged from 3.5 to 3.8 out of 5 across groups and satisfaction with treatment perceptions ranging from 3.7 to 3.8 across groups. No adverse effects were reported. Statistically significant improvements in pain and function were reported in all groups. The exercise and education combined group had a statistically significant greater improvement in pain compared to the education group only and in functional disability compared to the exercise group only.

Appendix III: Barriers and facilitators to community-based and digital health interventions

Authors, year of publication	Barriers to implementation of health intervention	Facilitators to implementation of health intervention
Mohan et al, 2012[49]	None reported	Funding was provided and property was donated to enable screening and other facilities to assist the local communities. The process involved community engagement, which may have assisted with community integration.
Pires et al, 2022[53]	None reported	Community engagement was utilised to assist with the development of context-specific strategies such as opportunities to exercise and access to healthy food. Community advisory groups were created and patient input was obtained during development.
Morrison et al, 2022[50]	Barriers to the m-health component included not wanting to share mobile numbers or changing mobile numbers after signing up. Additionally, those who received the messages said they stopped listening before it was complete due to lack of interest, being too busy, or not recognising the voice. Message fatigue was also reported as a barrier to receiving or listening to messages. This included that participants assumed messages were advertising, related to social networking or unsolicited, or due to fears of the messages being fraud/scams. Technological faults were reported by the researcher, which affected the ability to successfully deliver m-health messages to participants. Environmental and social barriers such as gender norms, stigma surrounding the disease and buying healthy food were also reported. Some participants mentioned that the use of dramatic arts was confusing and not as helpful in conveying messages.	Participants with type 2 diabetes or family members with the condition indicated that the information was relevant. 71–74% of participants reported a preference for information provided by a doctor, which was confirmed during the qualitative component of data analysis.
Morrison et al, 2019[51]	Cultural and societal norms and stigmas particularly regarding gender-based expectations presented possible barriers to accessing facilities (eg women are expected to travel with a companion). This increased reluctance to adhere to healthier lifestyle choices such as diet and physical activity. Lack of funding also raised as barrier to seeking health care.	The use of group discussions, participation and repetition of information was described as useful for the transfer of knowledge. Social support and positive reinforcement were also mentioned as major themes underscoring the value of the intervention. This included the perception that behaviours were more likely to change due to community awareness and motivation from peers.
Jahan et al, 2020[45]	Researchers indicated that SMS messages may have been too short and too generalised for some participants. No formal assessment of this is described, however, the addition of SMS messages did not result in better outcomes.	None reported
Chen et al, 2014[40]	Internet supply disruptions and electricity supply interruptions were barriers to the intervention. Some patients reported not finding the web-based application helpful. Concerns were raised regarding over-standardisation (may not suit all individuals) by doctors. Some patients raised concerns regarding lack of personalisation with use of the intervention.	The intervention was described as easy to use, standardised, and valuable by doctors.
Balagopal et al, 2012[38]	None reported	Researchers reported that community engagement during the planning phases assisted with the value and continued involvement of the community during the intervention; for example, specific recipes presented were discussed among the community for acceptability. The community engagement and interaction during the sessions were also described as a facilitator for the intervention. Demonstrations of yoga were also mentioned by researchers as helpful to promote the uptake of exercise. No formal assessment methods for these factors were described.
Calano et al, 2012[39]	None reported	The intervention was developed using the PRECEED–PROCEED model, which involves evaluating community specific needs. No specific assessment was conducted to determine if this contributed to the value of the program.
Gamage et al, 2020[41]	None reported	The researchers indicated that the addition of blood pressure monitoring may have assisted with the success of the program, although the relative contribution of each component was not formally assessed. Using a group-based approach was also reported as a potential cost-saving method by researchers.

Tian et al, 2015[55]	None reported	The researchers reported that the study utilised the '2' approach (two lifestyle factors plus two medications), which means less resources were required than for other related multi-intervention studies. The researchers also indicated that the use of the m-health app and community healthcare workers may have assisted with the positive outcomes, although the study did not differentiate between the impact of different components.

Supplementary material is available on the live site https://www.rrh.org.au/journal/article/10304/#supplementary