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Citation:

Punna, M and Kettunen, T and Bagnall, A and Kasila, K (2019) Implementation and Outcomes of Lay Health Worker-led Self-management Interventions for Long-Term Conditions and Prevention: A Systematic Review. Health Education & Behavior. ISSN 1090-1981 DOI: <https://doi.org/10.1177/1090198119863842>

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Document Version:

Article (Accepted Version)

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Health Education & Behavior

Implementation and Outcomes of Lay Health Worker-led Self-management Interventions for Long-Term Conditions and Prevention: A Systematic Review

Journal:	<i>Health Education & Behavior</i>
Manuscript ID	HEB-17-0575.R1
Manuscript Type:	Review
Research Methods:	
Topics:	Lay Health Workers < GENERAL TERMS, Long-term Conditions, Self-management, Behavior Change Technique, Intervention Components
Abstract:	<p>The aim of this study was to systematically review lay health worker (LHW) -led self-management interventions for adults with long-term conditions (LTCs) to see how the interventions have been implemented and to compose a synthesis of their findings taking into consideration the intervention components that have been applied.</p> <p>We conducted systematic searches for articles published between January 2010 and December 2015 in five databases: Cochrane, MEDLINE, CINAHL, PsycINFO and Web of Science. Forty original studies were found that met the inclusion criteria that were self-management with diabetes (n=29), cardiovascular diseases (n=8), and those at risk of cardiovascular diseases (n=3), consisting of 22 randomized controlled trials and 18 other trials, with durations of one day to 24 months. The findings showed that the training of LHWs and the implementation of interventions varied widely. A synthesis of the implementation methods covers the background of the LHWs and the interventions as well as the components applied in each. Eight interventions had effects on physical activity and eight on nutrition behavior. The review also includes preliminary findings on intervention components effective in improving physical activity and nutrition behavior, including self-monitoring as a behavior change technique and group meetings as an intervention format. The same components and behavior change techniques were applied in effective and non-effective interventions.</p> <p>The review found that LHW-led interventions have potential in promoting self-management in LTC. In the future, a qualified and evidence-based structure for LHW-led interventions is suggested in order to improve the systematization of interventions and their effects.</p> <p>Keywords: lay health worker, long-term condition, self-management, intervention component, behavior change technique, systematic review</p>

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22 **Implementation and Outcomes of Lay Health Worker–Led Self-Management**
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3 March 2019: revised version

A manuscript for Health Education & Behavior

Abstract

The aim of this study was to systematically review lay health worker (LHW)-led self-management interventions for adults with long-term conditions (LTCs) to see how the interventions have been implemented and to compose a synthesis of research findings, taking into consideration the intervention components that have been applied.

We conducted systematic searches for articles published between January 2010 and December 2015 in five databases: Cochrane, MEDLINE, CINAHL, PsycINFO and Web of Science. Forty original studies were found that met the inclusion criteria: self-management with diabetes ($n = 29$), cardiovascular diseases ($n = 8$), and those at risk of cardiovascular diseases ($n = 3$). These consisted of 22 randomized controlled trials and 18 other trials, with durations of one day to 24 months. The findings showed that the training of LHWs and the implementation of interventions varied widely. A synthesis of the implementation methods covers the background of the LHWs and the interventions as well as the components applied in each. Eight interventions had effects on physical activity and eight on nutrition behavior. The review also includes preliminary findings on intervention components effective in improving physical activity and nutrition behavior, including self-monitoring as a behavior change technique and group meetings as an intervention format. The same components and behavior change techniques were applied in effective and non-effective interventions.

The review found that LHW-led interventions have potential in promoting self-management in LTC. In the future, a qualified and evidence-based structure for LHW-led interventions is suggested in order to improve the systematization of interventions and their effects.

Keywords: lay health worker, long-term condition, self-management, intervention component, behavior change technique, systematic review

Introduction

Non-communicable diseases (NCD) are long-term conditions (LTC) that require ongoing self-management over a period of years as individuals learn to manage their health challenges (Eaton, Roberts, & Turner, 2015; Taylor et al., 2014; Nolte & McKee, 2008). The self-management of LTCs has been defined as a daily and flexible process where an individual, as a responsible actor, is able to perform individual goal-driven activities (Lorig & Holman, 2003; Ausili, Masotto, Dall’Ora, Salvini, & Di Mauro, 2014), such as adopting information, drug and symptom management, and adjustment to psychological consequences such as emotions and stress (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002).

Acquiring and applying individual skills related to self-management components demands effort from patients, peers, and health professionals (Kaptein, Fischer, & Scharloo, 2014; Kawi, 2012). People’s beliefs that they can cope in their everyday activities and meet the challenges of self-management have been labelled as self-efficacy (Bandura, 1977; Vervekina, Shi, Fuentes-Caceres & Scanlon, 2014). Self-management interventions provide support to modify one’s decisions and behavior for a healthier lifestyle. Interventions usually include a variety of observable and replicable behavior change techniques (BCT), such as goal setting, action planning, and self-monitoring (Michie et al., 2013; Duff et al., 2017).

The self-management of LTC has been supported by peers (Tang, Funnell, Gillard, Nwankwo, & Heisler, 2011; Dale, Williams, & Bowyer 2012; CADTH, 2013), who are usually people with the same diagnosis or health condition as the people they assist (Lorig & Holman, 2003; Carr et al., 2011; van Ginneken et al., 2013). Lay health workers (LHW) as LTC self-management supporters are especially able to share values, socioeconomic status or cultural background and, in some cases, also the experience of LTC (South, Meah, Bagnall & Jones, 2013; Hunt, Grant, & Appel, 2011; Islam et al., 2015).

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3 LHWs act as peer supporters, educators, role models, and community capacity builders
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5 (South et al., 2013). LHWs have been shown to improve equity in health care services by
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7 reaching underserved people with a poorer health status (Walker & Jan, 2005; Shah & Patel,
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9 2013). There has been a wide variety of LHW training in terms of duration and methods
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11 (O'Brien, Squires, Bixby, & Larson, 2009; South et al., 2013).
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15 The effectiveness of LTC self-management interventions has been measured through
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17 individuals' knowledge, psychological state, behavior, and clinical outcomes (Dube, Van de
18
19 Broucke, Housiaux, Dhoore, & Rendall-Mkosi, 2015). Lay-led self-management programs
20
21 for those with chronic conditions may improve short-term self-management outcomes, such
22
23 as physical activity (PA) and self-efficacy (Foster, Taylor, Eldridge, Ramsay, & Griffiths,
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25 2009). Previous systematic reviews of LHW interventions for diabetes found that (a) LHWs'
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27 roles in individuals' self-management counseling were diverse in their ways to support,
28
29 educate, advocate, and facilitate, and (b) interventions were partially effective in improving
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31 HbA1C levels and health behavior outcomes (Hunt et al., 2011; Little, Wang, Castro,
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33 Jimenez, & Rosal, 2014). Carr et al. (2011) investigated connections between the
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35 implementation of interventions and their outcomes, but found no firm relationships between
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37 them.
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44 However, in this study we systematically reviewed previous LHW-led self-management
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46 interventions for adults with LTCs in terms of the implementation of interventions. The first
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48 objective was to investigate those characteristics of LHWs and their training that have been
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50 reported within the context of self-management. The second objective was to investigate the
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52 implementation of interventions. The third objective was to investigate what kind of
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54 relationships, if any, there are between intervention components and nutrition behavior (NB)
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56 and PA outcomes.
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Methods

Search strategies and selection criteria

The present review was conducted according to standard systematic review methodology (CRD, 2009) and reported according to the PRISMA Statement (Liberati et al., 2009). A systematic search for articles, reported full text in English (due to limited facilities and resources for translation) and published between 2010 and 2015, was undertaken in five databases between December 2015 and January 2016: Cochrane, MEDLINE, CINAHL, PsycINFO, and Web of Science. Search terms included Community Health Worker* OR Lay health* OR Lay supporter* OR Lay tutor* OR Advisor* OR counsellor* OR counselor* OR peer OR peer counsellor* OR peer counselor* OR peer-advisor* OR peer-coach* OR peer-counsellor* OR peer-counselor* OR peer-educator* OR peer-led* OR health trainer* AND Self-Management OR Self care. Both MeSH and free-text terms were used. The full search strategy is available from the authors on request.

One of the authors extracted the following data independently and discussed it with the other researchers who were involved with study selection. Disagreements between reviewers were resolved by consensus. The following inclusion criteria were applied: adults as recipients; non-communicable and somatic diseases or their prevention; LHW-led self-management intervention; organized by primary health care, community health center or corresponding organization; RCTs and quantitative trials. The exclusion criteria were the following: studies that reported outcomes of LHWs' own self-management; intervention was led by non-trained peer supporter; family interventions; cancer, HIV, asthma or mental health self-management interventions; review papers; study protocols; and papers presenting baseline results only (Figure 1).

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3 All of the included studies deal with self-management of diabetes and cardiovascular
4 diseases. Both diseases, as long-term somatic and non-communicable conditions, can largely
5 be prevented or treated by allied self-management activities covering certain daily behavioral
6 and psychological actions taken by individuals. NB and PA are key self-management
7 activities when dealing with type 2 diabetes and cardiovascular diseases on a daily basis
8 (WHO, 2013; Donaldson & Rutter, 2017). In addition, there is a vital need for research with a
9 scope that combines self-management and prevention in both diabetes and cardiovascular
10 diseases. The quality of the included studies was assessed using the 14-item checklist from
11 the Manual for Quality Scoring of Quantitative Studies with a range of 0–28 points (MQSQ;
12 Kmet, Lee, & Cook, 2004). The quality evaluation was conducted by the first author, and the
13 decisions have also been discussed with two other authors.
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32 *Analysis*

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35 The analysis of the first and second objectives concerned the contents of LHWs, their training
36 and LHW-led self-management interventions. The interventions' components were classified
37 according to their formats (e.g., group, individual, telephone, home visit), elements (e.g.,
38 lectures, PA classes; Davidson et al., 2003), and BCTs (Michie et al., 2013). The data were
39 analyzed using content analysis (Schreier, 2012) by identifying the units of meaning,
40 condensing them and finally creating subcategories. Based on similar subcategories, eight
41 main categories were composed: (1) characteristics of LHWs, (2) training of LHWs, (3)
42 intervention delivery by LHWs, (4) theoretical background and guidelines of the
43 interventions, (5) principles of implementation, (6) intervention formats and elements, (7)
44 behavior change techniques, and (8) intervention management and mediators. (Table 1.)
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3 For the third objective of the review, self-management was investigated as a behavioral
4 outcome of NB and PA in 13 original studies that measured them. The analysis was
5 conducted by identifying the components and clinical measurements and their links to NB
6 and PA. The data within these analyses was relatively narrow, however, it was eventually
7 grouped according to their improvements in NB and PA and those groups were compared.
8 This review describes and identifies the intervention features that indicate participants'
9 behavior changes within the original studies.
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20 All of the following aspects in the fields of NB and PA and clinical measurements were
21 manually coded and categorized in Microsoft Excel: the reported intervention formats and
22 elements, such as delivery in group or individual sessions, telephone or online contact, and
23 education lectures (Davisdon et al., 2003); behavior change techniques (applied by Michie et
24 al., 2013); intervention length and frequency; significantly improved and not improved self-
25 management outcomes in terms of PA and NB; and clinical measurements.
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35 This semi-qualitative metric was developed in the current study to extract and investigate the
36 links between intervention components and PA and NB. Additionally, there were a large
37 variety of measurements used to assess PA, NB, blood lipids, and blood pressure as self-
38 management outcomes, which were difficult to bring together. Therefore, all of the tests that
39 investigated similar items were classified as items of self-management (Table 2) in order to
40 allow the data to be analyzed and for the results to be explained based on the study topic. All
41 of the results are based on the published study results, and no original study data or
42 intervention material have been examined.
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57 **Results**

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Included studies

The included studies ($n = 40$) originated from seven countries, most of them from the United States ($n = 31$). Twenty-nine studies examined self-management in diabetes, eight in cardiovascular diseases, and three in a risk of cardiovascular diseases. The included studies consisted of 22 randomized controlled trials and 18 other trials. The methodological quality of the studies ranged from 9 to 25 points, with a total possible MQSQ sum of 28 points (9–12 points, 5 studies; 13–20 points, 23 studies; 21–25 points, 12 studies; see Table 3). Points were typically subtracted due to an absence of randomization or blinding, or due to a lack of reporting about them. No original studies were excluded, since the focus of the review was on qualitative description of LHWs and interventions. Additionally, MQSQ does not set any score limits for the appropriate level of study quality.

The durations of the self-management interventions varied from one day to 24 months. The number of baseline recipients in all the included studies was 10,065 (female 55%) and follow-up 7,970, with a total attrition rate of 21%. The studies varied largely in their reporting. For example, in some papers the background, training, and duties of LHWs as well as intervention details were clearly presented, and in others they were not. Due to the high number of studies included in the current review, the original studies will be cited according to the numbers referred to in Table 3.

Characteristics of LHWs and their training

The individual skills and characteristics often included having the similar health condition or experience of it as the participants had^(8,10,12,16,20,21,32,38). LHWs came from the same community as the recipients did^(6,8,26), and some of them also had a professional

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3 background^(24,26). Many of the studies were located in minority communities, therefore LHWs
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5 were often bilingual, combining, for example, Spanish and English^(11,25,27,30,31).
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8 **Training educators** were revealed to be health professionals^(7,14), specialists^(1,28), or
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10 university researchers^(25,29). **Training content** consisted of using community resources,
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12 navigating health care services, and organizational issues.^(5,8,9,12,16,18,20,22,29) (See Figure 2.)
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14 Additionally LHWs' training also included themes of supporting effective self-management
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16 techniques, such as motivational, self-monitoring and measuring
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18 ^(2,4,5,7,8,9,11,12,15,16,17,18,20,21,22,23,25,28,29,33,34,37,40), alongside clinical protocols ^(8,11,16,25,34,35),
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20 medication ^(9,20,34) and self-care routines ^(9,16). The training **elements** varied from, for
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22 example, classroom activities^(8,28,38,40) to home visits⁽⁹⁾. The LHWs were also trained in
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24 research practices^(2,5,8,12,16,25,28,38), protecting human subjects^(5,18,25), and cultural
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26 awareness^(5,18).
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32 The number of LHWs within one intervention varied from 1⁽¹⁴⁾ to 41⁽¹⁶⁾. LHWs had **multiple**
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34 **roles and duties related to intervention components**. Between the education sessions,
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36 LHWs contacted participants to provide support or to answer their questions^(1,7,17,25,35,39).
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38 They were also available for recipients' phone calls.⁽¹⁾ In a few interventions LHWs worked
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40 as equal members of health care teams^(5,11,12,24,27,29,30,33,34,40).
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44 LHWs also collected research data ^(1,25,31), contributed to intervention evaluations⁽²⁵⁾, and
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46 acted as a team leader for a group of LHWs.^(4,26,39) Some studies reported **supervision**
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48 **provided to LHWs** by program coordinators^(3,4,5,8,9,20,37), nurse care managers^(2,3,28), health
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50 care teams of community centers^(5,37), and university professionals⁽³⁷⁾. In some cases, LHWs
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52 were provided with a written manual to ensure consistency of delivery.^(37,38,40) They consulted
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54 with health professionals on any serious symptoms or for measurements of
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56 recipients.^(11,12,27,32)
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Intervention delivery of LHW-led interventions

Nearly half of the 40 studies reported no **theoretical background** for the intervention or program^(3,4,6,9,10,12,13,16,18-20,24,26,27,34-36,39), but some did (Table 4). In eight studies the theoretical background was presented as a combination of two theories^(5,8,11,23,25,33,38,40). The framework of an intervention's content or its components was often based on **national guidelines and recommendations** on diabetes^(1,2,5,11,12,14,15,26,27,32,35), hypertension^(8,29), or cardiovascular diseases^(30,39).

Meetings usually **took place** in community centers and churches, often held at a convenient location to the recipients^(1,2,4,22,23,25-27,31). **The length** of sessions, when reported, ranged from 30 to 90 minutes.^(26,27,29,37) **Group sizes** varied from two^(24,38) to twenty-five⁽³²⁾ participants. In a few interventions the interaction frequency was based on the needs of peers and recipients.^(2,21)

LHWs delivered educational activities for individuals or groups, including making action plans, motivating, problem solving, and self-management guidance with support given either face to face by telephone^(2,4,5,7,9,10,15,17,22,24,25,27,28,29,33,34,39,40), or online⁽³²⁾. Home visits were also conducted^(11,17). Some of the LHWs assessed goals⁽³⁹⁾, provided confident information⁽²⁹⁾, or helped patients to understand their long-term conditions and self-management^(2,9,25).

All together, the studies reported thirty-five separate **health behavior change techniques** being applied (Table 5).

Recruitment of potential individuals to participate in interventions was conducted at hospitals, health centers, community centers or churches^(6,7,8,12,15,34,35), or via the media, websites or seminars^(15,22,32). To ensure **fidelity of program delivery**, classes were

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3 monitored^(16,22) or audio recorded⁽¹²⁾, checklists were completed⁽²¹⁾ or activity reports were
4 submitted⁽²²⁾. Interventions acted as **bridges to local health and social services** by
5 encouraging participants to continue with their health care
6
7 services^(3,5,6,14,16,17,18,19,21,22,28,31,37,38,39). **Attrition prevention** was performed by implementing
8 make-up sessions⁽³¹⁾, providing cash incentives, stipends or gift cards^(14,19,20,37,39), and making
9 telephone support calls to recipients who did not attend the sessions⁽¹⁸⁾.
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21 *PA and NB outcomes in the LHW-led interventions*

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23 Statistically significant improvements (minimum of $p < .05$) in all self-management
24 outcomes, including psychological, behavioral, and clinical outcomes, were reported in many
25 studies. Because our review concentrated on behavior, the outcomes of PA and NB as self-
26 management activities, and their links to clinical outcomes, are presented. Ten studies
27 measured both PA and NB, and three studies measured only PA (see Table 6). Measurements
28 of the studies were mostly pre- and posttest, with only two studies having follow-ups^(32,37).
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38 Out of ten studies that investigated both PA and NB, six reported both improved PA and
39 NB^(7,23,25,29-31), two reported improved NB^(21,37), one reported improved PA⁽¹⁷⁾, and one found
40 no improvements⁽¹⁵⁾. NB- and PA-effective interventions were organized into groups, and
41 four of ~~them~~ these had additional individual activities.^(7,23,25,31) Their length varied from two-
42 and-a-half months⁽²⁵⁾ to 12 months⁽³⁰⁾. Four of them provided activities weekly, and five had
43 education lectures. Their number of identified BCTs were eight⁽²⁹⁾ or nine^(7,25,30). Three of the
44 NB- and PA-effective interventions also improved clinical measurements such as
45 HbA1C^(7,23,25), blood pressure^(23,25,29), blood lipids^(23,29,30), and weight loss^(7,23,29), and one⁽³¹⁾
46 found no clinical improvements. (Table 7)
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3 The current review also aimed to identify PA- and NB-effective interventions separately to
4 get more accurate results concerning behavior change in LHW-led self-management
5 interventions. In PA-effective interventions^(7,17,23,25,29-32) the number of applied BCTs varied
6 from three to fifteen. In some of the interventions, group meetings were combined with
7 individual face-to-face meetings, at recipients' homes, or via telephone. In PA-ineffective
8 interventions^(15,21,26,33,37) the intervention components were mainly similar to effective PA
9 interventions, with two of them providing only individual meetings. The number of BCTs
10 ranged from two to nine. Regarding the high number of applied BCTs, certain remarks
11 appeared in terms of PA as a form of self-management activity. Self-monitoring, enhancing
12 social support, hands-on activities, and self-efficacy support were mainly linked to
13 improvements, whereas goal setting was linked to both improvements and no improvements.
14 Increased PA was often related to positive effects on clinical measurements, but not in all
15 cases.

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34 In NB-effective interventions^(7,21,23,25,29-31,37) the number of BCTs was from three to nine, with
35 some variations in techniques, theoretical backgrounds, and durations. In those studies, it was
36 more likely that self-monitoring, goal setting, and motivation were used as BCTs. For
37 example, information providing had been used in four studies where NB improved but also in
38 both studies where no improvement was found. When measured alongside NB, many studies
39 also found positive effects on clinical measurements. Nevertheless, despite the improved NB,
40 blood pressure was more likely to increase than decrease.

41 42 43 44 45 46 47 48 49 50 51 52 53 54 **Discussion**

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57 The current review found that LHW-led self-management interventions have potential in
58 promoting self-management in LTC. The implementation of interventions varied widely.
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3 Only about one third of the studies investigated NB and PA as indicators of behavior change,
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5 however, some of those that did had found positive outcomes.
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9 The findings show that LHWs were often themselves trained LTC patients, who were
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11 personally interested in acting as LHWs. This study restates the previous descriptions of
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13 LHWs (Hunt et al., 2011; South, Kinsella & Meah, 2012; South et al., 2013), who are
14
15 considered to be trained peer workers, as having similar cultural, ethnic or health
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17 backgrounds to their clients. LHWs' roles were identified as educators, supporters, opinion
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19 leaders, organizers, and acting as bridges between communities, professionals, and clients.
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21 Interventions typically encompassed empowerment, social support, and tailoring-oriented
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23 principles, and they varied widely in length, frequency, and components. For example, group
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25 sessions, education lectures, and individual appointments were common formats, whereas
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27 self-monitoring, goal setting, information providing, action plans, and social support were
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29 frequently applied BCTs. Similar formats and BCTs were often applied in effective as well as
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31 in non-effective interventions.
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37 The implementation of and reporting on both LHW training and LHW-led interventions
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39 diverged, as has been shown in previous studies (Hunt et al., 2011; Shah et al., 2013). A
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41 number of interventions lacked a theoretical background, or at least did not report one (Hunt
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43 et al., 2011; Dale et al., 2012), which is a common issue in evidence-based health promotion.
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45 Implementation quality was assured in many interventions by providing continuous
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47 supervision during the intervention process (Hunt et al., 2011). That can be considered as a
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49 way to empower LHWs to be self-management tutors, and also assist them in cooperating
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51 with each other. As a non-professional workforce, they may benefit from organizational
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53 support for their work.
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3 Interventions often followed national recommendations or guidelines for particular LTCs, as
4 well the program for chronic disease self-management (Lorig et al., 2013). However, the
5 current review highlights self-management as a person's own activities and emotions for
6 taking care of a LTC by, for example, setting and modifying goals, solving problems, relying
7 on peer support, and action planning (also Richardson et al., 2014). It seems that part of the
8 interventions emphasized lecturing and giving advice, while many interventions consisted of
9 behavioral and emotional elements that supported self-management (also Kawi, 2012; Lorig,
10 Ritter, Ory & Whitelaw, 2013; Kaptein, et al., 2014). Effective self-management support
11 should correspond to recipients' unique needs as well as assist individuals in strengthening
12 their motivation and skills in coping in daily life with an LTC (Newbould, Taylor, & Bury,
13 2006). However, participants who lack knowledge and others with low self-efficacy may fail
14 to benefit from similar activities and support in improving their self-management. These
15 demands have been responded to in many interventions by tailoring intervention activities
16 according to individual participants' requirements.

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19 This review had similar findings to previous work, in that LHW-led self-management
20 interventions can be effective in HbA1c (Hunt et al., 2011; Dale et al 2012; Little et al.,
21 2014), and in a few interventions in PA, NB, blood pressure, and blood lipids (Hunt et al.,
22 2011; Dale et al., 2012). Even though the same components and BCTs led to both significant
23 and non-significant outcomes, some preliminary but not robust links were observed. Group
24 meetings and enhancing social support seemed to be particularly effective in improving PA.
25 This reflects earlier findings (Greaney et al., 2017) and also highlights the need for social
26 activities and for sharing motivation and feelings with LHWs and other recipients when
27 improving one's PA. Furthermore, self-monitoring and hands-on activities and exercises as
28 self-management actions were more likely linked to both improved PA and NB. Regarding
29 the findings of generally applied BCTs in PA interventions (Duff et al., 2017), goal setting
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3 did not appear as an effective BCT at this time. However, in terms of behavior change
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5 interventions, only about one third of the studies measured NB and/or PA as an outcome of
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7 behavior change. In considerations of behavior changes among long-term patients, measuring
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9 their health behavior may provide beneficial knowledge on how patients manage with self-
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11 management in the context of their daily lives. Both research and clinical practice would
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13 benefit from this information.
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21 Thus, a particular intervention component does not consistently lead to improvements.

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23 Firstly, identifying and understanding (Johnston et al., 2017) formats and BCTs and, second,
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25 applying them in self-management interventions are demanding processes, especially
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27 deciding how to maintain techniques based on recipients' unique needs, such as motivation or
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29 making action plans. When the training periods of LHWs last from days to months, it may
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31 have been challenging to learn the further ethos of the BCTs that were applied. In a portion of
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33 the interventions it remained unclear how the LHWs were trained in BCTs. Furthermore,
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35 based on the results of this study, it is possible that other intervention components, such as
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37 intensity (Palmas et al., 2015), duration, and overall personal interaction between LHWs and
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39 participants may play a role in effective interventions.
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45 Nevertheless, as this review suggests, LHWs may have particular potential in self-
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47 management interventions among cultural and lingual minorities due to their reciprocal
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49 ability to share culture and experiences. They may have the potential to increase vulnerable
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51 individuals' involvement in services but also to promote self-management and health
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53 behavior change.
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Limitations and strengths

The collected data enabled specific examinations of LHW-led self-management interventions, yet the current study has its limitations. The study protocols differed, combining RCT and trials with a variety of study participants. Due to the high variability and high numbers of different BCTs and self-management outcomes reported within the data, the evidence for making links between techniques and outcomes is limited. However, only the most prominent themes are presented in this paper. The heterogeneity across interventions and outcomes may also lead to limitations in identifying the intervention components (Abraham et al., 2015; Johnston et al 2017) and determining the results of this review, which itself contains reviews by Carr et al. (2011) and Little et al. (2014). The recipients of the original studies often represented cultural or linguistic minorities or low-income groups, so the results may not be transferable to other groups. In addition, there may be a risk of language bias because the included studies had to be reported only in English (CRD, 2009). Nevertheless, to our knowledge, the major studies regarding the topic have been conducted in an international context and reported in English.

This study has three primary strengths. First, it sets out a systematic synthesis of the characteristics and training of LHWs, the implementation and components of LHW-led interventions, and BCTs. The synthesis could serve as a framework for future research and clinical practice considering LHW-led self-management interventions. Second, it contains a number of original studies that provide robust data on LHW-led self-management interventions among people with diabetes and cardiovascular disease. Third, it presents preliminary links between intervention components and outcomes in the field of LHW-led self-management interventions. To our knowledge, there is currently only scant evidence of such a link.

Implications for Policy and Practice

LHW interventions, as a mode of health services for multiple groups of people, have the potential to improve self-management for those with diabetes, cardiovascular diseases and chronic conditions as well as assist in prevention. LHW-led services in self-management support may reach people who are vulnerable or underserved. However, to improve self-management in LTC, systematic training in adopting and applying formats and BCTs should be provided to LHW candidates. In the future, an evidence-based standard for LHW training and interventions may be formulated for the field of LHW self-management interventions and their investigation. Such a standard, however, requires further research on its implementation.

Another suggestion for further research on self-management outcomes of LHW interventions would be to examine whether interaction frequency, meeting minutes, or group size have effects on self-management and, if so, what are the mechanisms that make them effective. A further line of study could determine how different combinations of intervention formats and BCTs interact.

Additionally, promoting recipients' self-regulation strategies or improving their psychological flexibility as stages of health behavior change may offer new ways to achieve goals in LHW interventions. In summary, the results of this review suggest that LHW-led self-management interventions for diabetes and cardiovascular diseases have been implemented in multiple ways, and these interventions have seemed to improve, at least partially, behavioral and clinical self-management outcomes.

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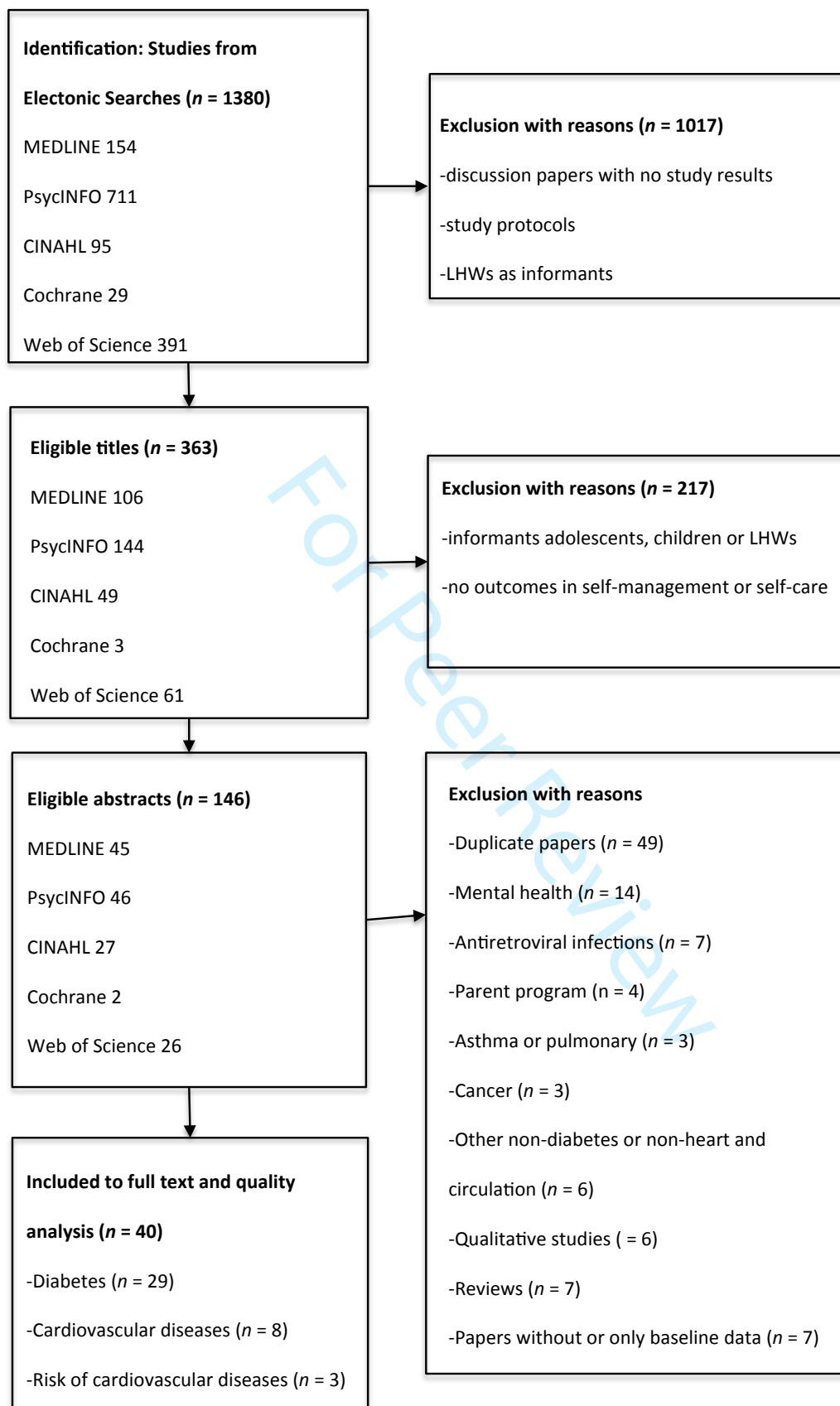


Figure 1. Flowchart of the searches.

Table 1. Example of the content analysis phase concerning LHW characteristics

Examples of the original expressions	Condensed expression	Subcategory	Main category
[The facilitators were six lay people with experience of heart disease, either personally -- or as carers of people with heart disease. 3.10]	The facilitators were six lay people with experience of heart disease self-management	Background and experience	Characteristics of LHWs
[The CHWs had an average of 6 years' experience leading DSME at CHASS. 18.22]	The CHWs had an average of six years' experience in leading diabetes self-management programs		
[--co-delivered by -- a patient (lay) tutor who had experience in these services 40.11.1]	Patient lay tutor had experience of services related to self-management support		
[-- an organization devoted to the education of people with diabetes and health care team members, on the basis of their excellent diabetes control, self-motivation, communication and support skills and interest. 4.21]	On the basis of their excellent diabetes control, self-motivation, communication and support skills and interest.	Eligibility criteria	
[simply interest of being a diabetes educator 24.9]	Simply one's own interest of being a diabetes educator		

[someone with diabetes or with a family member or friend with diabetes 24.8]	Having diabetes her/himself or a family member who has		
[16 hours training by the project manager or principal investor. 1.14]	Training provided by the project manager or principal investor	Training educators	LHWs' training
[The trainings were delivered by an interdisciplinary team of academics and practitioners with expertise in clinical medicine, health inequities, Latino health, diabetes self-management, diabetes medications, nutrition, exercise, cross-cultural counseling, and mental health. 11.27]	The culturally sensitive training delivered by an interdisciplinary team of academics and practitioners		
[CHWs trained by research staff from the University of Illinois at Chicago (UIC) 25.2.1]	CHWs trained by research staff from the University		
[to teaching blood pressure and glucose readings 1.18]	Training prepared CHWs in teaching blood pressure and glucose readings	Training purposes	
[building and reinforcing the participants' knowledge on diabetes, 23.22]	Building and reinforcing the participants' knowledge on diabetes		
[We trained community volunteers to be "Health	To train community volunteers to be health coaches		

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Coaches” for our project -- 29.34]

Table 2. Examples of self-management outcomes transferred to self-management items

Item of self-management	An example of original self-management measurement
Physical activity (PA)	Summary of Diabetes Self-Care Activities measure ^{(7)*} Moderate levels of physical activity 30 min per day at least 5 days per week ⁽¹⁷⁾ Physical Activity Scale for Elderly ⁽²¹⁾ Survey of Diabetes Self-Care Activities: Exercise ⁽²³⁾ Minutes of daily physical activity ⁽²⁵⁾ Questionnaire on physical activity ⁽³⁷⁾

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Nutrition behavior (NB)	Number of days to follow a diet ⁽⁷⁾
	Amount of daily servings of vegetable and fruits ⁽¹⁷⁾
	Survey of Diabetes Self-Care Activities: Nutrition ⁽²³⁾
	Following a healthy eating plan, eating fruits/vegetables ^(25,30)
	Self-reported eating behavior ⁽²⁹⁾
	Questionnaire on nutrition ^(31,37)
Blood lipids	HDL ^(23,30,35) LDL ^(17,30)
	Total cholesterol ^(23,30) Triglycerides ⁽³⁰⁾
Blood pressure	Systolic ^(23,25,29)
	Diastolic ⁽²³⁾

*References in Table 3.

Table 3. Studies included in the analysis

Num	Original Paper	Purpose of LHW intervention	Field	Method	Main outcome, analysis	Setting	Follow-up, N =	Format (briefly)	Months of duration + follow-up	Quality assessment score
1	Daniels, E., Powe, B., Metoyer, T., McCray, G., Baltrus, P., & Rust, G. (2012). Increasing knowledge of cardiovascular risk factors among African Americans by use of community health workers: The ABCD community intervention pilot project. <i>Journal of the National Medical Association, 104</i> (3-4), 179–185. USA	To increase knowledge of cardiovascular risk among African-Americans	CVD	RCT	Knowledge of CVD, health literacy, Depression, HBA1C, BP, cholesterol, BMI, waist circumference <i>t</i> tests	Church	25	Group meeting Telephone counselling	1.5	17
2	DePue, J., Dunsiger, S., Seiden A., Blume, J., Rosen, R., Goldstein, M., Nu'usolia, O., Tuitele, J., & McGarvey, S. (2013). Nurse-community health worker team improves diabetes care in American Samoa: results of a randomized controlled trial. <i>Diabetes Care, 36</i> (7), 1947–1953.	To support diabetes self-management among American Samoans	T2DM	RCT	HBA1C, BP, BMI, waist circumference, dietary intake Wilcoxon, <i>t</i> test, mixed effects	CHC	243	Group meetings Individual meetings	12	22

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	American Samoa, USA				longitudinal regression model						
3	Furze, G., Cox, H., Morton, V., Chuang, L- H., Lewin, R.J.P., Nelson, P., Carty, R., Norris, H., Patel, N., & Elton, P. (2012). Randomized controlled trial of a lay- facilitated angina management programme. <i>Journal of Advanced Nursing</i> , 68(10), 2267–2279. England	To assess the effectiveness of a angina management program	CVD (Angina manage- ment)	RCT	Angina frequency (1-week angina diary) Negative binomial, linear and logistic regression	Home- based	124	Individual interview Home visits Telephone calls	3	20	
4	Gagliardino, J.J., Arrechea, V., Assad, D., Gagliardino, G.G., González, L., Lucero, S., Rizzuti, L., Zufriategui, Z., & Clark, C Jr. (2013). Type 2 diabetes patients educated by other patients perform at least as well as patients trained by professionals. <i>Diabetes/Metabolism Research & Reviews</i> , 29(2), 152–160. Argentina	To compare standard care and the care and ongoing support of trained peers for people with T2DM	CVD (Hyper- tension)	RCT	HBA1C, BMI, BP, cholesterol, attitudes regarding diabetes and their care Chi-square test, <i>t</i> test	Health education center	198	Peer support group Face-to-face visits Telephone communication	1.5	15	

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5	Hargraves, J.L., Ferguson, W.J., Lemay, C.A., & Pernice, J. (2012). Community health workers assisting patients with diabetes in self-management. <i>Journal of Ambulatory Care Management</i> , 35(1), 15–26. Massachusetts, USA	To integrate community health workers into work with diabetes type 2 patients and support diabetes self-management	T2DM	RCT	HBA1C, cholesterol, BP, self-management	CHC	1,415	LHW in health care teams	13	9
6	Kronish, I.M., Goldfinger, J.Z., Negron, R., Fei, K.Z., Tuhim, S., Arniella, G., & Horowitz, C.R. (2014). Effect of peer education on stroke prevention: The Prevent Recurrence of All Inner-City Strokes Through Education (PRAISE) randomized controlled trial. <i>Stroke</i> , 45(11), 3330–3336. New York City, USA	To determine the effect of peer education on secondary stroke prevention	CVD (Stroke)	RCT	BP, cholesterol, use of antithrombotic medications, control of the stroke risk factors	Primary health care	510	Group meetings	1.5 + 6	20
7	Lynch, E.B., Liebman, R., Ventrelle, J., Avery, E., & Richardson, D. (2014). A self-	To determine the effectiveness of	T2DM, CVD	RCT	Medical history, clinical variables,	Communit y setting	55	Group sessions	6	19

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3		management intervention for African	comorbid diabetes and	(hypertens	BMI, medications,			Telephone calls		
4		Americans with comorbid diabetes and	hypertension self-	ion)	dietary intake, PA,					
5		hypertension: A pilot randomized	management		health literacy,					
6		controlled trial. <i>Preventing Chronic</i>	intervention for African		nutrition knowledge					
7		<i>Disease, 11</i> , 130349. Chicago, USA	Americans		and quality of life					
8					<i>t</i> tests, χ^2 tests,					
9					Fisher's exact test,					
10					continuous					
11					variables, Wilcoxon					
12					rank-sum test					
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22	8	Martin, M.Y., Kim, Y.I., Kratt, P., Litaker,	To examine the	CVD	RCT	Pill count	Online,	338	Online program	6 + 6
23		M.S., Kohler, C.L., Schoenberger, Y.M.,	effectiveness of	(hypertens		Means, standard	CHC		Home visits	
24		Clarke, S.J., Prayor-Patterson, H., Tseng,	community-based	ion)		deviations,			Telephone calls	
25		T.S., Pisu, M., & Williams, O.D. (2011).	multimedia intervention			frequencies. χ^2				
26		Medication adherence among rural, low-	in medication adherence			analysis, general				
27		income hypertensive adults: a randomized	among hypertensive			linear model				
28		trial of a multimedia community-based	patients							
29		intervention. <i>American Journal of Health</i>								
30		<i>Promotion, 25</i> (6), 372–378. Alabama, USA								
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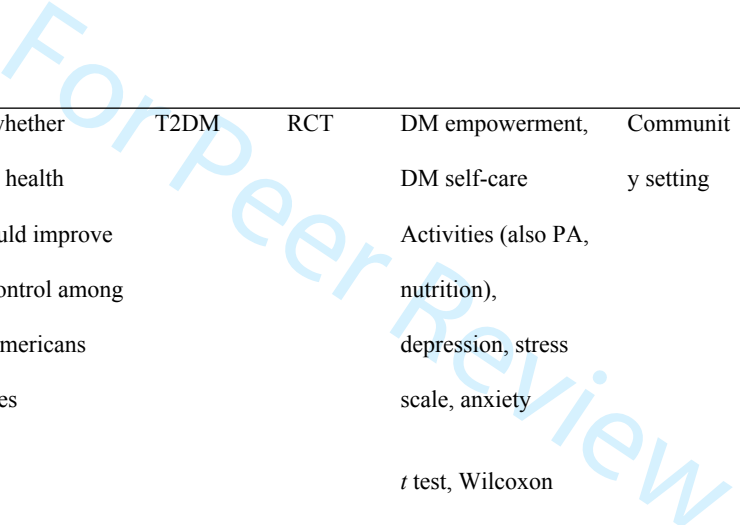
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9	McDermott, R.A., Schmidt, B., Preece, C., Owens, V., Taylor, S., Li, M., & Esterman, A. (2015). Community health workers improve diabetes care in remote Australian Indigenous communities: results of a pragmatic cluster randomized controlled trial. <i>BMC Health Services Research</i> , 15, 68. Australia (north)	To test the effectiveness of a community-based approach to intervention for indigenous adults with poorly controlled T2DM in Australian indigenous communities	T2DM	RCT	HbA1C	Primary health care	191	LHW in health care team	18	20
					<i>t</i> tests, Wilcoxon rank sum tests, chi-square test, generalized estimating equations regression models					
10	Moskowitz, D., Thom, D.H., Hessler, D., Ghorob, A., & Bodenheimer, T. (2013). Peer coaching to improve diabetes self-management: Which patients benefit most? <i>Journal of General Internal Medicine</i> , 28(7), 938–942. San Francisco, USA	To examine the effect of peer health coaching on HbA1C modified by diabetes control characteristics	T2DM	RCT	HbA1C	Public health care	299	NR	6	18
					<i>t</i> tests, Fischer's exact test					
11	Perez-Escamilla, R., Damio, G., Chhabra, J., Fernandez, M.L., Segura-Perez, S., Vega-Lopez, S., Kollannor-Samuel, G., Calle, M., Shebl, F.M., & D'Agostino, D. (2015). Impact of a Community Health Workers-Led Structured Program on Blood	To evaluate home-based culturally appropriate CHW-integrated T2DM counselling among Latino adults	T2DM	RCT	HbA1c, BG and lipid profile	Primary health care	148	Home visits	12 + 6	22
					χ^2 test for categorical variables and independent samples ANOVA					

		Glucose Control Among Latinos With Type 2 Diabetes: The DIALBEST Trial. <i>Diabetes Care</i> , 38(2), 197–205. Connecticut, USA										for continuous variables, a linear mixed effects
12	Philis-Tsimikas, A., Fortmann, A., Lleva-Ocana, L., Walker, C., & Gallo, L.C. (2011). Peer-Led Diabetes Education Programs in High-Risk Mexican Americans Improve Glycemic Control Compared With Standard Approaches A Project Dulce Promotora Randomized Trial. <i>Diabetes Care</i> , 34(9), 1926–1931. San Diego, USA	To evaluate the effect of a culturally sensitive diabetes self-management program among Mexican-American with T2DM	T2DM	RCT	HbA1C	CHC	156	Learning class	10 + 4	15	Multilevel models, within-group analysis	Support group Telephone calls
13	Prezio, E.A., Pagan, J.A., Shuval, K., & Culica, D. (2014). The Community Diabetes Education (CoDE) program: cost-effectiveness and health outcomes. <i>American Journal of Preventive Medicine</i> , 47(6), 771–779. USA	To examine the long term cost effectiveness and improvements in diabetes-related complications	T2DM	RCT	HBA1c	NR	10 000'	NR	NR	15	Archimedes model	
14	Prezio, E.A., Cheng, D., Balasubramanian, B.A., Shuval, K., Kendzor, D.E., & Culica, D. (2013). Community Diabetes Education	To determine the impact of a culturally tailored diabetes education	T2DM	RCT	HbA1C	CHC	156	LHW	12	23	t test to continuous	appointments along with usual

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	(CoDE) for uninsured Mexican Americans: a randomized controlled trial of a culturally tailored diabetes education and management program led by a community health worker. <i>Diabetes Research & Clinical Practice</i> , 100(1), 19–28. Texas, USA	program for uninsured Mexican-American with DM			variables and Pearson χ^2 for categorical variables, linear mixed-models			care		
15	Rothschild, S.K., Martin, M.A., Swider, S.M., Tumialan Lynas, C.M., Janssen, I., Avery, E.F., & Powell, L.H. (2014). Mexican American trial of community health workers: a randomized controlled trial of a community health worker intervention for Mexican Americans with type 2 diabetes mellitus. <i>American Journal of Public Health</i> , 104(8), 1540–1548. Chicago, USA	To assess whether community health workers could improve glycemic control among Mexican-Americans with diabetes	T2DM	RCT	DM empowerment, DM self-care, Activities (also PA, nutrition), depression, stress scale, anxiety	Communit y setting	121	Telephone calls	24	25
					<i>t</i> test, Wilcoxon rank sum test, mixed effect linear model analysis.			Home visits		
16	Safford, M.M., Andreae, S., Cherrington, A.L., Martin, M.Y., Halanych, J., Lewis, M., Patel, A., Johnson, E., Clark, D.,	To test the effectiveness of peer coaches plus brief diabetes education	T2DM	RCT	HbA1c, systolic BP, LDL-C, BMI, and	Communit y setting	270	Meetings	10 + 5	23
								Telephone calls		



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31	18	Tang, T.S., Funnell, M., Sinco, B., Piatt, G., Palmisano, G., Spencer, M.S., Kieffer, E.C., & Heisler, M. (2014). Comparative effectiveness of peer leaders and community health workers in diabetes self-	To compare a peer leader (PL) versus a community health worker (CHW) telephone intervention	T2DM	RCT	HbA1C	Community setting	69	Group Classes Home visits Primary care provider visits	18	23
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	management support: Results of a randomized controlled trial. <i>Diabetes Care</i> , 37 (6), 1525–1534. Detroit, USA	in diabetes self-management education			Pearson χ^2 test			Telephone calls		
19	Tang, T.S., Funnell, M.M., Sinco, B., Spencer, M.S., & Heisler, M. (2015). Peer-Led, Empowerment-Based Approach to Self-Management Efforts in Diabetes (PLEASED): A Randomized Controlled Trial in an African American Community. <i>Annals of Family Medicine</i> , 13(S1), S27–S35. Michigan, USA	To investigate whether a peer support model could sustain improvements achieved in a short-term diabetes self-management education program for African American adults with type 2 diabetes	T2DM	RCT	HbA1C	Community setting	64	Group sessions	15	25
					Linear mixed model, Spearman correlation, Student's <i>t</i> test, log rank test, Fisher's exact test, Pearson's χ^2			Face to face meetings		Telephone calls
20	Thom, D., Ghorob, A., Hessler, D., DeVore, D., Chen, E., & Bodenheimer, T.A. (2013). Impact of peer health coaching on glycemic control in low-income patients with diabetes: A randomized controlled trial. <i>Annals of Family Medicine</i> , 11(2), 137–144. San Francisco, USA	To test the impact of individual peer coaching on glucose control on patients with poorly controlled diabetes	T2DM	RCT	HbA1C	Public clinics	275	In person interactions	6	20
					Linear mixed model, logistic regression			Telephone calls		

21	van der Wulp, I., de Leeuw, J.R.J., Gorter, K.J., & Rutten, G.E.H.M. (2012). Effectiveness of peer-led self-management coaching for patients recently diagnosed with Type 2 diabetes mellitus in primary care: a randomized controlled trial. <i>Diabetic Medicine</i> , 29(10), e390–e397. Netherlands	To study the effectiveness of a self-management coaching intervention in recently diagnosed patients with Type 2 diabetes	T2DM	RCT	Self-efficacy, coping, physical activity, dietary habits, psychological well-being, depressive symptoms and diabetes related distress	General practices	119	Home visits Telephone calls Emails	18	22
22	Whittle, J., Schapira, M.M., Fletcher, K.E., Hayes, A., Morzinski, J., Laud, P., Eastwood, D., Ertl, K., Patterson, L., & Mosack, K.E. (2014). A randomized trial of peer-delivered self-management support for hypertension. <i>American Journal of Hypertension</i> , 27(11), 1416–1423. Milwaukee, USA	To compare changes in BP control among veterans participating in a peer-delivered vs. Professionally delivered health education intervention	CVD (Hypertension)	RCT	Systolic BP Mixed model, generalized linear model	Veterans' service organizations	379	Group sessions	12	24
23	Assah, F.K., Atanga, E.N., Enoru, S., Sobngwi, E., & Mbanya, J.C. (2015).	To examine the effectiveness of a	T2DM	Trial	HBA1C, BP, blood lipids, BMI, waist	Communit	192	Group meetings	6	17

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	Community-based peer support significantly improves metabolic control in people with Type 2 diabetes in Yaounde, Cameroon. <i>Diabetic Medicine</i> , 32(7), 886–889. Cameroon	structured peer support diabetes intervention in Cameroon			circumference, y setting diabetes self-care (also PA and nutrition)			Personal encounters Telephone calls		
24	Carey, M.E., Mandalia, P.K., Daly, H., Gray, L.J., Hale, R., Stacey, L.M., Taub, N., Skinner, T.C., Stone, M., Heller, S., Khunti, K., & Davies, M.J. (2014). Increasing capacity to deliver diabetes self-management education: Results of the DESMOND lay educator non-randomized controlled equivalence trial. <i>Diabetic Medicine</i> , 31(11), 1431–1438. England and Scotland	To develop and test a format of delivery of diabetes self-management education by paired professional and lay educators	T2DM	trial	Diabetes coherence, diabetes perception Intra-class-correlations, continuous and categorical variables, t test, χ^2 , Wilcoxon test	Primary health care	242	Group meeting	1 day	20

25	Castillo, A., Giachello, A., Bates, R., Concha, J., Ramirez, V., Sanchez, C., Pinsker, E., & Arrom, J. (2010). Community-based diabetes education for Latinos: The Diabetes Empowerment Education Program. <i>Diabetes Educator</i> , 36(4), 586–594. California, USA	To test the feasibility and effectiveness of a linguistic and culturally appropriate diabetes education program among Latinos	T2DM	trial	HbA1C, PA, nutrition	Community setting	47	Group meeting	2.5	15
26	Cene, C.W., Haymore, L.B., Ellis, D., Whitaker, S., Henderson, S., Lin, F.C. & Corbie-Smith, G. (2013). Implementation of the power to prevent diabetes prevention educational curriculum into rural African American communities: A feasibility study. <i>The Diabetes Educator</i> , 39(6), 776–785. North Carolina, USA	To describe the feasibility of using a community-based approach to implement a diabetes prevention education curriculum in rural African-American settings	T2DM	Trial	BG, BP, BMI, PA Mc Nemar test, <i>t</i> test	Community setting	30	Small group sessions	7.5	11
27	Collinsworth, A.W, Vulimiri, M., Schmidt, K. L., & Snead, C.A. (2013). Effectiveness of a community health worker–led diabetes self-management education program and implications for CHW involvement in care	To evaluate the effectiveness of a diabetes self-management education program and to	T2DM	Trial	HBA1C, BMI, Blood pressure <i>t</i> test	Community clinic	497	Group meetings	12	12

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		coordination strategies. <i>The Diabetes Educator</i> , 39(6), 792–799. Dallas, USA	understand how CHWs and primary care providers work together							
28	DePue, J.D., Rosen, R., Seiden, A., Bereolos, N., Chima, M., Goldstein, M., Nu’usolia, O., Tuitele, J., & McGarvey, S.T. (2013). Implementation of a culturally tailored diabetes intervention with community health workers in American Samoa. <i>The Diabetes Educator</i> , 39(6), 761–771. American Samoa, USA	To investigate a primary care-based, nurse–community health worker (CHW) team intervention to support type 2 diabetes self-management in American Samoa	T2DM	Trial	HBA1C, BP, smoking status, alcohol use, depression score, treatment dose	Primary care	104	Group visits Individual visits	12	16
29	Dye, C., Williams, J., & Hoffman Evatt, J. (2015). Improving hypertension self-management with community health coaches. <i>Health Promotion Practice</i> , 16(2), 271–281. Appalachians, USA	To improve hypertension self-management among rural residents older than 60 years through education and support	CVD (Hyper-tension)	Trial	Hypertension knowledge and self-management, BP, weight, waist circumference, blood lipids and	Communit y setting	146	Group classes Education program	4	20

					BG, PA, nutrition					
					Student <i>t</i> test,					
					McNemar's test,					
					Bonferroni					
					correction					
30	Fernandes, R., Braun, K., Spinner, J., Sturdevant, C., Ancheta, S., Yoshimura, S., Compton, M., Wang, J-H., & Lee, C. (2012). Healthy heart, healthy family: A NHLBI/HRSA collaborative employing community health workers to improve heart health. <i>Journal of Health Care for the Poor and Underserved</i> , 23(3), 988-999. Hawaii, USA	To evaluate the impact of the heart health curriculum on low- income Filipinos with CVD risk factors in Hawaii	CVD	Trial	Disease and medication histories, BMI, waist circumference, BP, BG, lipid profile, HBA1C, PA, nutrition <i>t</i> tests, chi-squared	Communit y setting	92	Group sessions	12	16
31	Islam, N., Wyatt, L., Patel, S., Shapiro, E., Darius Tandon, S., Runi Mukherji, B., Tanner, M., Rey, M.J., & Trinh-Shevrin, C. (2013). Evaluation of a community health	To explore the impact and feasibility of a pilot intervention to improve diabetes management	T2DM	Trial	HBA1C, weight, nutritional and physical activity behaviors, access to	Clinical and communit y setting	26	Group sessions Individual visits	9	20

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	worker pilot intervention to improve diabetes management in Bangladeshi immigrants with type 2 diabetes in New York City. <i>The Diabetes Educator</i> , 39(4), 478–493. New York, USA	among Bangladeshi-American individuals with type 2 diabetes living in New York City			health care, diabetes knowledge, self-management, self-efficacy, mental health					
32	Lorig, K., Ritter, P.L., Plant, K., Laurent, D.D., Kelly, P., & Rowe, S. (2013). The South Australia Health Chronic Disease Self-management Internet Trial. <i>Health Education & Behavior</i> , 40(1), 67–77. South Australia	To implement and investigate the effectiveness of a chronic condition self-management internet trial in South Australia	CC	Trial	Pain/physical discomfort, shortness of breath, tiredness, impact of disease, health distress, self-rated disability, number of illness days, PA	Online-based, community setting	194	Interactive web program	1.5 + 12	21

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33	Micikas, M., Foster, J., Weis, A., Lopez-Salm, A., Lungelow, D., Mendez, P., & Micikas, A. (2015). A Community Health Worker Intervention for Diabetes Self-management Among the Tz'utujil Maya of Guatemala. <i>Health Promotion Practice, 16</i> (4), 601–608. Guatemala	To investigate the effectiveness of a structured, community-led diabetes self-management intervention among the Tz'utujil Maya of Guatemala	T2DM	Trial	Health beliefs, practices, HbA1c, BMI, PA	Community setting	52	Individual visits at clinics and home	4	14
34	Otero-Sabogal, R., Arretz, D., Siebold, S., Hallen, E., Lee, R., Ketchel, A., Li, J., & Newman, J. (2010). Physician-community health worker partnering to support diabetes self-management in primary care. <i>Quality in Primary Care, 18</i> (6), 363–372. San Francisco, USA	To improve self-management among patients with type 2 diabetes	T2DM	Trial	HbA1c, LDL, BP and total cholesterol, Patient Activation Measure	Primary care	114	Participant visits.	24	9
35	Ryabov, I. (2014). Cost-effectiveness of Community health workers in controlling diabetes epidemic on the US-Mexico border. <i>Public Health, 128</i> (7), 636–642.	To evaluate clinical outcomes and long-term cost-effectiveness of T2DM intervention among Mexican-	T2DM	Trial	HbA1c, total cholesterol, HDL, triglycerides, BP, BMI	Community setting	30	Individual visits	24	13
								Telephone contacts		

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	Texas, USA	Americans									
36	Ryabov, I. (2011). The impact of community health workers on behavioral outcomes and glycemic control of diabetes patients on the U.S.-Mexico border. <i>International Quarterly of Community Health Education</i> , 31(4), 387–399. Texas, USA	To determine the impact of CHW on the self-management practices of people in with diabetes on the US–Mexico border	T2DM	Trial	DM knowledge	NR	30	NR	24	12	
37	Saxe-Custack, A., & Weatherspoon, L. (2013). A patient-centered approach using community-based paraprofessionals to improve self-management of Type 2 Diabetes. <i>American Journal of Health Education</i> , 44(4), 213–220. Michigan, USA	To examine if a lifestyle management program can initiate positive impacts on self-management and behavior change among participants with type 2 diabetes	T2DM	Trial	BP, BMI, HbA1c, demographic information, lifestyle behaviors (also PA and nutrition), behavior change by stages of change, appraisal of diabetes	Communit y setting	122	Group sessions Individual meetings Home visits	2.5+6	16	
38	Tsoh, J., Burke, N., Gildengorin, G., Wong,	To evaluate a smoking	CC	Trial	7-day and 30-day	Communit	192	Small group	2+3	21	

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4		C Le, K., Nguyen, A., Chan, J.L., Sun, A.,	cessation program:	(smoking		smoking abstinence,	y setting		sessions		
5		McPhee, S.J. & Nguyen, T.T. (2015). A	intention to quit, use of	cessation)		assessed by smokers			Telephone calls		
6		Social network family-focused intervention	cessation recourses and			and family members					
7		to promote smoking cessation in Chinese	smoking abstinence								
8		and Vietnamese American male smokers: A				Descriptive					
9		feasibility study. <i>Nicotine & Tobacco</i>				statistics,					
10		<i>Research</i> , 17(8), 1029–1038. USA				significance, linear					
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17	39	Tully, M., Kos, A., Eastwood, D., Kusch,	To describe the	CVD	Trial	BP	Health	83	Group sessions	6	16
18		J., & Kotchen, T. (2015). Implementation	development,	(blood		<i>t</i> tests and χ^2 tests.	center				
19		of an adjunct strategy to reduce blood	implementation, and	pressure)							
20		pressure in blacks with uncontrolled	evaluation of a BP								
21		hypertension: a Pilot Project. <i>Ethnicity &</i>	program								
22		<i>Disease</i> , 25(2), 168–174.									
23		Wisconsin, USA									
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30	40	Turner, A., Anderson, J.K., Wallace, L.M.	To investigate a self-	CC	Trial	Demographic data,	Communit	486	Group meetings	2	19
31		& Bourne, C. (2015). An evaluation of a	management program			Patient Activation,	y setting				
32		self-management program for patients with	among patients with			EuroQol, Hospital					
33		long-term conditions. <i>Patient Education</i>	long-term conditions			Anxiety and					
34		<i>and Counseling</i> , 98(2), 213–219. UK				Depression, Health					
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Questionnaire

Paired *t* tests,

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McNemar's test

NR = not reported

CVD = cardiovascular disease

CC = chronic conditions or its prevention

CHC = community health center

'=estimated

BMI = body mass index

BP = blood pressure

BG = blood glucose

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<p>Characteristics and training of LHWs</p>			<p>Theories and guidelines behind the intervention</p>
<p>Experience with long-term conditions</p>	<p>Self-management intervention components and delivery by LHWs</p>		<p>National guidelines for DM, hypertension and cardiovascular diseases</p>
<p>Eligibility based on personal interest or maintained self-management</p>	<p>Participants recruited by LHWs or health professionals</p>	<p>Interaction frequency from once a week to every second month, often besides usual health care</p>	<p>Transtheoretical model of change</p>
<p>Length of training from one day to 240 h, approx. 30 to 60 h</p>	<p>Attrition prevention by providing, e.g., make-up sessions, telephone support calls, gift cards.</p>	<p><u>Principles of implementation:</u> individual-empowering, culture and language sensitiveness, peer education, family-centering, social networking</p>	<p>Social cognitive theory</p>
<p>Elements of training: classroom training, hands-on activities, home visits, clinical measurements</p>	<p><u>Elements:</u> PA, nutrition, medication, clinical measurements, and other education classes; online programs</p>	<p><u>BCTs:</u> Self-monitoring, goal setting, information providing, action plans, enhancing social support</p>	<p>Chronic care model</p>
<p>Training contents: LTCs, motivation, self-monitoring, self-management, medication</p>	<p><u>Formats:</u> Individual or group meetings delivered by a LHW or a group of LHWs; LHW as a</p>	<p>provided face to face, via telephone, online, at clinics or community centers or home visits.</p>	<p>Self-efficacy theory</p>

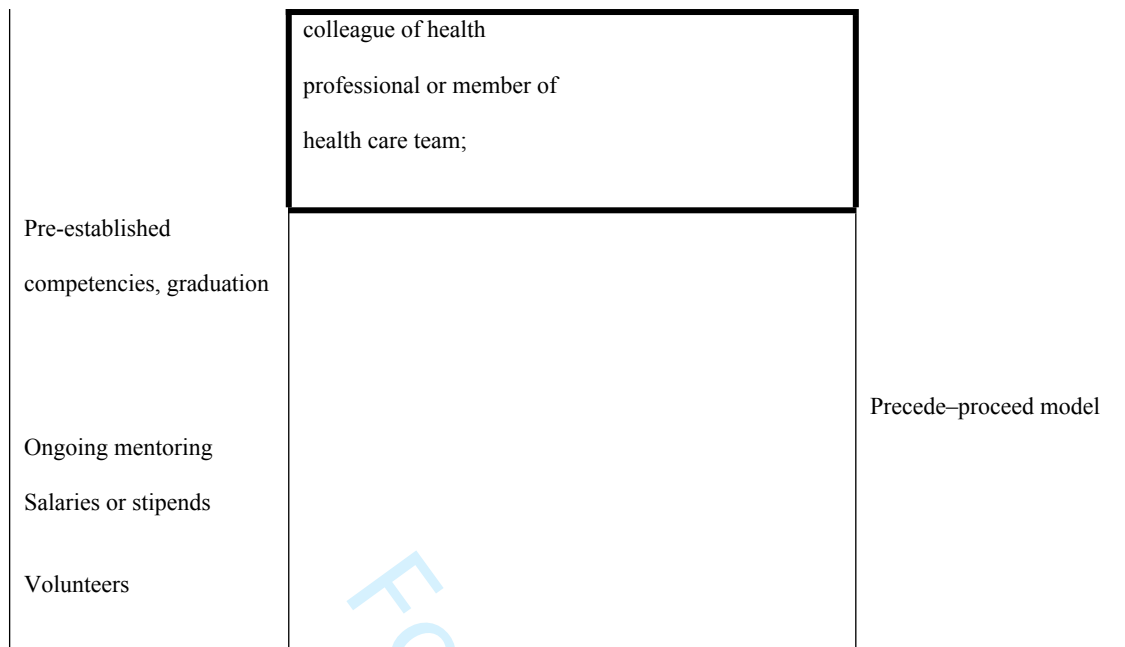


Figure 2. Synthesis of LHW-led self-management interventions for diabetes, cardiovascular diseases and prevention.

Table 4. Reported theories and principles.

Theories and models applied and reported	<i>n</i>
Transtheoretical model of change ^(7,8,11,23,29,30,33,37,38)	9
Social cognitive theory ^(1,8,14,21,38)	5
Chronic care model ^(22,40)	2
Self-efficacy theory ^(31,32)	2

Precede–proceed model ^(2,28)	2
Socioecological model ^(5,17)	2
Health belief model ⁽³³⁾	1
Self-management theory ⁽¹⁵⁾	1
Principles and methods applied and reported	<i>n</i>
Individual-empowerment ^(17–19,23,25,33,34,38–40)	10
Peer education principles ^(4,8,9,23,32,39,40)	7
Culture-sensitivity ^(11,12,14,23,33,34)	6
Understanding of the context in which behavior changes take place ^(4,8,21,23,33,30)	6
The active role of recipients ^(4,12,25)	3
Motivational interview ^(25,30,37)	3

Table 5. Examples of the most often reported BCTs.

BCT	<i>n</i>
Self-monitoring ^(3,4,6–8,12–14,16,18,19,21,22,25,27–32,37,39)	24
taking clinical measurements: blood sugar and blood pressure ^(2,6,15,16,19,28,30,39)	
monitoring of symptoms and health behavior related to the	

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assessed goals ^(4,7,28,29)	
using self-management monitors: blood glucose, blood pressure and pedometers ^(12,14,22,29,30,39)	
Goal setting ^(3,7,8,15,16,18–20,21,25,27–29,32–34,35,37,38)	20
Information providing ^(6,8,11,14,15,17,19,21,22,25,28,30–32)	17
Individual action plans to support health-related behavior ^(6,10,11,14,19,20,29,31–33,38,39)	12
Enhancing participants' social support ^(6,7,15,16,18,22,23,25,29,32,40)	11
Practicing problem solving techniques ^(2,6,7,15,18,19,28,29,32,37)	10
Possibilities to tailor intervention activities towards participants' personal needs ^(11,14,18,28,30,31,33,38–40)	10

Table 6. Original studies that reported outcomes of NB and/or PA

Original paper	Theory	Format	Individual / Group	Additional info	Number of BCTs	Frequency	Length + follow-up (month)	Improv ment in NB	Improv ment in PA	Improv- ment in CM
(7) Lynch et al., 2014	Models of behavior change	Telephone calls Education lectures	Individual + group	18 group sessions by dietitian and LHW weekly for three months, afterwards every second week; phone calls weekly by LHW	9	weekly	6	yes	yes	yes / no
(15) Rothschild et al., 2014	Self-management theory	Home visits Telephone calls	Individual	36 home visits	7	monthly	24	no	no	yes / no
(17) Spencer et al., 2011	Empowerment theory	Education lectures, Home visits, Accompanied clinic	Individual	Group session once every two weeks Telephone calls once	4	weekly	6	no	yes	yes / no

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		visits,		every two weeks						
		Telephone								
		counselling,								
		Peer activities								
(21) van der Wulp et al., 2012	Social cognitive theory	Home visits, Education lectures, Telephone counselling, Emails	Individual	Monthly meetings, Telephone calls two weeks after meetings. Plus calls and emails when needed.	5	two weeks	18	yes	no	-
(23) Assah et al., 2015	Socioculturally adapted community-based approach	Group meeting, Individual appointments, Telephone counselling, Home visits	Individual + group	Six group meetings, personal encounters, telephone calls (five calls)	3	monthly	6	yes	yes	yes

(25) Castillo et al., 2010.	Empowerment theory, Adult education	Group meeting, Individual appointments, Education lectures	Individual + group	Ten group education sessions + individual contacts between sessions	9	weekly	2.5	yes	yes	yes / no
(26) Cene et al., 2013	Community capacity building	Group meeting, Education lectures	Group	Group meetings weekly for six weeks, then monthly, 12 sessions total	2	six times weekly, afterwards monthly	7.5	-	no	no
(29) Dye et al., 2015	Transtheoretic al model of change	Group meeting, Education lectures	Group	Self-management curriculum: 7 meetings plus additional lectures on NB or PA	8	weekly	4	yes	yes	yes
(30) Fernandes et al., 2012	Transtheoretic al model of change	Group meeting, Education lecture, Peer work shop	Group	Group meetings, afterwards monthly meetings up to 12 months	9	11 times weekly, afterwards monthly	12	yes	yes	yes / no

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(31) Islam et al., 2013	Community-based approach	Group meeting, Individual appointments, Education lectures, Make-up sessions	Individual + group	Individual six monthly group meetings plus individual meetings at months 3, 6, and 9	4	monthly up to 6 months, individual at 9 months	9	yes	yes	no
(32) Lorig et al., 2013	Self-efficacy theory	Online group meetings, Education lectures, Weekly activities	Online: Individual + group	Online program	15	available every day	1.5 + 12	-	yes	-
(33) Micikas et al., 2015	Stages of change, Health belief model	Group meetings, Education lectures, Home visits	Individual + group	Individual home visits, group meetings	7	weekly	4	-	no	yes
(37) Saxe-Custack et al., 2013	Community-based approach	Group meetings, Individual appointments,	Individual + group	four individual weekly meetings at home, afterwards six home	9	weekly	2.5 + 6	yes	no	yes / no

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Education lectures,	visits or group meetings
Home visits	weekly

NB = nutrition behavior

PA = physical activity

CM = clinical measurements

- = was not measured

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Table 7. Outcomes in nutrition behavior and physical activity and their links to intervention components and clinical measurements

Measured outcome	Type of effect	Original paper	Formats	BCTs	Clinical measurements
					+improvement
					-no improvement
NB + PA	NB + PA improved	7	Telephone calls + Education lectures	9: Goal setting, motivating, emotional support, teaching problem-solving techniques, enhancing social support, self-monitoring, role	+HbA1C

	(individual + group)	model narratives, hands-on activities, taking and monitoring clinical measurements	+Weight loss -Blood lipids -Blood pressure
23	Group meeting + Individual appointments + Telephone counselling + Home visits	3: Teaching self-management skills, enhancing social support, discussion	+HbA1C +Blood lipids +Blood pressure +BMI +Fast BC +Waist circ +Weight loss
25	Group meeting + Individual appointments + Education lectures	9: Goal setting, self-efficacy support, motivating, teaching self-management skills, enhancing social support, support decision making, information providing, self-monitoring, hands-on activities	+HbA1C +Blood pressure -Weight loss
29	Group meeting + Education lectures (group)	8: Goal setting, self-efficacy support, teaching problem-solving techniques, enhancing social support, action plans, self-monitoring, personal health diary, taking and monitoring clinical measurements	+Blood pressure +Fast BC +Weight loss +Blood lipids

		Group meeting + Education lectures (group) + peer work shop	9: Information providing, self-monitoring, using written counselling materials, reminders, tailoring, hands-on exercises, taking and monitoring clinical measurements, healthy snacks, incentives	+Blood lipids +Fast BC -HBA1c -Blood pressure -BMI
	30			
		Group meeting + Individual appointments + Education lectures + Make-up sessions	4: Information providing, action plans, self-monitoring, tailoring	-Blood lipids -HbA1c -Blood pressure -BMI
	31			
		Home visits + Education lectures + Telephone counselling + emails	5: Goal setting, self-efficacy support, motivating, information providing, self-monitoring	NR
	21			
NB improved		Group meetings + Individual appointments + Education lectures + Home visits	9: Goal setting, motivating, teaching problem solving, teaching relapse prevention, information providing, self-monitoring, tailoring, guest speakers, hands-on exercises	+HbA1C +BMI -Blood pressure
	37			
PA improved		Education lectures + Home visits + Accompanied clinic visits	4: Self -efficacy support, keeping appointments, information providing, hands-on exercises	+HbA1C +Blood lipids
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				-Blood pressure
				-BMI
		<i>Home visits + Telephone calls</i>	<i>7: Goal setting, teaching self-management skills, teaching problem-solving techniques, enhancing social support, information providing, using metaphors, taking and monitoring self-management skills</i>	+HbA1C +Weight loss
	<i>no improvements</i>	15		-Blood lipids -Blood pressure
		Online group meetings + Education lectures + Activities	15: Goal setting, self-efficacy support, teaching self-management skills, emotional or behavioral support, teaching problem-solving skills, sharing feelings, enhancing social support, stress managements, information providing, action plan, self-monitoring, feedback, discussion, role model narratives, hands-on exercises	NR
	improved	32		
PA		<i>Group meeting + Education lectures</i>	<i>2: Guest speakers, taking and monitoring clinical measurements</i>	-Blood pressure -Fasting BC -Weight loss -Blood lipids -HbA1C
	<i>no improvements</i>	26		
		<i>Group meetings + Education lectures + Home visits</i>	<i>7: Goal setting, emotional and behavioral support, action plans, reminders, discussion, tailoring, hands-on exercises</i>	+HbA1C
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**Implementation and Outcomes of Lay Health Worker–Led Self–Management
Interventions for Long-Term Conditions and Prevention: A Systematic Review**

3 March 2019: revised version

A manuscript for Health Education & Behavior

For Peer Review

Abstract

The aim of this study was to systematically review lay health worker (LHW)-led self-management interventions for adults with long-term conditions (LTCs) to see how the interventions have been implemented and to compose a synthesis of [research](#) findings, taking into consideration the intervention components that have been applied.

We conducted systematic searches for articles published between January 2010 and December 2015 in five databases: Cochrane, MEDLINE, CINAHL, PsycINFO and Web of Science. Forty original studies were found that met the inclusion criteria: self-management with diabetes ($n = 29$), cardiovascular diseases ($n = 8$), and those at risk of cardiovascular diseases ($n = 3$). [These](#) consisted of 22 randomized controlled trials and 18 other trials, with durations of one day to 24 months. The findings showed that the training of LHWs and the implementation of interventions varied widely. A synthesis of the implementation methods covers the background of the LHWs and the interventions as well as the components applied in each. Eight interventions had effects on physical activity and eight on nutrition behavior. The review also includes preliminary findings on intervention components effective in improving physical activity and nutrition behavior, including self-monitoring as a behavior change technique and group meetings as an intervention format. The same components and behavior change techniques were applied in effective and non-effective interventions.

The review found that LHW-led interventions have potential in promoting self-management in LTC. In the future, a qualified and evidence-based structure for LHW-led interventions is suggested in order to improve the systematization of interventions and their effects.

Keywords: lay health worker, long-term condition, self-management, intervention component, behavior change technique, systematic review

Introduction

Non-communicable diseases (NCD) are long-term conditions (LTC) that require ongoing self-management over a period of years as individuals learn to manage their health challenges (Eaton, Roberts, & Turner, 2015; Taylor et al., 2014; Nolte & McKee, 2008). The self-management of LTCs has been defined as a daily and flexible process where an individual, as a responsible actor, is able to perform individual goal-driven activities (Lorig & Holman, 2003; Ausili, Masotto, Dall’Ora, Salvini, & Di Mauro, 2014), such as adopting information, drug and symptom management, and adjustment to psychological consequences such as emotions and stress (Barlow, Wright, Sheasby, Turner, & Hainsworth, 2002).

Acquiring and applying individual skills related to self-management components demands effort from patients, peers, and health professionals (Kaptein, Fischer, & Scharloo, 2014; Kawi, 2012). People’s beliefs that they can cope in their everyday activities and meet the challenges of self-management have been labelled as self-efficacy (Bandura, 1977; Vervekina, Shi, Fuentes-Caceres & Scanlon, 2014). Self-management interventions provide support to modify one’s decisions and behavior for a healthier lifestyle. Interventions usually include a variety of observable and replicable behavior change techniques (BCT), such as goal setting, action planning, and self-monitoring (Michie et al., 2013; Duff et al., 2017).

The self-management of LTC has been supported by peers (Tang, Funnell, Gillard, Nwankwo, & Heisler, 2011; Dale, Williams, & Bowyer 2012; CADTH, 2013), who are usually people with the same diagnosis or health condition as the people they assist (Lorig & Holman, 2003; Carr et al., 2011; van Ginneken et al., 2013). Lay health workers (LHW) as LTC self-management supporters are especially able to share values, socioeconomic status or cultural background and, in some cases, also the experience of LTC (South, Meah, Bagnall & Jones, 2013; Hunt, Grant, & Appel, 2011; Islam et al., 2015).

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3 LHWs act as peer supporters, educators, role models, and community capacity builders
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5 (South et al., 2013). LHWs have been shown to improve equity in health care services by
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7 reaching underserved people with a poorer health status (Walker & Jan, 2005; Shah & Patel,
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9 2013). There has been a wide variety of LHW training in terms of duration and methods
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11 (O'Brien, Squires, Bixby, & Larson, 2009; South et al., 2013).
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15 The effectiveness of LTC self-management interventions has been measured through
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17 individuals' knowledge, psychological state, behavior, and clinical outcomes (Dube, Van de
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19 Broucke, Housiaux, Dhoore, & Rendall-Mkosi, 2015). Lay-led self-management programs
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21 for those with chronic conditions may improve short-term self-management outcomes, such
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23 as physical activity (PA) and self-efficacy (Foster, Taylor, Eldridge, Ramsay, & Griffiths,
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25 2009). Previous systematic reviews of LHW interventions for diabetes found that (a) LHWs'
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27 roles in individuals' self-management counseling were diverse in their ways to support,
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29 educate, advocate, and facilitate, and (b) interventions were partially effective in improving
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31 HbA1C levels and health behavior outcomes (Hunt et al., 2011; Little, Wang, Castro,
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33 Jimenez, & Rosal, 2014). Carr et al. (2011) investigated connections between the
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35 implementation of interventions and their outcomes, but found no firm relationships between
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37 them.
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44 However, in this study we systematically reviewed previous LHW-led self-management
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46 interventions for adults with LTCs in terms of the implementation of interventions. The first
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48 objective was to investigate those characteristics of LHWs and their training that have been
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50 reported within the context of self-management. The second objective was to investigate the
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52 implementation of interventions. The third objective was to investigate what kind of
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54 relationships, if any, there are between intervention components and nutrition behavior (NB)
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56 and PA outcomes.
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Methods

Search strategies and selection criteria

The present review was conducted according to standard systematic review methodology (CRD, 2009) and reported according to the PRISMA Statement (Liberati et al., 2009). A systematic search for articles, reported full text in English (due to limited facilities and resources for translation) and published between 2010 and 2015, was undertaken in five databases between December 2015 and January 2016: Cochrane, MEDLINE, CINAHL, PsycINFO, and Web of Science. Search terms included Community Health Worker* OR Lay health* OR Lay supporter* OR Lay tutor* OR Advisor* OR counsellor* OR counselor* OR peer OR peer counsellor* OR peer counselor* OR peer-advisor* OR peer-coach* OR peer-counsellor* OR peer-counselor* OR peer-educator* OR peer-led* OR health trainer* AND Self-Management OR Self care. Both MeSH and free-text terms were used. [The full search strategy is available from the authors on request.](#)

One of the authors extracted [independently](#) the following data [independently](#) and discussed [it](#) with the other researchers who were involved with study selection. Disagreements between reviewers were resolved by consensus. [The](#) following inclusion criteria were applied: adults as recipients; non-communicable and somatic diseases or [their](#) prevention [of them](#); LHW-led self-management intervention; organized by primary health care, community health center or corresponding organization; RCTs and quantitative trials. The exclusion criteria were the following: studies that reported outcomes of LHWs' own self-management; intervention was led by non-trained peer supporter; family interventions; cancer, HIV, asthma or mental health self-management interventions; review papers; study protocols; and papers presenting baseline results only (Figure 1).

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3 All of the included studies deal with self-management of diabetes and cardiovascular
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5 diseases. Both diseases, as long-term somatic and non-communicable conditions, can largely
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7 be prevented or treated by allied self-management activities covering certain daily behavioral
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9 and psychological actions taken by individuals. NB and PA are key self-management
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11 activities when dealing with type 2 diabetes and cardiovascular diseases on a daily basis
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13 (WHO, 2013; Donaldson & Rutter, 2017). In addition, there is a vital need for research with a
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15 scope that combines self-management and prevention in both diabetes and cardiovascular
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17 diseases. The quality of the included studies was assessed using the 14-item checklist from
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19 the Manual for Quality Scoring of Quantitative Studies **with a range of 0–28 points** (MQSQ;
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21 Kmet, Lee, & Cook, 2004). The quality evaluation was conducted by the first author, and the
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23 decisions have also been discussed with two other authors.
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33 *Analysis*

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35 **The analysis of the first and second objectives** ~~of the current study aimed to investigate~~
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37 **concerned the contents of LHWs, their training and LHW-led self-management interventions.**
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39 **The interventions' components** were classified according to their formats (e.g., group,
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41 individual, telephone, home visit), elements (e.g., lectures, PA classes; Davidson et al.,
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43 2003), and BCTs (Michie et al., 2013). ~~For the first and the second research objectives,~~ The
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45 data were analyzed using content analysis (Schreier, 2012) by identifying the units of
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47 meaning, condensing them and finally creating subcategories. Based on similar
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49 subcategories, eight main categories were composed: (1) characteristics of LHWs, (2)
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51 training of LHWs, (3) intervention delivery by LHWs, (4) theoretical background and
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53 guidelines of the interventions, (5) principles of implementation, (6) intervention formats and
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3 elements, (7) behavior change techniques, and (8) intervention management and mediators.
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5 (Table 1.)
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9 For the third objective of the [review](#), self-management was investigated as a [behavioral](#)
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11 outcome of NB and PA in 13 original studies that [measured](#) them. The analysis was
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13 conducted by identifying the components and clinical measurements and their links to NB
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15 and PA. The data within these analyses [was](#) relatively narrow, however, [it was eventually](#)
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17 [grouped](#) according to their improvements in NB and PA and those groups were compared.
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19 This review describes and identifies the intervention features that indicate participants'
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21 [behavior changes within the original studies.](#)
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25 All of the following aspects in the fields of NB and PA and clinical measurements were
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27 manually coded and categorized in Microsoft Excel: the reported intervention formats and
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29 elements, such as delivery in group or individual sessions, telephone or online contact, and
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31 education lectures (Davisdon et al., 2003); behavior change techniques (applied by Michie et
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33 al., 2013); [intervention length and frequency](#); significantly improved and not improved self-
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35 management outcomes [in terms of PA and NB; and clinical measurements.](#)
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40 This semi-qualitative metric was developed in the current study to extract and investigate the
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42 [connections](#) [links between intervention components and PA and NB.](#) Additionally, there were
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44 a large [variety of measurements](#) ~~number of different scales and measures~~ used to assess [PA,](#)
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46 [NB, blood lipids, and blood pressure as self-management outcomes,](#) which were difficult to
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48 bring together. Therefore, all of the tests that investigated similar items ~~needed to be~~ [were](#)
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50 classified as items of self-management (Table 2) in order to allow the data to be analyzed and
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52 for the results to be explained based on the study topic. All of the results are based on the
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54 published study results, and no original study data or intervention material have been
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56 examined.
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Results

Included studies

The included studies ($n = 40$) originated from seven countries, most of them from the United States ($n = 31$). Twenty-nine studies examined self-management in diabetes, eight in cardiovascular diseases, and three in a risk of cardiovascular diseases. The included studies consisted of 22 randomized controlled trials and 18 other trials. The methodological quality of the studies ranged from 9 to 25 points, with a total possible MQSQ sum of 28 points (9–12 points, 5 studies; 13–20 points, 23 studies; 21–25 points, 12 studies; see Table 3). Points were typically subtracted due to an absence of randomization or blinding, or due to a lack of reporting about them. No original studies were excluded, since the focus of the review was on qualitative description of LHWs and interventions. Additionally, MQSQ does not set any score limits for the appropriate level of study quality.

The durations of the self-management interventions varied from one day to 24 months. The number of baseline recipients in all the included studies was 10,065 (female 55%) and follow-up 7,970, with a total attrition rate of 21%. The studies varied largely in their reporting. For example, in some papers the background, training, and duties of LHWs as well as intervention details were clearly presented, and in others they were not. Due to the high number of studies included in the current review, the original studies will be cited according to the numbers referred to in Table 3.

Characteristics of LHWs and their training

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3 **The individual skills and characteristics** often **included** having the similar health condition
4 or experience of it as the participants had^(8,10,12,16,20,21,32,38). LHWs came from the same
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6 community as the recipients did^(6,8,26), and some of them also had a professional
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8 background^(24,26). Many of the studies were located in minority communities, therefore LHWs
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10 were often bilingual, combining, for example, Spanish and English^(11,25,27,30,31).

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15 **Training educators** were revealed to be health professionals^(7,14), specialists^(1,28), or
16 university researchers^(25,29). **Besides of self-management-related**
17 **themes**^(2,4,5,7,8,9,11,12,15,16,17,18,20,21,22,23,25,28,29,33,34,37,40), **Training content** consisted of using
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19 community resources, navigating health care services, and organizational
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21 issues.^(5,8,9,12,16,18,20,22,29) (See Figure 2.) **Additionally LHWs' training also included themes of**
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23 **supporting effective self-management techniques, such as motivational, self-monitoring and**
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25 **measuring** ^(2,4,5,7,8,9,11,12,15,16,17,18,20,21,22,23,25,28,29,33,34,37,40), **alongside clinical protocols**
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27 **(8,11,16,25,34,35)**, **medication** ^(9,20,34) **and self-care routines** ^(9,16). The training **elements** varied
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29 **from, for example, classroom activities**^(8,28,38,40) **to home visits**⁽⁹⁾. The LHWs were also trained
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31 in research practices^(2,5,8,12,16,25,28,38), protecting human subjects^(5,18,25), and cultural
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33 awareness^(5,18).

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42 The number of LHWs within one intervention varied from 1⁽¹⁴⁾ to 41⁽¹⁶⁾. LHWs had **multiple**
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44 **roles and duties related to intervention components**. Between the education sessions,
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46 LHWs contacted participants to provide support or to answer their questions^(1,7,17,25,35,39).
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48 They were also available for recipients' phone calls.⁽¹⁾ In **a few** interventions LHWs worked
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50 as equal members of health care teams^(5,11,12,24,27,29,30,33,34,40).

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54 LHWs also collected research data ^(1,25,31), contributed to intervention evaluations⁽²⁵⁾, and
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56 acted as a team leader for a group of LHWs.^(4,26,39) Some studies reported **supervision**
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58 **provided to LHWs** by program coordinators^(3,4,5,8,9,20,37), nurse care managers^(2,3,28), health
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3 care teams of community centers^(5,37), and university professionals⁽³⁷⁾. In some cases, LHWs
4 were provided with a written manual to ensure consistency of delivery.^(37,38,40) They consulted
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6 with health professionals on any serious symptoms or for measurements of
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8 recipients.^(11,12,27,32)
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16 *Intervention delivery of LHW-led interventions*

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19 Nearly half of the 40 studies reported no **theoretical background** for the intervention or
20 program^(3,4,6,9,10,12,13,16,18-20,24,26,27,34-36,39), but some did (Table 4). In eight studies the
21 theoretical background was presented as a combination of two theories^(5,8,11,23,25,33,38,40). The
22 framework of an intervention's content or its components was often based on **national**
23 **guidelines and recommendations** on diabetes^(1,2,5,11,12,14,15,26,27,32,35), hypertension^(8,29), or
24 cardiovascular diseases^(30,39).
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34 Meetings usually took place in community centers and churches, often held at a convenient
35 location to the recipients^(1,2,4,22,23,25-27,31). **The length** of sessions, when reported, ranged from
36 30 to 90 minutes.^(26,27,29,37) **Group sizes** varied from two^(24,38) to twenty-five⁽³²⁾ participants.
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38 In a few interventions the interaction frequency was based on the needs of peers and
39 recipients.^(2,21)
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46 **LHWs delivered educational activities for individuals or groups, including making action**
47 **plans, motivating, problem solving, and self-management guidance with support given either**
48 **face to face by telephone** ^(2,4,5,7,9,10,15,17,22,24,25,27,28,29,33,34,39,40), or online ⁽³²⁾. **Home visits were**
49 **also conducted** ^(11,17). **Some of the LHWs assessed goals** ⁽³⁹⁾, **provided confidant information**
50 **(29), or helped patients to understand their long-term conditions and self-management** ^(2,9,25).
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3 **All together, the** studies reported thirty-five separate **health behavior change techniques**
4
5 being applied (Table 5).

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8 **Recruitment** of potential individuals to participate in interventions was conducted at
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10 hospitals, health centers, community centers or churches^(6,7,8,12,15,34,35), or via the media,
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12 websites or seminars^(15,22,32). To ensure **fidelity of program delivery**, classes were
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14 monitored^(16,22) or audio recorded⁽¹²⁾, checklists were completed⁽²¹⁾ or activity reports were
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16 submitted⁽²²⁾. Interventions **acted as bridges to local health and social services** by
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18 encouraging participants to continue with their health care
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20 services^(3,5,6,14,16,17,18,19,21,22,28,31,37,38,39). **Attrition prevention** was performed by implementing
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22 make-up sessions⁽³¹⁾, providing cash incentives, stipends or gift cards^(14,19,20,37,39), and making
23
24 telephone support calls to recipients who did not attend the sessions⁽¹⁸⁾.

33 *PA and NB outcomes in the LHW-led interventions*

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36 Statistically significant **improvements** (minimum of $p < .05$) in all self-management
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38 outcomes, including psychological, behavioral, and clinical **outcomes**, were reported in many
39
40 studies. Because our review concentrated on behavior, **the** outcomes of PA and NB as self-
41
42 management activities, and their **links connections** to clinical outcomes, are presented. **Ten**
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44 **studies measured both PA and NB, and three studies measured only PA** (see Table 6).
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46 Measurements of the studies were mostly pre- and posttest, **with** only two studies **having**
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48 **follow-ups**^(32,37).

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53 Out of ten studies that investigated both PA and NB, six **interventions improved reported**
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55 both **improved** PA and NB^(7,23,25,29-31), two **interventions reported** improved NB^(21,37), one
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57 **reported improved** PA⁽¹⁷⁾, and one found no improvements⁽¹⁵⁾. NB- and PA-effective
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3 interventions were organized into groups, and four of **them these** had additional individual
4 activities.^(7,23,25,31) Their length varied from two-and-a-half months⁽²⁵⁾ to 12 months⁽³⁰⁾. Four
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6 of them provided activities weekly, and five had education lectures. Their number of
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8 identified BCTs were eight⁽²⁹⁾ or nine^(7,25,30). Three of the NB- and PA-effective interventions
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10 also improved clinical measurements such as HbA1C^(7,23,25), blood pressure^(23,25,29), blood
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12 lipids^(23,29,30), and weight loss^(7,23,29), and one⁽³¹⁾ found no clinical improvements. **(Table 7)**
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**The current review also aimed to identify PA- and NB-effective interventions separately to
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get more accurate results concerning behavior change in LHW-led self-management

interventions. In PA-effective interventions^(7,17,23,25,29–32) the number of applied BCTs varied
from three to fifteen. In **part some** of the interventions, group meetings were combined with
individual face-to-face meetings, at recipients' homes, or via telephone. In PA-ineffective
interventions^(15,21,26,33,37) the intervention components were mainly similar to effective PA
interventions, with two of them providing only individual meetings. The number of BCTs
ranged from two to nine. Regarding the high number of applied BCTs, certain remarks
appeared in terms of PA as a form of self-management activity **(Figure 3)**. Self-monitoring,
enhancing social support, hands-on activities, and self-efficacy support were mainly
connected linked to improvements, whereas goal setting was **connected linked** to both
improvements and no improvements. Increased PA was often related to positive effects on
clinical measurements, but not in all cases.

In NB-effective interventions^(7,21,23,25,29–31,37) the number of BCTs was from three to nine, with
some variations in techniques, theoretical backgrounds, and durations. In those studies, it was
more likely that self-monitoring, goal setting, and motivation **were used as BCTs**. **(Figure 4)**
For example, information providing **was had been** used in four studies where NB improved
but also in both studies where no improvement was found. When measured alongside NB,

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3 many studies also found positive effects on clinical measurements. Nevertheless, despite the
4 improved NB, blood pressure was more likely to increase than decrease.
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11 Discussion

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15 The current review found that LHW-led self-management interventions have potential in
16 promoting self-management in LTC. The implementation of interventions varied widely.
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18 Only about one third of the studies investigated NB and PA as indicators of behavior change,
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20 however, some of those that did had found positive outcomes.
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25 The findings show that LHWs were often themselves trained LTC patients, who were
26 personally interested in acting as LHWs. This study restates the previous descriptions of
27 LHWs (Hunt et al., 2011; South, Kinsella & Meah, 2012; South et al., 2013), who are
28 considered to be trained peer workers, as having similar cultural, ethnic or health
29 backgrounds to their clients. LHWs' roles were identified as educators, supporters, opinion
30 leaders, organizers, and acting as bridges between communities, professionals, and clients.
31
32 Interventions typically encompassed empowerment, social support, and tailoring-oriented
33 principles, and they varied widely in length, frequency, and components. For example, group
34 sessions, education lectures, and individual appointments were common formats, whereas
35 self-monitoring, goal setting, information providing, action plans, and social support were
36 frequently applied BCTs. Similar formats and BCTs were often applied in effective as well as
37 in non-effective interventions.
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53 The implementation of and reporting on both LHW training and LHW-led interventions
54 diverged, as has been shown in previous studies (Hunt et al., 2011; Shah et al., 2013). A
55 number of interventions lacked a theoretical background, or at least did not report one (Hunt
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3 et al., 2011; Dale et al., 2012), which is a common issue in evidence-based health promotion.
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5 Implementation quality was assured in many interventions by providing continuous
6
7 supervision during the intervention process (Hunt et al., 2011). That can be considered as a
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9 way to empower LHWs to be self-management tutors, and also assist them in cooperating
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11 with each other. As a non-professional workforce, they may benefit from organizational
12
13 support for their work.
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17 Interventions often followed national recommendations or guidelines for particular LTCs, as
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19 well the program for chronic disease self-management (Lorig et al., 2013). However, the
20
21 current review highlights self-management as a person's own activities and emotions for
22
23 taking care of a LTC by, for example, setting and modifying goals, solving problems, relying
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25 on peer support, and action planning (also Richardson et al., 2014). It seems that part of the
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27 interventions emphasized lecturing and giving advice, while many interventions consisted of
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29 behavioral and emotional elements that supported self-management (also Kawi, 2012; Lorig,
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31 Ritter, Ory & Whitelaw, 2013; Kaptein, et al., 2014). Effective self-management support
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33 should correspond to recipients' unique needs as well as assist individuals in strengthening
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35 their motivation and skills in coping in daily life with an LTC (Newbould, Taylor, & Bury,
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37 2006). However, participants who lack knowledge and others with low self-efficacy may fail
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39 to benefit from similar activities and support in improving their self-management. These
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41 demands have been responded to in many interventions by tailoring intervention activities
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43 according to individual participants' requirements.
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51 This review had similar findings to previous work, in that LHW-led self-management
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53 interventions can be effective in HbA1c (Hunt et al., 2011; Dale et al 2012; Little et al.,
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55 2014), and in a few interventions in PA, NB, blood pressure, and blood lipids (Hunt et al.,
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57 2011; Dale et al., 2012). Even though the same components and BCTs led to both significant
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59 and non-significant outcomes, some preliminary but not robust **connections** **links** were
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3 observed. Group meetings and enhancing social support seemed to be particularly effective in
4
5 improving PA. This reflects earlier findings (Greaney et al., 2017) and also highlights the
6
7 need for social activities and for sharing motivation and feelings with LHWs and other
8
9 recipients when improving one's PA. Furthermore, self-monitoring and hands-on activities
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11 and exercises as self-management actions were more likely ~~connected~~ **linked** to both
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13 improved PA and NB. Regarding the findings of generally applied BCTs in PA interventions
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15 (Duff et al., 2017), goal setting did not appear as an effective BCT at this time. **However, in**
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17 **terms of behavior change interventions, only** about one third of the studies measured NB
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19 **and/or PA as an outcome of behavior change.** In considerations of behavior changes among
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21 long-term patients, measuring their health behavior may provide beneficial knowledge on
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23 how patients manage with self-management in the context of their daily lives. Both research
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25 and clinical practice would benefit from this information.
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35 Thus, a particular intervention component does not consistently lead to improvements.
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37 Firstly, identifying and understanding (Johnston et al., 2017) formats and BCTs and, second,
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39 applying them in self-management interventions are demanding processes, especially
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41 deciding how to maintain techniques based on recipients' unique needs, such as motivation or
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43 making action plans. When the training periods of LHWs last from days to months, it may
44
45 have been challenging to learn the further ethos of the BCTs that were applied. In a portion of
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47 the interventions it remained unclear how the LHWs were trained in BCTs. Furthermore,
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49 based on the results of this study, it is possible that other intervention components, such as
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51 intensity (Palmas et al., 2015), duration, and overall personal interaction between LHWs and
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53 participants may play a role in effective interventions.
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3 Nevertheless, as this review suggests, LHWs may have particular potential in self-
4 management interventions among cultural and lingual minorities due to their reciprocal
5 ability to share culture and experiences. They may have the potential to increase vulnerable
6 individuals' involvement in services but also to promote self-management and health
7 behavior change.
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19 *Limitations and strengths*

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21 The collected data enabled specific examinations of LHW-led self-management
22 interventions, yet the current study has its limitations. The study protocols differed,
23 combining RCT and trials with a variety of study participants. Due to the high variability and
24 high numbers of different BCTs and self-management outcomes reported within the data, the
25 evidence for making **connections links** between techniques and outcomes is limited.
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33 However, only the most **obvious findings prominent themes** are presented in this paper. The
34 **heterogeneity across interventions and outcomes variation** may also **cause lead to** limitations
35 in identifying the intervention components (Abraham et al., 2015; Johnston et al 2017) and
36 determining the results of this review, which itself contains reviews by Carr et al. (2011) and
37 Little et al. (2014). The recipients of the original studies often represented cultural or
38 linguistic minorities or low-income groups, so the results may not be transferable to other
39 groups. In addition, there may be a risk of language bias because the included studies had to
40 be reported only in English (CRD, 2009). Nevertheless, to our knowledge, the major studies
41 regarding the topic have been conducted in an international context and reported in English.
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54 This study has three primary strengths. First, it sets out a systematic synthesis of **the**
55 characteristics and training **of LHWs, the implementation and components of LHW-led**
56 **interventions**, and BCTs. The synthesis could serve as a framework for future research and
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3 clinical practice considering LHW-led self-management interventions. Second, it contains a
4 number of original studies that provide robust data on LHW-led self-management
5 interventions among people with diabetes and cardiovascular disease. Third, it presents
6 preliminary ~~connections~~ **links** between intervention components and outcomes in the field of
7 LHW-led self-management interventions. To our knowledge, there is currently only scant
8 evidence of such a ~~connection~~ **link**.

20 21 *Implications for Policy and Practice*

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24 LHW interventions, as a mode of health services for multiple groups of people, have the
25 potential to improve self-management for those with diabetes, cardiovascular diseases and
26 chronic conditions as well as **assist and** in prevention. LHW-led services in self-management
27 support may reach people who are vulnerable or underserved. However, to improve self-
28 management in LTC, systematic training in adopting and applying formats and BCTs should
29 be provided to LHW candidates. In the future, an evidence-based standard for LHW training
30 and interventions may be formulated for the field of LHW self-management interventions
31 and their investigation. Such a standard, however, requires further research on its
32 implementation.

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45 Another suggestion for further research on self-management outcomes of LHW interventions
46 would be to examine whether interaction frequency, meeting minutes, or group size have
47 effects on self-management and, if so, what are the mechanisms that make them effective. A
48 further line of study could determine how different combinations of intervention formats and
49 BCTs interact.

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3 Additionally, promoting recipients' self-regulation strategies or improving their
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5 psychological flexibility as stages of health behavior change may offer new ways to achieve
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7 goals in LHW interventions. In summary, the results of this review suggest that LHW-led
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9 self-management interventions for diabetes and cardiovascular diseases have been
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11 implemented in multiple ways, and these interventions have seemed to improve, at least
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13 partially, behavioral and clinical self-management outcomes.
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26 Walker, D.G., & Jan, S. (2005). How do we determine whether community health workers
27 are cost-effective? Some core methodological issues. *Journal of Community*
28 *Health*, 30(3), 221–229.
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34 *diseases 2013–2020*. Geneva: World Health Organization. Retrieved from
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For Peer Review

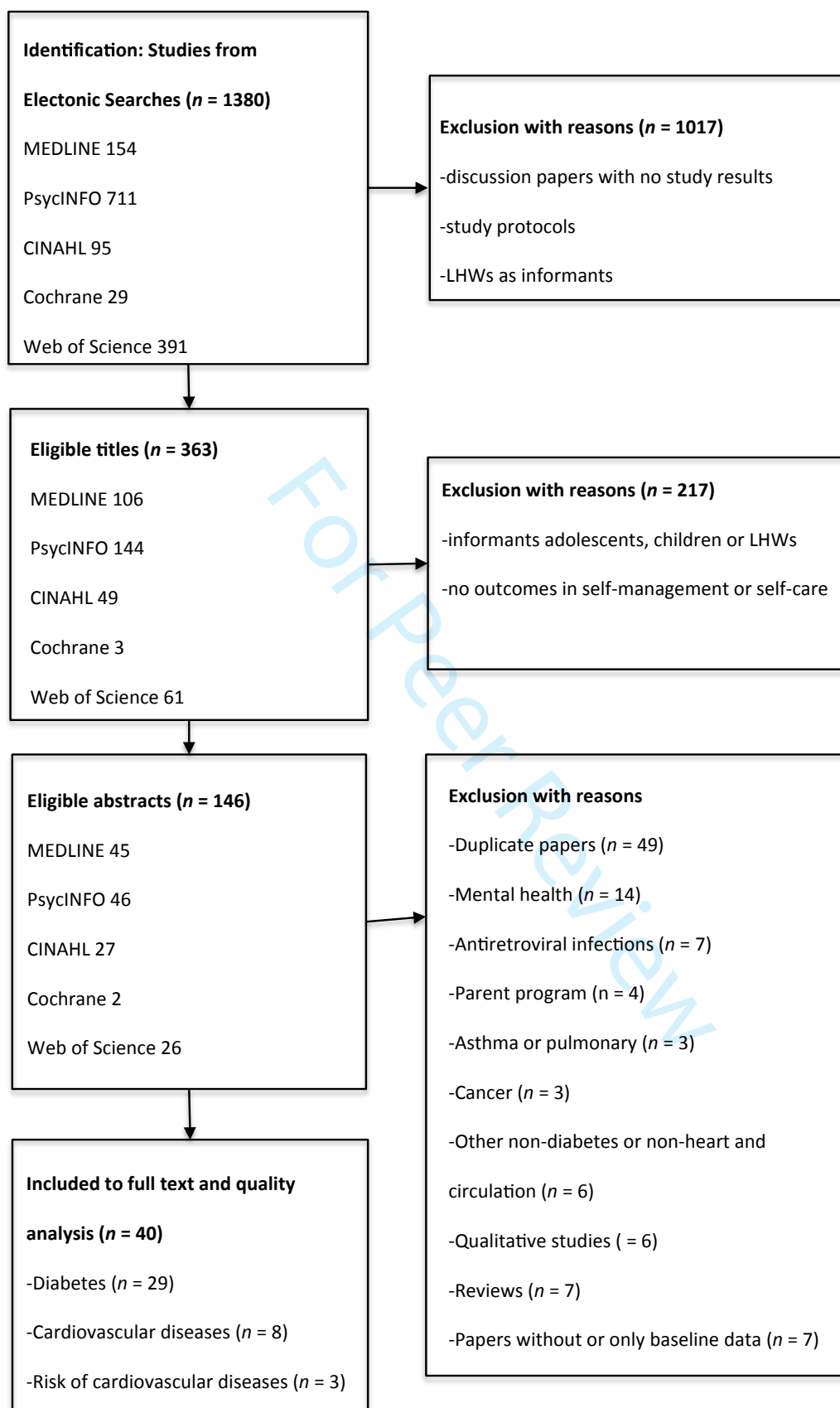


Figure 1. Flowchart of the searches.

Table 1. Example of the content analysis phase concerning LHW characteristics

Examples of the original expressions	Condensed expression	Subcategory	Main category
[The facilitators were six lay people with experience of heart disease, either personally -- or as carers of people with heart disease. 3.10]	The facilitators were six lay people with experience of heart disease self-management	Background and experience	Characteristics of LHWs
[The CHWs had an average of 6 years' experience leading DSME at CHASS. 18.22]	The CHWs had an average of six years' experience in leading diabetes self-management programs		
[--co-delivered by -- a patient (lay) tutor who had experience in these services 40.11.1]	Patient lay tutor had experience of services related to self-management support		
[-- an organization devoted to the education of people with diabetes and health care team members, on the basis of their excellent diabetes control, self-motivation, communication and support skills and interest. 4.21]	On the basis of their excellent diabetes control, self-motivation, communication and support skills and interest.	Eligibility criteria	
[simply interest of being a diabetes educator 24.9]	Simply one's own interest of being a diabetes educator		

[someone with diabetes or with a family member or friend with diabetes 24.8]	Having diabetes her/himself or a family member who has		
[16 hours training by the project manager or principal investor. 1.14]	Training provided by the project manager or principal investor	Training educators	LHWs' training
[The trainings were delivered by an interdisciplinary team of academics and practitioners with expertise in clinical medicine, health inequities, Latino health, diabetes self-management, diabetes medications, nutrition, exercise, cross-cultural counseling, and mental health. 11.27]	The culturally sensitive training delivered by an interdisciplinary team of academics and practitioners		
[CHWs trained by research staff from the University of Illinois at Chicago (UIC) 25.2.1]	CHWs trained by research staff from the University		
[to teaching blood pressure and glucose readings 1.18]	Training prepared CHWs in teaching blood pressure and glucose readings	Training purposes	
[building and reinforcing the participants' knowledge on diabetes, 23.22]	Building and reinforcing the participants' knowledge on diabetes		
[We trained community volunteers to be "Health	To train community volunteers to be health coaches		

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Coaches” for our project -- 29.34]

Table 2. Examples of self-management outcomes transferred to self-management items

Item of self-management	An example of original self-management measurement
Physical activity (PA)	Summary of Diabetes Self-Care Activities measure ^{(7)*} Moderate levels of physical activity 30 min per day at least 5 days per week ⁽¹⁷⁾ Physical Activity Scale for Elderly ⁽²¹⁾ Survey of Diabetes Self-Care Activities: Exercise ⁽²³⁾ Minutes of daily physical activity ⁽²⁵⁾ Questionnaire on physical activity ⁽³⁷⁾

For Peer Review

Nutrition behavior (NB)	Number of days to follow a diet ⁽⁷⁾
	Amount of daily servings of vegetable and fruits ⁽¹⁷⁾
	Survey of Diabetes Self-Care Activities: Nutrition ⁽²³⁾
	Following a healthy eating plan, eating fruits/vegetables ^(25,30)
	Self-reported eating behavior ⁽²⁹⁾
	Questionnaire on nutrition ^(31,37)
Blood lipids	HDL ^(23,30,35) LDL ^(17,30)
	Total cholesterol ^(23,30) Triglycerides ⁽³⁰⁾
Blood pressure	Systolic ^(23,25,29)
	Diastolic ⁽²³⁾

*References in Table 3.

Table 3. Studies included in the analysis

Num	Original Paper	Purpose of LHW intervention	Field	Method	Main outcome, analysis	Setting	Follow-up, N =	Format (briefly)	Months of duration + follow-up	Quality assessment score
1	Daniels, E., Powe, B., Metoyer, T., McCray, G., Baltrus, P., & Rust, G. (2012). Increasing knowledge of cardiovascular risk factors among African Americans by use of community health workers: The ABCD community intervention pilot project. <i>Journal of the National Medical Association, 104</i> (3-4), 179–185. USA	To increase knowledge of cardiovascular risk among African-Americans	CVD	RCT	Knowledge of CVD, health literacy, Depression, HBA1C, BP, cholesterol, BMI, waist circumference <i>t</i> tests	Church	25	Group meeting Telephone counselling	1.5	17
2	DePue, J., Dunsiger, S., Seiden A., Blume, J., Rosen, R., Goldstein, M., Nu'usolia, O., Tuitele, J., & McGarvey, S. (2013). Nurse-community health worker team improves diabetes care in American Samoa: results of a randomized controlled trial. <i>Diabetes Care, 36</i> (7), 1947–1953.	To support diabetes self-management among American Samoans	T2DM	RCT	HBA1C, BP, BMI, waist circumference, dietary intake Wilcoxon, <i>t</i> test, mixed effects	CHC	243	Group meetings Individual meetings	12	22

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2											
3		American Samoa, USA				longitudinal					
4						regression model					
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10	3	Furze, G., Cox, H., Morton, V., Chuang, L-	To assess the	CVD	RCT	Angina frequency	Home-	124	Individual	3	20
11		H., Lewin, R.J.P., Nelson, P., Carty, R.,	effectiveness of a	(Angina		(1-week angina	based		interview		
12		Norris, H., Patel, N., & Elton, P. (2012).	angina management	manage-		diary)			Home visits		
13		Randomized controlled trial of a lay-	program	ment)					Telephone		
14		facilitated angina management programme.				Negative binomial,			calls		
15		<i>Journal of Advanced Nursing</i> , 68(10),				linear and logistic					
16		2267–2279. England				regression					
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22											
23	4	Gagliardino, J.J., Arrechea, V., Assad, D.,	To compare standard	CVD	RCT	HBA1C, BMI, BP,	Health	198	Peer support	1.5	15
24		Gagliardino, G.G., González, L., Lucero,	care and the care and	(Hyper-		cholesterol,	education		group		
25		S., Rizzuti, L., Zufriategui, Z., & Clark, C	ongoing support of	tension)		attitudes regarding	center		Face-to-face		
26		Jr. (2013). Type 2 diabetes patients	trained peers for people			diabetes and their			visits		
27		educated by other patients perform at least	with T2DM			care			Telephone		
28		as well as patients trained by							communicatio		
29		professionals. <i>Diabetes/Metabolism</i>				Chi-square test, <i>t</i>			n		
30		<i>Research & Reviews</i> , 29(2), 152–160.				test					
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5	Hargraves, J.L., Ferguson, W.J., Lemay, C.A., & Pernice, J. (2012). Community health workers assisting patients with diabetes in self-management. <i>Journal of Ambulatory Care Management</i> , 35(1), 15–26. Massachusetts, USA	To integrate community health workers into work with diabetes type 2 patients and support diabetes self-management	T2DM	RCT	HBA1C, cholesterol, BP, self-management	CHC	1,415	LHW in health care teams	13	9
6	Kronish, I.M., Goldfinger, J.Z., Negron, R., Fei, K.Z., Tuhim, S., Arniella, G., & Horowitz, C.R. (2014). Effect of peer education on stroke prevention: The Prevent Recurrence of All Inner-City Strokes Through Education (PRAISE) randomized controlled trial. <i>Stroke</i> , 45(11), 3330–3336. New York City, USA	To determine the effect of peer education on secondary stroke prevention	CVD (Stroke)	RCT	BP, cholesterol, use of antithrombotic medications, control of the stroke risk factors	Primary health care	510	Group meetings	1.5 + 6	20
7	Lynch, E.B., Liebman, R., Ventrelle, J., Avery, E., & Richardson, D. (2014). A self-	To determine the effectiveness of	T2DM, CVD	RCT	Medical history, clinical variables,	Communit y setting	55	Group sessions	6	19

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	management intervention for African Americans with comorbid diabetes and hypertension: A pilot randomized controlled trial. <i>Preventing Chronic Disease, 11</i> , 130349. Chicago, USA	comorbid diabetes and hypertension self-management intervention for African Americans	(hypertens ion)		BMI, medications, dietary intake, PA, health literacy, nutrition knowledge and quality of life			Telephone calls		
8	Martin, M.Y., Kim, Y.I., Kratt, P., Litaker, M.S., Kohler, C.L., Schoenberger, Y.M., Clarke, S.J., Prayor-Patterson, H., Tseng, T.S., Pisu, M., & Williams, O.D. (2011). Medication adherence among rural, low-income hypertensive adults: a randomized trial of a multimedia community-based intervention. <i>American Journal of Health Promotion, 25</i> (6), 372–378. Alabama, USA	To examine the effectiveness of community-based multimedia intervention in medication adherence among hypertensive patients	CVD (hypertens ion)	RCT	Pill count Means, standard deviations, frequencies. χ^2 analysis, general linear model	Online, CHC	338	Online program Home visits Telephone calls	6 + 6	16

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9	McDermott, R.A., Schmidt, B., Preece, C., Owens, V., Taylor, S., Li, M., & Esterman, A. (2015). Community health workers improve diabetes care in remote Australian Indigenous communities: results of a pragmatic cluster randomized controlled trial. <i>BMC Health Services Research</i> , 15, 68. Australia (north)	To test the effectiveness of a community-based approach to intervention for indigenous adults with poorly controlled T2DM in Australian indigenous communities	T2DM	RCT	HbA1C	Primary health care	191	LHW in health care team	18	20
10	Moskowitz, D., Thom, D.H., Hessler, D., Ghorob, A., & Bodenheimer, T. (2013). Peer coaching to improve diabetes self-management: Which patients benefit most? <i>Journal of General Internal Medicine</i> , 28(7), 938–942. San Francisco, USA	To examine the effect of peer health coaching on HbA1C modified by diabetes control characteristics	T2DM	RCT	HbA1C	Public health care	299	NR	6	18
11	Perez-Escamilla, R., Damio, G., Chhabra, J., Fernandez, M.L., Segura-Perez, S., Vega-Lopez, S., Kollannor-Samuel, G., Calle, M., Shebl, F.M., & D'Agostino, D. (2015). Impact of a Community Health Workers-Led Structured Program on Blood	To evaluate home-based culturally appropriate CHW-integrated T2DM counselling among Latino adults	T2DM	RCT	HbA1c, BG and lipid profile	Primary health care	148	Home visits	12 + 6	22

		Glucose Control Among Latinos With Type 2 Diabetes: The DIALBEST Trial. <i>Diabetes Care</i> , 38(2), 197–205. Connecticut, USA											for continuous variables, a linear mixed effects
12	Philis-Tsimikas, A., Fortmann, A., Lleva-Ocana, L., Walker, C., & Gallo, L.C. (2011). Peer-Led Diabetes Education Programs in High-Risk Mexican Americans Improve Glycemic Control Compared With Standard Approaches A Project Dulce Promotora Randomized Trial. <i>Diabetes Care</i> , 34(9), 1926–1931. San Diego, USA	To evaluate the effect of a culturally sensitive diabetes self-management program among Mexican-American with T2DM	T2DM	RCT	HbA1C	CHC	156	Learning class	10 + 4			15	Multilevel models, within-group analysis Support group Telephone calls
13	Prezio, E.A., Pagan, J.A., Shuval, K., & Culica, D. (2014). The Community Diabetes Education (CoDE) program: cost-effectiveness and health outcomes. <i>American Journal of Preventive Medicine</i> , 47(6), 771–779. USA	To examine the long term cost effectiveness and improvements in diabetes-related complications	T2DM	RCT	HBA1c	NR	10 000'	NR	NR			15	Archimedes model
14	Prezio, E.A., Cheng, D., Balasubramanian, B.A., Shuval, K., Kendzor, D.E., & Culica, D. (2013). Community Diabetes Education	To determine the impact of a culturally tailored diabetes education	T2DM	RCT	HbA1C	CHC	156	LHW	12			23	t test to continuous appointments along with

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	(CoDE) for uninsured Mexican Americans: a randomized controlled trial of a culturally tailored diabetes education and management program led by a community health worker. <i>Diabetes Research & Clinical Practice</i> , 100(1), 19–28. Texas, USA	program for uninsured Mexican-American with DM			variables and Pearson χ^2 for categorical variables, linear mixed-models			usual care		
15	Rothschild, S.K., Martin, M.A., Swider, S.M., Tumialan Lynas, C.M., Janssen, I., Avery, E.F., & Powell, L.H. (2014). Mexican American trial of community health workers: a randomized controlled trial of a community health worker intervention for Mexican Americans with type 2 diabetes mellitus. <i>American Journal of Public Health</i> , 104(8), 1540–1548. Chicago, USA	To assess whether community health workers could improve glycemic control among Mexican-Americans with diabetes	T2DM	RCT	DM empowerment, DM self-care, Activities (also PA, nutrition), depression, stress scale, anxiety	Communit y setting	121	Telephone calls	24	25
16	Safford, M.M., Andreae, S., Cherrington, A.L., Martin, M.Y., Halanych, J., Lewis, M., Patel, A., Johnson, E., Clark, D.,	To test the effectiveness of peer coaches plus brief diabetes education	T2DM	RCT	HbA1c, systolic BP, LDL-C, BMI, and	Communit y setting	270	Meetings Telephone	10 + 5	23

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3		Gamboa, C., & Richman, J.S. (2015). Peer	compares with brief			quality of life			calls		
4		Coaches to Improve Diabetes Outcomes in	education alone in Rural								
5		Rural Alabama: A Cluster Randomized	Alabama			Frequencies and <i>p</i>					
6		Trial. <i>Annals of Family Medicine</i> , 13(S1),				values					
7		S18–S26. Alabama, USA									
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13	17	Spencer, M.S., Rosland, A.M., Kieffer,	To test a culturally	T2DM	RCT	HbA1C, PA,	Communit	136	Home visits	6	21
14		E.C., Sinco, B.R., Valerio, M., Palmisano,	tailored CHW			nutrition	y health		Group classes		
15		G., Anderson, M., Guzman, J.R., & Heisler,	intervention for diabetes				center				
16		M. (2011). Effectiveness of a community	self-management			Student <i>t</i> test,			Telephone		
17		health worker intervention among African	improved diabetes			Pearson χ^2 test			calls		
18		American and Latino adults with type 2	clinical measures, self-								
19		diabetes: a randomized controlled trial.	management and								
20		<i>American Journal of Public Health</i> ,	distress among African								
21		101(12), 2253–2260. Detroit, USA	American and Latino								
22			adults								
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31	18	Tang, T.S., Funnell, M., Sinco, B., Piatt, G.,	To compare a peer	T2DM	RCT	HbA1C	Communit	69	Group Classes	18	23
32		Palmisano, G., Spencer, M.S., Kieffer, E.C.	leader (PL) versus a				y setting		Home visits		
33		, & Heisler, M. (2014). Comparative	community health			Linear mixed					
34		effectiveness of peer leaders and	worker (CHW)			methods, Student's <i>t</i>			Primary care		
35		community health workers in diabetes self-	telephone intervention			test, log-rank test,			provider visits		
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	management support: Results of a randomized controlled trial. <i>Diabetes Care</i> , 37 (6), 1525–1534. Detroit, USA	in diabetes self-management education			Pearson χ^2 test			Telephone calls		
19	Tang, T.S., Funnell, M.M., Sinco, B., Spencer, M.S., & Heisler, M. (2015). Peer-Led, Empowerment-Based Approach to Self-Management Efforts in Diabetes (PLEASED): A Randomized Controlled Trial in an African American Community. <i>Annals of Family Medicine</i> , 13(S1), S27–S35. Michigan, USA	To investigate whether a peer support model could sustain improvements achieved in a short-term diabetes self-management education program for African American adults with type 2 diabetes	T2DM	RCT	HbA1C	Community setting	64	Group sessions Face to face meetings Telephone calls	15	25
20	Thom, D., Ghorob, A., Hessler, D., DeVore, D., Chen, E., & Bodenheimer, T.A. (2013). Impact of peer health coaching on glycemic control in low-income patients with diabetes: A randomized controlled trial. <i>Annals of Family Medicine</i> , 11(2), 137–144. San Francisco, USA	To test the impact of individual peer coaching on glucose control on patients with poorly controlled diabetes	T2DM	RCT	HbA1C	Public clinics	275	In person interactions Telephone calls	6	20

21	van der Wulp, I., de Leeuw, J.R.J., Gorter, K.J., & Rutten, G.E.H.M. (2012). Effectiveness of peer-led self-management coaching for patients recently diagnosed with Type 2 diabetes mellitus in primary care: a randomized controlled trial. <i>Diabetic Medicine</i> , 29(10), e390–e397. Netherlands	To study the effectiveness of a self-management coaching intervention in recently diagnosed patients with Type 2 diabetes	T2DM	RCT	Self-efficacy, coping, physical activity, dietary habits, psychological well-being, depressive symptoms and diabetes related distress	General practices	119	Home visits Telephone calls Emails	18	22
22	Whittle, J., Schapira, M.M., Fletcher, K.E., Hayes, A., Morzinski, J., Laud, P., Eastwood, D., Ertl, K., Patterson, L., & Mosack, K.E. (2014). A randomized trial of peer-delivered self-management support for hypertension. <i>American Journal of Hypertension</i> , 27(11), 1416–1423. Milwaukee, USA	To compare changes in BP control among veterans participating in a peer-delivered vs. Professionally delivered health education intervention	CVD (Hypertension)	RCT	Systolic BP Mixed model, generalized linear model	Veterans' service organizations	379	Group sessions	12	24
23	Assah, F.K., Atanga, E.N., Enoru, S., Sobngwi, E., & Mbanya, J.C. (2015).	To examine the effectiveness of a	T2DM	Trial	HBA1C, BP, blood lipids, BMI, waist	Communit	192	Group	6	17

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	Community-based peer support	structured peer support			circumference, y setting			meetings		
	significantly improves metabolic control in	diabetes intervention in			diabetes self-care			Personal		
	people with Type 2 diabetes in Yaounde,	Cameroon			(also PA and			encounters		
	Cameroon. <i>Diabetic Medicine</i> , 32(7), 886–				nutrition)			Telephone		
	889. Cameroon				Continuous			calls		
					variables and					
					differences, Student					
					<i>t</i> test					
24	Carey, M.E., Mandalia, P.K., Daly, H.,	To develop and test a	T2DM	trial	Diabetes coherence,	Primary	242	Group	1 day	20
	Gray, L.J., Hale, R., Stacey, L.M., Taub,	format of delivery of			diabetes perception	health		meeting		
	N., Skinner, T.C., Stone, M., Heller, S.,	diabetes self-			Intra-class-	care				
	Khunti, K., & Davies, M.J. (2014).	management education			correlations,					
	Increasing capacity to deliver diabetes self-	by paired professional			continuous and					
	management education: Results of the	and lay educators			categorical					
	DESMOND lay educator non-randomized				variables, <i>t</i> test, χ^2 ,					
	controlled equivalence trial. <i>Diabetic</i>				Wilcoxon test					
	<i>Medicine</i> , 31(11), 1431–1438. England and									
	Scotland									

25	Castillo, A., Giachello, A., Bates, R., Concha, J., Ramirez, V., Sanchez, C., Pinsker, E., & Arrom, J. (2010). Community-based diabetes education for Latinos: The Diabetes Empowerment Education Program. <i>Diabetes Educator</i> , 36(4), 586–594. California, USA	To test the feasibility and effectiveness of a linguistic and culturally appropriate diabetes education program among Latinos	T2DM	trial	HbA1C, PA, nutrition	Community setting	47	Group meeting	2.5	15
26	Cene, C.W., Haymore, L.B., Ellis, D., Whitaker, S., Henderson, S., Lin, F.C. & Corbie-Smith, G. (2013). Implementation of the power to prevent diabetes prevention educational curriculum into rural African American communities: A feasibility study. <i>The Diabetes Educator</i> , 39(6), 776–785. North Carolina, USA	To describe the feasibility of using a community-based approach to implement a diabetes prevention education curriculum in rural African-American settings	T2DM	Trial	BG, BP, BMI, PA Mc Nemar test, <i>t</i> test	Community setting	30	Small group sessions	7.5	11
27	Collinsworth, A.W, Vulimiri, M., Schmidt, K. L., & Snead, C.A. (2013). Effectiveness of a community health worker–led diabetes self-management education program and implications for CHW involvement in care	To evaluate the effectiveness of a diabetes self-management education program and to	T2DM	Trial	HBA1C, BMI, Blood pressure <i>t</i> test	Community clinic	497	Group meetings Clinical assessments	12	12

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		coordination strategies. <i>The Diabetes Educator</i> , 39(6), 792–799. Dallas, USA	understand how CHWs and primary care providers work together								
28	DePue, J.D., Rosen, R., Seiden, A., Bereolos, N., Chima, M., Goldstein, M., Nu’usolia, O., Tuitele, J., & McGarvey, S.T. (2013). Implementation of a culturally tailored diabetes intervention with community health workers in American Samoa. <i>The Diabetes Educator</i> , 39(6), 761–771. American Samoa, USA	To investigate a primary care-based, nurse-community health worker (CHW) team intervention to support type 2 diabetes self-management in American Samoa	T2DM	Trial	HBA1C, BP, smoking status, alcohol use, depression score, treatment dose	Primary care	104	Group visits	12	16	
29	Dye, C., Williams, J., & Hoffman Evatt, J. (2015). Improving hypertension self-management with community health coaches. <i>Health Promotion Practice</i> , 16(2), 271–281. Appalachians, USA	To improve hypertension self-management among rural residents older than 60 years through education and support	CVD (Hyper-tension)	Trial	Hypertension knowledge and self-management, BP, weight, waist circumference, blood lipids and	Communit y setting	146	Group classes	4	20	
								Education program			

					BG, PA, nutrition					
					Student <i>t</i> test,					
					McNemar's test,					
					Bonferroni					
					correction					
30	Fernandes, R., Braun, K., Spinner, J., Sturdevant, C., Ancheta, S., Yoshimura, S., Compton, M., Wang, J-H., & Lee, C. (2012). Healthy heart, healthy family: A NHLBI/HRSA collaborative employing community health workers to improve heart health. <i>Journal of Health Care for the Poor and Underserved</i> , 23(3), 988–999. Hawaii, USA	To evaluate the impact of the heart health curriculum on low- income Filipinos with CVD risk factors in Hawaii	CVD	Trial	Disease and medication histories, BMI, waist circumference, BP, BG, lipid profile, HBA1C, PA, nutrition <i>t</i> tests, chi-squared	Communit y setting	92	Group sessions	12	16
31	Islam, N., Wyatt, L., Patel, S., Shapiro, E., Darius Tandon, S., Runi Mukherji, B., Tanner, M., Rey, M.J., & Trinh-Shevrin, C. (2013). Evaluation of a community health	To explore the impact and feasibility of a pilot intervention to improve diabetes management	T2DM	Trial	HBA1C, weight, nutritional and physical activity behaviors, access to	Clinical and communit y setting	26	Group sessions Individual	9	20

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	worker pilot intervention to improve diabetes management in Bangladeshi immigrants with type 2 diabetes in New York City. <i>The Diabetes Educator</i> , 39(4), 478–493. New York, USA	among Bangladeshi-American individuals with type 2 diabetes living in New York City			health care, diabetes visits knowledge, self-management, self-efficacy, mental health Fisher’s exact test, <i>t</i> test, frequencies, means, standard deviations					
32	Lorig, K., Ritter, P.L., Plant, K., Laurent, D.D., Kelly, P., & Rowe, S. (2013). The South Australia Health Chronic Disease Self-management Internet Trial. <i>Health Education & Behavior</i> , 40(1), 67–77. South Australia	To implement and investigate the effectiveness of a chronic condition self-management internet trial in South Australia	CC	Trial	Pain/physical discomfort, shortness of breath, tiredness, impact of disease, health distress, self-rated disability, number of illness days, PA	Online-based, community setting	194	Interactive web program	1.5 + 12	21

For Peer Review

33	Micikas, M., Foster, J., Weis, A., Lopez-Salm, A., Lungelow, D., Mendez, P., & Micikas, A. (2015). A Community Health Worker Intervention for Diabetes Self-management Among the Tz'utujil Maya of Guatemala. <i>Health Promotion Practice, 16</i> (4), 601–608. Guatemala	To investigate the effectiveness of a structured, community-led diabetes self-management intervention among the Tz'utujil Maya of Guatemala	T2DM	Trial	Health beliefs, practices, HbA1c, BMI, PA <i>t</i> tests	Community setting	52	Individual visits at clinics and home	4	14
34	Otero-Sabogal, R., Arretz, D., Siebold, S., Hallen, E., Lee, R., Ketchel, A., Li, J., & Newman, J. (2010). Physician-community health worker partnering to support diabetes self-management in primary care. <i>Quality in Primary Care, 18</i> (6), 363–372. San Francisco, USA	To improve self-management among patients with type 2 diabetes	T2DM	Trial	HbA1c, LDL, BP and total cholesterol, Patient Activation Measure Frequencies, cross tabulations, <i>t</i> test comparisons	Primary care	114	Participant visits.	24	9
35	Ryabov, I. (2014). Cost-effectiveness of Community health workers in controlling diabetes epidemic on the US-Mexico border. <i>Public Health, 128</i> (7), 636–642.	To evaluate clinical outcomes and long-term cost-effectiveness of T2DM intervention among Mexican-	T2DM	Trial	HbA1c, total cholesterol, HDL, triglycerides, BP, BMI	Community setting	30	Individual visits Telephone contacts	24	13

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	Texas, USA	Americans									
36	Ryabov, I. (2011). The impact of community health workers on behavioral outcomes and glycemic control of diabetes patients on the U.S.-Mexico border. <i>International Quarterly of Community Health Education</i> , 31(4), 387–399. Texas, USA	To determine the impact of CHW on the self-management practices of people in with diabetes on the US–Mexico border	T2DM	Trial	DM knowledge	NR	30	NR	24	12	
37	Saxe-Custack, A., & Weatherspoon, L. (2013). A patient-centered approach using community-based paraprofessionals to improve self-management of Type 2 Diabetes <i>American Journal of Health Education</i> , 44(4), 213–220. Michigan, USA	To examine if a lifestyle management program can initiate positive impacts on self-management and behavior change among participants with type 2 diabetes	T2DM	Trial	BP, BMI, HbA1c, demographic information, lifestyle behaviors (also PA and nutrition), behavior change by stages of change, appraisal of diabetes	Communit y setting	122	Group Individual meetings Home visits	2.5+6	16	
38	Tsoh, J., Burke, N., Gildengorin, G., Wong,	To evaluate a smoking	CC	Trial	7-day and 30-day	Communit	192	Small group	2+3	21	

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	C Le, K., Nguyen, A., Chan, J.L., Sun, A., McPhee, S.J. & Nguyen, T.T. (2015). A Social network family-focused intervention to promote smoking cessation in Chinese and Vietnamese American male smokers: A feasibility study. <i>Nicotine & Tobacco Research, 17</i> (8), 1029–1038. USA	cessation program: intention to quit, use of cessation recourses and smoking abstinence	(smoking cessation)		smoking abstinence, assessed by smokers and family members	y setting Telephone calls Descriptive statistics, significance, linear model adjustment			sessions		
39	Tully, M., Kos, A., Eastwood, D., Kusch, J., & Kotchen, T. (2015). Implementation of an adjunct strategy to reduce blood pressure in blacks with uncontrolled hypertension: a Pilot Project. <i>Ethnicity & Disease, 25</i> (2), 168–174. Wisconsin, USA	To describe the development, implementation, and evaluation of a BP program	CVD (blood pressure)	Trial	BP t tests and χ^2 tests.	Health center	83	Group sessions	6	16	
40	Turner, A., Anderson, J.K., Wallace, L.M. & Bourne, C. (2015). An evaluation of a self-management program for patients with long-term conditions. <i>Patient Education and Counseling, 98</i> (2), 213–219. UK	To investigate a self- management program among patients with long-term conditions	CC	Trial	Demographic data, Patient Activation, EuroQol, Hospital Anxiety and Depression, Health Education Impact	Communit y setting	486	Group meetings	2	19	

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Questionnaire

Paired *t* tests,

General linear

model, and analysis

of covariance,

McNemar's test

NR = not reported

CVD = cardiovascular disease

CC = chronic conditions or its prevention

CHC = community health center

'=estimated

BMI = body mass index

BP = blood pressure

BG = blood glucose

For Peer Review

<p>Characteristics and training of LHWs</p>			<p>Theories and guidelines behind the intervention</p>
<p>Experience with long-term conditions</p>	<p>Self-management intervention components and delivery by LHWs</p>		<p>National guidelines for DM, hypertension and cardiovascular diseases</p>
<p>Eligibility based on personal interest or maintained self-management</p>	<p>Participants recruited by LHWs or health professionals</p>	<p>Interaction frequency from once a week to every second month, often besides usual health care</p>	<p>Transtheoretical model of change</p>
<p>Length of training from one day to 240 h, approx. 30 to 60 h</p>	<p>Attrition prevention by providing, e.g., make-up sessions, telephone support calls, gift cards.</p>	<p><u>Principles of implementation:</u> individual-empowering, culture and language sensitiveness, peer education, family-centering, social networking</p>	<p>Social cognitive theory</p>
<p>Elements of training: classroom training, hands-on activities, home visits, clinical measurements</p>	<p><u>Elements:</u> PA, nutrition, medication, clinical measurements, and other education classes; online programs</p>	<p><u>BCTs:</u> Self-monitoring, goal setting, information providing, action plans, enhancing social support</p>	<p>Chronic care model</p>
<p>Training contents: LTCs, motivation, self-monitoring, self-management, medication</p>	<p><u>Formats:</u> Individual or group meetings delivered by a LHW or a group of LHWs; LHW as a</p>	<p>provided face to face, via telephone, online, at clinics or community centers or home visits.</p>	<p>Self-efficacy theory</p>

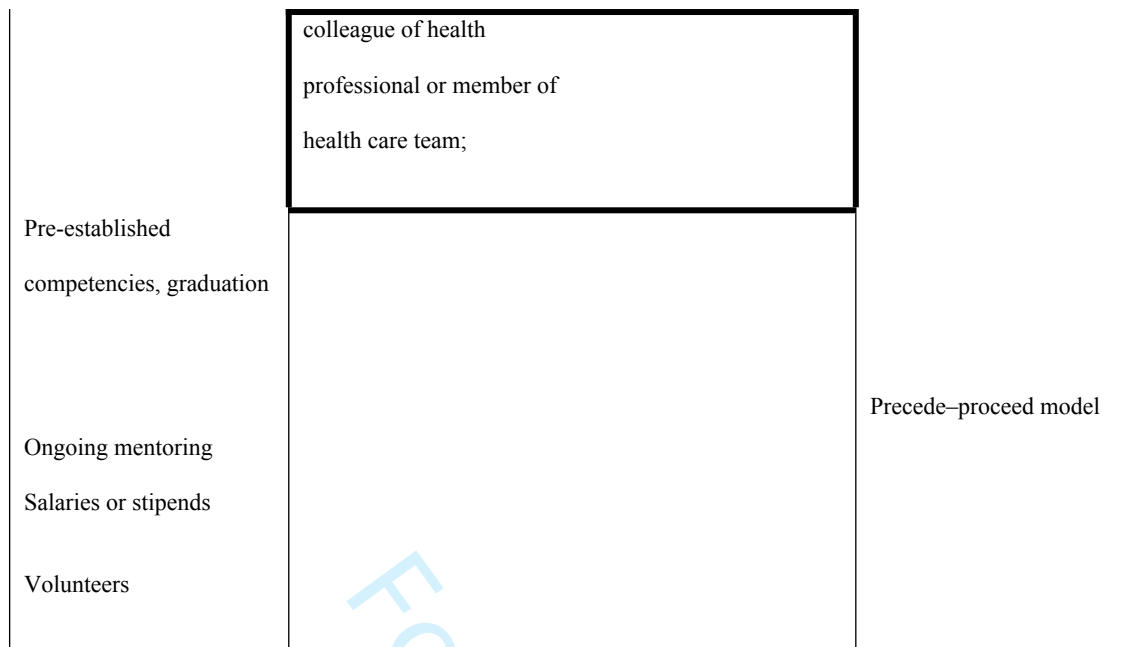


Figure 2. Synthesis of LHW-led self-management interventions for diabetes, cardiovascular diseases and prevention.

Table 4. Reported theories and principles.

Theories and models applied and reported	<i>n</i>
Transtheoretical model of change ^(7,8,11,23,29,30,33,37,38)	9
Social cognitive theory ^(1,8,14,21,38)	5
Chronic care model ^(22,40)	2
Self-efficacy theory ^(31,32)	2

Precede–proceed model ^(2,28)	2
Socioecological model ^(5,17)	2
Health belief model ⁽³³⁾	1
Self-management theory ⁽¹⁵⁾	1
Principles and methods applied and reported	<i>n</i>
Individual-empowerment ^(17–19,23,25,33,34,38–40)	10
Peer education principles ^(4,8,9,23,32,39,40)	7
Culture-sensitivity ^(11,12,14,23,33,34)	6
Understanding of the context in which behavior changes take place ^(4,8,21,23,33,30)	6
The active role of recipients ^(4,12,25)	3
Motivational interview ^(25,30,37)	3

Table 5. Examples of the most often reported BCTs.

BCT	<i>n</i>
Self-monitoring ^(3,4,6–8,12–14,16,18,19,21,22,25,27–32,37,39)	24
taking clinical measurements: blood sugar and blood pressure ^(2,6,15,16,19,28,30,39)	
monitoring of symptoms and health behavior related to the	

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assessed goals ^(4,7,28,29)	
using self-management monitors: blood glucose, blood pressure and pedometers ^(12,14,22,29,30,39)	
Goal setting ^(3,7,8,15,16,18–20,21,25,27–29,32–34,35,37,38)	20
Information providing ^(6,8,11,14,15,17,19,21,22,25,28,30–32)	17
Individual action plans to support health-related behavior ^(6,10,11,14,19,20,29,31–33,38,39)	12
Enhancing participants' social support ^(6,7,15,16,18,22,23,25,29,32,40)	11
Practicing problem solving techniques ^(2,6,7,15,18,19,28,29,32,37)	10
Possibilities to tailor intervention activities towards participants' personal needs ^(11,14,18,28,30,31,33,38–40)	10

Table 6. Original studies that reported outcomes of NB and/or PA

Original paper	Theory	Format	Individual / Group	Additional info	Number of BCTs	Frequency	Length + follow-up (month)	Improv ment in NB	Improv ment in PA	Improv- ment in CM
(7) Lynch et al., 2014	Models of behavior change	Telephone calls Education lectures	Individual + group	18 group sessions by dietitian and LHW weekly for three months, afterwards every second week; phone calls weekly by LHW	9	weekly	6	yes	yes	yes / no
(15) Rothschild et al., 2014	Self-management theory	Home visits Telephone calls	Individual	36 home visits	7	monthly	24	no	no	yes / no
(17) Spencer et al., 2011	Empowerment theory	Education lectures, Home visits, Accompanied clinic	Individual	Group session once every two weeks Telephone calls once	4	weekly	6	no	yes	yes / no

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		visits,		every two weeks						
		Telephone								
		counselling,								
		Peer activities								
(21) van der Wulp et al., 2012	Social cognitive theory	Home visits, Education lectures, Telephone counselling, Emails	Individual	Monthly meetings, Telephone calls two weeks after meetings. Plus calls and emails when needed.	5	two weeks	18	yes	no	-
(23) Assah et al., 2015	Socioculturally adapted community-based approach	Group meeting, Individual appointments, Telephone counselling, Home visits	Individual + group	Six group meetings, personal encounters, telephone calls (five calls)	3	monthly	6	yes	yes	yes

(25) Castillo et al., 2010.	Empowerment theory, Adult education	Group meeting, Individual appointments, Education lectures	Individual + group	Ten group education sessions + individual contacts between sessions	9	weekly	2.5	yes	yes	yes / no
(26) Cene et al., 2013	Community capacity building	Group meeting, Education lectures	Group	Group meetings weekly for six weeks, then monthly, 12 sessions total	2	six times weekly, afterwards monthly	7.5	-	no	no
(29) Dye et al., 2015	Transtheoretic al model of change	Group meeting, Education lectures	Group	Self-management curriculum: 7 meetings plus additional lectures on NB or PA	8	weekly	4	yes	yes	yes
(30) Fernandes et al., 2012	Transtheoretic al model of change	Group meeting, Education lecture, Peer work shop	Group	Group meetings, afterwards monthly meetings up to 12 months	9	11 times weekly, afterwards monthly	12	yes	yes	yes / no

(31) Islam et al., 2013	Community-based approach	Group meeting, Individual appointments, Education lectures, Make-up sessions	Individual + group	Individual six monthly group meetings plus individual meetings at months 3, 6, and 9	4	monthly up to 6 months, individual at 9 months	9	yes	yes	no
(32) Lorig et al., 2013	Self-efficacy theory	Online group meetings, Education lectures, Weekly activities	Online: Individual + group	Online program	15	available every day	1.5 + 12	-	yes	-
(33) Micikas et al., 2015	Stages of change, Health belief model	Group meetings, Education lectures, Home visits	Individual + group	Individual home visits, group meetings	7	weekly	4	-	no	yes
(37) Saxe-Custack et al., 2013	Community-based approach	Group meetings, Individual appointments,	Individual + group	four individual weekly meetings at home, afterwards six home	9	weekly	2.5 + 6	yes	no	yes / no

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Education lectures,	visits or group meetings
Home visits	weekly

NB = nutrition behavior

PA = physical activity

CM = clinical measurements

- = was not measured

For Peer Review

Table 7. Outcomes in nutrition behavior and physical activity and their links to intervention components and clinical measurements

Measured outcome	Type of effect	Original paper	Formats	BCTs	Clinical measurements
					+improvement
					-no improvement
NB + PA	NB + PA improved	7	Telephone calls + Education lectures	9: Goal setting, motivating, emotional support, teaching problem-solving techniques, enhancing social support, self-monitoring, role	+HbA1C

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	(individual + group)	model narratives, hands-on activities, taking and monitoring clinical measurements	+Weight loss
			-Blood lipids
			-Blood pressure

	Group meeting + Individual appointments + Telephone counselling + Home visits	3: Teaching self-management skills, enhancing social support, discussion	+HbA1C
			+Blood lipids
			+Blood pressure
23			+BMI
			+Fast BC
			+Waist circ
			+Weight loss

	Group meeting + Individual appointments + Education lectures	9: Goal setting, self-efficacy support, motivating, teaching self-management skills, enhancing social support, support decision making, information providing, self-monitoring, hands-on activities	+HbA1C
			+Blood pressure
25			-Weight loss

	Group meeting + Education lectures (group)	8: Goal setting, self-efficacy support, teaching problem-solving techniques, enhancing social support, action plans, self-monitoring, personal health diary, taking and monitoring clinical measurements	+Blood pressure
			+Fast BC
29			+Weight loss
			+Blood lipids

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	30	Group meeting + Education lectures (group) + peer work shop	9: Information providing, self-monitoring, using written counselling materials, reminders, tailoring, hands-on exercises, taking and monitoring clinical measurements, healthy snacks, incentives	+Blood lipids +Fast BC -HbA1c -Blood pressure -BMI
	31	Group meeting + Individual appointments + Education lectures + Make-up sessions	4: Information providing, action plans, self-monitoring, tailoring	-Blood lipids -HbA1c -Blood pressure -BMI
	21	Home visits + Education lectures + Telephone counselling + emails	5: Goal setting, self-efficacy support, motivating, information providing, self-monitoring	NR
NB improved	37	Group meetings + Individual appointments + Education lectures + Home visits	9: Goal setting, motivating, teaching problem solving, teaching relapse prevention, information providing, self-monitoring, tailoring, guest speakers, hands-on exercises	+HbA1C +BMI -Blood pressure
PA improved	17	Education lectures + Home visits + Accompanied clinic visits	4: Self -efficacy support, keeping appointments, information providing, hands-on exercises	+HbA1C +Blood lipids

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					-Blood pressure
					-BMI
			<i>Home visits + Telephone calls</i>	<i>7: Goal setting, teaching self-management skills, teaching problem-solving techniques, enhancing social support, information providing, using metaphors, taking and monitoring self-management skills</i>	+HbA1C +Weight loss
	no improvements	15			-Blood lipids -Blood pressure
			<i>Online group meetings + Education lectures + Activities</i>	<i>15: Goal setting, self-efficacy support, teaching self-management skills, emotional or behavioral support, teaching problem-solving skills, sharing feelings, enhancing social support, stress managements, information providing, action plan, self-monitoring, feedback, discussion, role model narratives, hands-on exercises</i>	NR
	improved	32			
PA			<i>Group meeting + Education lectures</i>	<i>2: Guest speakers, taking and monitoring clinical measurements</i>	-Blood pressure -Fasting BC -Weight loss -Blood lipids -HbA1C
	no improvements	26			
			<i>Group meetings + Education lectures + Home visits</i>	<i>7: Goal setting, emotional and behavioral support, action plans, reminders, discussion, tailoring, hands-on exercises</i>	+HbA1C
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Identification: Studies from Electronic Searches (= 1380)

MEDLINE 154
 PsycINFO 711
 CINAHL 95
 Cochrane 29 →

Web of Science 391

Eligible titles (= 363)

↓
 MEDLINE 106
 PsycINFO 144
 CINAHL 49 →
 Cochrane 3
 Web of Science 61

↓

Eligible abstracts (= 146)

MEDLINE 45 →
 PsycINFO 46
 CINAHL 27
 Cochrane 2
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 Web of Science 26

Included to full text and quality analysis (n = 40)

-Diabetes (n = 29)
 -Cardiovascular diseases (n = 8)

Health Education & Behavior

Exclusion with reasons (n = 1017)

-discussion papers with no study results
 -study protocols
 -LHWs as informants

Exclusion with reasons (n = 217)

-informants adolescents, children or LHWs
 -no outcomes in self-management or self-care

Exclusion with reasons

- Duplicate papers (n = 49)
 -Mental health (n = 14)
 -Antiretroviral infections (n = 7)
 -Parent program (n = 4)
 -Asthma or pulmonary (n = 3)
 -Cancer (n = 3)
 -Other non-diabetes or non-heart and circulation (n = 6)
 -Qualitative studies (= 6)
 -Reviews (n = 7)
 -Papers without or only baseline data