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by Rian Adi Pamungkas

REVIEW ARTICLE

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HbA1c reduction and weight-loss outcomes: a systematic review and meta-analysis of community-based intervention trials among patients with type 2 diabetes mellitus

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Abstract

Managing blood glucose and maintaining weight could prevent the risk of diabetes complications and maintain of T2DM. The study aimed to provide the systematic review and meta-analysis to test the effect of community-based interventions on HbA1c reduction and weight loss after receiving the community-based intervention and to determine any gaps in the literature and set up the recommendations for future intervention. Two databases PubMed and Medline were included to extract the relevant articles. "Type 2 diabetes (T2D)," "Community-Based Intervention," "glycemic control," and "weight reduction" were used as the keywords. Appraisal of systematic review was based on PRISMA format. Out of 475 publications identified, 12 studies that fulfilled inclusion criteria which characterized by predominantly measure HbA1c and weight were included in the meta-analysis. Overall, the community-based intervention decreased the HbA1c levels by -0.25% (-0.33, 0.16) and ($Z = -582$, $p = 0.00$) and weight loss ($Z = -5.110$, $p = 0.00$). The community-based intervention positively decreased the HbA1c level. Our findings could guide the significance of community-based interventions for T2DM patients in the future.

Keywords Diabetes mellitus community-based intervention · HbA1c reduction · Weight loss

Introduction

The estimated global prevalence of diabetes mellitus has risen more rapidly in the past two decades. International Diabetes Federation (IDF) estimated 415 million people have lived with DM [1]. This number had been predicted as 642 million in 2040.

Type 2 diabetes mellitus (T2DM) is often associated with adverse consequences, including nephropathy, retinopathy, and cardiovascular problem [2]. Emerging complications linked with unhealthy diabetes mellitus self-management (DMSM) practice include unhealthy eating habits, physical inactivity, non-medication adherence, lack of regular blood glucose monitoring, and uncontrolled weight [3–6].

DMSM practice is a key strategy to prevent complications and to maintain health-related behaviors. T2DM patients are required to perform multiple tasks such as to attend medical appointment regularly, to adhere medication regimens, and to engage in self-care behaviors including home blood glucose monitoring, healthy eating, and increasing physical activity [7]. However, it is difficult for T2DM to engage in healthy behaviors continuously [8]. The problem is due to some common barriers including low self-commitment, low self-efficacy to maintain an activity, and insufficient support from family and community [9, 10].

Community members are important aspect of the DMSM practice since most of self-management activities for many T2DM patients occur within the community environment. Communities are the ultimate coordinators and key stakeholders for supportive system of long-term care for people with T2DM including their health-related behaviors.

A community-based approach may improve the DMSM practices by addressing barriers related to facility-based approaches and individual-based approaches [11]. Engaging

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community in facilitating DMSM practice is fundamental strategy for prevention of diabetes among risk groups as well as prevention of complications among T2DM patients [12, 13]. The Global Partnership for Effective Diabetes Management recommended that the diabetes healthcare team should be multi and interdisciplinary teamwork [14].

Several community-based interventions obtained positive impacts on weight loss [15], HbA1c reduction, raising physical activity and decreasing of waist circumference [16], increasing of self-efficacy and quality of life [17]. In contrary, some studies showed negative effects of the community-based intervention in HbA1c and weight loss [9, 18]. A meta-analysis reported that the interventions decreased HbA1c by 1.6% (95% CI = 0.1–3.1%) compared to the control group over 12 months follow-up [9].

Even though, those studies reported a tendency toward positive effects of community-based intervention in health outcomes [9, 15, 16]. However, there was still being a gap of analysis of the study on a controversy of health outcomes from community-based interventions for DMSM practice that need to be explored by both systematic review and meta-analysis. The result of this study was to ensure congruent findings of community-based interventions as one approach for effective management of DMSM practice to improve health outcomes and to elevate quality of life among T2DM patients.

Methods

Data sources

Databases through PubMed and Medline were used to extract relevant articles. More than 400 articles were initially obtained using the inclusion criteria and critical appraisal using systematic review articles followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) framework. Community-based intervention was applied as the primary search term and entered as the medical subject heading (MeSH) in an abstract and title of an article. This initial review includes 12 articles that almost fit to the systematic review.

Search strategy

A term used to find the relevant articles in this review, including "type 2 diabetes (T2D)," "Community Based Intervention," "HbA1c," "blood glucose control," and "weight reduction." Available title and abstract related to the community-based intervention were reviewed in systematic way to find out the most suitable articles. The searching articles were limited to those articles, which had been published between 2012 and 2017 to make sure that the articles were up-to-date and relevant to the current situation.

Eligibility criteria of study

The PICO (Participant-Intervention-Comparison-Outcomes) format was used to design the inclusion criteria for reviewing the articles.

P   Type 2 diabetes mellitus (T2DM)
I   Community-based intervention
C   Control group
O   HbA1c reduction, A1c, weight loss

The inclusion criteria compromised of (1) English language articles published between 2012 and 2017, (2) full articles of randomized control trial (RCT), (3) a community-based intervention was applied to improve health outcomes, and (4) the outcomes measured were HbA1c or body weight. Description of what an appropriate program (e.g., articles in which not include community as a part of diabetes prevention) would be listed as reasons to exclude from this study. Types of study designs include a single design, descriptive, qualitative design, one group quasi-experimental, and quasi-experimental study with two groups pretest-posttest design with non-equivalent control group. While unpublished dissertation, and inappropriate populations such as type 1 diabetes, gestational diabetes as well as other metabolic diseases were also excluded from this study.

Literature search

Figure 1 described the flow chart of screening and selection of articles based on the PRISMA flow chart. Two databases provided 485 documents during the years of 2012–2017. The process was conducted on December 21, 2018. After duplication of study has been verified, 475 articles were recruited. The researchers screened the relevant studies based on the abstracts and excluded 325 articles out.

After selecting articles based on abstracts and research titles, there were 123 articles that fulfilled the requirements with full texts of publication. Referred of inclusion criteria, only 12 articles can be examined in the meta-analysis stage. In contrary, 111 articles have to be excluded for several reasons including the following: 25 articles designed the program by using other approaches rather than community-based approach. Seventeen articles measured outcomes other than HbA1c and weight loss were not included as outcomes of this meta-analysis. Twelve studies focused on populations such as type 1 diabetes mellitus, gestational diabetes, hypertension or other population who are not related to T2DM. Since this review was focused on RCT studies, 48 studies were excluded due to inappropriate study designs that did not fit with our purpose, such as single design, descriptive study, qualitative study, one group quasi-experimental study, and two groups quasi-experimental, pretest-posttest design with non-equivalent control group. Other reasons for being excluded in this study are no full texts available (18

Fig. 1 Summary of evidence search and selection criteria
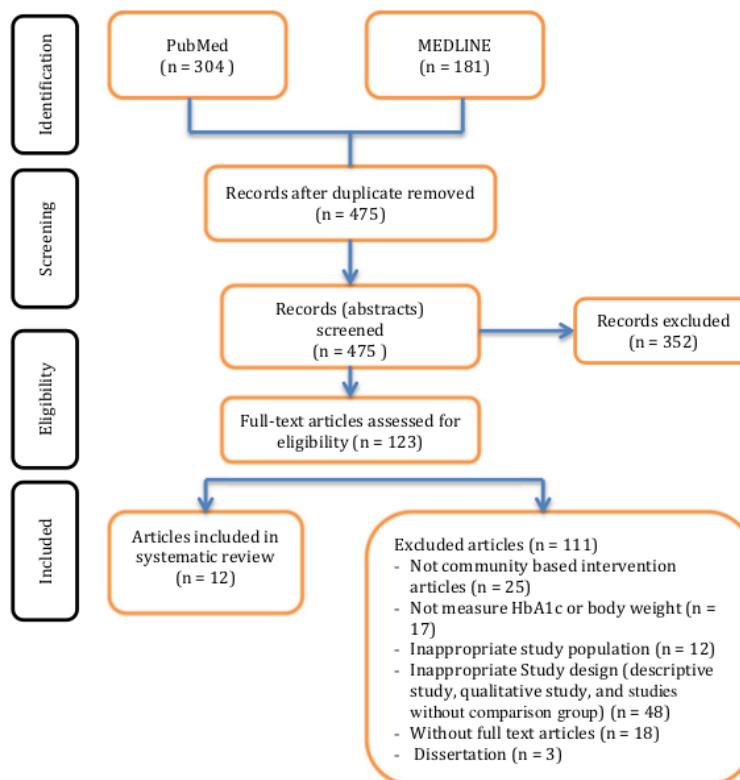
articles) and the others were published in dissertation formats (3 articles).

Data extraction procedure and quality assessment

A single reviewer was tasked to assess the eligible articles based on the study title. Then, two authors assessed abstracts independently based un-blinded standardized manner. We extracted the articles published between 2012 and 2017 to make sure up-to-date information. Special characteristics of each study have been identified and extracted by two authors. We extracted the following information from each study as follows: authors and year of research publication, study design which is a community-based approach, sample size, details of the community-based program, duration of interventions, and health outcomes measured in terms of HbA1c reduction as well as weight loss (Table 1).

Quality assessment was performed according to the Consolidated Standards of Reporting Trials (CONSORT), which is a validated scale for intervention studies in meta-analysis. This scale awards a maximum of 9 points of each study comprised of 2 for assessment of sample size and sample allocation, 1 for

assessor blinding, 4 for selection of outcomes and adequate data, and 2 for addressing biases of study. We assigned scores of 0–3, 4–6, and 7–9 as a low, moderate, and high quality of studies. When the study has several adjustment models, we extract all information that reflects the maximum adjustment level for controlling potential bias.

To verify the degree of acceptance for articles to pool in meta-analysis, we assigned the mean difference and standard deviation in each study. When the mean difference was not reported in that study, a midpoint of the upper and lower boundaries in each study was assigned.

Controlling of potential bias

A nine-item checklist tool adapted from Consolidated Standards of Reporting Trials (CONSORT) was used to assess the risk of bias by [19]. The following items included are (1) adequate sequence generation, (2) allocation adequately concealed, (3) assessor blinding, (4) incomplete outcome data adequately addressed, (5) selective reporting, (6) free of other bias, and (7) free of bias X.

Each item scored using "yes" ($\checkmark$ = score 1), "no" ($\boldsymbol{X}$ = score 0), and unclear (? = score 0). The total scores were calculated for

Table 1 MeSH, PubMed, and Scopus headings and free text (keyword) for community-based intervention, HbA1c, blood glucose control, and weight reduction

Term	PubMed	MEDLINE
Subject heading	MeSH (controlled vocabulary of PubMed)	MeSH (controlled vocabulary of MEDLINE)
Community-based intervention	Method/Intervention/Community based/	Exp[a] Community-based intervention/Consumer/ Community health systems/Population-based planning/Intervention study/Early medical intervention/
Blood glucose	Blood glucose/Control group/Prevention/Dextrose/ Relion glucose/	Blood sugar/Self-monitoring/Blood glucose/Glucose dehydrogenases/Glucose monohydrate/L-Glucose
Weight loss	Weight reduction/Reduction/	Weight reduction/Weight loss program/Weight loss diet/Anti-obesity agents/
Free text		
Community-based intervention	[b]Ti (community-based intervention) OR Ab (Community-based intervention)	[b]Community based intervention. ab, kw, ti
Blood glucose	Blood glucose*. ab, kw, ti (Blood Glucose OR HbA1c* OR blood Sugar* OR Fasting blood sugar) ab, kw, ti	Blood glucose*. ab, kw, ti (Blood Glucose OR HbA1c* OR blood Sugar* OR Fasting blood sugar) ab, kw, ti
Weight loss	Weight loss * ab, kw, ti (Weight loss OR weight reduction OR body weight * OR Weight) ab, kw, ti	Weight loss * ab, kw, ti (Weight loss OR weight reduction OR body weight * OR Weight) ab, kw, ti

[a] Explode a subject heading in PubMed and MEDLINE (retrieved results using the selected descriptor and its more specific descriptor)

[b] Runs a search through these field: abstract (ab), keywords (kw), and title (ti) in PubMed and Medline

each study, in which a score of low-risk bias was 7–9; a moderate risk of bias presented scores of 4–6 and a high risk of bias scored was 0–3.

Statistical analysis

The meta-analysis was conducted using Revman version 5.1 software [The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark; Review Manager (RevMan), 2011]. Effectiveness of community-based intervention on HbA1c reduction and weight loss between experimental group and control group was described by using mean difference. All data were considered continuous and thereby the mean difference with 95% confidence intervals was used to determine effect measures. The heterogeneity of variance was described via Chi-square and I^2-index test. Fixed effect model was conducted when the Chi-square for the heterogeneity was not significant. The statistical analysis with the standard of $p < 0.05$ performed a review manager. Funnel plots as well as Egger's strategy were conducted to discuss the publication bias.

Results

Population and setting

The mean average age of study participants was 56 years, the percentage of female participants (67.76%) is more likely than male (32.24%). The median duration of illness was 7 years (5

to 9). The percentage of type 2 diabetes mellitus was more than twice in the adult population compared to the young population or the older population. This group was more likely to develop glycemic uncontrolled and diabetes complications.

This study was restricted to intervention in which a community-based dimension was included. Among 12 studies recruited participants were recruited from various groups of population including two studies were American-Indian [20, 21], two studies were African-American [15, 22], one study was Latino [22], one study was Asian [16], and one study was Korean-American [17]. Three studies did not mention race or ethnicity of the study population [18, 23–26]. Studies also described the different regions of research conducted including the western countries [15–22, 26], Australia [23, 24], and Asian countries [9, 25].

Controlling of potential bias

Table 1 showed an assessment of potential bias from each study. Seven studies were identified as low risk of bias, five studies were moderate risk of bias. Four studies reported assessor blinding to avoid the performance bias during implementing the program. Twelve studies employed an objective measured of HbA1c and/or body weight loss.

Community-based intervention

Twelve studies examined the effectiveness of the community-based intervention on health outcomes among type 2 diabetes

mellitus. All studies were randomized control trials (RCT), pretest and posttest design with non-equivalent control group. Therefore, it is considered as a high valid and reliable research design.

Intervention approach

The intervention was led by several disciplines including community health workers and village health volunteer [16–18, 21–25], community leaders [22], nurse practitioners [9, 15, 17, 22, 23], pharmacists [15], physicians [9, 15, 24, 25], dietitians [21, 23], certified diabetes educators [9, 18, 20, 23], nutritionists [22], psychologists [22], fitness trainers [26], general practitioners [26], and local community experts [21]. Multidisciplinary approaches to diabetes self-management may particularly be necessary for patients with T2DM. Increasing the role-play by allied health professionals in diabetes care may represent a more effective diabetes self-management.

Duration of program

Duration of the intervention ranged from 2 to 18 months. Eight studies offered the program within 12 months [9, 15, 18–21, 23, 25, 26], one study spent duration on 18 months [24], and two studies conducted the community-based intervention within 6 months [16]. One pilot study examined the feasibility of the community-based intervention program within 2 months [22]. With regard to the duration of the intervention, lengths of the program also varied from weekly to monthly sessions.

Intervention strategies

In general, intervention strategies are compromised of an individual education and group-based education toward diabetes self-management followed by encouraging the patients' active involvement in the learning process. Moreover, group discussion sessions, goal setting, problem-solving, decision-making, and communication skills are also included in the strategies.

Twelve studies can be classified as combined didactic learning with participatory learning strategies including skill building and goal setting [15, 16, 20–23], problem-solving [17, 20, 21, 23, 24], rewarding system [15], effective communication [17, 23], and emotional support [18, 23, 24]. In addition, health literacy skills in food preparation, food choice, and read food label were included in this review [15–17, 20–22, 25, 26]. Five studies mentioned engaging participants in exercise behaviors as an initial planning phase of the intervention in managing the blood glucose and body weight [15, 16, 22, 25, 26].

Community-based intervention

Commonly, the community-based intervention incorporated the program into the community and involved several stakeholders in the program to facilitate on health behaviors, blood glucose control, body weight control, and promote effective day-to-day coping with stress. Some studies applied the weight loss strategies by controlling food intakes such as increasing fruits and vegetable consumption, decreasing calorie intake and saturated fat as well as promoting in actively physical activity [15, 16, 21, 25].

In Patel et al study [16], the researcher encouraged to increase physical activity in daily life about 150 min/week. A group-based lifestyle program followed by goal setting, problem-solving, group discussion, and rewarding strategy are also implemented in this study to promote behavioral change. A pedometer is used to record the physical activity change every week. In this study, the roles of the community to facilitate the orally translated information, adopting health behaviors, were evaluated. Using the community-based approach concept, the facilitators also encourage the fruits and vegetables intake to help the weight loss. The myPlate plastic plate model measures trans fat intake and fruits and vegetables intake minimum of 5 servings per day. Engaging community in the program was also used to demonstrate the exercise and cooking of healthy foods, a grocery store tour, and a recipe makeover potluck party. Findings demonstrated that participation in a culturally tailored, lifestyle intervention program in a community setting can effectively improve the health outcomes.

Another study conducted in China has introduced the "Zhiji management." This Zhiji management is a 3-month lifestyle program designed to calculate and balance the nutrition intake with energy consumption from physical activity. Health education followed by weekly consultation, encouragement, and community involving of physical activity and dietary restriction were conducted in this program. The role of a community physician is to provide dietary and physical activity information from the computer software into charts and tables format in order to make it more understandable. The physician also illustrated ways to balance energy intake and consumption based on the prescription. The findings of this study found positive effects on community participation in physical activity, increasing energy consumption up to 54.6 kcal per day and total reducing the dietary intake by 328.5 kcal [25].

In addition, a study involved community members and university advisory board to create the faith-based adaptation of the Group Lifestyle Balance (GLB) programs and health education (HE) programs. The HE program consisted of strategies for reducing calorie intake, dietary fat consumption, and behavioral style followed by stimulus control, goal setting, and problem-solving. Involving community members in the weight loss program provided 12 weeks following six-booster

session to perform at least 150 MET-minutes/week of physical activity. The church health advisors (CHAs) who are compromised on nurses, pharmacists, and physicians were invited to deliver a faith-based adaptation of the GLB program. The program consisted of the weekly sessions followed by six monthly 1-h post-cores "booster" sessions. This program was positively affected on decreasing the body weight at least 3, 5, or 7% weight loss at either 12 weeks or 12 months post-baseline and maintaining the lifestyle change among diabetes patients [15].

Effectiveness of community-based intervention on health outcomes

We found that 12 studies were included in this review based on inclusion criteria. Summary findings of effects of the community-based intervention on health outcomes between the intervention and the control groups are presented as follows:

HbA1c

HbA1c level associated with the community-based intervention was also examined in seven studies, while two studies measured only fasting blood glucose to monitor the blood glucose level. Of those nine studies which measured the HbA1c/FBG, six studies showed the improvement of HbA1c after implementing the community-based intervention [16, 17, 20, 21, 24, 25]. Three studies reported non-significant difference in HbA1c level between the intervention group and the control group [9, 15, 18].

Weight

This review examined an association of the community-based intervention with weight reduction. Regarding the 12 studies, 60% of the studies described positive impacts of the community-based intervention on BMI as the primary outcomes of the intervention [15, 16, 20–22, 25]. Two studies confirmed non-significant in decreasing body weight after receiving the program between baseline and follow-up period [18, 24].

Other outcomes

More physical activity has been confirmed with HbA1c reduction and maintaining the body weight. In this systematic review, three studies examined the physical activity as a primary outcome [15, 16, 25]. Other health outcomes included improvement of quality of life [9, 17], controlling levels of both systolic and diastolic blood pressure [22, 25], reduction of waist circumference [16, 21], and improving the insulin resistance among patients with T2DM.

Summary of effects analysis of interventions

HbA1c reduction

Eleven randomized control trials contributed to this meta-analysis and were pooled to establish the effects of interventions in HbA1c levels (see Fig. 2 and Table 2). Community-based intervention has a positive effect on HbA1c reduction. There was considerable heterogeneity among interventions [$x^2 = 92.16$, df $= 9$, ($p < 0.05$); $I^2 = 99\%$]; the random effect models were used in this study. The impact of community-based intervention has significantly effect on HbA1c levels (0.25%), (-0.33, 0.16) and (Z $= -0.581$, $p = 0.00$).

Weight loss

Figure 3 summarized the effect of the community-based intervention in weight loss. Body weight of the intervention group was slightly reduced than in the control group (Z $= -5.110$, $p = 0.00$) (Table 3). The data analysis showed heterogeneity among all interventions [Tau$^2 = 0.538$, df $= 7$ ($p < 0.05$), $I^2 = 97.343\%$].

Discussion

This study is aimed at conducting a systematic review and meta-analysis to investigate the effectiveness of the community-based interventions in weight reduction and HbA1c control among T2DM patients. Managing blood
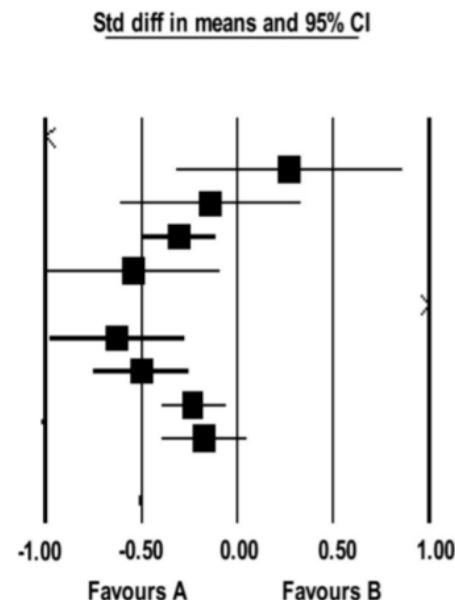

Std diff in means and 95% CI

Favours A   Favours B

Fig. 2 Forest plot for HbA1c

Table 2 Meta-analysis results of HbA1c

Studies	Intervention		Total	Control		Total	Std diff in mean	95% CI (%)	Z-value	p value
	Mean (%)	SD (%)		Mean (%)	SD (%)					
Sattin et al. (2016) [15]	5.8	0.48	317	6.8	0.48	287	−2.083	−2.282, −1.885	−20.596	0.000
Patel et al. (2017) [16]	5.7	0.37	26	5.6	0.37	20	0.27	−0.315, 0.856	0.905	0.366
Riddell et al. (2016) [23]	0.06	1.1	35	0.22	1.2	35	−0.139	−0.608, 0.330	−0.581	0.561
Sugiyama et al. (2015) [9]	−1.0	1.6	224	−0.5	1.7	217	0.303	−0.491, −0.115	−3.163	0.002
Kim et al. (2009) [17]	1.2	1.3	40	1.7	0.1	39	−0.539	−0.988, −0.090	−2.352	0.019
McDermott et al. (2015) [24]	−0.2	0.2	84	−0.7	0.2	107	2.5	2.120, 2.880	12.891	0.000
Tucker et al. (2014) [22]	2.1	0.01	64	2.11	0.02	66	−0.63	−0.982, −0.277	−3.50	0.000
Yu et al. (2014) [25]	−0.3	1	175	0.2	1	98	−0.5	−0.751, −0.249	3.907	0.000
Simmons et al. (2014)	−0.1	1.3	272	0.2	1.3	283	−0.231	−0.398, −0.064	−2.709	0.007
Ockene et al. (2012) [20]	−0.10	0.3	162	−0.04	0.4	150	−0.171	−0.393, 0.052	−1.503	0.133
Miyong et al.(2015)	−1.3	0.1	105	−0.7	0.1	104	−6.00	−6.636, −5.364	−18.493	0.000

Heterogeneity: Tau2 = 1.554, df = 10 ($p < 0.05$), 12 = 98.753%. Test for overall effect Z = −13.573 ($p = 0.00$)

glucose and maintaining weight could prevent the risk of diabetes complications and manage the condition of T2DM.

Obesity is one of an issue concerning among T2DM patients. It has a negative impact on uncontrolled glycemic level and associated with severity of diabetes and risk of cardiovascular problem. Since there is an increasing number of obese patients with T2DM, managing and preventing of complications among this population becomes a public health priority.

Twelve studies were conducted in various countries and represented across ethnic groups comparison. An RCT design was considered as a high visibility design to verify health outcomes achievement with minimum of measurement bias (Table 4). The

Std diff in means and 95% CI

Fig. 3 Forest plot for weight loss

primary outcomes indicated from those studies include HbA1c, weight loss, and other health outcomes. The other health outcomes were waist circumference, systolic and diastolic blood pressure, and quality of life. In conclusion, the present study confirmed that the community-based intervention affects on increasing of physical activity level that can induce the reduction of body weight.

Eleven from 12 of the studies reported HbA1c as an outcome that has been pooled in the meta-analysis. Meta-analysis showed that community-based interventions had contributed significantly in decreasing of HbA1c by − 0.25% ($p < 0.001$). It was consistent with the previous meta-analysis which revealed that community-based PA program has a positive effect on lowering HbA1c by − 0.32 respectively [30]. However, it is interesting to note that meta-analysis of clinically based exercise intention by promoting physical among T2DM patients can decrease HbA1c by − 0.66% (− 30.71 mmol/mol) [31]. Another study by Plotnikoff et al. also reported that stronger intervention had contributed to lower of HbA1c [32]. The findings noticed that a more significant intervention doses had been significantly impacting on increasing the physical activity and healthy food intake. As the result, the improvement on HbA1c was identified (Table 5).

Eight studies revealed that community-based interventions also decreased body weight in this meta-analysis. The intervention had contributed to reduce body weight index by Z = − 5.110, $p < 0.001$. The high weight loss changed among target population does not necessarily increase even among the group which fully participated. Therefore, scalability of diabetes intervention program is an essential element to gain high participation at the population-level. For this reason, besides the importance of intensive intervention that plays an important role in losing weight, participation in the program is also important as a fundamental factor that contributed on decreasing blood sugar levels and reducing diabetes complications.
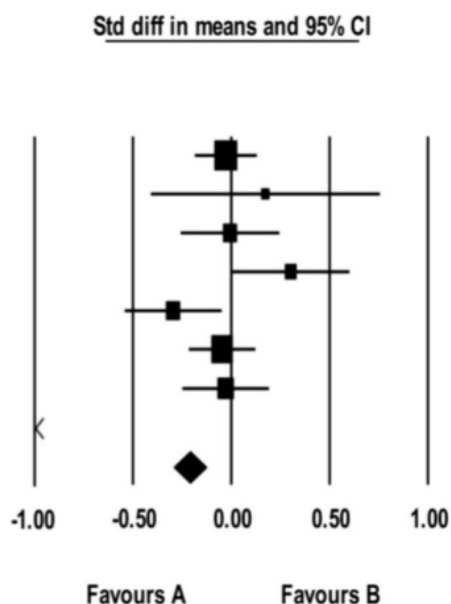
Table 3 Meta-analysis results of weight loss

Studies	Intervention		Total	Control		Total	Std diff in mean	95% CI (%)	Z-value	*p* value
	Mean (%)	SD (%)		Mean (%)	SD (%)					
Sattin et al. (2016) [15]	98.4	21	317	99	22.1	287	− 0.028	− 0.188, − 0.132	− 0.342	0.732
Patel et al. (2017) [16]	67.4	11.6	26	65.5	10.1	20	0.173	− 0.411, 0.757	0.581	0.561
Riddell et al. (2016) [23]	87.3	18.4	120	87.7	8.7	120	− 0.006	− 0.259, 0.247	− 0.049	0.961
McDermott et al. (2015) [24]	91	23.1	81	84.7	18.6	92	− 0.302	0.002, 0.603	1.974	0.048
Yu et al. (2014) [25]	68.7	10.7	175	72	11.9	98	− 0.296	− 0.545, − 0.048	− 2.335	0.020
Simmons et al. (2014)	89.2	17.0	245	90	17.2	283	− 0047	− 0.218, 0.124	− 0.536	0.592
Ockene et al. (2012) [20]	190.19	31.9	162	191.16	36.3	150	0.028	− 0.251, 0.194	0.251	0.802
Katula et al. (2011) [21]	87.44	1.28	151	90.93	1.37	150	− 2.633	− 2.941, − 2.324	− 16.717	0.000

Heterogeneity: Tau2 = 0.538, df = 7 (*p* < 0.05), 12 = 97.343%. Test for overall effect Z = − 5.110 (*p* = 0.00)

It is essential that the weight loss appears consistent as plateau at 6 months. The findings demonstrated that weight loss program not only focused on how to reduce the weight but also how to maintain it within an acceptable range [34]. Therefore, emphasis on the lower-energy intake and regular exercise behavior is the cornerstone to reduce the weight. This finding supported by the previous study reported that the mean weight loss of participants that underwent the interventions-diet alone, diet and exercise, and meal replacements are accounted as 5 to 9% more after 6 months follow-up [35]. Another systematic review also confirmed that regular exercise with low-energy intake has positive impact to reduce

Table 4 Assessment scores of potential risk of bias in community-based interventions among T2DM patients

Authors	Adequate sequence generation	Adequate allocation concealment	Adequate blinding	Incomplete outcomes data addressed	Free of selective reporting	Free of other bias	Free of bias X	Objective measures HbA1c	Objective measures weight	Score
Sattin et al. (2016) [15]	✓	✓	✓	✓	?	✗	✓	✓	✓	7/9
Patel et al. (2017) [16]	✓	✓	✓	✓	✗	✗	✓	✓	✓	7/9
Riddell et al. (2016) [23]	✓	✓	?	✓	✓	?	?	✓	✓	6/9
Sugiyama et al. (2015) [9]	✓	✓	✓	✓	✓	?	✓	✓	✗	7/9
Kim et al. (2009) [17]	✓	✓	✗	✓	✓	?	✓	✓	✗	6/9
McDermott et al. (2015) [24]	✓	✓	✗	✓	✓	✓	✓	✓	✓	8/9
Tucker et al. (2015) [27]	✓	✓	?	✓	?	✓	✓	✓	✗	6/9
Yu et al. (2014) [25]	✓	✓	✗	?	✓	?	✓	✓	✓	6/9
Simmons et al. (2014) [18]	✓	✓	✓	✓	✓	?	✓	✓	✓	8/9
Ockene et al. (2012) [20]	✓	✓	?	✓	✓	✓	✓	✓	✗	7/9
Kim et al. (2015) [29]	✓	✓	✗	✓	✓	?	✓	✓	✓	7/9
Katula et al. (2011) [21]	✓	✓	?	✓	✓	?	✓	✗	✓	6/9

The quality of articles was described based on the score of articles assessment as following; score of 0–3 was low quality article, score of 4–6 was moderate quality article, and score of 7–9 was high quality article

Table 5 Community-based intervention and health outcomes

References	Design	Community stakeholder	Sample size	Community-based program	Program duration	Result
Sattin et al. (2016) [15]	Cluster—randomized trial (RCT)	• Church health advisors (CHAs) • Church's health ministry (nurses, pharmacists, and physicians)	• Intervention group (n = 317) • Control group (n = 287)	• Weight loss strategies by reducing calories and dietary fat consumption, • Facilitated to stimulus control, goal setting, and problem-solving • Providing health education about information and risk improvement strategies about mental health and stress	12 months	• The intervention group showed a significant on weight reduction • Non-significant on fasting blood glucose (FBG) and physical activity
Patel et al. (2017) [16]	Randomized control trial (RCT)	• Community • Mandir's medical officer • Executive committee • Volunteer	• Intervention group (n = 26) • Control group (n = 20)	• Weight loss strategies by increasing the physical activity 150 min per week, increase the fruit and vegetable intake minimum of 5 servings per day, and decreasing the saturated and trans fat intake • Group-based lifestyle intervention session about 75 min • Set the goals • Rewarding strategies for success achievement • Reinforcement and follow-up strategies	6 months	• The intervention group showed a significant on weight reduction and decreasing HbA1c level • The intervention group showed a significant on increasing of physical activity and reducing waist circumference

References	Design	Community involving	Sample size	Community-based program	Program duration	Result
Riddell et al. (2016) [23]	Randomized cluster design	• Volunteer • Dietitians Diabetes educator	• Intervention group (n = 35) Control group (n = 35)	• Assisting how to self-management in daily living • Promotion and support of regular linkage to clinical care • Providing the emotional support • Provision of ongoing and sustained support to assist in the lifelong needs of diabetes self-management • Briefly the phone call for remaining and seeking their intentions to attend the program • Skill in goal setting, problem-solving and effective communication	12 months	• The intervention group showed a significant on decreasing HbA1 and improving the medication adherence • The intervention group showed a significant on fruit and vegetables intake per day, and participating in exercise • The intervention group showed the improvement of peer support and satisfaction
Sugiyama et al. (2015) [9]	Randomized control trial (RCT)	• Diabetes educator • Doctor • Community	• Intervention group (n = 224) • Control group (n = 217)	• Training on self-monitoring blood glucose • Six weekly 2-h groups self-care session • The 1-year training program and 8 h of education program related to diabetes and its clinical presentations and complication • 12 h of training and implementation of the empowerment sessions	12 months	• The intervention group showed a significant on mental health related to the quality of life • The community-based intervention showed that there is no significance of the HbA1c level and social support

Table 5 (continued)

				• A one-on-one discussion session with the health educator to review his or her baseline and follow-up laboratory and biometric data		
Tucker et al. (2014) [22]	Randomized control trial (RCT)	• Researcher team • Community leader • Nutritionist • Nurses • Psychologist	• Intervention group ($n=64$) • Control group ($n=66$)	• Didactic presentation regarding healthy eating and physical activity behavior • Demonstration of how to read and understand the nutrition label • Demonstration of how to prepare a healthy meal • A small discussion on sharing strategies and overcoming barriers • Training on assertiveness anger and depression management, and stress/anxiety management • Individualized personal goals	2 months	• The intervention group showed a significant on lower levels of BMI, diastolic blood pressure, and physical stress
Yu et al. (2014) [25]	Randomized control trial (RCT)	• Volunteer • Doctor • Community	• Intervention group ($n=175$) • Control group ($n=98$)	• The 3-month lifestyle intervention program designed to quantify and balance dietary energy intake and energy consumption • Monitor the energy consumption of physical activity, by using an electronic accelerometer-like (Zhiji Energy Monitor) • Encouraging to keep the dietary diary for 2 days a week and a weekend day • 3-month of health-related individualized consultations • Trained community physicians in each the clinic, aided with customized computer software designed for the Zhiji intervention for addressing the improvement	12 months	• The intervention group showed a significant on increasing the physical activity and decreasing the total dietary intake • The intervention group showed a significant on lower of body weight, waist circumference, as well as systolic and diastolic blood pressure
Simmons et al. (2014) [28]	Cluster—randomized control trial (RCT)	• Peer support facilitator (PSF) • Diabetes educator	• Intervention group ($n=272$) • Control group ($n=283$)	• Group education workshop for diabetes overview of approximately 3.5 h • 2-day training and PSF support • 4–6 months discussion on how to address barriers to care for DM patients, social, and emotional aspect of diabetes and health care received • A meeting of PSFs and nurse to share positive and challenging experiences, generate solutions, discuss clinical issues related to the intervention • PSFs kept the record their peers improvement and	12 months	• The community-based program was not positive impact on HbA1c, diastolic BP, weight, total cholesterol, diabetes knowledge, depression, quality of life, medical adherence, and self-efficacy

Table 5 (continued)

				reflect the experience of delivering the intervention		
Ockene et al. (2012) [20]	Randomized control trial (RCT)	• Diabetes educator	• Intervention group (*n* = 162)	• Providing basic information on diabetes prevention	12 months	• The intervention group showed a significant on weight reduction, HbA1c level, and improving the insulin resistance
		• Community	• Control group (*n* = 150)	• Promoting positive attitudes to behavior changes • Building skills in goal setting, self-monitoring, problem-solving challenges, healthy cooking skills, and grocery shopping skills • Demonstrations of healthy cooking methods, demonstration of portion sizes with real foods, and practice walking with pedometers during the sessions • Training in motivational counseling and group management skills		
Katula et al. (2011) [21]	Randomized control trial (RCT)	• Community health worker	• Intervention group (*n* = 151)	• Six months program of limiting the caloric intake	12 months	• The intervention group showed a significant on blood glucose control, body weight, BMI, and waist circumferences
		• Register dietitians • Research team • Local community expert	• Control group (*n* = 150)	• Weekly for CHW led group session and three personalized consultations • One group session and telephone contact • Facilitating on healthy eating, goal setting, and problem-solving		
Miyong, Kim et al. (2015) [33]	Randomized control trial (RCT)	• Team of RNs	• Intervention group (*n* = 105)	• A series of structured behavioral education programs including knowledge of DM and its treatment	12 months	• The intervention group demonstrated 1.0–1.3% reductions in HbA1c
		• Community health workers	• Control group (*n* = 104)	• Advancing the problem-solving skill, cognitive reframing, and belief in self-monitoring, health literacy skill (reading the food label, medical terminology, etc.) and encouraging to actively engage including multimedia presentations, teach-back, role-play, and group discussions • Ongoing self-monitoring of glucose • Individualized counseling using a motivational interviewing method that was conducted by nurses/community health workers (CHWs) who had an extensive training in DM management		• The intervention group showed a significant improvement in diabetes-related self-efficacy and quality of life when compared with the control group.
Kim et al. (2009) [17]	Randomized control trial (RCT)	• Nurses	• Intervention group (*n* = 41)	• Weekly education session (overview self-care, healthy eating, reading food label, exercise,	30 weeks	• The intervention was effective in significantly lowering HbA1c and fasting blood glucose

Table 5 (continued)

		• Nutritionist • Physician	• Control group (n = 42)	medication, and food-drug interactions		• The intervention also improved knowledge, self-care activities, self-efficacy, attitudes, depressive score, and quality of life among the experimental group
Tucker et al. (2014) [22]	Randomized control trial (RCT)	• Research team members • Team of RNs • Community health workers • Psychologist	• Intervention group (n = 65) • Control group (n = 65)	• Home glucose monitoring • Monthly telephone counseling • Problem-solving and communication skill • Health promotion workshop consisted of didactic presentations about healthy eating and physical activity behaviors • Cognitive-behavior skills and strategies to facilitate the health promoting behaviors • Demonstrations by a nutritionist on how to read and understand nutrition labels • Demonstrations on how to shop for and prepare desired culture-linked meals in a healthier way • Small group discussion to share strategies for engaging in health promoting behaviors and overcoming barriers	12 months	• The intervention group showed significantly lower levels of BMI, diastolic blood pressure, and physical stress

the mean weight by approximately 6.7 kg during the last 1 year of intervention [36]. In addition, types of exercise such as resistance training (RT), aerobic training (AT), and high-intensity interval training (HIIT) are able to avoid and fight insulin resistance as well as maintain the weight among patients with T2DM [37].

This study highlights the significant results that focused on community-based diabetes prevention program. The program has a high degree of participation and is highly effective against outcomes mainly for weight loss. These programs have varieties of basic protocols for maximizing the programs fidelity. However, some barriers to the program approach related to participation rate tend to be low. As the findings, no studies had been counted on diabetes risk reduction.

Strength and limitation

This systematic review was focused on RCTs to test the effects of the community-based interventions on health outcomes. This design was considered as the rigorous methodology to ensure validity of outcome measures. Another strength was concerned on representativeness of the studies with variety of cultural groups among different countries. Whereas, limitation of this study was concerned on the articles published between 2012 and 2017 to ensure that the articles were up-to-date and relevant to the current situation. Therefore, only 12 studies related to community-based intervention on HbA1c reduction and weight reduction were included in this study. The total number of studies might not cover all target groups in different setting. However, some limitations that are still found in this review include the difficulty of generalization of the contribution to multi-component interventions and the relatively small number of studies that were included in the meta-analysis. We analyze the potential sources of heterogeneity including types of community-based interventions, different ethnicity, sex, and how the researchers provide the intervention. Some studies combined the intervention of low-energy intake with regular exercise that showed more impact than a single intervention. Another limitation related to the interpretation of study results that should be interpreted with caution due to outcome measured in this study was focused only the reduction of HbA1c and body weight.

Conclusions

This review confirms that community-based intervention significantly affected on HbA1c and body weight reduction.

Even a low level of small changed effect was found, but it could be meaningful for T2DM patients. These results provide a valuable evidence to support development of the community-based intervention to improve self-management behaviors in order to reduce and to maintain the HbA1c and body weight of T2DM patients. The community-based intervention studies have shown positive results, but further studies should be strengthened on long-term community trials with other health outcomes measured need to be investigated.

Compliance with ethical standard

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14