Review Article

A systematic review and meta-analysis of primary prevention programmes to improve cardio-metabolic risk in non-urban communities

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ABSTRACT

Introduction. Although cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM) prevention programmes have been effective in urban residents, their effectiveness in non-urban settings, where cardio-metabolic risk is typically elevated, is unknown. We systematically reviewed the effectiveness of primary prevention programmes aimed at reducing risk factors for CVD/T2DM, including blood pressure, body mass index (BMI), blood lipid and glucose, diet, lifestyle, and knowledge in adults residing in non-urban areas.

Methods. Twenty-five manuscripts, globally, from 1990 were selected for review (seven included in the meta-analyses) and classified according to: 1) study design (randomised controlled trial [RCT] or pre-/post-intervention); 2) intervention duration (short [≤ 12 months] or long term [≥ 12 months]); and; 3) programme type (community-based programmes or non-community-based programmes).

Results. Multiple strategies within interventions focusing on health behaviour change effectively reduced cardio-metabolic risk in non-urban individuals. Pre-/post-test design studies showed more favourable improvements generally, while RCTs showed greater improvements in physical activity and disease and risk knowledge. Short-term programmes were more effective than long-term programmes and in pre-/post-test designs reduced systolic blood pressure by 4.02 mm Hg (95% CI − 6.25 to − 1.79) versus 3.63 mm Hg (95% CI − 7.34 to 0.08) in long-term programmes. Community-based programmes achieved good results for most risk factors except BMI and (glycated haemoglobin) HbA1c.

Conclusion. The setting for applying cardio-metabolic prevention programmes is important given its likelihood to influence programme efficacy. Further investigation is needed to elucidate the individual determinants of cardio-metabolic risk in non-urban populations and in contrast to urban populations.

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Keywords:
Cardiovascular disease
Diabetes
Prevention
Rural
Intervention

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1. Introduction

The burden of cardiovascular disease (CVD), and its common precursor type 2 diabetes mellitus (T2DM), extends globally but differentially according to location and population profile (Mendis et al., 2011). Globally, CVD accounts for over 30% of deaths per year (Mendis et al., 2011) and a significant proportion of the population have risk factors that contribute to the development of CVD (ABS, 2011). While CVD can be attributed to risk factors that cannot be modified, many cases are caused by risk factors that can be detected and treated; including but not limited to, elevated blood cholesterol and sugar, overweight/obesity, hypertension, smoking and physical inactivity (Mendis et al., 2011). Individuals with multiple risk factors, as in the case of metabolic syndrome (MetS) and type 2 diabetes mellitus (T2DM) are at increased risk of CVD (Mendis et al., 2011). Many risk factors are shared between diabetes and CVD such that diabetes risk reduction programmes are associated with a reduced incidence of CVD and all-cause-mortality, as well as diabetes after 23-years follow-up (Li et al., 2014). Hence, application of public health and clinical interventions to reduce the major risk factors for these diseases, while differing in their focus (e.g., dietary intervention to reduce saturated fats for CVD versus carbohydrates for diabetes), could substantially reduce the disease burden.

People living in rural, regional and remote (non-urban) locations have worse health compared to their metropolitan counterparts (Department of Health, Victoria, 2008) with mortality rates rising with greater remoteness (ABS, 2011). Non-urban residing individuals are renowned for having higher levels of antecedent risk for CVD and this observation is paralleled around the globe from Africa (Strasser, 2003) and Europe (World Health Assembly, 2009), to USA (Singh and Siahpush, 2014) and Australia (Trickett et al., 1998). In particular in Australia, a higher proportion of non-urban individuals had high blood pressure (BP, 40%) (Carrington et al., 2010) and were overweight or obese (70%) (Carrington et al., 2010) compared to urban residents, where 32% had high blood pressure (Carrington et al., 2010) and 64% are overweight or obese (Carrington et al., 2010). Non-urban populations are geographically more distant from specialist health care (Carrington et al., 2012) and locally, have limited availability to primary care services per capita (Clark et al., 2007), few or no walking paths or bike tracks and may pay more for fresh produce and meat (Burns et al., 2004). Non-urban dwelling residents tend to be from lower socioeconomic backgrounds (reflecting by occupational and educational status) (Trickett et al., 1998), engage in sub-optimal dietary and lifestyle behaviours (ABS, 2011), and have poorer attitudes towards health (Elliot-Schmidt, 1997) which may contribute to regional disparities in cardio-metabolic health outcomes. The interpretation of these findings are strongest when representative national comparisons are made yet may be diluted when extrapolated to more local areas where CVD risk and outcomes have been shown to be no worse between urban and non-urban residents (Tideman et al., 2013). These key differentials suggest that a one-size-fits-all approach to preventive health may not always suffice. While lifestyle modifications to improve cardio-metabolic risk in an urban setting have been widely reviewed and deemed efficacious (Gillies et al., 2007), few studies have investigated their effectiveness in non-urban populations. The aim of this systematic review therefore was to assess the effectiveness of primary prevention programmes targeting cardiovascular disease and/or diabetes risk in non-urban adults.

2. Methods

In 2015, relevant publications and research reports on primary prevention programmes relating to cardio-metabolic health were identified utilising specific search terms with Boolean operators (rural/regional/remote AND prevention/intervention/programme AND cardiovascular disease/CVD/diabetes/T2DM/metabolic syndrome) via Ovid Medline, PubMed, PsychINFO, EMBASE, Cochrane Database of Systematic Reviews and CINAHL plus. Reference lists of included publications were also examined for additional relevant inclusions.

3. Inclusion and exclusion criteria

The abstracts of potentially relevant manuscripts were reviewed by two independent reviewers for eligibility with a third reviewer’s opinion where there was no consensus. Publications were included if they: were published between the years inclusive of 1990 and 2015, were defined as rural, regional or remote studies; were primary prevention in nature; and were focused on CVD or diabetes risk factors. Studies were excluded from review if: the publication pre-dated 1990, sample size was less than 30, the programme duration was less than 6 months; or if analyses included individuals aged under 18 years of age. Observational studies and studies targeting secondary prevention were excluded in addition to literature reviews, single-participant case-studies, opinion pieces, animal studies and non-peer reviewed publications such as editorials and letters.

As shown in Fig. 1, a total of 8671 records were identified. After removal of duplicates, 6215 titles were identified for review. Of these, 6154 abstracts were excluded, predominantly because their focus was incongruent with the aims of this review. Upon reading the articles (61 in total), an additional 36 manuscripts were excluded, again mainly due to incongruence. Ultimately, 25 eligible study publications were included in this systematic review.

4. Definitions

4.1. Non-urban

There is no universal definition for “non-urban”. For the purpose of this review, the term non-urban will be used as a collective for rural, regional and remote communities, indicating distance from a...
Definitions of these terms vary depending on purpose or policy; often in health research, the term rural represents small towns, isolation or low population density (compared to those residing in more densely populated areas) (Hart et al., 2005). Studies were included if literature searches identified ‘rural’, ‘regional’ or ‘remote’ as a respective keyword or if sample population characteristics were concordant with respective national definitions concerning rurality and remoteness set by national statistical offices; including distance from urban health centres, population size and density, geographical size and location.

4.2. Primary CVD/T2DM prevention programmes

Primary prevention pertains to preventing the onset of a disease or condition (in contrast to secondary prevention that aims to reduce the impact of a disease or injury that has already occurred). A primary prevention programme was defined as an intervention targeting dietary, lifestyle and behavioural modifications to reduce the likelihood of developing T2DM and/or CVD. Lifestyle modification for physical activity (PA), diet, smoking and alcohol consumption could be achieved via support that includes goal-setting (Artinina et al., 2010), education (Staten et al., 2004), regular follow-up of participants (Green et al., 2002), incentives (Jeffery et al., 1998), print- or media-delivery strategies (Marcus et al., n.d.), or PA and diet demonstrations (Artinina et al., 2010). Prevention programmes can be administered in either group or one-on-one sessions by trained research personnel, health professionals, nurses, diabetes educators and/or exercise physiologists. Counselling methods such as cognitive behavioural therapy and motivational interviewing can assist participants in overcoming barriers to positive health behaviour changes (Gulliksson et al., 2011; Rollnick and Miller, 1995). Pharmacological treatments upon referral may also be a feature of some prevention programmes.

4.3. Investigated outcomes

Widely recognised biomedical risk factors for CVD and T2DM reported in this review were all objectively measured (i.e. not self-reported). They included: systolic and diastolic blood pressure (SBP and DBP), body mass index (BMI), body weight, lipids including triglycerides, total-, high-density lipoprotein (HDL)-, and low-density lipoprotein (LDL)-cholesterol, fasting blood glucose (FBG) and glycated haemoglobin (HbA1c). Self-reported knowledge and behaviours: knowledge about CVD or diabetes, PA, diet, smoking and alcohol consumption.

4.4. Data extraction and analyses

Accepted publications were classified according to 3 criteria: 1) study design (randomised controlled trial [RCT] or pre-/post-intervention studies); 2) intervention duration (short [<12 months] or long
Table 1
Findings of included randomised controlled trials (RCTs) to improve cardio-metabolic risk factors in rural adults.

<table>
<thead>
<tr>
<th>Study</th>
<th>Design/duration</th>
<th>Participants</th>
<th>Control groups (C)/intervention (I)</th>
<th>Between group biomedical outcomes</th>
<th>Between group behavioural outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis et al., (2010)</td>
<td>Community based RCT/12-months</td>
<td>N = 165; adult with HbA1c over 7%; BMI over 25; aged over 35 years</td>
<td>C: One 20 min diabetes education session conducted individually I: Delivered by health professionals to groups: education classes, education material, face-to-face counselling, dietary advice, video-conferencing component. Follow-up once per month.</td>
<td>Systolic: I: − 3.2 mm Hg v C: − 3.7 mm Hg; Diastolic: I: − 2.5 mm Hg v C: − 1.6 mm Hg; BMI: I: − 0.2 v C: − 0.2; LDL: I: − 13.3 mg/dl v C: + 0.6 mg/dl; HbA1c: I: − 1.2 v C: − 0.2</td>
<td>...</td>
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<tr>
<td>Ko et al., (2004)</td>
<td>RCT/12-months</td>
<td>N = 180; Chinese diabetic adults; aged 25–70 years</td>
<td>C: Received a doctor consultation every 3 months, usual care I: Delivered by health professionals to individuals: education classes, face-to-face counselling, dietary and physical activity advice. Follow-up once per month.</td>
<td>% Change Smoking (quit or reduced): I: − 16.7% v C: − 5.7 Systolic: I: 0.7 v C: 1.0 Diastolic: I: − 3.2 v C: − 0.4 BMI: I: − 0.2 v C: 0.3 Triglycerides: I: − 6.8 v C: − 11.9 Total cholesterol: I: − 9.3 v C: − 10.0 LDL: I: − 12.2 v C: − 15.4 HDL: I: 1.1 v C: 0.2 Glucose: I: − 0.9 v C: − 1.4 HbA1c: I: − 6.0 v C: − 2.1</td>
<td>Smoking (quit or reduced): I: − 16.7% v C: − 5.7</td>
</tr>
<tr>
<td>Lupton et al., (2003)</td>
<td>Community based RCT/6-years</td>
<td>N = 1324; Norwegian adults; 50.4% male</td>
<td>C: Reference community/usual care; Delivered by researchers to groups: education classes, physical activity demonstrations, educational material. Follow-up once per month</td>
<td>Men Systolic: I: − 0.1 mm Hg v C: + 2.2 mm Hg; Diastolic: I: − 2.1 mm Hg v C: + 0.8 mm Hg; BMI: I: + 1.1 kg/m² v C: + 1.1 kg/m²; Total cholesterol</td>
<td>Men Smoking: I: − 7.5% v C: − 2.7 Physical activity: % of physically active people I: + 8.6% v C: 0.6%; Diet: Low-fat milk I: + 0.05% v C: + 1.1%</td>
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<td>Women Systolic: I: + 2.1 mm Hg v C: + 4.6 mm Diastolic: I: − 2.1 mm Hg v C: − 1.8 mm Hg; BMI: I: + 1.9 kg/m² v C: + 1.4 kg/m²; Total cholesterol</td>
<td>Women Smoking: I: 0.6% v C: 1.2% Physical activity: % of physically active people I: + 7.9% v C: 2.1%; Diet: Low-fat milk I: + 11.2% v C: + 3.3%</td>
</tr>
<tr>
<td>Majumdar et al., (2003)</td>
<td>RCT/6-months</td>
<td>N = 379; type 2 diabetic adults from North Alberta; 58.4% male</td>
<td>C: Three bimonthly visits from the Canadian Diabetes Association (CDA) Resource Programme I: Delivered by health professionals to groups and individuals: education classes, face-to-face counselling. Follow-up once per month</td>
<td>Blood pressure: I: 42% saw 10% decrease or more; HbA1c; Total cholesterol</td>
<td>...</td>
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<tr>
<td>Mayer-Davis et al., (2004)</td>
<td>RCT/12-months</td>
<td>N = 105; diabetic adults; aged over 45 years; BMI over 25 kg/m²</td>
<td>C: Usual care I: Delivered by health professionals to groups and researchers to individuals: education classes, educational material, face-to-face counselling, dietary and physical activity advice, goal setting. Follow-up once per month</td>
<td>Systolic: I: − 3.31 mm Hg v C: − 9.52 mm Hg; Diastolic: I: − 0.49 mm Hg v C: − 2.65 mm Hg; BMI: I: − 0.97 kg/m² v C: − 0.16 kg/m²; Triglycerides: I: 0.87 mg/dl v C: 0.91 mg/dl; Total cholesterol: I: − 0.09 mg/dl v C: − 6.32 mg/dl; LDL: I: − 3.37 mg/dl v C: − 7.07 mg/dl; HDL: I: 0.73 mg/dl v C: − 1.12 mg/dl</td>
<td>Physical activity; Diet; Smoking; Alcohol</td>
</tr>
<tr>
<td>Study</td>
<td>Design/duration</td>
<td>Participants</td>
<td>Control groups (C)/intervention (I)</td>
<td>Between group biomedical outcomes</td>
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</table>
| Miller et al., (2001)     | RCT/24-months    | N = 277; Premenopausal Women; aged over 18 years                             | C: Usual care  
I: Intervention delivered by health professionals to groups: face-to-face counselling, dietary and physical activity advice. Follow-up ≥ once per month | HbA1c: I: $-1.56\%$ v C: $-1.12\%$  
BMI: I: $0.1$ v C: $0.0$  
Diabetes: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C | Diet: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C |
| Nguyen et al., (2012)     | Community based RCT/36-months | N = 4650; Vietnamese adults; aged over 25 years                             | C: Routine Conventional Primary Healthcare  
I: Delivered by disease educators to groups and individuals: education classes, physical activity demonstrations, educational material, and dietary advice. Follow-up ≥ once per month | BMI: I: $0.0$ kg/m$^2$ v C: $0.0$  
Systolic: I: $-10.3$ mm Hg v C: $-8.6$ mm Hg  
Diastolic: I: $-1.0$ mm Hg v C: $-0.5$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.4$ kg  
Men: Systolic: I: $-10.3$ mm Hg v C: $-8.6$ mm Hg  
Diastolic: I: $-1.0$ mm Hg v C: $-0.5$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.4$ kg  
Diabetes: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+6\%$ v C: $-0.4\%$  
Diet: Salt intake I: $-7.4\%$ v C: $-2.4\%$  
Smoking: I: $-0.6\%$ v C: $0.0\%$  
Alcohol: I: $-0.2\%$ v C: $-0.2\%$  
Men: Physical activity: I: $+2.6\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-7.4\%$ v C: $-2.4\%$  
Smoking: I: $-2.3\%$ v C: $-2.3\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ | Diet: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+2.6\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-7.4\%$ v C: $-2.4\%$  
Smoking: I: $-2.3\%$ v C: $-2.3\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ |
| Pieber et al., (1995)      | RCT/6-months     | N = 108; diabetic adults; mean age 63.9 years                               | C: Usual care  
I: Delivered by investigators to groups: education classes, face-to-face counselling, and advice on physical activity. Follow-up ≥ once per month | BMI: I: $0.38$ kg/m$^2$ v C: $0.63$ kg/m$^2$  
Systolic: I: $-11.1$ mm Hg v C: $5.4$ mm Hg  
Diastolic: I: $-0.9$ mm Hg v C: $-0.9$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.4$ kg  
Men: Systolic: I: $-11.1$ mm Hg v C: $5.4$ mm Hg  
Diastolic: I: $-0.9$ mm Hg v C: $-0.9$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.4$ kg  
Diabetes: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ | Diet: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ |
| Schuit et al., (2006)      | Community based RCT/5-years | N = 2414; adults from Maastricht Holland; aged 30–70 years                 | C: Usual care  
I: Delivered by investigators to groups: education classes, cooking demonstrations, physical activity groups, educational material, dietary advice. Follow up ≥ once per month | HDL: I: $-0.09$ mmol/l v C: $-0.17$ mmol/l  
Total cholesterol: I: $-0.45$ mmol/l v C: $-0.45$ mmol/l  
BMI: I: $-0.08$ mmol/l v C: $-0.11$ mmol/l  
Men: Systolic: I: $-15.8$ mm Hg v C: $-5.0$ mm Hg  
Diastolic: I: $-4.1$ mm Hg v C: $-4.7$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.7$ kg  
Men: Systolic: I: $-15.8$ mm Hg v C: $-5.0$ mm Hg  
Diastolic: I: $-4.1$ mm Hg v C: $-4.7$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.7$ kg  
Diabetes: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ | Diet: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ |
| Shahar et al., 2012)       | RCT/6-months     | N = 42; Malaysian adults with metabolic syndrome; mean age 66.3 years, 28.6% diabetic; 73.8% hypertensive | C: General Health Education Package  
I: Delivered by investigators to groups: education classes, cooking demonstrations, physical activity demonstrations, educational material. Follow-up ≥ once per month | Triglycerides: I: $-0.1$ mmol/l v C: $-0.1$ mmol/l  
Total cholesterol: I: $-0.9$ mmol/l v C: $-0.9$ mmol/l  
LDL: I: $-0.8$ mmol/l v C: $-0.8$ mmol/l  
HDL: I: $-0.0$ mmol/l v C: $-0.0$ mmol/l  
Men: Systolic: I: $-15.8$ mm Hg v C: $-5.0$ mm Hg  
Diastolic: I: $-4.1$ mm Hg v C: $-4.7$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.7$ kg  
Men: Systolic: I: $-15.8$ mm Hg v C: $-5.0$ mm Hg  
Diastolic: I: $-4.1$ mm Hg v C: $-4.7$ mm Hg  
Weight: I: $-0.8$ kg v C: $-0.7$ kg  
Diabetes: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ | Diet: % of calories from fat  
I: $-2.8\%$ v C: $-1.3\%$  
Knowledge: I > C  
Physical activity: I: $+7.4\%$ v C: $+2.6\%$  
Diet: Salt intake I: $-8.2\%$ v C: $-3.1\%$  
Smoking: I: $-2.3\%$ v C: $-2.1\%$  
Alcohol: I: $-10.4\%$ v C: $-10.6\%$ |

* Not significant.  
* p < 0.05.  
** p < 0.01.  
*** p < 0.001.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design/duration</th>
<th>Participants</th>
<th>Control groups (C)/intervention (I)</th>
<th>Within group biomedical outcomes</th>
<th>Within group behavioural outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balogopal et al., (2008)</td>
<td>Community based/7-months</td>
<td>N = 585; adults from Almarathupatti, India; mean age 46.3 years; 41% male; 5.1% diabetic</td>
<td>I: Delivered by health professionals, disease educators to individuals: education classes, cooking demonstrations, physical activity groups, face-to-face counselling, and dietary and physical activity advice. Unspecified follow up intervals</td>
<td>Systolic: −1.07 mm Hg; Diastolic: −5.9 mm Hg; BMI: +0.2 kg/m²; Glucose: −3.2 mg/dl</td>
<td>Physical activity: Diet: Protein intake − 0.7 g/day; Knowledge: T2DM knowledge improved</td>
</tr>
<tr>
<td>Balogopal et al., (2012)</td>
<td>Community based/6-months</td>
<td>N = 1638; adults from Gujarat, India; mean age 41.9 years; 44.2% smokers; 7.1% diabetic</td>
<td>I: Delivered by health professionals to groups and individuals: education classes, cooking demonstrations, physical activity demonstrations, face-to-face counselling, and dietary advice. Follow-up 1 zonce per month</td>
<td>Systolic: −7.37 mm Hg; Diastolic: −3.24 mm Hg; BMI: −0.46 mmol/l; Glucose: −1.28 mg/dl</td>
<td>Physical activity: 11.6% improved; self-reported **; Diet: Fruit intake + 0.4 servings/day; vegetables intake + 0.19 servings/day; Knowledge: T2DM and CVD improved **</td>
</tr>
<tr>
<td>Carrington and Stewart, (2014)</td>
<td>Community based/6-months</td>
<td>N = 530; Australia adults; mean age 54 years; 62% female; high CVD risk status</td>
<td>I: Delivered by health professionals and researchers to individuals: education classes, physical activity groups, educational material, face-to-face counselling, dietary and physical activity advice, goal setting. Follow-up 1 zonce per month</td>
<td>Systolic: −4.0 mm Hg; Diastolic: −1.3 mm Hg; Weight: −0.8 kg; BMI: −0.3 kg/m²; Triglycerides: −0.4 mmol/l; Total cholesterol: −0.6 mmol/l; LDL: −0.3 mmol/l; HDL: −0.1 mmol/l; Glucose: −0.6 mmol/l</td>
<td>Physical activity: −36 MET; Diet: Saturated Fat intake decreases ***</td>
</tr>
<tr>
<td>Chockalingam and Fodor, (1990)</td>
<td>Pilot study/6-month intervention/12-month follow-up</td>
<td>N = 41; adults from fishing communities in Newfoundland, Canada; 30% smokers; 54% overweight</td>
<td>I: Delivered by health professionals to groups: educational material, face-to-face counselling, dietary advice, goal setting. Follow-up intervals not specified</td>
<td>Systolic: −4.38 kg/m²; Diastolic: −2.56 mm Hg; BMI: −0.34 kg/m²</td>
<td>...</td>
</tr>
<tr>
<td>Daniel et al., (1999)</td>
<td>Community based/24-months</td>
<td>N = 295; Indian adults from Okanagan region; aged over 35 years;</td>
<td>I: Delivered by disease educators and researchers to groups and individuals: education classes, cooking demonstrations, physical activity demonstrations, and physical activity groups. Follow-up – once per month</td>
<td>Systolic: −3 mm Hg; Diastolic: −0.0 mm Hg; BMI: −0.0 kg/m²; Triglycerides: −2.0 mg/dl; Total cholesterol: −12 mmol/l; LDL: −5 mmol/l; HDL: −7 mmol/l; Glucose: −0.0 mg/dl; HbA1c: −0.5%</td>
<td>Physical activity; Smoking; Alcohol</td>
</tr>
<tr>
<td>Farag et al., (2010)</td>
<td>Community based/6-months</td>
<td>N = 187; employees from public school system in Oklahoma; mean age 45 years</td>
<td>I: Delivered by educators to groups: Advice on physical activity. Follow-up &lt;once per month</td>
<td>Systolic: −3.1 mm Hg</td>
<td>...</td>
</tr>
<tr>
<td>Franks and Gold, (1990)</td>
<td>Community based/24-months</td>
<td>N = 625; adults from Meredith and Kortright communities; mean age 47.6 years</td>
<td>I: Delivered by health professionals to individuals: education classes, face-to-face counselling, and dietary advice. Follow-up intervals not specified</td>
<td>Systolic: −3.1 mm Hg</td>
<td>...</td>
</tr>
<tr>
<td>Giampaoli et al., (1991)</td>
<td>Community based/36-months</td>
<td>N = 3585; adults aged 20–69 years; 46.9% male</td>
<td>I: Delivered by educators to groups: Dietary and physical activity advice. Follow-up – once per month</td>
<td>I: Men</td>
<td>...</td>
</tr>
</tbody>
</table>

(continued on next page)
<table>
<thead>
<tr>
<th>Study</th>
<th>Design/duration</th>
<th>Participants</th>
<th>Control groups (C)/intervention (I)</th>
<th>Within group biomedical outcomes</th>
<th>Within group behavioural outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huang et al., (2011)</td>
<td>Community based/36-months</td>
<td>N = 1636; Chinese adults; aged over 35 years</td>
<td>I: Delivered by investigators to groups: education classes, educational material, and advice on physical activity. Follow-up once per month</td>
<td>I: Women Systolic: −3.2 mm Hg**; Diastolic: +2.6 mm Hg***; BMI: +0.4 kg/m²; Cholesterol: −3.5 mg/dl**; I: Systolic; Diastolic; Weight; BMI ***</td>
<td>I: Percent with salty diet −30.0%; fat intake reduced in −9.1%; percent smoking −3.5%; percent consuming alcohol −4.2%; percent exercising +16.4%; knowledge increased by 28.5% C: Percent with salty diet −5.5%; Fat intake reduced in −16.6% of people; smoking −3.1%; percent consuming alcohol −7.3%; percent exercising +26.5%; knowledge: Increased by 15.5%</td>
</tr>
<tr>
<td>Laatikainen et al., (2007)</td>
<td>Longitudinal/12-months</td>
<td>N = 237; non-diabetic adults at high-risk of diabetes; 27.4% male</td>
<td>I: Delivered by health professionals to groups: education classes, face-to-face counselling, educational material, dietary advice, goal setting. Follow-up intervals not specified</td>
<td>Systolic: −1.01%; Weight: −2.7%; BMI: −2.8%; Triglycerides: −7.6%; Total cholesterol: −5.1%; LDL: −7.3%; HDL: 4.4%</td>
<td>...</td>
</tr>
<tr>
<td>Nafziger et al., (2001)</td>
<td>Hospital-based/5-years</td>
<td>N = 548; adults from Otsego and Schoharie Counties, USA; aged 20–79 years</td>
<td>I: Delivered by educators to groups: education classes, cooking demonstrations, educational material, dietary advice. Follow-up once per month</td>
<td>I: Systolic: −6.9 mm Hg***; Diastolic: −0.2 mm Hg; Triglycerides: +8.5 mg/dl; Total cholesterol: −0.5 mg/dl; LDL: −0.2 mg/dl; HDL: −2.6 mg/dl*** Systolic: −2.88 mm Hg***; Diastolic: −1.13 mm Hg; Weight: +0.417 kg; BMI: +0.25 kg/m²; Total cholesterol: −0.158 mmol/l***; HDL: −0.101 mmol/l***; Glucose: −0.184 mmol/l***</td>
<td>I: Physical activity: +11.6%; Smoking: −8.9%</td>
</tr>
<tr>
<td>Richardson et al., (2008)</td>
<td>Community based/10-years</td>
<td>N = 313; overweight adults; aged 45–64 years</td>
<td>I: Delivered by educators to individuals: educational material with referrals. Follow-up: once per month</td>
<td>...</td>
<td>Physical activity; Diet: fruit and vegetable intake increased ***; Smoking: smoking decreased; Alcohol: consumption decreased</td>
</tr>
<tr>
<td>Sherman et al., (2007)</td>
<td>Female study/6-months</td>
<td>N = 61; Women; mean age 42.5 years; at least one risk factor for CVD; 78% overweight/obese</td>
<td>I: Delivered by researchers to individuals: physical activity demonstrations, physical activity groups, educational material, physical activity advice. Follow-up once per month</td>
<td>...</td>
<td>Physical activity: I: Mean pedometer count +2573***</td>
</tr>
<tr>
<td>Vadheim et al., (2010)</td>
<td>Community based/6-months</td>
<td>N = 65; Overweight Adults; mean age 50.5 years; 88% female; 66% dyslipidemia — paid to participate in intervention</td>
<td>I: Delivered by health professional to groups: cooking demonstrations, physical activity demonstrations, face-to-face counselling, and dietary and physical activity advice. Follow-up once per month</td>
<td>Weight: Mean weight loss: 7.5 kg***</td>
<td>...</td>
</tr>
<tr>
<td>Weinhehall et al., (2001)</td>
<td>Community based/10-years</td>
<td>I: Delivered by health professionals to groups and individuals: face-to-face counselling, and dietary and physical activity advice. Follow-up once per month</td>
<td>Men Systolic: I: −6.7 mm Hg***; Diastolic: I: −2.9 mm Hg***; Total cholesterol: I: −0.83 mmol/l*** Women Systolic: I: −7.3 mm Hg***; Diastolic: I: −2.7 mm Hg; Total cholesterol: I: −0.73 mmol/l***</td>
<td>...</td>
<td>Smoking</td>
</tr>
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</table>

* Not significant.
  ** p < 0.05.
  *** p < 0.01.
  **** p < 0.001.
term [≥12 months]), and; 3) programme type (community-based programmes which utilised existing community resources (McLeroy et al., 2003) [e.g. local fitness, health groups] as part of their intervention or non-community-based programmes [interventions constructed and applied internally within studies]). Results were summarised as between-group differences (for RCTs) and within individual changes (for pre-/post-test study designs).

Mean differences and 95% confidence intervals (CIs) were calculated where there were a significant number of publications for meta-analyses. This applied to SBP, DBP, BMI, LDL cholesterol and HbA1c for

| Fig. 2. Overall effect size (represented as a black diamond) for mean differences in SBP and DBP for short and long term programmes. |
selected programmes via direct comparison meta-analysis. Pre- and post-test results for each respective outcome and standard errors calculated for each resulting mean difference were entered into Review Manager (RevMan) 5.1.7. A random effects model was used due to heterogeneity between the included studies. Effect sizes of the change in risk factors as a result of the programme were calculated using the generic inverse variance method and the I² statistic was utilised to estimate the proportion of variance as a result of heterogeneity.

5. Results

5.1. Description of publications

Ten of the manuscripts included RCTs (Table 1) and fifteen were pre-/post-test designs (Table 2). Publications were included from Asia (Ko et al., 2004; Nguyen et al., 2012; Shahar et al., 2012; Balagopal et al., 2008; Balagopal et al., 2012; Huang et al., 2011), North America (Davis et al., 2010; Majumdar et al., 2003; Mayer-Davis et al., 2004; Miller et al., 2001; Chockalingam and Fodor, 1990; Daniel et al., 1999; Farag et al., 2010; Franks and Gold, 1990; Nafziger et al., 2001; Sherman et al., 2007; Vadheim et al., 2010), Europe (Lupton et al., 2003; Pieber et al., 1995; Giampaoli et al., 1991; Richardson et al., 2008; Weinheil et al., 2001) and Australia (Carrington and Stewart, 2014; Laatikainen et al., 2007), to enable a broad inclusion of studies. The length of intervention included 10 short (<12 months) (Majumdar et al., 2003; Pieber et al., 1995; Shahar et al., 2012; Balagopal et al., 2008; Balagopal et al., 2012; Carrington and Stewart, 2014; Chockalingam and Fodor, 1990; Farag et al., 2010; Sherman et al., 2007; Vadheim et al., 2010) and 15 long-term (≥12 months) (Davis et al., 2010; Ko et al., 2004; Lupton et al., 2003; Mayer-Davis et al., 2004; Miller et al., 2001; Nguyen et al., 2012; Schuit et al., 2006; Daniel et al., 1999; Franks and Gold, 1990; Giampaoli et al., 1991; Huang et al., 2011; Laatikainen et al., 2007; Nafziger et al., 2001; Richardson et al., 2008; Weinheil et al., 2001) prevention programmes. A considerable number (64%) were community-based programmes (Davis et al., 2010; Lupton et al., 2003; Nguyen et al., 2012; Schuit et al., 2006; Balagopal et al., 2008; Balagopal et al., 2012; Carrington and Stewart, 2014; Chockalingam and Fodor, 1990; Farag et al., 2010; Sherman et al., 2007; Vadheim et al., 2010) and 15 long-term (≥12 months) (Davis et al., 2010; Ko et al., 2004; Lupton et al., 2003; Mayer-Davis et al., 2004; Miller et al., 2001; Nguyen et al., 2012; Schuit et al., 2006; Daniel et al., 1999; Franks and Gold, 1990; Giampaoli et al., 1991; Huang et al., 2011; Laatikainen et al., 2007; Nafziger et al., 2001; Richardson et al., 2008; Weinheil et al., 2001) prevention programmes.

5.2. Programme approaches and components

The majority of studies included in this systematic review delivered their programme to groups of individuals (Lupton et al., 2003; Miller et al., 2001; Pieber et al., 1995; Schuit et al., 2006; Shahar et al., 2012; Balagopal et al., 2008; Daniel et al., 1999; Farag et al., 2010; Giampaoli et al., 1991; Huang et al., 2011; Laatikainen et al., 2007; Nafziger et al., 2001) while a lesser number administered it individually (Ko et al., 2004; Mayer-Davis et al., 2004; Franks and Gold, 1990; Richardson et al., 2008; Sherman et al., 2007), some studies combined both group and individual delivery (Davis et al., 2010; Majumdar et al., 2003; Balagopal et al., 2012; Daniel et al., 1999; Vadheim et al., 2010; Weinheil et al., 2001). Eleven studies had infrequent (<1 per month) follow-up contact either by telephone or face-to-face while nine studies contacted participants regularly (Davis et al., 2010; Majumdar et al., 2003; Mayer-Davis et al., 2004; Miller et al., 2001; Nguyen et al., 2012; Pieber et al., 1995; Balagopal et al., 2012; Sherman et al., 2007; Vadheim et al., 2010) (>1 per month). Studies that had frequent contact between investigators and participants (Ko et al., 2004; Lupton et al., 2003; Schuit et al., 2006; Daniel et al., 1999; Farag et al., 2010; Giampaoli et al., 1991; Nafziger et al., 2001; Richardson et al., 2008; Weinheil et al., 2001) were not as effective in lowering CVD or T2DM risk compared to programmes where participants were regularly contacted (>1 per month). Programmes were conducted by health professionals, disease educators and researchers. The programmes reported consisted of disease and risk education classes, cooking- and PA-demonstrations, PA groups, distribution of educational material, and face-to-face counselling. Advice on diet modification and exercise benefits were also included while one study utilised a videoconferencing component to deliver part of the programme (Balagopal et al., 2008). Individual goal setting was also implemented as a motivational tool in some interventions and while it was not widely utilised, the few studies that incorporated goal setting were effective, all exhibiting statistically significant improvements across all respective outcomes targeted (Carrington and Stewart, 2014; Daniel et al., 1999; Laatikainen et al., 2007; Vadheim et al., 2010).

6. Biomedical risk factors

6.1. Blood pressure

Of the 25 publications selected, 20 reported SBP changes comprising 8 RCTs and 12 pre-/post-test studies. Overall, 3 RCTs reported a decrease in SBP in favour of the intervention group and 9 pre-/post-test studies reported a decrease within individuals. The remaining 8 papers reported no statistically significant changes in SBP. Six out of 8 short term and 6 of 12 long term studies reported decreases in SBP. Thirteen community-based studies reported on SBP; 11 found a decrease in SBP and 2 found no statistically significant changes. Of the 7 non-community-based programmes, 2 found a decrease in SBP and 5 found no change.

Nineteen publications reported changes in DBP including 8 RCTs and 11 pre-/post-test studies. Four RCTs and 8 pre-/post-test studies reported a decrease in DBP with the remaining 7 papers reporting no statistically significant changes. Six of 8 short term studies and 6 of 11 long term studies reported a decrease in DBP. Nine out of twelve community-based programme studies found a decrease in DBP and 3 showed no difference. Seven non-community-based programmes reported on DBP; four found a decrease and 3 found no change. Neither SBP nor DBP increased in any of the included studies.

The mean difference in BP in short-term, pre-/post-test programmes (Fig. 2A and D) was −4.0 mm Hg (95% CI −6.3 to −1.8) and −2.6 mm Hg (95% CI −5.1 to −0.0) for SBP and DBP respectively. Effect sizes were significant for SBP (p = 0.0004), although most variation was due to heterogeneity (I² = 91%). The mean difference in BP in long-term pre-/post-test programmes (Fig. 2B and E) was −3.6 mm Hg (95% CI −7.3 to 0.08) and −1.0 mm Hg (95% CI −2.12 to 0.10) for SBP and DBP respectively. Effect sizes were not significant (p = 0.05 and 0.07 respectively) and heterogeneity was high for SBP (I² = 87%) but lower for DBP (I² = 42%). The mean difference in SBP and DBP in long-term RCT programmes (Fig. 2C and F) was −3.1 mm Hg (95% CI −4.2 to −2.0) and −2.5 mm Hg (95% CI −3.1 to −1.8) respectively. Effect sizes were significant (p < 0.001) and heterogeneity was low for SBP and DBP (I² = 0% for both).

6.2. Body mass index

Eighteen studies reported BMI changes; 9 RCTs and 9 pre-/post-test design. A total of 3 RCTs found a reduction in BMI in favour of the intervention group and 4 pre-/post-test studies reported a decrease within individuals. Two RCTs and 2 pre-/post-test studies found an increase in BMI. Seven papers reported no statistically significant changes. Four of seven short-term studies and 3 of 11 long term studies reported a decrease in BMI. Eleven community-based studies reported on BMI; 5 found a decrease, 4 found an increase and 2 showed no change in BMI. Of 7 non-community-based programmes, 5 found a decrease in BMI and 2 found no change.

The mean difference in BMI in long-term RCT programmes (Fig. 3) was −0.2 kg/m² (95% CI −0.60 to 0.17). Effect size was not significant (p = 0.27) and heterogeneity was 0.
6.3. Lipids

Fourteen studies measured changes in total cholesterol; 7 RCTs and 7 pre-/post-test studies. Only 1 RCT and 5 pre-/post-test studies reported a decrease in total cholesterol with the remaining 8 papers finding no difference. Two of 5 short term studies and 4 of 9 long term studies found a decrease in total cholesterol. Eight community-based studies measured total cholesterol; 5 showed a decrease and 3 found no significant change. Six non-community-based programmes reported on total cholesterol; 1 reported a decrease and 5 reported no change. In fewer studies, LDL cholesterol followed the same pattern of results as total cholesterol (data shown in Tables 1 and 2).

The mean difference in total cholesterol in long-term pre-/post-test programmes (Fig. 4) was \(-0.2 \text{ mmol/l (95\% CI -0.30 to 0.01)}\). Effect size was not significant \((p = 0.07)\) and heterogeneity was relatively high \((I^2 = 66\%)\).

Nine studies reported HDL cholesterol changes; 4 RCTs and 5 pre-/post-test studies. Two pre-/post-test studies found an increase in HDL cholesterol and 3 pre-/post-test studies found a decrease. The remaining RCTs reported no change. Two of three short term studies and 1 of 6 long-term studies reported a decrease in HDL cholesterol. Three of 5 community-based studies showed an increase, another reported a decrease and the other showed no change in HDL cholesterol. Four non-community-based programmes reported HDL cholesterol; 1 found an increase and 3 reported no change.

6.4. Glucose and HbA1c

Seven studies measured FBG changes; 2 RCTs and 5 pre-/post-test studies. One RCT and 4 pre-/post-test studies found a decrease in FBG and the other 2 found no change. Three of 4 short term studies and 2 of 3 long term studies showed a decrease in FBG levels. Five of 6 community-based studies showed a decrease in FBG and the remaining showed no change. Both non-community-based programmes showed a reduction in FBG. In fewer studies, HbA1c followed the same pattern of results as FBG (data shown in Tables 1 and 2).

7. Behavioural risk factors

7.1. Physical activity

Of the 25 publications selected, 11 studies included self-reported PA changes; 3 RCTs and 8 pre-/post-test studies. Two RCTs reported an increase in PA in favour of the intervention group and 3 pre-/post-test studies reported an increase in individuals. The other 6 papers reported no statistically significant changes. Two of 5 short term studies showed increases in PA, while 3 of 6 long term studies reported increases. Four of 8 community-based studies reported increases in PA. Only one of 2 non-community-based programmes found an increase in PA. No studies found a decrease in PA.

7.2. Diet

Dietary change included self-reported fruit and vegetable intake, fibre content, fat intake and/or salt intake. One of 4 RCTs reported a reduction in dietary fat-intake while 5 of 6 pre-/post-test studies reported dietary improvements. All short term studies and 3 of 6 long term studies found dietary improvements. Of 8 community-based studies incorporating dietary change, 6 found improvements and 2 found no changes. Both non-community-based programmes showed no significant changes in diet.

7.3. Smoking

Eleven studies assessed smoking status changes (i.e. cigarettes per day); 4 RCTs and 7 pre-/post-test studies. One RCT and 2 pre-/post-test studies reported a decrease in the number of cigarettes smoked per day. The other 8 papers reported no change. The only short term study which reported on smoking did not report an improvement, while 3 of 10 long term studies reported reductions in cigarettes smoked per day. Eight community-based studies reported on smoking but only 2 showed improvements. Two non-community-based programmes reported on smoking rates with only one finding a decrease in cigarettes smoked per day.

7.4. Disease and risk knowledge

Six manuscripts assessed disease and risk knowledge; 2 RCTs and 4 pre-/post-test studies; both RCTs and 3 pre-/post-test studies showed increased knowledge. All short term studies and 2 of 3 long term studies showed an improvement in knowledge. Three of 4 community-based studies showed improvements while both non-community-based programmes reported enhanced knowledge.

8. Discussion

To our knowledge, this is the first systematic review to investigate the effectiveness of primary prevention programmes to improve cardio-metabolic risk in non-urban communities. In a total of 25 studies, we reaffirmed the overall potential for primary prevention programmes to reduce cardio-metabolic risk through improved risk factor control. We found that slightly more pre-/post-test design studies were associated with better outcomes, with the exception of BMI. More RCTs however were only associated with improving physical activity and disease and risk knowledge. Longer study durations showed to be of lesser value overall predominantly due to difficulties in sustaining health promoting behaviours, with programmes of less than 12 months duration shown to be more effective than longer-term interventions (≥12 months) in improving all biomedical outcomes. Community-based programmes were more effective than non-community-based programmes in improving all biomedical parameters with the exception of BMI and HbA1c.

Although more pre-/post-test design programmes than RCTs showed improvements in risk factors, differences were marginal. Pre-/post-design interventions have also been known to over-estimate effects due to confounding by factors external to the intervention (Robinson and Doueck, 1994). Appropriately designed and powered RCTs remain the gold standard for evaluating the effectiveness of interventions by virtue of randomization and having a comparator group who may similarly be affected by extraneous confounders. Participants within a control group may also modify their behaviour as a result of being involved in research (the well-known Hawthorne effect (Adair, 1984)). This would have the effect of reducing group differences making (greater) change in the intervention arm more onerous to achieve.

Our findings indicated more obvious changes in risk factor levels and behaviour over a shorter than longer intervention period. This may be due to difficulty associated with maintaining health behaviours over time. A study by Mathews et al. (2007) elicited the challenges associated with maintaining health related behavioural improvements in the long term, particularly concerning diet and PA, that may be counteracted by regular and frequent follow-up (Marcus et al., 1998). A growing body of evidence suggests that short-term programmes including regular follow-up of participants are generally more effective (Yanek et al., 2001; Appel et al., 2003; Stevens et al., 2001; McNabb et al., 1997; Coates et al., 1999; Rosal et al., 2005; Simkin-Silverman et al., 2003; Toobert et al., 2005; Veh et al., 2003) as frequently contacting subjects also cultivates trust between the participant and study staff (Yanek et al., 2001). As an intervention eases over time or contact is reduced, a participant’s adherence to novel behaviour change often declines in accordance with a reduction in reinforcement of health goals (Wadden et al., 2005). On this basis, it is imperative that regular...
follow-up with a health professional is maintained to assess diabetes and cardiovascular risk and initiate pharmacotherapy where needed.

Community-based programmes were shown to be more effective than non-community-based programmes in improving all biomedical risk factors with the exception of BMI and HbA1c. These programmes utilised existing community resources (McLeroy et al., 2003) such as local fitness and health groups, as part of their intervention. Health behaviours are influenced by a range of factors including cultural, political and socioeconomic factors (Schooler et al., 1997; Stokols, 1992). Sourcing suitable programmes that an individual can relate to within the community in which they belong or identify with may be important in instigating and promoting health behaviour change (McLeroy et al., 2003). Although some health behaviour change is a representation of an individual’s recognition of risk and their decision to minimise that risk, community-based programmes may exude an effect whereby individuals adopt novel behaviours characteristic of their friends, family and social networks.

Significant heterogeneity in the elements of the intervention amongst the programmes in this review made it difficult to delineate the particular aspect(s) responsible for the beneficial effect. Most programmes however were multi-faceted in implementation. Various modes of contacts have achieved effective results, including telephone, electronic mail, and face-to-face communication (Yeh et al., 2003; McManus et al., 2001; Tate et al., 2003; Elliot et al., 2007). Both group and individual intervention delivery have been effective in urban studies targeting smoking cessation and reducing alcohol consumption (Wadden et al., 2005; Schooler et al., 1997) and disease and risk education classes have been valuable in reducing the risk of diseases (Farquhar et al., 1977; Luepker et al., 1994). Goal setting at the outset of a programme is associated with positive health related behaviour change (Cullen et al., 2001; Strecher et al., 1995) and can lead to better results in comparison to vague, or no goals (Bodenheimer and Handley, 2009). It is unknown whether the effectiveness of prevention intervention programmes (or factors thereof) differs by the setting within which it is applied. While a comparison between (matched) urban and non-urban individuals of the benefit of cardio-metabolic primary prevention interventions and their components was not the focus of this review, there is reason to believe that the context may indeed be important. A previous study in one location in Australia provided some evidence that the socio-economic gradient in cardiovascular health is not due to location of residence (Tideman et al., 2013). There may therefore be barriers to health behaviour change in non-urban settings that do not apply in metropolitan locations such as geographical isolation causing residents to drive short distances and less autonomy to engage in physical activities such as walking/riding to work or shopping due to no safe walking and bicycle paths. Furthermore, there may be urban and non-urban disparities in health that have a differential impact in developing compared to developed countries; urban areas in developing countries can lead to unsanitary environments, poorer working and living conditions and are associated with poorer health than non-urban locations (McManus et al., 2001). Despite this, the interventions conducted in developing countries included in this review (Nguyen et al., 2012; Shahar et al., 2012; Balagopal et al., 2008; Balagopal et al., 2012; Huang et al., 2011) showed that individuals living in urban communities enjoyed better health.

9. Limitations

There are a number of limitations that require comment. To enable a sufficient number of manuscripts to be used in this review, older studies worldwide were included spanning a period of socioeconomic and technological change. Despite this however, there has been no significant change in the attributable burden of cardio-metabolic risk factors which have remained the highest ranked of the top 15 and shown upwards shift, not an improvement, since 1990 (Lim et al., 2012). The tradeoff was that extensive meta-analyses may not have been possible due to heterogeneity, variation in the presentation of data, variable outcome measures and inconsistent follow-up intervals. As such, the data presented were predominantly descriptive. Despite broad investigation efforts, all relevant manuscripts may not have been located; the included studies however likely capture the current status of this field of research.

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**Fig. 3.** Overall effect size (represented as a black diamond) for mean differences in BMI for long term RCTs.

**Fig. 4.** Overall effect size (represented as a black diamond) for mean differences in total cholesterol for long term pre-/post-test programmes.
Although there was variance in the strength and direction of reported findings across the included studies, we cannot rule out a bias effect against programmes with results that were not significant. Some prominent programme approaches are discussed, however a comprehensive breakdown of all the elements of interventions was beyond the scope of this review and any potential pharmacological influence on outcomes was not assessed. Additionally, it is also important to note that some studies included in this review had near-normal baseline values which may have diminished intervention effects on some risk factors; as a result, the effect of some interventions may have been underestimated.

10. Summary, implications and future direction

This review has highlighted the significance of primary prevention health behaviour programmes, particularly those utilising community and health resources within study populations in order to promote health change in adults of a non-urban community. The context of the setting in the development of CVD and/or T2DM prevention programmes is potentially important given the likelihood to influence key individual determinants of cardio-metabolic risk in these non-urban populations and in contrast to urban populations.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

Transparency document

The Transparency document associated with this article can be found, in online version.

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