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Systematic Reviews and Meta- and Pooled Analyses

Community Programs for the Prevention of Cardiovascular Disease: A Systematic Review

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In this systematic review, the authors aimed to assess the effectiveness of community programs for prevention of cardiovascular disease (CVD). They searched numerous electronic databases (CDSR, DARE, HTA, EED, and CENTRAL via the Cochrane Library, MEDLINE, MEDLINE In Process, EMBASE, CINAHL, PsycINFO, HMIC, and ASSIA) and relevant Web sites from January 1970 to mid-July 2008. Controlled studies of community programs for the primary prevention of CVD were included. Net changes in CVD risk factors were used to generate an overall index for net change in 10-year CVD risk. The authors identified 36 relevant community programs that took place between 1970 and 2008. These programs were multifaceted interventions employing combinations of media, screening, and counseling activities and environmental changes and were primarily evaluated using controlled before-after studies. In 7 studies, investigators reported changes in CVD/total mortality rates, and in 5 they reported net changes. In all cases, these net changes were positive but were largely nonsignificant. In 22 studies, investigators reported changes in physiologic CVD risk factors, and there was a positive trend in the calculated CVD risk score. The average net reduction in 10-year CVD risk was 0.65%. Community programs for CVD prevention appear to have generally achieved favorable changes in overall CVD risk and, with adaptation to current circumstances, deserve continued consideration as possible approaches to preventing CVD.

cardiovascular diseases; health education; health promotion; intervention studies; public health

Abbreviations: CVD, cardiovascular disease; NICE, National Institute for Health and Clinical Excellence.

Cardiovascular disease (CVD) is the biggest cause of mortality in the Western world and contributes a sizeable burden of cost to health services (1). It has been demonstrated that risk factors such as smoking (2), obesity (3), and elevated cholesterol (4) and blood pressure (5) can increase the risk of developing CVD, but there is debate about the most effective approach for risk factor change (6).

Community approaches to CVD prevention are attractive, since they can target all groups in the community and, if effective, may achieve widespread behavioral change and risk reduction. A number of community CVD prevention programs have been implemented over the last 40 years. Despite their continued development and use, there is currently limited evidence to support or refute the effectiveness of these types of programs.

Few reviews have addressed the effectiveness of community CVD prevention. Of those that have, 1 included only studies targeting dietary factors (7), 1 evaluated only interventions in schoolchildren (8), and 2 included only randomized controlled trials and predominantly covered prevention in high-risk groups (9, 10). One review did cover community programs (11), but, as with all of these reviews, the investigators undertook literature searches prior to 1998 and did not include more recent programs, which are potentially of the most relevance and applicability to the present. To our knowledge, no reviewers to date have attempted to combine risk factor changes into a single measure of CVD risk.

The initial stages of this systematic review were conducted to inform the development of public health guidance on CVD prevention by the National Institute for Health and

Clinical Excellence (NICE). NICE is an independent United Kingdom organization that is responsible for providing national guidance on promoting good health and preventing and treating ill health. We report results from this and subsequent work, in which a single index of overall CVD risk was generated to assess the effectiveness of community CVD programs.

MATERIALS AND METHODS

Search strategy

We searched MEDLINE, MEDLINE In Process, EMBASE, CINAHL, PsycINFO, HMIC, ASSIA, and the Cochrane Library databases (CDSR, DARE, HTA, EED, and CENTRAL) for systematic reviews and primary studies relating to population-level CVD programs that had been published between January 1970 and mid-July 2008. A highly sensitive search strategy was used covering terms relating to the 3 key concepts: CVD, health education, and risk factors for CVD. The MEDLINE search strategy is given in Appendix Table 1.

Eligibility criteria

Community programs were defined as those targeting whole populations living within a certain geographic area. The size of target areas was not specified, but programs were required to have aimed to bring about change across the whole community within that area. Programs were required to have targeted multiple CVD risk factors and to have included primary prevention strategies to tackle at least 2 of the following: smoking, poor diet, insufficient physical activity, high blood pressure, high blood cholesterol levels, obesity/overweight, diabetes, psychosocial stress, and high alcohol consumption. Acceptable study designs were interventional studies such as randomized controlled trials, controlled before-after studies, and controlled interrupted time series. Intervention programs had to have specifically aimed to address CVD with the goal of reducing morbidity/mortality from CVD or reducing levels of CVD risk factors and had to have evaluated 1 or more of the following outcomes: CVD mortality; CVD morbidity; biochemical precursors of CVD, including lipid levels, ratio of high density lipoprotein to low density lipoprotein, and triglyceride levels; physiologic precursors of CVD, including cholesterol, blood pressure, and body mass index; behaviors associated with the risk of CVD, including smoking, diet, physical activity, and alcohol consumption; knowledge, attitudes, and intentions regarding CVD; and adverse events.

Studies confined to populations clinically diagnosed as being at high risk of CVD or diagnosed with CVD were excluded, as well as any studies undertaken in countries that are not part of the Organisation for Economic Co-operation and Development. Studies were excluded if they did not include a control group or if the investigators did not give data on any relevant outcome measures. Books, book chapters, theses, and dissertations were excluded. Inclusion decisions were made by 1 reviewer, with reference to a second reviewer in the case of uncertainty.

Quality assessment and data extraction

Quality assessment of included studies was undertaken using the controlled before-after checklist in *Methods for Development of NICE Public Health Guidance* (12). Studies were scored with regard to 8 items: contemporaneous data collection, appropriate choice of control site, similarity of baseline measurements, similarity of study/control providers, blinded outcome assessment, protection against contamination, reliability of outcome measures, and follow-up of individuals (for cohort studies only), with higher scores indicating programs considered to be of higher quality. Study quality was assessed independently by 2 reviewers, with differences being resolved by consensus. Two reviewers independently extracted data on baseline and follow-up levels of CVD risk factors, and any differences were resolved by consensus.

Statistical analysis

Net changes in mortality rates were calculated as the change in mortality rate from baseline to the intervention/postintervention period in the intervention group minus the change in the control group. Where available, data for CVD mortality rates were recorded; for studies where this was not reported, total mortality rates were recorded.

Net changes in individual risk factors were calculated as risk factor change from baseline to follow-up in the intervention group minus change in mortality rate in the control group. Average values for risk factor changes were calculated from mean changes for each program—that is, average change in men and women and in cohort and cross-sectional surveys was first calculated for each program before calculation of the average net change across programs.

In order to estimate the number of cardiovascular events prevented, we determined the net change in CVD risk pre- to postintervention. CVD risk was calculated from age, sex, diabetes status, smoking status, systolic blood pressure, diastolic blood pressure, total cholesterol, and high density lipoprotein cholesterol using the Framingham equation (13). Because individual participants' risk factor data were not available, mean ages and risk factor levels were used for the intervention population as a whole. Where a risk factor value was unavailable, we used a default value based on the age- and sex-stratified population average, derived from the Health Survey for England 1998 (14). This procedure followed a previously described method (15). Increases in age from the start to the end of the intervention period have a large impact on calculated CVD risk, but this does not reflect the effectiveness of the intervention. In order to avoid the spurious influence of increasing age in cross-sectional surveys, we also used baseline age to calculate CVD risk for the final survey, and for cohort data, we used baseline age plus duration of the intervention to calculate CVD risk at follow-up.

Graphical representations of net changes in 10-year CVD risk were generated on the basis of all programs with more than 2 relevant outcome measures. Formal meta-analysis could not be conducted because of the lack of statistical information in the majority of included studies. Mean net

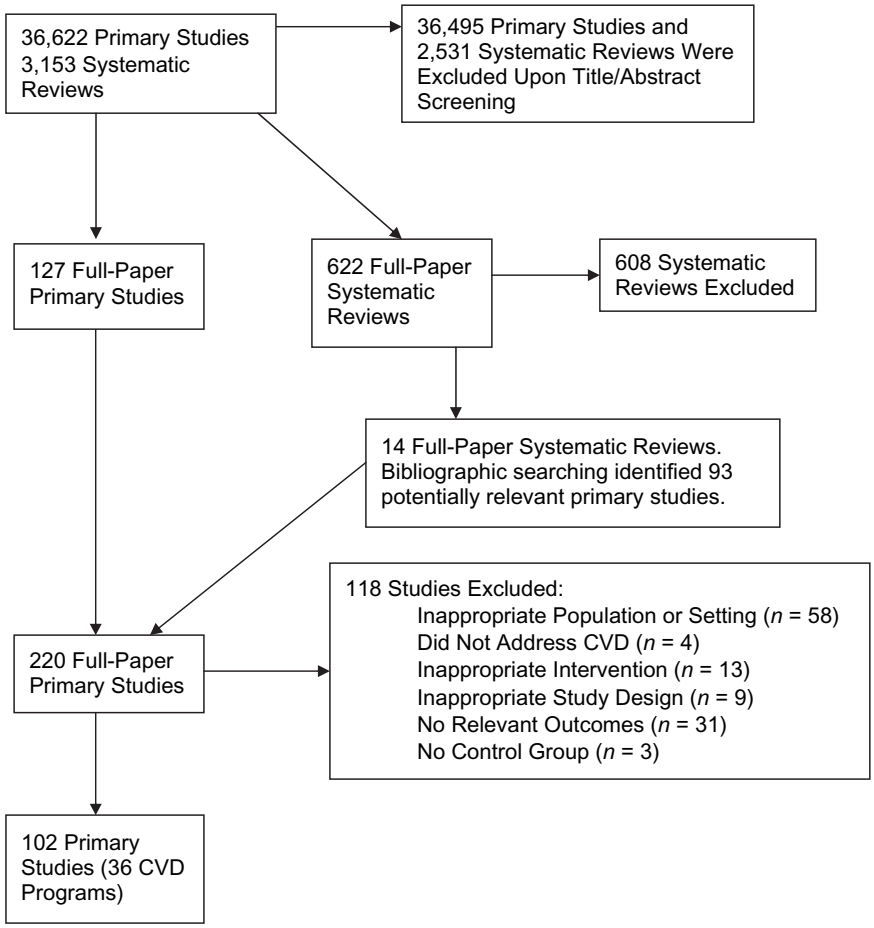

Figure 1. Selection of studies included in a systematic review of the effectiveness of community programs for prevention of cardiovascular disease (CVD), 1970–2008.

changes in 10-year CVD risk and 10-year CVD risk relative to baseline were calculated separately for programs that used cross-sectional surveys for evaluation and programs that used cohort surveys for evaluation. Mean net changes over all programs were calculated using both cross-sectional and cohort data; where evaluation had been done using both survey designs, cohort data were used, since this type of data was considered less at risk of bias compared with cross-sectional data (see Discussion). For studies where data were presented separately by sex, mean net changes were also calculated separately for men and women.

RESULTS

Trial flow and study characteristics

The search of the literature generated 3,153 reviews and 36,622 primary study citations (Figure 1). We identified 102 publications as relevant to the current review and identified 36 community CVD prevention programs (Table 1) (only the main index publications for each program are cited (16–50)).

The programs were based in Europe ($n = 20$), the United States ($n = 10$), Canada ($n = 4$), and Australia ($n = 2$). All programs included a media-based approach, using combinations of radio, television, and printed material to communicate heart health messages. Many programs also included screening interventions ($n = 19$), individual ($n = 21$) and group ($n = 17$) counseling, and environmental changes ($n = 14$). Health departments ($n = 22$), local health committees ($n = 13$), voluntary organizations ($n = 11$), and community volunteers ($n = 11$) had roles in program delivery, and interventions were delivered in a variety of settings, including workplaces ($n = 13$) and schools ($n = 21$). Program lengths ranged from 1 year to more than 20 years during the period 1970–2008, and the sizes of the intervention populations ranged from approximately 600 people to over 1,000,000 people.

The majority of programs were evaluated using controlled before-after studies ($n = 33$), and 3 were evaluated using controlled interrupted time series. Risk factor levels in control and experimental groups were measured preintervention, postintervention, and, in some cases, during the intervention period. For data collection, researchers in the majority of programs ($n = 28$) used independent cross-sectional surveys, some followed up cohorts ($n = 15$), and some used both cross-sectional and cohort approaches

Table 1. Characteristics of Programs Included in a Systematic Review of the Effectiveness of Community Programs for Prevention of Cardiovascular Disease, 1970–2008

Program (Reference No.)	Country	Start Date	Length of Follow-up, years	Population Size	Outcome(s) Measured					Evaluation Method		QA Score[a]
					Mean TC Level	Mean HDL Cholesterol Level	Mean SBP	Mean DBP	Smoking, %	Cohort	Cross-Sections	
Action Heart (16)	United Kingdom	1991	4	22,000					Y		Y	3
Bootheel Heart Health Project (17)	United States	1989	1	~70,000					Y		Y	3
CardioVision 2020 (18)	United States	1999	4	87,685					Y		Y	3
Coalfields Healthy Heartbeat Program (19)	Australia	1990	10	46,520	Y		Y	Y	Y		Y	4
Coeur en Santé St.-Henri (20)	Canada	1992	3.5	25,000					Y		Y	3
Di.S.Co. Project (21)	Italy	1982	3	26,000	Y		Y	Y	Y	Y	Y	4
Danish Municipality Project (22)	Denmark	1989	1	8,000					Y		Y	4
Dutch Heart Health Community Intervention (23)	Netherlands	1998	>6	180,000	Y		Y	Y		Y		6
Eberbach-Wiesloch Project (24)	Germany	1980	4	16,000	Y		Y	Y	Y		Y	4
Epernon Cardiovascular Health Programme (25)	France	1993	5	5,500			Y		Y	Y		6
Health and Inequality in Finnmark Programme	Norway	1988	6									
Båtsfjord (26)				2,500	Y		Y	Y	Y	Y		4
North Cape (27)				4,000	Y		Y	Y	Y	Y		4
Franklin Cardiovascular Health Program (28)	United States	1974	20	29,645							Y	6

German Cardiovascular Prevention Project (29)	Germany	1985	7	1,000,000	Y			Y	Y	Y		Y	5
Have a Heart Paisley (30)	United Kingdom	2000	2.5	74,170							Y		3
Heartbeat Wales (31)	United Kingdom	1985	>5	~3,000,000						Y		Y	4
Kentucky Blood Pressure Control Program (32)	United States	1979	5	32,400				Y	Y			Y	5
Kilkenny Health Project (33)	Ireland	1985	5	73,000	Y			Y	Y	Y		Y	4
Martignacco Project (24)	Italy	1977	5	5,259	Y			Y	Y	Y	Y		5
Minnesota Heart Health Program (34)	United States	1980	5	232,000	Y			Y	Y	Y	Y	Y	4
Norsjö Project (35, 36)	Sweden	1985	10	5,500	Y			Y	Y	Y	Y	Y	5
North Coast Healthy Lifestyle Programme (37)	Australia	1978	2	22,083	Y[b]					Y		Y	5
North Karelia Project (38)	Finland	1972	>20	180,000	Y			Y	Y	Y		Y	6
National Research Program (39)	Switzerland	1978	3	28,000	Y			Y	Y	Y	Y		3
Olöfstrom Community Program (40)	Sweden	1988	5	15,000	Y				Y		Y	Y	2
Otsego-Schoharie Heart Health Program (41)	United States	1989	5	100,000	Y		Y	Y	Y	Y	Y	Y	4
Pawtucket Heart Health Program (42)	United States	1982	9	71,000	Y			Y	Y	Y	Y	Y	4
Quebec Heart Health Demonstration Project (43)	Canada	1992	5										
Rural				90,000								Y	3
Suburban				35,216								Y	3
Urban				41,625								Y	3

Table continues

Table 1. Continued

Program (Reference No.)	Country	Start Date	Length of Follow-up, years	Population Size	Outcome(s) Measured					Evaluation Method		QA Score[a]
					Mean TC Level	Mean HDL Cholesterol Level	Mean SBP	Mean DBP	Smoking, %	Cohort	Cross-Sections	
Project Schleiz (44)	Germany	1976	5	33,000	Y		Y	Y	Y		Y	5
South Carolina Cardiovascular Disease Prevention Project (45)	United States	1987	2	46,000					Y		Y	4
Stanford Heart Disease Prevention Program (Three-Community Study) (46)	United States	1972	3	42,000	Y		Y			Y		5
Stanford Five-City Project (47, 48)	United States	1979	6	126,000	Y		Y	Y	Y	Y	Y	4
Tessin Cardiovascular Health Programme (49)	Switzerland	1982	6	>300,000					Y		Y	3
Zurich Cardiovascular Health Programme (50)	Switzerland	1974	1	~600	Y		Y	Y	Y		Y	3

Abbreviations: DBP, diastolic blood pressure; Di.S.Co., Sezze District Community Control; HDL, high density lipoprotein; QA, quality assessment; SBP, systolic blood pressure; TC, total cholesterol; Y, yes.

[a] Quality assessment was conducted using the controlled before-after checklist in *Methods for Development of NICE Public Health Guidance* (12). Possible scores ranged from 0 to 8.

[b] No control group data.

Table 2. Changes in Rates of Mortality From Cardiovascular Disease After Implementation of Community Heart Health Programs, 1970–2008

Program (Reference No.)	Outcome and Sex	Control Group	Intervention Group	Net Change	*P* Value[a]
Coalfields Healthy Heartbeart Program (19)	Change in CVD mortality (no. of deaths/100,000 persons/year)				
	Men	−7.0	−10.9	−3.9	NS
	Women	−7.8	−14.2	−6.4	NS
Franklin Cardiovascular Health Program (28)	Relative risk of death from CVD during program period[b] (both sexes combined)		0.91	NR	NR
Kentucky Blood Pressure Control Program (32)	% change in CVD mortality				
	Men	−8.6	−36.0	−27.4	<0.04
	Women	−11.6	−21.2	−9.6	NS
Martignacco Project (24)	CVD mortality during project[b] (mean annual incidence/ 1,000 persons)				
	Men	2.4	1.2	NR	NR
	Women	1.4	0.7	NR	NR
Project Schleiz (44)	% change in CVD mortality				
	Men	4.8	2.0	−2.8	NS
	Women	5.4	−3.5	−8.9	NS
Stanford Five-City Project (47, 48)	All-cause mortality[c] (no. of deaths/1,000 persons/10 years)				
	Men	2.0	−1.1	−3.1	0.447
	Women	0.9	0.4	−0.5	0.795
Tessin Cardiovascular Health Programme (49)	% change in CVD mortality				
	Men	−14.7	−26.9	−12.2	NR
	Women	−20.0	−25.0	−5.0	NR

Abbreviations: CVD, cardiovascular disease; NR, not reported; NS, not significant.
[a] *P* value for significance of net change in mortality rate.
[b] Changes from baseline were not reported.
[c] Rates of CVD mortality were not reported.

($n = 7$) (Table 1). Program evaluation varied in quality (Table 1). In the majority of studies, protection against contamination was not clear. In some studies, intervention and control groups were not similar at baseline and only self-reported outcome measures were used, resulting in overall poorer quality scores.

Programs assessed different outcome measures, including CVD and total mortality ($n = 7$) and physiologic and behavioral CVD risk factors, such as total cholesterol level ($n = 21$), blood pressure ($n = 22$), smoking ($n = 27$), diet ($n = 18$), and physical activity ($n = 18$). Of the 36 included programs, 22 provided sufficient information on physiologic CVD risk factors (cholesterol, blood pressure, and smoking) to calculate the net treatment effect on 10-year CVD risk.

Changes in mortality rates

In 7 studies, investigators reported changes in mortality rates (primarily CVD mortality), and results are given in Table 2. Data were reported as change and percent change in CVD mortality rate and change in total mortality rate. In 2 studies, researchers presented postintervention mortality rates but not baseline mortality rates; therefore, it was not possible to calculate net change for those studies. Where net changes could be calculated, all studies showed favorable changes in CVD/total mortality rates, but this was significant for only 1 study (32); in that case, only men showed a significant net reduction in the rate of CVD mortality.

Risk factor changes

Net changes in individual CVD risk factors were mixed but generally showed a trend towards a positive program effect (Table 3). There appeared to be reasonable consistency in outcome changes—that is, where positive effects were seen in 1 risk factor, there also tended to be positive changes in others. As a general indication of the size of effects, the mean net changes in systolic and diastolic blood

Table 3. Net Changes in Levels of Cardiovascular Disease Risk Factors and Overall 10-Year Risk of Cardiovascular Disease After Implementation of Community Heart Health Programs, 1970–2008

Program (Reference No.) and Survey Design	Sex	Net Change				
		SBP, mm Hg	DBP, mm Hg	TC, mmol/L	Smoking, %	10-Year CVD Risk, %
Coalfields Healthy Heartbeart Program (19)						
Cross-sectional	Men	−2.1	−2.2	−0.1	9.4	0.15
Cross-sectional	Women	2.2	0.9	0.3	12.8	1.47
Di.S.Co. Project (21)						
Cross-sectional	Men	−0.5	−0.3	0.3	−2.8	0.14
Cross-sectional	Women	−4.9	3.6	0.0	−5.6	−0.77
Cohort	Men	0.5	0.3	0.1	0.3	0.38
Cohort	Women	−4.2	−1.8	0.0	−1.2	−0.55
Dutch Heart Health Community Intervention (23)						
Cohort	Men	−8.2	−5.3	0.0		−2.31
Cohort	Women	−5.8	−4.5	0.1		−1.06
Eberbach-Wiesloch Project (24)						
Cross-sectional	Men	−10	−6	0.3	12	−0.38
Cross-sectional	Women	−7	−2	0.1	−24	−1.30
Epernon Cardiovascular Health Programme (25)						
Cohort	Both	−3.8			−1.9	−0.66
Health and Inequality in Finnmark Programme						
Båtsfjord (26)						
Cohort	Men	−2.2	−2.9	0.2	−4.8	−1.11
Cohort	Women	−2.5	−3.9	0.0	−0.6	−0.98
North Cape (27)						
Cohort	Men	1.0	0.8	−0.1	1.9	0.12
Cohort	Women	1.1	−0.2	−0.1	−7.2	−0.52
German Cardiovascular Prevention Project (29)						
Cross-sectional	Men	−2.1	−1.3	−0.1	−4.5	−0.79
Cross-sectional	Women	−3.1	−1.9	−0.1	−0.4	−0.45
Kentucky Blood Pressure Control Program (32)						
Cross-sectional	Men	−3.8	−7.6			−0.69
Cross-sectional	Women	2.9	−2.3			0.31
Kilkenny Health Project (33)						
Cross-sectional	Men	0.0	5.9	0.4	1.9	0.03
Cross-sectional	Women	−1.1	1.9	0.0	−2.9	−0.11
Martignacco Project (24)						
Cohort	Men	−14	−7	−0.4	−6.5	−5.16
Cohort	Women	−14	−3	−0.1	0	−2.36

Table continues

pressure were −2.9 mm Hg and −1.1 mm Hg, respectively; mean net change in total cholesterol level was −0.01 mmol/L, and there was a net reduction in smoking prevalence of 1.7%. However, since there was no formal meta-analysis, these may not necessarily represent valid summary estimates.

Calculation of overall net changes in 10-year CVD risk showed a more consistent trend (Table 3 and Figures 2

Table 3. Continued

Program (Reference No.) and Survey Design	Sex	Net Change				
		SBP, mm Hg	DBP, mm Hg	TC, mmol/L	Smoking, %	10-Year CVD Risk, %
Minnesota Heart Health Program (34)						
Cross-sectional	Both	1.0	−0.2	0.0	−1.8	0.27
Cohort	Both	1.4	0.6	0.1	2.6	0.10
Norsjö Project (35, 36)						
Cross-sectional	Men	−5.6	−3.5	−0.6	−2	−1.84
Cross-sectional	Women	−4.4	−0.5	−0.3	0	−0.76
Cohort	Men	−3.6	−1.6	−0.7	−3	−2.30
Cohort	Women	−5.4	−1.7	−0.6	−4	−1.55
North Karelia Project (38)						
Cross-sectional	Men	−4.4	−1.0	−0.2	−2.7	−1.35
Cross-sectional	Women	−7.7	−1.5	0.0	−0.1	−0.99
National Research Program (39)						
Cohort	Both	4.9	3.9	0.0	−3.6	0.40
Olöfstrom Community Programme (40)						
Cross-sectional	Men		−5.4	−0.6		−0.90
Cross-sectional	Women		−3.7	−0.5		−0.40
Cohort	Men		−4.3	−0.4		−0.74
Cohort	Women		−2.9	−0.3		−0.32
Otsego-Schoharie Heart Health Program (41)						
Cross-sectional	Both	0.4	2.0	0.0	−12.7	−0.90
Cohort	Both	−1.6	1.1	0.1	−7.5	−0.84
Pawtucket Heart Health Program (42)						
Cross-sectional	Both	−0.6	−1.2	0.0	0.3	0.00
Cohort	Both	0.6	−0.7	0.0	−1.4	−0.14
Project Schleiz (44)						
Cross-sectional	Both	−5.4	−5.0	−0.3	−3.2	−1.51
Stanford Three-Community Study (46)						
Cohort	Both	−10.1		−0.2		−1.45
Stanford Five-City Project (47, 48)						
Cross-sectional	Men	−3.5	−2.5	−0.1	4.1	−0.50
Cross-sectional	Women	−4.8	−4.1	−0.1	6.3	−0.29
Cohort	Both	−5.2	−3.7	0.0	−3.9	−0.49
Zurich Cardiovascular Health Programme (50)						
Cross-sectional	Men	6.4	6.9	0.6	1.5	3.10
Cross-sectional	Women	3.2	2	0.3	−0.1	0.91

Abbreviations: CVD, cardiovascular disease; DBP, diastolic blood pressure; Di.S.Co., Sezze District Community Control; SBP, systolic blood pressure; TC, total cholesterol.

and 3), with an average net reduction in 10-year CVD risk of 0.32% for cross-sectional surveys (Figure 2) and 0.88% for cohort surveys (Figure 3) (an average 0.65% reduction over all programs). When expressed as a percentage of baseline risk, the average net reduction in 10-year CVD risk was 5.81% for cross-sectional surveys and 11.14% for cohort surveys (9.08% over all programs). For studies in which data were available for men and women separately ($n = 15$),

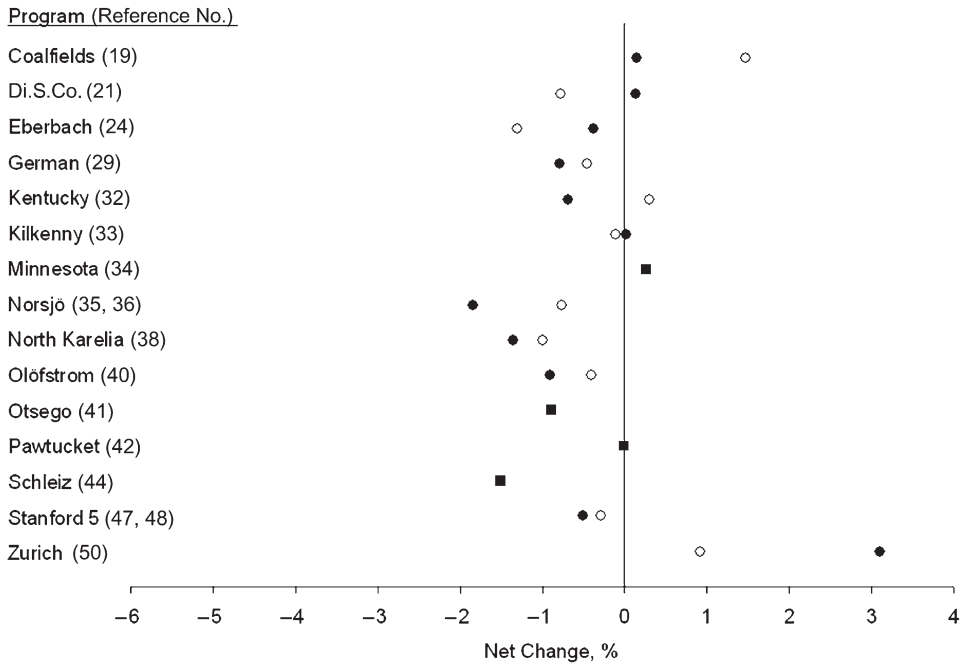

Figure 2. Mean net changes in 10-year cardiovascular disease risk in heart health programs evaluated by means of cross-sectional surveys for men (●), women (○), and all study participants (■), 1970–2008. (For complete names of programs, see Table 1.)

the average reduction in 10-year CVD risk across all programs was 0.77% for men and 0.52% for women. When expressed as a percentage of baseline risk, this reduction was 6.35% for men and 9.71% for women.

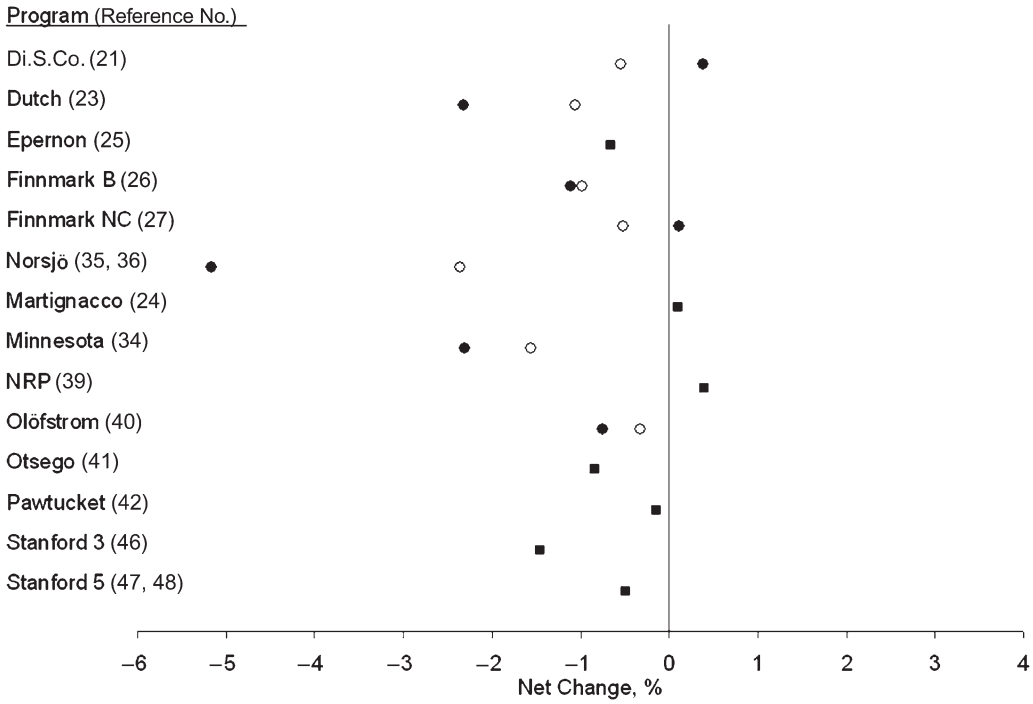

Figure 3. Mean net changes in 10-year cardiovascular disease risk in heart health programs evaluated by means of cohort follow-up for men (●), women (○), and all study participants (■), 1970–2008. B, Båtsfjord; NC, North Cape; NRP, National Research Program. (For complete names of programs, see Table 1.)

DISCUSSION

There are a number of well-known community CVD prevention programs, but this systematic review identified an unexpectedly large number of additional programs, and many of these have not been featured in previous systematic reviews. Therefore, this systematic review brought together a large body of previously unreviewed evidence.

The favorable trend toward reduced rates of CVD mortality suggests that these programs may be beneficial for the prevention of CVD, but the limited number of studies presenting these data and the lack of statistically significant findings limit the interpretation of mortality results.

A larger amount of data was available on changes in physiologic CVD risk factors. Consistent trends in favor of CVD programs for individual risk factors were evident, but in isolation the sizes of these effects appeared clinically insignificant. On the basis of a potential cumulative effect of individual risk factor changes, it appeared likely that the overall effect might be more clinically significant, and this was the purpose of considering the impact on an overall risk score.

The calculated risk score findings suggest that there is a net favorable effect associated with community CVD prevention programs. Although it was not obtained via meta-analysis, the average net reduction of 0.65% in 10-year CVD risk (a 9.08% reduction relative to baseline) provides support for the view that changes in individual risk factors, when considered together, produce a clinically important improvement. This risk reduction equates to a number needed to treat of 154 in order to avoid 1 case of CVD over 10 years. In population terms, this may have important benefits, where large-scale, whole-population approaches are being implemented.

Most interventions appear to have achieved net reductions in 10-year CVD risk of approximately 1%, but some showed smaller or greater risk reductions. An important question in public health practice is, What type/mode of intervention is most effective for achieving improvements in population heart health? Investigators have sought to untangle possible determinants of program success (51–53), and in 1 review, Sellers et al. (11) used regression analysis to attempt to determine correlates of program effectiveness. They showed that the biggest predictor of risk factor changes was the method of program evaluation (length of follow-up, matching of intervention and control communities, and number of intervention/reference communities), with little apparent influence of intervention or population type (11).

Although variation in both the nature of programs and the apparent effectiveness of programs was observed, the limited information on the nature of each program, the large number of other factors which also varied between programs, and the lack of statistical information made further investigation of the effect of variation in intervention futile. This key question thus remains unanswered by this systematic review. However, it is interesting to note that the North Karelia program, highlighted for its particular effectiveness, showed a reduction in risk (average of −1.17% for men and women) similar to that of some other programs. This intervention appears not to have been unique, and there may be more uniformity in the ability of programs to bring about reduction in risk than previously thought.

Net increases in CVD risk were observed in some cases, and 4 programs showed net negative effects (Coalfields (19), Minnesota (34), National Research Program (39), and Zurich (50)). On the whole, the size of these increases was relatively small, but for the Zurich study, there appears to have been a large increase in predicted CVD risk associated with the intervention. The study investigators discussed this finding and noted that there may have been some systematic error in the measurement of cholesterol levels (50). They also commented on the limited intensity of the intervention program and suggested that this may have been responsible for the unfavorable results (50). These factors may have contributed to the apparent ineffectiveness of this particular program, but the potential for harm cannot be ruled out.

It is possible that a program of this kind, if received badly or implemented in a way that increases social inequalities, could result in adverse effects. After 5 years of intervention in Norsjö, participants of a lower social class were less likely to recall having seen newspaper or television news on the CVD project or to have heard radio coverage of the project (54). Of those that did recall media messages, the less educated and manual workers, particularly men, were less likely to report having been influenced by those messages (54). However, when health outcomes were examined according to social stratum, net changes in overall estimated risk were found to be similar, if not more beneficial, in persons with a low educational level compared with persons with a high educational level, and investigators concluded that this project had, if anything, reduced health inequalities (55). Despite these findings, it remains uncertain whether programs of this type have the potential to increase health inequalities, and the potential for harm may be an important consideration.

The observed results are affected by uncertainty arising from limitations in the primary research and review method. All of the included studies used a controlled before-after or controlled interrupted time series design, and a potentially important methodological issue is the mode of outcome data collection. The scale of the intervention populations dictated that only samples of the whole population could be evaluated, and differences in approach are potentially important. In some studies, researchers employed a cohort approach, using the same subpopulation to measure outcomes throughout the study, while others used a cross-sectional approach, where different randomly selected samples of the whole population were chosen at different time points. These study designs are open to different sources of bias (contamination in cross-sectional surveys and differential attrition in cohort studies). Cohort studies may provide a better measure of an intervention's effect on a stable population, whereas cross-sectional studies may provide a better measure of the total population effect (including the effect of contamination).

Where treatment and control areas are similar with respect to social and geographic factors that govern rates of

dropout, differential attrition may be unlikely. In the majority of studies, the investigators stated that communities with similar age ranges and socioeconomic profiles were selected as controls. Although differential attrition cannot be discounted, it appears unlikely that this factor had a major influence on results for cohort evaluations. Results for cross-sectional surveys appear to have been less favorable than those for cohort surveys, and a potential cause may be cross-community contamination. In order to select controls with similar socioeconomic profiles and secular trends in CVD, investigators often chose control communities that were located reasonably close to intervention communities. The spread of media coverage and individual migration between the intervention and control communities may, to some extent, have reduced the apparent intervention effect in programs evaluated by means of cross-sectional surveys.

Another potential source of bias associated with these types of studies is the choice of control group. Differences in intervention and control groups at baseline may not in themselves be a source of bias, since baseline measurements are taken into account in the calculation of net change. However, differences present at baseline may reflect differences in the types of people living in each community. Where control and intervention groups are well-matched at baseline, secular trends are more likely to be equivalent, and there may be less risk of bias. However, where there are substantial differences at baseline, these may reflect differences in population groups with different underlying secular trends. It is unclear in which direction this source of bias may act, but the quality of control group selection is an important consideration in assessing the validity of these types of studies.

The applicability of programs included in this review to the present is also uncertain. The majority of programs were conducted in the 1970s ($n = 9$), 1980s ($n = 17$), and 1990s ($n = 9$), with only 1 being implemented since 2000. Changes in the prevalence of risk factors and changes in attitudes, lifestyles, and community settings may have an impact on the effectiveness of these types of programs and may limit the generalizability of findings.

Areas for intervention were often selected on the basis of elevated CVD risk, and this may have implications for their applicability to future program implementation. It is unclear from the current review whether these types of programs have a lesser or greater effect in high-risk communities, but the possibility of differential program effectiveness should be considered.

Another issue relating to the applicability of programs is the nature of subjects taking part in evaluation surveys. Persons who lead less healthy lifestyles, younger persons, ethnic minorities, and persons of lower socioeconomic status may be less likely to participate in surveys, and this can lead to response bias. Weinehall et al. (56) compared survey participants with nonparticipants and found that younger persons, the unemployed, and those with the lowest incomes were less likely to participate. However, only minor differences regarding socioeconomic status (assessed by employment type) and educational level were found. Survey respondents had a more favorable total cholesterol level but higher average blood pressure, and there were no differences in body mass index or rates of smoking (56). However, these findings may not be true in all cases, and the extent to which response bias affects the applicability of findings to whole populations is unclear.

In addition to limitations arising from the nature of the primary research, there are some limitations arising from the review method. In this review, because of a lack of statistical information in the majority of included studies, it was not possible to calculate confidence intervals or to carry out meta-analysis. For approximately half of the included studies, no information relating to within-study error for risk factor changes was given. This hinders the interpretation of the overall findings, since overall statistical significance could not be assessed.

Additionally, risk factor data that could be used to generate a CVD risk score were not reported for all included programs. Results for the 14 programs that were not included in the calculation of CVD risk were mixed (Appendix Table 2). Although some showed favorable results, overall these programs appeared less promising than those for which CVD risk was calculated, and their exclusion may have produced an overly optimistic result. However, for programs that were included in the calculation, missing values for certain risk factors (diabetes status and high density lipoprotein cholesterol level were missing for most programs, smoking status was missing for 3 programs, diastolic blood pressure and total cholesterol level were missing for 2 programs, and systolic blood pressure was missing for 1 program) would tend to counteract this. Missing values are likely to reduce apparent effect size, since, where values are missing, risk factors are presumed to remain constant, resulting in smaller apparent treatment-versus-control differences. Therefore, the calculated average net CVD risk reduction may be a realistic estimate of the effectiveness of community CVD programs.

Finally, an ever-present threat in systematic reviews is the possibility of publication bias. We were able to guard against this to a considerable degree because of the comprehensive search used, which included possible sources of gray literature. It is therefore improbable that there were large numbers of negative studies missed from the review, and publication bias appears unlikely to overturn the current findings.

Community interventions for the prevention of CVD appear to have generally achieved favorable changes in overall CVD risk. Considerable uncertainty remains, but this review provided no evidence that community prevention can be rejected as a useful approach to preventing CVD. However, programs implemented in the past need to be adapted to current circumstances, and revised approaches should be reevaluated before widespread implementation.

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(Appendix Tables 1 and 2 follow)

Appendix Table 1. MEDLINE Search Strategy Used in a Systematic Review of the Effectiveness of Community Programs for Prevention of Cardiovascular Disease, 1970–2008

1	cardiovascular disease$.mp. or exp cardiovascular diseases/
2	CVD.mp.
3	coronary disease$.mp.
4	heart disease$.mp.
5	atherosclerosis.mp.
6	arteriosclerosis.mp.
7	hypertension.mp.
8	blood pressure.mp.
9	exp hyperlipidemias/or hyperlipidaemia$.mp.
10	hyperlipidemia$.mp.
11	exp cholesterol/or cholesterol.mp.
12	exp stroke/or stroke$.mp.
13	peripheral vascular disease$.mp.
14	peripheral arterial disease$.mp.
15	hypercholesterol$.mp.
16	hyperlipid$.mp.
17	or/1–16
18	health education.mp. or exp health education/
19	health promotion.mp. or exp health promotion/
20	primary prevention.mp. or exp primary prevention/
21	campaign$.mp.
22	media.mp. or exp mass media/
23	exp counseling/or advice$.mp.
24	counsel$.mp.
25	program$.mp.
26	(policy or policies).mp.
27	or/18–26
28	exp smoking/or smoking.mp.
29	exp tobacco/or tobacco.mp.
30	exp diet/or diet.mp.
31	exercise.mp. or exp exercise/
32	obesity.mp. or exp obesity/
33	diabetes.mp. or exp diabetes mellitus/
34	stress.mp. or exp stress/
35	exp cholesterol/or cholesterol.mp.
36	exp hypertension/or hypertension.mp.
37	blood pressure.mp. or exp blood pressure/
38	alcohol$.mp.
39	drinking.mp. or exp alcohol drinking/
40	(cardiovascular adj3 risk$).mp.
41	multiple risk$.mp.
42	or/28–41
43	17 and 27 and 42
44	limit 43 to (humans and year = "1970–2008")
45	limit 44 to "therapy (sensitivity)"
46	epidemiologic studies/
47	longitudinal studies/
48	(control$ before and after).mp.
49	cohort.mp.
50	case control.mp.
51	interrupted time series.mp.
52	or/46–51
53	44 and 52
54	45 or 53

Appendix Table 2. Programs Not Included in the Calculation of 10-Year Risk of Cardiovascular Disease in a Systematic Review of Heart Health Programs, 1970–2008

Program (Reference No.)	Net Change(s) Relative to Control Group
Action Heart (16)	Significant reduction in smoking rates and an increase in low-fat milk consumption. No other significant changes.
Bootheel Heart Health Project (17)	Significant increase in leisure-time physical activity. No significant effects on smoking, fruit and vegetable consumption, or prevalence of overweight. Significantly more participants with cholesterol checked in the past 2 years. Black population showed improvements in physical activity, smoking, fruit and vegetable consumption, weight status, and cholesterol checks.
CardioVision 2020 (18)	No significant difference in trends for smoking or body mass index. Significantly worse trends for physical activity. Significantly more people eating 5 fruits and vegetables per day.
Coeur en Santé St.-Henri (20)	Trend toward net reduction in smoking prevalence and frequency (not significant). Trend toward increased leisure-time physical activity (not significant). No difference in body mass index or blood pressure. Significantly more participants with blood pressure and cholesterol checked in the past year. No difference in dietary outcomes.
Danish Municipality Project (22)	No differences in smoking, diet, or physical activity.
Franklin Cardiovascular Health Program (28)	Lower rates of death from stroke and significantly lower rates of death from coronary heart disease.
Have a Heart Paisley (30)	No significant effects on any self-reported outcomes.
Heartbeat Wales (31)	No significant effects on any self-reported outcomes.
North Coast Healthy Lifestyle Programme (37)	Significant decrease in smoking prevalence.
Quebec Heart Health Demonstration Project (43)	
Rural	Significant increase in consumption of low-fat processed meats. No significant difference in dietary index measures.
Suburban	Significant increase in consumption of low-fat milk in women and of low-fat meats in men and women. No significant difference in dietary index measures.
Urban	No significant difference in dietary index measures.
South Carolina Cardiovascular Disease Prevention Project (45)	Significantly smaller increase in the prevalence of high cholesterol and significantly higher rates of cholesterol screening. No significant difference in smoking or physical activity. Significant net negative effect on blood pressure. Significantly smaller increase in the prevalence of overweight. Significant net reduction in consumption of animal fats.
Tessin Cardiovascular Health Programme (49)	Significant reductions from baseline in 12 out of 15 risk-factor measures (related to smoking, blood pressure, body mass index, physical activity, and diet) in intervention area as compared with 3 out of 15 for the control area. No direct comparison of individual risk-factor changes in intervention area versus control area.