

REVIEW

Addressing noncommunicable disease at the population level: a focus on diabetes



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Practice Points

- Noncommunicable disease (NCD) and Type 2 diabetes are leading causes of mortality and morbidity worldwide, and costs associated with NCD are forecast to account for 5% of gross domestic product by 2030.
- NCD prevention has been highlighted as a priority by the WHO and the UN.
- Lifestyle modification and weight loss have been identified as key interventions for prevention of NCD and Type 2 diabetes.
- Randomized, controlled trials in high-risk individuals have shown that 5% weight loss can reduce progression to Type 2 diabetes by approximately 60%.
- Many countries have adapted lifestyle diabetes prevention programs at the community level, but all target at-risk individuals.
- Despite these efforts, diabetes prevalence continues to rise.
- There is mounting evidence that population approaches, incorporating all sectors in society, may be a more appropriate strategy for effective diabetes prevention.

SUMMARY The prevalence of both noncommunicable disease and Type 2 diabetes is increasing worldwide, and much of this increase is explained by lifestyle factors and obesity. There is now robust evidence from randomized, controlled trials in high-risk individuals that lifestyle interventions, including diet and physical activity, can reduce both obesity and progression to Type 2 diabetes. There is some evidence of translation of these trials to the wider community, but most local and national programs utilize the high-risk approach and fail to address noncommunicable disease and Type 2 diabetes prevention at the population level. This review addresses the measures needed to introduce Type 2 prevention at the community level, summarizes the multiple stakeholder approach and reviews the evidence for efficacy of population-based prevention.

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Noncommunicable disease (NCD), including Type 2 diabetes, cardiovascular disease (CVD), chronic lung disease and cancer, is now the leading cause of death in the world, accounting for 65.5% of the 52.8 million deaths in 2010 [1]. Traditionally, NCD is seen as a disease of affluence, occurring mainly in high-income countries, but in 2008 more than 80% of the mortality attributed to NCD occurred in low- and middle-income countries (LMIC), and it is calculated that 30% of these deaths were premature and largely preventable [2]. Type 2 diabetes is one of the most common NCDs and is a leading cause of morbidity and premature death [3]. In 2012, more than 371 million people worldwide had diabetes, 4.8 million died as a result of diabetes and half of these were aged under 60 years [4]. Approximately 90% of people with diabetes have Type 2 diabetes, and rates of Type 2 diabetes are increasing rapidly in all countries; this is of significance in countries with large populations, such as China [5] and India [6], and it is estimated that by 2030, 551 billion people in the world will have diabetes, amounting to just under 10% of the global population [4].

NCD affects quality of life, general health and well-being and is responsible for the loss of healthy years of life (disability-adjusted life years [DALYs]). The premature mortality associated with NCD is preceded by years of disability [2]. Apart from the human consequences of the morbidity and mortality associated with NCD, the economic impact is enormous and is related to both the direct medical costs of treatment and the indirect costs of labor units lost. NCD, and Type 2 diabetes in particular, is now affecting people at a younger age during their prime economically productive years, and it has been estimated that the global economic impact of NCD, including mental ill-health, could total US\$47 trillion over the next 20 years, equivalent to 5% of GDP [7]. The estimated global cost of diabetes alone was US\$471 billion in 2012 [4]. NCD is forecast to have substantial negative effects on individual, national and international economic well-being over the next 20 years, and this will have particular effect in newly emerging economies.

NCDs share four main behavioral risk factors: tobacco use; physical inactivity; unhealthy diet; and harmful use of alcohol. The Type 2 diabetes epidemic is strongly related to increases in obesity, and this in turn is related to lifestyle factors including physical inactivity and high intakes of

energy dense foods [8]. Many of the risk factors associated with NCD and Type 2 diabetes are modifiable and present an opportunity to reduce the impact of these diseases. A report from the World Bank has suggested that more than half of the NCD burden could be prevented by the implementation of a few key interventions to address the main risk factors [9].

The international community has begun to pay closer attention to the human and economic burden of NCDs, and prevention has been highlighted following the formation of the NCD Alliance in 2009, with reports from the WHO, the World Economic Forum and the World Bank, culminating with a high-level United Nations (UN) meeting held in New York, USA, in September 2011. The NCD Alliance was formed in 2009 by four leading nongovernmental organizations (NGOs) in order to advocate for NCD recognition and prevention [10]. The UN meeting included actions that could be taken to reduce NCD risk factors [10] and the WHO and the World Economic Forum have produced a list of 'best buys' in terms of lifestyle change [11]. The WHO has recently published a draft global plan for the prevention and control of NCD [12]. These authorities all recommend evidence-based strategies for lifestyle interventions, and although there is broad recognition of the main components of healthy lifestyles, the majority of evidence comes from studies targeting individuals at high risk of disease. There is limited high-grade evidence for population- or community-based approaches and most of the available evidence is derived from studies conducted in high-income countries [12]. This review aims to provide a summary of the strategies for diabetes prevention and make a case for population approaches.

Prevention of NCD

■ Risk factor reduction

Prevention of NCD begins with the identification of modifiable risk factors. For CVD, for example, hypertension is a modifiable risk factor, and CVD risk can be reduced by identifying and treating hypertension in high-risk individuals. There are three approaches for prevention of NCD:

- Primary prevention: identifying and treating individuals at high risk;
- Secondary prevention: treating patients with established disease;

- Population prevention: reducing risk in the entire population, regardless of individual risk.

The traditional medical model of prevention of NCD promotes primary prevention in order to prevent progression from high-risk status to established disease. Secondary prevention aims to reduce risk by effective treatment of those with established disease. These traditional medical models of disease prevention rely largely upon the use of medication to prevent NCD, and although lifestyle modification is used to address risk factors such as cholesterol levels and blood pressure, multisectoral approaches are largely ignored. By contrast, the population approach addresses risk factors at the community level and its success depends on factors including health education, structural environmental change, engagement of health providers, transport, policy and legislative initiatives, and partnerships and coalitions with community organizations.

Population approaches are predicated on the assumption that small changes at the population level translate to large health benefits. For example, it has been estimated that a reduction as small as 2 mmHg in systolic blood pressure is associated with a 10% reduction in stroke mortality and 7% reduction in deaths from ischemic heart disease [13], and relatively small weight losses (5.5 kg) in the adult population in Cuba during the embargo from 1991–1995 reduced mortality from diabetes by half, and from coronary heart disease by one third [14]. In terms of public health, it has long been argued that the population strategy is more effective in reducing risk factors and improving health than the traditional high-risk approach [15], and the WHO has recently called for a paradigm shift to prevention by addressing these different behavioral, environmental, social and economic factors [12]. Intervening at the community level to improve general health and reduce the risk factors for NCD is more attractive in LMIC, where resources and health systems are stretched, and it is unlikely that effective primary prevention by pharmaceutical intervention is feasible.

▪ Population strategies

Most authorities are in agreement that complex challenges such as the rise in NCDs cannot be solved with simple solutions, and that multifaceted interventions, engaging with all sectors of society, will be needed. Individuals

are responsible for their own health, but healthy lives can be enabled and supported by the communities and society where individuals live and equally, unhealthy environments will have a negative impact on health and will promote NCD. The WHO draft action plan for the prevention and control of NCD stated in its introduction that the overarching aim is:

‘To reduce the preventable and avoidable burden of morbidity, mortality and disability due to non-communicable diseases by means of multisectoral collaboration and cooperation at national, regional and global levels, so that populations reach the highest attainable standards of health and productivity at every age and those diseases are no longer a barrier to well-being or socioeconomic development.’

– WHO, 2013 [12].

The report goes on to identify principles and approaches that should be utilized, including human rights, equity, national and international co-operation and solidarity, a life-course approach spanning all generations, the use of evidence-based strategies, provision of universal health coverage and management of potential conflicts of interest. Multisectoral action is recommended, with co-ordinated multiple stakeholder engagement at all levels of society including:

- International, national and local governments across all sectors including health, agriculture and food, communication, education, employment, energy, environment, finance, foreign affairs, housing, justice and security, legislature, social welfare, social and economic development, sports and leisure, tax and revenue, trade and industry, transport, urban and town planning and youth affairs;
- The health sector, both public and private, has a role to play in assessment and monitoring of NCD, shaping evidence-based interventions, and monitoring and evaluating outcomes;
- Civil society, including NGOs and voluntary organizations;
- The private sector, which is an essential part of the solution, but where are acknowledged conflicts of interest.

This multisectoral approach is now considered the most effective method to address control and prevention of NCD, but the role of risk

reduction at the community or population level has not been fully researched. In terms of diabetes prevention, high-risk strategies only have been applied in both randomized, controlled trials (RCTs) and when rolling these out at the population level, and community strategies are underutilized.

Diabetes prevention

The risk factors for diabetes are both nonmodifiable (age, ethnic origin, family history) and modifiable (obesity, physical inactivity, unhealthy diet, elevated blood glucose levels). In terms of diabetes prevention, there is now strong evidence from RCTs that a variety of interventions, including pharmaceutical and lifestyle, can reduce the rate of progression to Type 2 diabetes in high-risk individuals, see Table 1. Although antidiabetic pharmaceutical agents have been shown to be effective in reducing the risk of diabetes [16–22], these agents have adverse side effects – especially true in the case of thiazolidinediones [23], they are relatively expensive and, most importantly, they are not as effective as lifestyle interventions for diabetes prevention. In addition, it appears that some pharmaceutical agents such as pioglitazone are ineffective in certain ethnic groups [24]. The current epidemic of Type 2 diabetes is strongly associated with increased prevalence of overweight and obesity, unhealthy diet, physical inactivity and urbanization [25], and pharmaceutical agents fail to address these fundamental issues.

Lifestyle interventions are therefore the preferred option for diabetes prevention, and robust evidence from RCTs has demonstrated that interventions incorporating diet, physical activity and weight loss can prevent Type 2 diabetes in high-risk individuals from different ethnic backgrounds [16,26–28]. The risk of diabetes is reduced by 50% after implementation of lifestyle change [29], and there is some evidence of a legacy effect, with three of the major trials reporting lower incidences of diabetes at 7–20 years follow-up beyond the planned intervention period [30–32]. However, despite this strong published evidence for diabetes prevention, the prevalence of Type 2 diabetes continues to increase in all countries, with newly industrialized nations such as China and India of particular concern. In higher income countries, such as the UK and the USA, where there is an established structure of primary care, targeted and opportunistic screening to identify high-risk individuals and to offer appropriate intervention has been recommended by an

International Diabetes Federation (IDF) consensus [33]. Despite these measures, the prevalence of diabetes continues to rise in higher income countries. In the USA, diabetes prevalence amongst adults has more than doubled over the past 10 years from 4.0% to 9.4% [102], and in the UK from 2.5% [103] to 5.8% [104]. This indicates that present strategies for diabetes prevention have not yet taken effect and a more integrated approach utilizing both high-risk and community strategies may have more effect. The translation of evidence from RCTs in high-risk individuals to diabetes prevention at the population level is fundamental and, unless this is addressed, it is likely that the prevalence of Type 2 diabetes will continue to rise.

Diabetes prevention at the population level

There have been some attempts to translate the positive results from the successful lifestyle RCTs to wider populations by adapting diabetes prevention programs for use in community settings. Although there is some heterogeneity in the design and implementation of diabetes prevention studies, the key components of lifestyle programs have been identified [34].

■ Key components of lifestyle interventions

There is broad agreement among authorities that the following are effective for diabetes prevention [34]:

- Bodyweight reduction in overweight or obese individuals, aiming for 5–7% weight reduction;
- Increased physical activity, aiming for at least 30 min/day of moderate to vigorous activity;
- Dietary modification including: increased dietary fibre intake (≥ 15 g/1000 kcal); moderate total fat intake ($\leq 35\%$ total energy intake); reduced saturated and trans fat intake ($\leq 10\%$ total energy intake).

A cohort study in the UK tested the achievement of five similar behavior goals (BMI < 25 kg/m², ≥ 4 h physical activity/week, fibre intake ≥ 15 g/1000 kcal, total fat intake $\leq 30\%$ energy intake, saturated fat $\leq 10\%$ energy intake) and the incidence of Type 2 diabetes and found a strong inverse relationship. The highest incidence of Type 2 diabetes occurred in those subjects who failed to achieve any of the five goals, and none of the subjects meeting all five goals developed

diabetes. The incidence of Type 2 diabetes was inversely and linearly related to the number of goals achieved, and it was calculated that if the entire cohort achieved just one extra goal, the total incidence of diabetes would fall by 20% [35].

■ Translation of diabetes prevention programs to the population level

The majority of diabetes prevention programs at the community level are adapted from either the US Diabetes Prevention Programme (DPP) [16] or the Finnish Diabetes Prevention Study (DPS) [26] and apply the above key components of lifestyle intervention. In the USA, for example, the National Diabetes Prevention Recognition Program was launched by the government in 2012 to provide the overarching structure for lifestyle diabetes prevention programs and the Young Men's Christian Association (YMCA) [36], the Montana Diabetes Control Program [37] and the University of Pittsburgh Diabetes Prevention Support Centre [38] have all successfully replicated DPP at a lower cost. The YMCA program in particular is claiming great success, with more than 8000 participants in 23 states that have shown mean weight losses of 5% [39]. Other countries have also addressed diabetes prevention through lifestyle modification at the community level, including the Finnish DEKHO program [40], the Dutch SLIM program [41] and the Australian Greater Green Triangle project [42].

However, all the community-based diabetes prevention programs to date have targeted at-risk individuals, and rely on identification of those with a raised BMI (≥ 25 kg/m²), impaired glucose tolerance (or prediabetes, as it is more generally known) or a raised diabetes risk score, rather than utilizing a true population-based approach. In addition, these studies tend to be of short duration and as a result the main outcomes are changes in bodyweight rather than development of diabetes. A recent meta-analysis of community-based studies reported that they are successful in achieving weight loss (4% loss in the intervention group compared with 2% in the control group) and although diabetes incidence was not measured, those studies that reported HbA1c or glucose levels showed some reduction in the intervention group [43]. Although many of these studies are described as community programs they are based in healthcare settings, often out-patient clinics, as linking to the healthcare provider can promote long-term lifestyle change and support management of comorbidities. However, in many LMIC, resources

Table 1. Summary of relative risk reduction from a variety of strategies designed to prevent Type 2 diabetes.

Strategy	Relative risk reduction (%)	Ref.
Lifestyle interventions	58	[16,26]
Pharmaceutical interventions		
Metformin	31	[16]
Acarbose	25–33	[17]
Orlistat	37	[18]
Troglitazone	56	[19]
Rosiglitazone	60	[20]
Pioglitazone	0–72	[21,22]

and access to healthcare prevent the utilization of this approach, but relatively few programs have attempted to deliver the intervention in various settings in the community, including the YMCA [36], local recreation centres [44] and churches [45–47]. A summary of these studies is shown in **Table 2**, and show small but significant improvements in risk factors in the intervention groups compared with no change in the control group. There is no indication that studies taking place outside healthcare facilities are inferior to those that take place within healthcare settings.

A major disadvantage of delivering diabetes prevention programs in health care settings is that many of those at higher risk, including the socially disadvantaged and minority ethnic groups, may encounter barriers to access. In the UK for example, gaps were reported in health professional's understanding of culture, religious beliefs, gender dynamics and perceived body image and the way that these impact on lifestyle factors for diabetes prevention in people from black and minority ethnic groups (BME) [48]. Those of low socioeconomic status also encounter a number of barriers that prevent access to health-promoting behaviors to prevent diabetes, including lack of resources, illiteracy and social and psychological issues [49].

■ Technological approaches to diabetes prevention at the population level

Reducing the impact of diabetes through effective prevention requires innovative solutions, and the use of health information technology (IT) has been proposed as a suitable solution at the population level. Health IT has advantages over traditional lifestyle modification programs as it is neither as intense nor as expensive, and new technologies are widely used around the world. Recent advances in health IT have resulted in a number of studies examining the role of new technologies in diabetes prevention, including mobile phone

Table 2. An overview of recent studies designed to translate diabetes prevention programs to community settings.								
Setting	Study design	Participants	Intervention	Follow-up	Dropout (%)	Outcome measures	Results (% changes in intervention group only)	Ref.
YMCA, USA	Matched-pair, group randomized trial	92 high-risk 45% M 58.3 years	Adapted DPP	4–6 months	16	Weight, BMI HbA1c TC HDLc SBP	-6.0, -5.8 -0.1 -21.6 1.1 -1.9	[36]
				12–14 months	33	Weight, BMI HbA1c TC HDLc SBP	-6.0, -6.7 -0.1 -13.5 1.9 -1.6	
Church, USA	Nonrandomized controlled trial	246 high-risk African–Americans 19% M	Adapted DPP	15 months	35	Weight BMI	0.1 -1.8	[45]
Church, USA	Intervention trial	10 African–Americans with prediabetes	Adapted DPP	6 months	10	Weight, BMI FBG SBP DBP	-2.8, -2.9 -9.1 -7.8 -12.9	[46]
				12 months	10	Weight, BMI FBG SBP DBP	-4.6, -5.3 -8.2 -9.2 -22.3	
Church, USA	Intervention trial	37 high-risk African–Americans	Adapted DPP	12 months		Weight BMI FBG	-0.8 -0.9 -5.9	[47]
Parks, recreation centers	RCT	301 overweight or obese 42.5% M 57.9 years	Adapted DPP	24 months	13	Weight BMI FBG	-5.9 -5.8 -2.0	[44]
DBP: Diastolic blood pressure; DPP: Diabetes Prevention Programme; FBG: Fasting blood glucose; HDLC: High-density lipoprotein cholesterol; M: Male; RCT: Randomized controlled trial; SBP: Systolic blood pressure; TC: Total cholesterol; YMCA: Young Men's Christian Association.								

apps, web-based interventions, telemedicine and text messaging. Most of these studies are short-term, investigate surrogate end points (changes in physical activity and weight) and do not report development of diabetes, and although there are indications that they may have positive effects [50], current evidence is mixed and more research is needed [51].

■ Comprehensive diabetes prevention

The majority of countries around the world that are addressing diabetes prevention are focusing on identification of high-risk individuals and utilizing intensive lifestyle education programs, often conducted in healthcare settings, to reduce risk in these individuals. Many countries have developed national diabetes prevention programs, including the NDPP in the USA [105] and ‘Let’s prevent diabetes’ in Australia [106], but the multisectoral population approach is largely ignored. There are

a few exceptions, one of which is Finland, which is probably the only country worldwide that has adopted a comprehensive approach to diabetes prevention. The Finnish DPS showed that lifestyle interventions including weight loss, dietary change and increased physical activity reduced the risk of progression to Type 2 diabetes by 58% in those at high-risk [26]. This highly significant outcome led to the development of a comprehensive national strategy for diabetes prevention in Finland, encompassing three approaches: high-risk, early diagnosis and management and a population strategy [40]. The population strategy is aimed primarily at obesity prevention and includes eleven society-oriented measures including staff education and training, improvements in mass catering, health education and promotion, improving access to physical activity in the built environment and sports facilities, co-operating with NGOs and strengthening health systems. In addition, lifestyle

counseling and health promotion through the media are offered to individuals. Although it is impossible to report the relative effects of each of the strategies, the combined effects on obesity have been reported and show that bodyweight and prevalence of obesity has decreased over a 3–5-year period in Finns aged 45–74 years since the introduction of the initiative, and it is hoped that this will result in reduction in the incidence of Type 2 diabetes in the years to come [52]. This comprehensive approach may need further modification in more heterogeneous populations with differences in ethnicity, education and language.

Community interventions for health

There is little evidence for multicomponent approaches to NCD and diabetes prevention at the community level, although there have been many small studies investigating the effect of particular strategies for improving community health, for example, how altering the local environment may influence diet and physical activity or evaluating the effect of local health education campaigns [53]. Specifically, there is little evidence for multi-stakeholder initiatives that address the complex nature of NCD and address the societal, behavioral, economic and political factors affecting health at the population level. The majority of studies have been aimed at reducing the risk of CVD and have been conducted in high-income countries [54]. The experience of the North Karelia study in Finland (Box 1), perhaps the best-known example, has shown that comprehensive community-based interventions are feasible in high-income countries [55].

The available evidence suggests that an effective response to the prevention and control of all NCD, including diabetes, involves all

stakeholders at every level of society from international bodies, through national, regional and local government to the individual, although there appears to be little application in practice [56]. Numerous stakeholders are involved including individuals, families, local communities, governmental organizations and NGOs, religious institutions, academic institutions, health and education services, civil society, the media and the private sector and industry. Prevention and control of NCD is likely to have the greatest impact by addressing behavioral risk factors at the whole community or population level in a way that is culturally appropriate and where all sectors are working in partnership.

In response to this, the Oxford Health Alliance, a UK registered health charity (No 1117580), began its Community Interventions for Health (CIH) program in 2007, which is the largest study to date and which was designed to apply a population approach adopting multifactorial, comprehensive strategies for prevention of NCD by addressing modifiable lifestyle risk factor reduction at all levels. CIH was an international collaborative study that took place between 2008 and 2012 in communities in China, India and Mexico and was designed to reduce the risk of NCD by targeting the three main risk factors of tobacco use, physical inactivity and unhealthy diet. The aim of CIH was to formulate, implement and evaluate culturally sensitive strategies that were applicable on a large scale in local communities and which were designed to:

- Reduce the prevalence of smoking and smokeless tobacco use;
- Improve dietary intake by increasing intake of fruit and vegetables and reducing use of salt;

Box 1. Case study: the North Karelia project.

- In the 1960s, Finland led the world in deaths from coronary heart disease (CHD), and this was especially true in the province of North Karelia. The North Karelia project was initiated through a grass-roots campaign supported by regional and national authorities – the first true bottom-up, top-down approach to improving community health. Prevention was seen as key, with interventions aimed at reducing risk for the total population by transforming the social and physical environment.
- Lifestyle factors were identified as the drivers of CHD and included smoking, high intakes of salt and saturated fats, low intakes of fruit and vegetables and physical inactivity. Interventions included health education, support for tobacco cessation, redesign of towns to create opportunities for increased physical activity, the introduction of healthy school meals and compulsory changes in food manufacturing to reduce both saturated fat and salt. Thirty years later, there has been a dramatic improvement in the health of the population, with deaths from all causes reduced by 62% in men aged 35–64 years, including a reduction of 85% in deaths from CHD.

Data taken from [55].

Table 3. Examples of Community Interventions for Health designed to increase physical activity and improve dietary intake.

Strategy	Practical applications – examples from CIH
Physical activity	
Creating or enhancing public access to places for increasing physical activity	Renovating unused public spaces for recreational purposes Providing street gyms and fixed exercise equipment in local parks Building walking trails along a local canal with stone distance markers
Providing support groups	Introducing sports interest groups in local workplaces Establishing walking clubs in local communities
Increasing physical education in schools	Introducing supervised physical education sessions in schools Providing secure parking for bicycles Providing sports equipment to schools Building physical activity into the curriculum
Using point of decision prompts	Putting posters encouraging stair use near elevators and escalators Painting footprints around playgrounds and public recreational areas
Creating and implementing transport policies	Introducing city-wide bicycle hire systems Closing streets to traffic at regular intervals and supporting walking running, cycling and skating on the streets
Health education and healthcare	Providing physical fitness testing Displaying posters encouraging physical activity in workplaces, community centers and local recreational areas Encouraging health professionals to screen and support increased physical activity
Diet	
Encouraging consumption of healthy foods	Increasing affordability by offering subsidies on healthy choices in workplace canteens Providing healthy snacks in workplaces Introducing healthy school meals and working with school meal providers to improve quality of meals Increasing accessibility by supporting 'Grow your own' schemes and providing vegetable seeds and information
Supporting local farmers markets and communal gardens	Working with local farmers and established markets to provide healthy food to local communities Introducing communal gardens into schools
Promoting institutional policy change	Working with local restaurants, hospitals, schools and workplace canteens to add less salt and oil in food preparation, include more fruit and vegetables and to use healthier cooking methods
Providing accurate nutritional information	Displaying nutritional information (energy, salt and dietary fibre) of dishes served in workplace canteens
Using point-of-purchase prompts	Displaying posters in workplace canteens encouraging healthy choices
Health education and healthcare	Providing salt spoons and oil pots indicating maximum daily amounts to adults in the local community Displaying healthy eating posters in workplaces, community centers and local recreational areas Encouraging health professionals to screen and support dietary change

CIH: Community Interventions for Health.

- Increase levels of physical activity;
- Reduce the prevalence of overweight and obesity.

■ Methodology

The full methodology of CIH has been reported previously [57]. Briefly, CIH took place in three different sites in Hangzhou city in China, Kerala in India and in Mexico City. As one of the aims

of the study was to change health-related behavior on a large scale, each country site identified intervention and control areas with a population size between 150,000 and 250,000, meaning the study involved over three-quarters of a million people. The study was undertaken according to the Declaration of Helsinki and obtained institutional review board (IRB) approval in each country site (China: IRB00001052-08003

certified by the Institutional Review Board at Peking University Health Sciences Centre, India: IEC/184, Mexico: Oficio JST/1003/08) and written, informed consent was obtained where required.

CIH was conducted in four main settings; health centers, workplaces, schools and the community at large. Baseline and follow-up data were collected from independent selected samples of adults and children within each intervention and control site. The information collected included self-reported risk factor assessment by means of a questionnaire, which was administered by trained professionals. A menu of evidence-based interventions, addressing the three main risk factors, was formulated by the CIH international advisory group and these interventions were summarized in the form of a manual [107]. The intervention strategies used for CIH included structural change, community mobilization, health education and social marketing, and were designed to be delivered in the four settings. Each country site selected culturally appropriate interventions for local application, and some examples of interventions designed to increase physical activity and improve dietary intake are shown in Table 3. The intervention stage of the CIH project lasted 18–24 months.

■ Results

The results from the CIH study have yet to be reported, but initial analyses have shown positive effects for risk factor reduction in the intervention area compared with the control area. There have been significant improvements in physical activity and fruit and vegetable intake and reduction in salt intake in the intervention group, and this has had a significant effect in reducing the prevalence of overweight and obesity. Although CIH was designed as a NCD prevention program, and did not specifically target diabetes reduction or include any measurements of glycemia, it has shown significant improvements in the risk factors for diabetes and it is hoped that this will translate to a reduction in diabetes prevalence over time.

■ Strengths & limitations of CIH

The CIH study illustrated that it is feasible to utilize the population approach for obesity and diabetes prevention, and that community mobilization can be used to reduce the risk factors for Type 2 diabetes. This strategy has one great strength, that of sustainability as the majority of interventions have continued after the end of the study. However, there are some limitations to these types of studies including lack of resources, short duration of the interventions and the fact that diabetes prevalence was not an outcome.

Conclusion

Despite strong evidence from RCTs showing the efficacy of lifestyle interventions to prevent diabetes in high-risk individuals, and the introduction and implementation of community programs for those at risk, diabetes prevalence continues to rise around the world. Translating diabetes prevention studies to the general population will require political engagement and a community-based approach encompassing all sectors of society. Community-based programs involving all sectors of society, including local and national governments, the food industry, health and education services, families and individuals are needed to improve dietary intake, increase physical activity and reduce the prevalence of obesity and Type 2 diabetes. Until these issues are addressed, it is likely that the prevalence of both will continue to increase.

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