



Ischaemic Heart Disease 1

Primary prevention of ischaemic heart disease: populations, individuals, and health professionals

Rajeev Gupta, David A Wood

Ischaemic heart disease has a multifactorial aetiology and can be prevented from developing in populations primordially, and in individuals at high risk by primary prevention. The primordial approach focuses on social determinants of health in populations: political, economic, and social factors, principally unplanned urbanisation, illiteracy, poverty, and working and living conditions. Implementation of the UN Sustainable Development Goals can lead to major improvements in cardiovascular health, and adequate health-care financing and universal health care are important for achieving these goals. Population-level interventions should focus on tobacco control, promotion of healthy foods (fruits, vegetables, legumes, and nuts), curbing unhealthy foods (saturated fats, trans fats, refined carbohydrates, excessive salt, and alcohol), promotion of physical activity in everyday living, and control of ambient and indoor pollution. At the individual level, identification of people at high multifactorial risk and guideline-driven management of hypertension, LDL cholesterol, and diabetes is required. Strategies to improve adherence to healthy lifestyles and drug therapies are essential and can be implemented at health system, health care, and patient levels with use of education, technology, and personalised approaches. Improving quality of medical education with a focus on ischaemic heart disease prevention for physicians, nurses, allied health workers, and the public is required.

Introduction

Ischaemic heart disease continues to be the most important cause of premature mortality and a major cause of disability worldwide.^{1,2} The decline in ischaemic heart disease mortality rates in developed countries has largely been due to addressing political, economic, and social determinants, control of major cardiovascular risk factors, and improved acute and chronic care.¹ Recent data show that the decline in ischaemic heart disease has stalled and the incidence is increasing in some high-income countries.³ This finding is due to re-emergence of long-standing barriers to prevention such as a lack of political will, competing financial and commercial interests, and failing focus on social determinants.⁴

Primordial prevention is defined as preventing the onset of disease before there is any evidence of the condition by addressing the underlying determinants in populations.⁵ Primary prevention addresses individuals at high multifactorial risk of developing ischaemic heart disease. Modelling studies in Europe and the USA have reported that more than 60% of decline in ischaemic heart disease mortality in the last century is attributable to primordial and primary prevention.⁵ An ischaemic heart disease prevention pyramid highlights the overlapping importance of political, economic, and social determinants, health policies and financing, population and individual-level risk factor control, secondary prevention, and medical education (figure 1).⁶ In this Series paper, we highlight strategies that are effective for primary prevention of ischaemic heart disease, ranging from population-based to individual interventions. This topic is important in view of the escalating burden of ischaemic heart disease, especially in middle-income and low-income countries.

Risk factors

Ischaemic heart disease is due to a complex interaction of political, social, behavioural, physical, biological, and genetic risk factors (figure 2). Primacy of political and social factors and the environment in influencing behavioural, physical, and biological factors is fundamental to understanding causation.^{6,7} A risk factor is any attribute, characteristic, or exposure of an individual or group that increases the likelihood of developing a disease or injury. Bradford Hill's criteria to determine causality of a hypothesised risk factor—ie, strength of association, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy—still hold true.⁸ These criteria are not absolute and causality is a matter of judgment based on the totality of observational and experimental evidence. The panel summarises the major risk factors of ischaemic heart disease.

Political and social determinants

The fundamental strategy to control risk factors of ischaemic heart disease in populations is primordial prevention.⁹ Social determinants include conditions in which women and men are born, grow, work, live, and die; and

Lancet 2019; 394: 685–96

This is the first in a Series of two papers about ischaemic heart disease

Academic Research Development Unit, Rajasthan University of Health Sciences, Jaipur, Rajasthan, India (R Gupta MD); Department of Preventive Cardiology and Internal Medicine, Eternal Heart Care Centre and Research Institute, Jaipur, Rajasthan, India (R Gupta); National Institute for Prevention and Cardiovascular Health, National University of Ireland Galway, Galway, Ireland (Prof D A Wood FRCP); and National Heart and Lung Institute, Imperial College, London, UK (Prof D A Wood)

Correspondence to: Dr Rajeev Gupta, M-Floor, Eternal Heart Care Centre and Research Institute, Jaipur, Rajasthan 302017, India dr Rajeev.gupta@eternalheart.org

Search strategy and selection criteria

A search of databases for terms relating to prevention of ischaemic heart disease returns many thousands of results. Both authors have been practising preventive cardiology for many years; thus, instead of a formal search strategy, we obtained citations from personal databases, recent reviews, and original articles. This was supplemented by searches using PubMed and other databases.

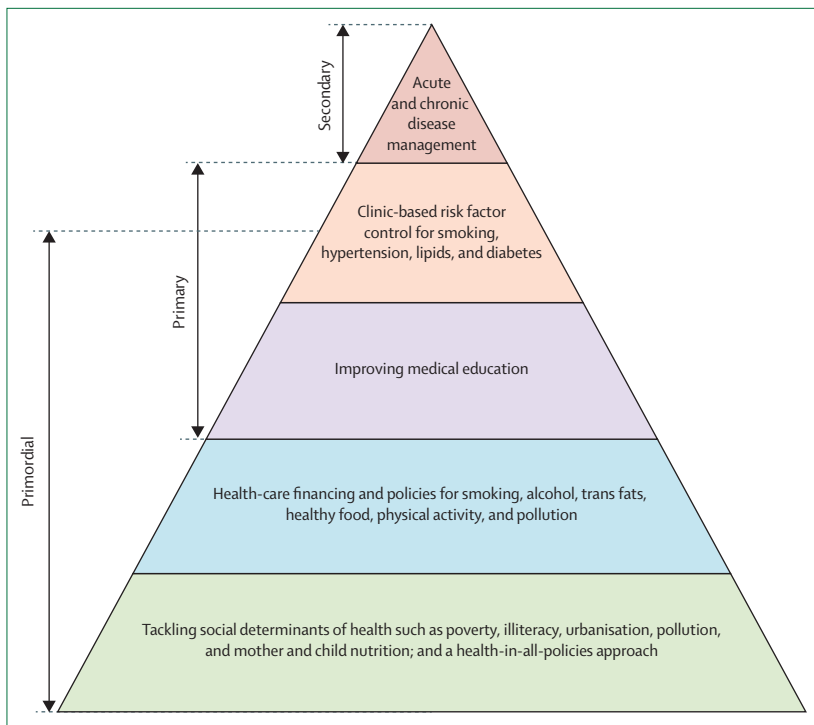


Figure 1: The cardiovascular prevention pyramid

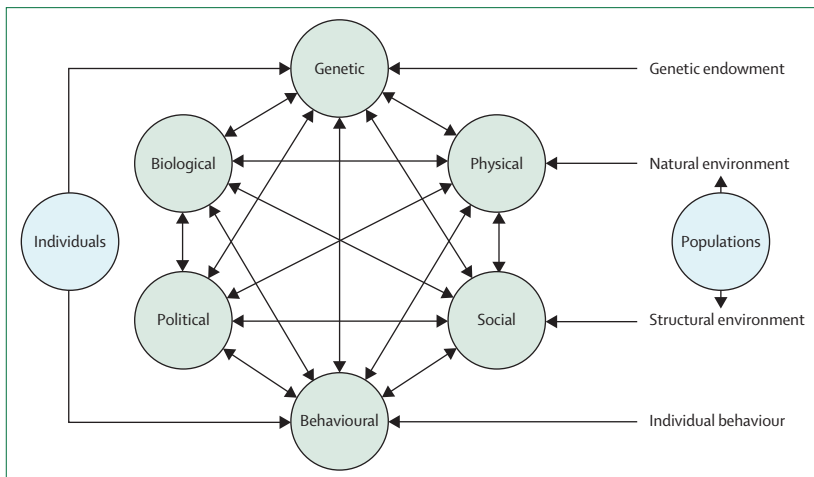


Figure 2: Determinants of cardiovascular health and disease

this strategy shapes these conditions so people can lead flourishing lives.⁹ High-quality universal health care with population and opportunistic screening identifies at-risk individuals requiring preventive interventions.¹⁰ Taken together, these approaches to prevention influence many risk factors: tobacco use, unhealthy foods, sedentariness, obesity, psychosocial stress, and ambient pollution using multilevel and multidisciplinary approaches.^{11,12}

Political determinants

Association of better and sustainable social development with lower ischaemic heart disease burden and mortality

is well known.^{4,13} Politics influences social change. A striking example of politics and ischaemic heart disease was observed in Russia following the breakdown of the Soviet Union.⁹ This period led to profound socio-economic turmoil (eg, decline in gross national product, deindustrialisation, unemployment, poverty, and social stress) and resulted in large increases in ischaemic heart disease mortality.¹⁴ Restoration of political order in recent years has reversed this trend. Political focus on social determinants and adoption of a health-in-all-policies approach has led to the lowest ischaemic heart disease prevalence in Scandinavian countries.¹⁵ By contrast, in many lower-middle-income and low-income countries, where there is a poor focus on political and social determinants of health, ischaemic heart disease burden is high and increasing.¹³ An important social development over recent centuries has been democratic industrialisation leading to better employment, income, and living conditions.¹⁶ Successive waves of industrialisation with creation of a wealth and knowledge-based economy has led to better cardiovascular health, because of societal and individual health empowerment. WHO recommends this approach to achieve substantial reduction in non-communicable disease burden and to achieve the UN Sustainable Development Goals (SDGs).¹⁷ The American Heart Association has suggested that future research should focus on design and evaluation of interventions, programmes, and policies that address political and social determinants.¹⁸

UN SDGs and ischaemic heart disease prevention

Influencing social determinants of health is not easy, as the social world is complex and ever-changing.¹⁰ A commission on social determinants of health was established by WHO to support countries in addressing factors that lead to ill health and health inequities.¹⁹ The three overarching recommendations of this commission, also relevant to cardiovascular health, are: improve daily living conditions; tackle inequitable distribution of power, money, and resources; and measure and understand the problem and assess the effect of action.²⁰ The UN has promulgated 17 SDGs to address multiple social issues,¹⁷ WHO has added a health component to each of these goals,²¹ and a *Lancet* Taskforce has highlighted the strength of association of SDGs with non-communicable diseases.²² Table 1 shows the potential applicability of each goal to promote cardiovascular health. There is need for governments in every country to legislate policies to promote each of the SDGs. A major focus should be a health-in-all-policies approach, which entails prevention through better health-care financing, universal health care, and urban infrastructure, improvements to agriculture, transportation, employment, sanitation, and mother and child nutrition, and reductions in poverty, illiteracy, smoking and tobacco use, alcohol misuse, and consumption of unhealthy foods.¹⁵ Each of the SDGs addresses upstream social determinants of these factors

(table 1). Implementation of policies to address these goals is yet to take root in most countries.²³

Universal health care and health financing

Transformation of health-care infrastructure to address preventive rather than curative health care is important. Life expectancy at birth is the highest for countries that have greater public health expenditure per capita and low in countries with high out-of-pocket expenditure.¹⁶ Countries with better health-care systems have lower ischaemic heart disease mortality despite greater burden of risk factors.²⁴ Countries with a greater universal health-care coverage have greater health-care service capacity and access, and have lower smoking and tobacco consumption, blood pressure, lipids, and hyperglycaemia.²⁵ High-quality universal health coverage should focus on ischaemic heart disease prevention.

Social policies

A number of social policies that influence ischaemic heart disease and are related to the environment, urban development, poverty alleviation, and literacy promotion have been implemented in most developed countries.²⁶ The level of implementation is low in most developing countries.^{24,26} The development and implementation of such policy interventions can lead to substantial declines in coronary risk factors and accelerate prevention (table 2). Policies to promote health literacy, reduction of psychosocial stress, modification of social and cultural influences on food and physical activity, creation of better neighbourhood environments, and control of environmental and social stressors are also important.¹¹

Population-level interventions

These interventions shift the Gaussian distribution of risk factors (body-mass index [BMI], blood pressure, LDL cholesterol, and glycated haemoglobin) and have been shown to reduce ischaemic heart disease incidence in prospective studies.²⁷ Population-wide interventions include curbs on smoking, smokeless tobacco, saturated fats, trans fats, salt, sugar, and alcohol; and promotion of healthy diets (including fruits, vegetables, unsaturated fats, and nuts) and physical activity. The US Healthy People Initiative provides an example of population-wide approaches by efforts targeted at communities and public health systems using a multilevel multifactorial approach.²⁸

Smoking and tobacco control

The WHO Framework Convention on Tobacco Control recommends legislating smoke-free environments, availability of cessation services, adequately sized warning labels, plain packaging, and mass media campaigns.²⁹ It has been estimated that reduction of ischaemic heart disease by one-third could be achieved by doubling the inflation-adjusted cost of cigarettes through tripling the excise tax on tobacco in many

Panel: Risk factors of ischaemic heart disease

Social determinants

- Urban and rural infrastructure
- Social organisation, stress
- Illiteracy
- Early life events, maternal and child health
- Work environment, unemployment, job stress
- Transportation
- Social support, cohesion
- Food, agriculture
- Unhealthy food promotion
- Poverty, social exclusion, minorities
- Social patterning
- Sanitation
- Facilities for physical activity, and beneficial health behaviours
- Health-care financing
- Universal health care

Risk factors

- Ambient (outdoor and indoor) air pollution
- Smoking and smokeless tobacco
- Physical inactivity
- Dietary factors (saturated fats, trans fats, refined carbohydrates, and low fruit and vegetable intake)
- High salt intake
- Psychosocial stress, anxiety, and depression
- Alcohol abuse
- Elevated blood pressure and hypertension
- Elevated LDL cholesterol and dyslipidaemia
- Elevated blood glucose concentration and diabetes
- Family history
- Genetic factors

low-income and middle-income countries.^{29,30} Studies have reported steep declines in smoking in regions that have implemented comprehensive tobacco control programmes compared with those that have not.³⁰ A meta-analysis of 17 studies reported that implementation of population-wide smoking cessation policies led to a 10% decline (95% CI 6–14) in the incidence of acute coronary syndromes.³¹ Unfortunately, implementation of these interventions in most countries is poor and less than half of the global population is monitored for tobacco control activities.³⁰

Dietary saturated and trans fats

Guidelines recommend reducing saturated fats and eliminating trans fats in the diet.^{11,12} Relationship of dietary fats to ischaemic heart disease has been extensively evaluated.³² Studies show a modest reduction by decreasing saturated fat, when replaced by a combination of polyunsaturated and monounsaturated fats, with little or no benefit if saturated fat is replaced by carbohydrates.^{32,33} In practice, reducing red meat and

| SDG domain | WHO response | Relevance to IHD prevention |
|--|---|-----------------------------|
| SDG 1 No poverty | Prioritising the health needs of the poor | Highly relevant |
| SDG 2 Zero hunger | Addressing the causes and consequences of all forms of malnutrition | Relevant |
| SDG 3 Good health and wellbeing | Ensuring healthy lives and promoting wellbeing for all at all ages | Highly relevant |
| SDG 4 Quality education | Supporting high-quality education for all to improve health and health equity | Highly relevant |
| SDG 5 Gender equality | Fighting gender inequality including violence against women | Low relevance |
| SDG 6 Clean water and sanitation | Preventing disease through safe water and sanitation for all | Not relevant |
| SDG 7 Affordable and clean energy | Promoting sustainable energy for healthy homes and lives | Relevant |
| SDG 8 Decent work and economic growth | Promoting health employment as a driver of inclusive economic growth | Relevant |
| SDG 9 Industry, innovation, and infrastructure | Promoting national research and development capacity and manufacturing of affordable essential medical products | Relevant |
| SDG 10 Reduced inequalities | Ensuring equitable access to health services through universal health coverage based on strong primary care | Relevant |
| SDG 11 Sustainable cities and communities | Fostering healthier cities through urban planning and cleaner air, and safer and more active living | Relevant |
| SDG 12 Responsible consumption and production | Promoting responsible consumption of medicines to combat antibiotic resistance (or overmedication) | Low relevance |
| SDG 13 Climate action | Protecting health from climate risks and promoting health through low-carbon development | Relevant |
| SDG 14 Life below water | Supporting the restoration of fish stocks to improve safe and diversified healthy diets | Relevant |
| SDG 15 Life on land | Promoting health and preventing disease through healthy natural environments | Relevant |
| SDG 16 Peace, justice, and strong institutions | Empowering strong local institutions to develop, implement, monitor, and account for ambitious SDG responses | Relevant |
| SDG 17 Partnerships for the goals | Mobilising partners to monitor and attain health related SDGs | Relevant |

IHD=ischaemic heart disease. SDG=Sustainable Development Goal.

Table 1: UN SDGs, WHO response, and IHD primary prevention

| | Relevance to IHD prevention |
|---|-----------------------------|
| Social and financial policies | |
| Universal right to education | Highly relevant |
| Job and income guarantee schemes | Relevant |
| Maternal and child health care | Relevant |
| Framework convention on tobacco control | Highly relevant |
| Taxes on cigarettes, tobacco, and sugar-sweetened beverages | Highly relevant |
| Bans on trans fats | Highly relevant |
| Health-care policies | |
| Socialised and state-funded health services (eg, UK NHS) | Highly relevant |
| Universal primary and secondary health care | Highly relevant |
| Health insurance for below-poverty line population | Low relevance |
| Drug price control and free medicine supply in public health system | Relevant |

IHD=ischaemic heart disease. NHS=National Health Service.

Table 2: Examples of social, financial, and health-care policies in low-income and lower-middle-income countries and their effect on IHD prevention

dairy products and increasing intakes of nuts, fish, soy products, and non-hydrogenated vegetable oils increases the intake of unsaturated fatty acids with beneficial effect.³⁴ In the Prospective Urban Rural Epidemiology study,³⁵ intake of each type of fat was associated with a

lower risk of all-cause mortality. Saturated fat intake appeared to be neutral whereas higher intake of unsaturated fats was associated with lower ischaemic heart disease events. An American Heart Association Presidential Advisory concluded that, based on the totality of current evidence, a lower intake of saturated fat coupled with greater intake of polyunsaturated and monounsaturated fat is associated with lower ischaemic heart disease.³⁶ Primary prevention guidelines recommend lowering consumption of saturated fat and replacing it with unsaturated fats, especially polyunsaturated fats, to prevent ischaemic heart disease.¹²

Trans fatty acids from partially hydrogenated vegetable oils have major adverse effects.³⁷ A systematic review reported that policies aimed at reducing trans fats in the food supply are effective and will reduce the burden of related disease.³⁸ People with low socioeconomic status are more exposed to trans fats, especially in low-income and lower-middle-income countries, as foods high in trans fats are cheaper.³⁹ Although all policy approaches (voluntary self-regulation, mandatory labelling, voluntary reduction in restaurants, or their combination) lead to a reduction of dietary trans fats, population-level trans fatty acid bans are the most effective.³⁸

Refined carbohydrates and sugar

Reviews have reported that high consumption of refined carbohydrates is associated with greater risk of ischaemic

heart disease.⁴⁰ A meta-analysis of prospective epidemiological studies observed a dose-response relative risk for ischaemic heart disease mortality of 1.44 (95% CI 1.25–1.65) per 65 g glucose load, and 1.24 (1.12–1.38) per 10 glycaemic index increase.⁴¹ In another meta-analysis of 432 179 participants in eight cohort studies, it was observed that both high and low carbohydrate diets were associated with increased ischaemic heart disease mortality, with minimal risk observed at 50–55% carbohydrate intake.⁴² WHO has recommended that not more than 10% of calories should be from added sugar.⁴³ Guidelines recommend a prudent upper limit of 150 calories per day.^{11,12,44} Imposing tax on refined sugars and sugar-sweetened beverages is an important policy intervention.⁴⁵

Sodium (salt) intake

There is incontrovertible evidence that high dietary sodium is associated with high blood pressure and the relationship is linear.^{46,47} A Cochrane review concluded that a modest reduction in sodium intake causes a significant and important fall in blood pressure in both hypertensive and normotensive individuals.⁴⁸ This review recommended limiting population-wide sodium intake to less than 1.5 g per day from the recommended 2–2.5 g per day. Recent observational studies have reported a U-shaped association of salt intake with all-cause and cardiovascular mortality.^{49,50} Mente and colleagues⁵⁰ reported that, compared with moderate sodium intake (4–5 g per day), a low sodium intake (≤ 3 g per day) was associated with increased risk of cardiovascular events. Lowering sodium intake should be targeted at populations that consume high sodium diets. Both European and US prevention guidelines recommend a reduction in sodium intake, specifying a maximum of 5 g per day, for hypertension management and ischaemic heart disease prevention.^{11,12} A number of policy and community-based interventions exist for promoting sodium reduction in diets.⁵¹ Hyseni and colleagues⁵² compared population-based approaches (community diet counselling, media campaigns, nutrition labelling, and voluntary or mandatory reformulation) and policy interventions (regulatory, fiscal), and reported that multi-component population-based interventions were better.

Food patterns

People eat food and not nutrients, and changes in overall dietary patterns towards a healthy diet from sustainable food systems are important. The diet recommended by the EAT–*Lancet* Commission consists of a diversity of plant-based foods, low amounts of animal source foods, unsaturated rather than saturated fats, and small amounts of refined grains, highly processed foods, and added sugars.⁵³ A Mediterranean diet is one example of such a composition and a meta-analysis of observational studies reported a 10% (95% CI 7–13) risk reduction in cardiovascular incidence or mortality, and an 8% (6–10)

reduction in all-cause mortality.⁵⁴ Evidence from randomised trials is available for Dietary Approaches to Stop Hypertension, French-Mediterranean (Lyon), and Spanish-Mediterranean diets.^{55–57} However, some elements of these healthy diets might be beyond the reach of populations in many low-income and lower-middle-income countries. For example, a 1800 calorie EAT–*Lancet* diet would cost 540 international dollars per year in India.⁵⁸ Studies of low-cost substitute diets are needed.

Alcohol

Harmful use of alcohol is associated with cardiovascular diseases (hypertension, heart failure, stroke), cancer, liver disease, injuries, and mental health problems.⁵⁹ Policy interventions for curbing harmful use are leadership commitment, awareness promotion, marketing restrictions, pricing, addressing informal and illicit production, and continuous surveillance.⁵⁹ Enactment of alcohol control policies is variable across countries and better implementation and monitoring is needed. Despite strong evidence of harm, most guidelines of alcohol control are ambiguous in this regard and should be strengthened.^{11,12}

Physical activity

Systematic reviews and meta-analyses have shown a dose-response relationship between sedentariness and premature mortality.^{60,61} Physical activity levels remain low worldwide.⁶² Hindrances are dominance of motorised vehicles, inadequate number of sidewalks, cycle lanes, and paths, poor street connectivity and street lighting, neighbourhood safety, and poor access to open spaces, parks, and trails.⁶³ Population interventions to improve physical activity need to address the built environment so people can safely enjoy all forms of physical activity.^{63,64}

Ambient air pollution

Outdoor and indoor air pollution have emerged as important risk factors.⁶⁵ The *Lancet* Commission on pollution and health estimated that 9.0 million deaths are directly attributable to environmental pollution, 4.2 million to ambient air pollution, and 2.9 million to the household.⁶⁶ More than 50% of these deaths are due to cardiovascular diseases.⁶⁷ Although the relative risk of ambient particulate matter with a diameter of less than 2.5 μm is small (1.025, 95% CI 1.015–1.036), the magnitude is high as more than 90% of people are exposed.⁶⁸ A number of interventions are available to reduce exposure to air pollution (appendix p 1). Government policies are important to shift to clean fuels (public and household), emission trading programmes, transportation reforms, reduction in traffic emissions, urban landscape reform, and redirection of science and funding.^{66,67} Other interventions include use of face masks and air purifiers, reduction of in-house exposure to outdoor air pollution, home ventilation to eliminate

See Online for appendix

kitchen pollution, and reduction in traffic exposure time.⁶⁷ Legal enforcement backed by technology, targets, and timelines is important but is suboptimal in many large countries, such as India, where harms from pollution are the highest.⁶⁹

Multifactorial population-wide interventions

Systematic reviews of multifactorial interventions have shown major benefits in reducing risks with only small-to-moderate effects on reducing mortality.⁷⁰ A Cochrane review of multifactorial intervention in low-income and middle-income countries concluded that because of inadequate data there is inconclusive evidence of effectiveness.⁷¹ Larger studies with longer follow-up are required.

High-risk clinic-level interventions

Risk assessment

Screening identifies individuals at high absolute risk based on a multifactorial risk assessment. The level of absolute risk requiring intervention varies between countries and depends on capacity of the health services to deliver effective care.⁷² Guidelines recommend absolute risk assessment to guide intensity of interventions.^{11,12} Differences exist in methods of risk assessment between clinical guidelines issued by different regions, countries, and organisations (appendix p 2).^{73,74} Specialised risk prediction models are necessary because risk assessment tools developed for one population might be inaccurate when applied to another.⁷⁵ Clinical tools (eg, SCORE, Framingham) are widely used in Europe and the USA.^{11,12}

| | 2016 European Society of Cardiology guidelines | 2019 American College of Cardiology and American Heart Association guidelines |
|----------------------------|--|--|
| Smoking and tobacco use | No exposure to tobacco in any form; it is recommended to identify smokers and provide repeated advice on stopping with offers to help, by the use of follow-up support, nicotine replacement therapies, varenicline, and bupropion individually or in combination; to stop all smoking of tobacco or herbal products, as this is strongly and independently causal; and to avoid passive smoking | All adults should be assessed at every health-care visit for tobacco use and their tobacco use status recorded to facilitate tobacco cessation; to achieve tobacco abstinence, all adults who use tobacco should be firmly advised to quit; in adults who use tobacco, a combination of behavioural interventions plus pharmacotherapy is recommended to maximise quitting, and tobacco abstinence is recommended to reduce risk |
| Healthy diet | A healthy diet is recommended as a cornerstone of cardiovascular prevention, with a focus on wholegrain products, vegetables, fruit, and oily fish; 30 g unsalted nuts, >200 g fruits, and >200 g vegetables are recommended per day | A diet emphasising intake of vegetables, fruits, legumes, nuts, whole grains, and fish is recommended to decrease risk factors |
| Dietary fats | Diet should be low in saturated fat; saturated fatty acids should account for <10% of total energy intake, through replacement with polyunsaturated fats; transunsaturated fatty acids should be avoided, with preferably no intake from processed food and <1% of total energy intake from natural origins | Replacement of saturated fat with dietary monounsaturated and polyunsaturated fats can be beneficial; intake of trans fats should be avoided |
| Dietary sodium (salt) | <2000 mg per day | Optimal goal of <1500 mg per day; aim for 1000 mg per day reduction in most adults |
| Dietary potassium | Consume fruits and vegetables high in potassium | Aim for 3500–5000 mg per day, preferably by consumption of a diet high in potassium |
| Physical activity | At least 150 min per week of moderate aerobic physical activity (30 min for 5 days per week) or 75 min a week of vigorous aerobic activity (15 min for 5 days per week) or a combination thereof; for additional benefit in healthy adults, a gradual increase in activity to 300 min a week of moderate intensity or 150 min a week of vigorous intensity, or an equivalent combination thereof; this is recommended in all low-risk individuals without any assessment | Adults should be routinely counselled in health-care visits to optimise a physically active lifestyle; adults should engage in ≥150 min per week of accumulated moderate-intensity or ≥75 min per week of vigorous-intensity aerobic physical activity (or an equivalent combination of moderate and vigorous activity) |
| Psychosocial interventions | Multimodal behavioural interventions, integrating health education, physical exercise, and psychological therapy, for psychosocial risk factors and coping with illness | Important for increasing adherence to therapies |
| Obesity | It is recommended that individuals with healthy bodyweight maintain it; and that people who are overweight or obese achieve a healthy bodyweight (or aim for a reduction in weight) to reduce blood pressure, dyslipidaemia, diabetes, and vascular disease | In individuals who are overweight or obese, weight loss is recommended to improve the risk factor profile; counselling and comprehensive lifestyle interventions, including calorie restriction, are recommended for achieving and maintaining weight loss in adults who are overweight or obese; calculating body-mass index is recommended annually or more frequently to identify adults who are overweight or obese for weight loss; it is reasonable to measure waist circumference to identify those at higher cardiometabolic risk |
| Hypertension* | Hypertension is defined by office blood pressure of ≥140/90 mm Hg, ambulatory blood pressure of ≥130/80 mm Hg, or home blood pressure of ≥135/85 mm Hg; important to screen every individual for hypertension (opportunistic screening) and diagnosis confirmed using out-of-office blood pressure measurement; blood pressure control targets of <140/90 mm Hg as initial target and <130/80 mm Hg in all high-risk categories; lifestyle interventions are important; initiate hypertension treatment with two drugs in most people with a single-pill combination; simplified drug treatment algorithm with a combination of angiotensin converting enzyme inhibitor, an angiotensin receptor blocker, calcium channel blocker, or diuretic at initial step; β-blockers used when special indication exists | Hypertension is defined by average blood pressure of ≥130/80 mm Hg, with blood pressure measured at multiple occasions; in adults with hypertension, including those requiring antihypertensive medications, non-pharmacological interventions are recommended to reduce blood pressure—these include weight loss, heart-healthy dietary pattern, sodium reduction, potassium supplementation, increased physical activity with a structured exercise programme, and limited alcohol consumption; in adults with an estimated 10-year risk of ≥10% and average systolic blood pressure of ≥130 mm Hg or average diastolic blood pressure of ≥80 mm Hg, use of blood pressure-lowering medications is recommended for primary prevention; in adults with confirmed hypertension and a 10-year event risk of ≥10%, chronic kidney disease, or diabetes, a blood pressure target of <130/80 mm Hg is recommended; in adults with an estimated 10-year atherosclerotic cardiovascular disease risk of <10% and systolic blood pressure of ≥140 mm Hg or diastolic blood pressure of ≥90 mm Hg, initiation and use of blood pressure-lowering medication is recommended |

(Table 3 continues on next page)

| 2016 European guidelines | | 2019 American College of Cardiology and American Heart Association guidelines |
|--------------------------------|--|--|
| (Continued from previous page) | | |
| LDL cholesterol | In very-high-risk patients the target is <1.8 mmol/L, or a reduction of at least 50% if the baseline is between 1.8 mmol/L and 3.5 mmol/L; in high-risk patients the target is <2.6 mmol/L or a reduction of at least 50% if the baseline is between 2.6 mmol/L and 5.1 mmol/L; in low-to-moderate-risk patients the target is <3.0 mmol/L | In intermediate-risk ($\geq 7.5\%$ to <20% 10-year risk) patients, statin therapy reduces risk of ischaemic heart disease, and in the context of a risk discussion, a moderate-intensity statin should be recommended; in intermediate-risk patients, LDL concentrations should be reduced by $\geq 30\%$; for optimal risk reduction, especially in patients at high risk ($\geq 20\%$ 10-year risk), concentrations should be reduced by $\geq 50\%$; in adults aged 40–75 years with diabetes, regardless of estimated 10-year risk, moderate-intensity statin therapy is indicated; in patients aged 20–75 years with an LDL concentration of ≥ 4.9 mmol/L or higher, maximally tolerated statin therapy is recommended; in adults with diabetes who have multiple risk factors, it is reasonable to prescribe high-intensity statin therapy with the aim to reduce LDL concentrations by $\geq 50\%$ |
| Triglycerides | No target but <1.7 mmol/L indicates lower risk and higher concentrations indicate a need to look for other risk factors | No definite recommendation |
| HDL cholesterol | No target but >1.0 mmol/L in men and >1.2 mmol/L in women indicate lower risk for ischaemic heart disease | No definite recommendation |
| Diabetes | HbA _{1c} <7% (<53 mmol/mol); a target HbA _{1c} of $\leq 6.5\%$ (≤ 48 mmol/mol) should be considered at diagnosis or early in the course of type 2 diabetes; lifestyle changes including smoking cessation, healthy diet, aerobic physical activity, and strength training are recommended | For all adults with diabetes, a tailored nutrition plan focusing on a heart-healthy dietary pattern is recommended; adults should do at least 150 min per week of moderate-intensity physical activity or 75 min of vigorous-intensity physical activity; reasonable to initiate metformin as first-line therapy along with lifestyle therapies to improve glycaemic control and reduce risk |
| Aspirin | Anti-platelet drug therapy is not recommended in individuals without ischaemic heart disease | Low-dose aspirin (75–100 mg orally per day) should not be administered routinely for primary prevention |

HbA_{1c}=glycated haemoglobin. *2018 European hypertension guidelines have been used for blood pressure management.⁸³

Table 3: Risk factor control targets and interventions (class I or IIA recommendations) by the European Society of Cardiology¹¹ and the American College of Cardiology and American Heart Association¹²

Only two risk assessment tools, WHO and GLOBORISK-2, have region-specific charts.^{76,77} INTERHEART risk score has been validated in different regions and populations.⁷⁸ Other strategies are vascular imaging-based tools and polygenic risk scores.^{79,80} Combination of clinical, imaging, and gene-based risk score using artificial intelligence algorithms could be important but need validation.⁸¹

Following risk assessment, shared decision making involving the clinician and patient regarding benefits of treatments, adverse effects, drug-to-drug interactions, and individual preferences is important.⁸² This process individualises the therapeutic approach for a specific patient and varies according to the level of risk and presence of risk enhancers.¹¹ Although a systematic approach to total risk estimation results in better risk factor control for individuals, there is insufficient randomised controlled trial data to demonstrate better clinical outcomes.⁷²

Risk factor control

Overarching recommendations for risk factor control include utilisation of multidisciplinary team-based care, shared decision making, and focus on individual social determinants. Guidelines recommend that all adults at high risk should be assessed for psychosocial stressors and provided with counselling.¹¹ Health literacy should be assessed to maximise effectiveness.¹² Recommended targets and strategies for control of various risk factors by European¹¹ and US¹² guidelines are shown in table 3.

Smoking and tobacco control

A number of individual factors are associated with smoking initiation and continuance—eg, interpersonal influences, social support, age, sex, beliefs, and genetics. In adults who use tobacco, assistance and arrangement for individualised and group counselling are recommended.²⁹ A number of medications are available for smoking cessation including nicotine patch, nicotine gum, nicotine inhaler, nicotine nasal spray, varenicline, and bupropion.⁸⁴

Nutrition and dietary counselling

The EAT–Lancet Commission has advocated a healthy diet from sustainable food systems.⁵³ This diet is high in whole grains, vegetables, fruits, dairy foods, legumes, and nuts, and low in tubers, starchy vegetables, animal sources of proteins, and added fats and sugars. Drivers of poor diet quality are lack of knowledge, lack of availability, price of healthy food, time scarcity, social and cultural norms, marketing and branding, and taste and flavour.⁸⁵ These barriers can be overcome by better education from health-care providers, especially nutritionists and dietitians, focused on individual behaviour change.

Physical activity promotion

Guidelines recommend at least 150 min per week of moderate intensity aerobic physical activity, 30 min per day for 5 days per week, or 75 min per week of high intensity activity.^{11,12} It is important that physical activity education is disseminated at outpatient clinics and

endorsed by health organisations, as well as to identify physical activity barriers and develop self-regulatory skills for lifelong adherence. Self-goal setting, self-monitoring (wearable devices or mobile apps), feedback about progress, evaluation of activity levels, and fresh goal settings are important.⁸⁶

Psychosocial stress management

European guidelines emphasise psychosocial risk factor assessment using clinical interview for identification of possible barriers to lifestyle change or adherence to medication. Workplaces are using wellbeing-focused interventions to promote health.⁸⁷

Overweight and obesity

Counselling for weight loss should include assessment and control for psychosocial stressors, sleep hygiene, and individualised barriers.⁸⁸ Bodyweight reduction leads to beneficial changes in intermediate risk factors but there is insufficient evidence of benefit for ischaemic heart disease prevention in controlled trials.⁸⁹ A number of pharmacological agents have been used in obesity management but are not widely used because of the lack of effectiveness.⁹⁰ Bariatric surgery has emerged as an option for treatment of morbidly obesity and a meta-analysis reported a reduced risk of cardiovascular events and mortality.⁹¹

Hypertension management

Prevention and control of hypertension can be achieved through population-based and targeted strategies.⁹² In most countries, hypertension treatment and control rates are suboptimal.⁹³ Targeted strategy involves interventions to increase awareness, treatment, and control among individuals. Having a usual source of care, minimising therapeutic inertia, and optimising adherence are associated with better blood pressure control.⁹⁴ A collaborative partnership is needed among the patient, provider, and health system, which incorporates a multilevel approach for control of hypertension.⁹⁵ Such approaches are recommended in recent hypertension guidelines.^{83,96}

LDL cholesterol management

Targets for ideal LDL cholesterol for ischaemic heart disease primary prevention in individuals of high, intermediate, and low risk are shown in table 3. Dietary interventions and drugs such as statins are the mainstay of treatment. Recent reviews have highlighted the importance of these drugs in primary prevention.^{97,98} Non-statin lipid lowering drugs can be prescribed in statin-intolerant patients or statin non-responders according to recent guidelines.¹²

Diabetes management

Table 3 shows the guidance on blood pressure and lipid control in diabetes to reduce cardiovascular risk in primary prevention.^{11,12} Control of hyperglycaemia has not been

shown to prevent ischaemic heart disease.⁹⁹ The so-called legacy effect is debatable.^{99,100} Benefits of new drug classes, such as sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide receptor agonists, have been reported in secondary prevention but not in primary prevention.^{101,102}

Aspirin

Recent clinical trials have shown no benefit of aspirin in primary prevention.¹⁰³ Data from these trials, combined with overall data, does not support its use in any category of patients for primary prevention.¹⁰⁴

Adherence, patient empowerment, and personalised medicine

Adherence

Primary prevention involves lifelong adherence to a healthy lifestyle and drug therapies. Studies have reported that in chronic diseases only 50% of patients are adherent to therapies at 12 months and just 20% take medications in the appropriate dose.¹⁰⁵ Several barriers and facilitators to adherence exist (appendix p 3). Outcomes of interventions to promote adherence are limited. Some evidence suggests that technology-based (combination of pills, polypills, and e-messaging), pharmacist-level, and health worker-based interventions are useful.¹⁰⁶ However, long-term effectiveness outcomes require more evidence.

Patient empowerment

An important factor that promotes adherence in ischaemic heart disease primary prevention is self-management of risk.¹⁰⁶ Individual empowerment and motivation is crucial and leads to substantial behaviour change.¹⁰⁷ The basic self-care activities important in ischaemic heart disease prevention are captured by the American Heart Association's Life's Simple-7 slogan, which focuses on smoking cessation, physical activity, healthy diet, and maintaining normal BMI, cholesterol, blood pressure, and fasting blood glucose concentration.¹⁰⁸ Technology-based strategies to promote adherence to healthy lifestyles and drugs are available, and given the universality of smartphone devices the potential for a personalised approach is enormous.^{109,110}

Personalised and genomic medicine

For centuries, physicians have been practicing personalised medicine by listening to and talking with patients, undertaking a careful physical examination, appropriate investigations, and then reaching a diagnosis and prescribing. The US National Cancer Institute defines it as a form of medicine that uses information about an individual's genes, proteins, and environment to prevent, diagnose, and treat disease.¹¹¹ Improved predictive ability of phenotypic and polygenic risk scores has been documented in recent studies,¹¹² but this finding needs to be matched by evidence from randomised

trials that such interventions will reduce the risk of ischaemic heart disease and lead to a healthier life.

Medical education

WHO recommends that physicians should be adequately trained to understand the health needs of people and develop systems for prevention, as well as providing high-quality care for the sick.¹¹³ An action plan for reviewing the medical curriculum to include prevention, along with innovative teaching methods, should be implemented globally. Stakeholders such as governments, medical councils, medical associations, and national and regional networks must all take action in improving teaching of prevention in medical schools.¹¹⁴ Change is especially important in large countries such as China and India, which have the largest ischaemic heart disease burden.¹³ Better physician education and enhancing interdisciplinary care delivery can massively reduce the health and economic burden from ischaemic heart disease.

Training of nurses, allied health professionals, and other health workers in all aspects of preventive medicine should be promoted.^{115,116} Nurses have an important role for assessment and management of unhealthy lifestyles, hypertension, lipids, and diabetes, especially in middle-income and low-income countries.^{117,118} Task sharing with pharmacists for hypertension management has substantially improved adherence to lifestyles and medications.^{119,120} Education of community health workers for prevention is important.¹²¹ In low-income and middle-income countries, where physician shortage is widespread, task sharing with health workers in public education, lifestyle improvement, and medication adherence can lead to better control of risk factors.^{122–124} Health education for the general public for adoption of healthy lifestyles starting in schools and continuing over the life-course is important for primary prevention.^{107,125,126}

Conclusions

Sustainable political, economic, and social policies are central to cardiovascular health. Interventions are best delivered by a health-in-all-policies approach working cross-sectorally within governments. The primordial strategy addresses social determinants of health: illiteracy, poverty, urbanisation, agriculture and pollution, elimination of tobacco, providing heart-healthy foods, discouraging unhealthy foods, and promoting physical activity. Individuals at high risk should be identified through screening and targeted using interventions tailored to their needs and delivered through an interdisciplinary team drawing on expertise of nurses, dietitians, physiotherapists, pharmacists, and other health workers. Personal empowerment through education and technology-based strategies could further reduce the risk of ischaemic heart disease. To prevent is better than to cure, and to wait until people develop ischaemic heart disease is too late for too many.

Contributors

RG developed the theme of the article, created subheadings, obtained references from online medical and personal databases, and wrote the first draft. All the subsequent drafts were written jointly with DAW. RG and DAW have seen the final manuscript and agree to its contents and submission.

Declaration of interests

We declare no competing interests.

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