## Review Article

# Physical Activity and Cardiovascular Health: A Brief Review

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## ABSTRACT

Focus has shifted from cardiovascular risk factors to cardiovascular health and physical fitness. Epidemiological studies have reported that poor cardiovascular health and low levels of physical fitness and physical inactivity are widespread globally, including India. Prospective studies have reported an inverse association of cardiovascular health, physical fitness, and physical activity with cardiovascular events and deaths. Physical fitness can be improved by regular physical activity and prospective studies have reported a dose-response effect. Guidelines recommend regular walking (>30 minutes/day, at least 5 days/week) and muscle-strengthening exercises (>15 minutes/day, 2 days/week). Regular exercise leads to improvement of fitness, improved quality of life, reduction in cardiometabolic risks, inflammation, blood pressure, dyslipidemias and obesity indices, better blood rheology, and decreased cardiovascular and all-cause morbidity and mortality. Multisectoral and multifactorial interventions are crucial in this regard and can be at the level of social determinants, populations, and individuals. Interventions include planned urbanization, healthy climate and healthy nutrition using target-oriented interventions. Population level interventions should use informational approaches, behavioral and social approaches, school-based strategies and environmental and policy approaches, while individual level interventions should focus on behavior change for promotion of physical activity. Use of technology is important.

**Keyword:** Cardiovascular disease, physical activity, physical fitness.

## INTRODUCTION

Cardiovascular diseases (CVD), especially ischemic heart disease (IHD), are epidemic not only in high and upper-middle income countries but also in lower-middle and low-income countries.[1] For years they have been leading cause of premature mortality across the world. It is estimated that by the year 2030, 23.6 million people will die of CVD per year.[2] It is the most important cause of disease burden and deaths in India.[3] CVD and IHD burden is increasing in India in contrast to most developed countries where it is declining.[4,5] The reduction in CVD mortality in developed countries is due to risk factor control (45-75%) and proper treatment (25-55%).[6-8]

IHD is due to a complex interaction of social, behavioral, biological, and genetic risk factors.[7] Studies have identified a range of IHD risk factors that can be addressed at the individual and population levels that include individual-level lifestyle, physical, biological and genetic factors (primary or proximate risk factors), and political, economic, legal, and social determinants of cardiovascular health (primordial or upstream risk factors) (Table 1). Modifiable risk factors are unhealthy lifestyle- smoking or tobacco use, air pollution, physical inactivity, unhealthy diet, alcohol, etc., and biological factors are hypertension, low density lipoprotein (LDL) cholesterol, non-high-density lipoprotein (non-HDL) cholesterol, triglycerides, diabetes, obesity, and abdominal obesity.

The INTERHEART case-control study was the first large international epidemiological study to report that nine (09) common risk factors explain more than 90% of incident acute myocardial infarction (Table 2).[8] The Prospective Urban Rural Epidemiology (PURE) is the first large-scale population based prospective study in developing countries including India. This study has identified that 12 common risk factors are responsible for 85-90% of incident IHD events and mortality (Table 2).[9] In contrast to focus on risk factors, the American Heart Association (AHA) has developed a 7-health factor metrics for

**Table 1: Ischemic heart disease risk factors**

| Social determinants of risk: Upstream factors | Lifestyle and biological proximate factors |
|---|---|
| • Low quality urban and rural infrastructure | • Ambient (outdoor, indoor) air pollution |
| • Social disorganization, stress | • Smoking and smokeless tobacco |
| • Illiteracy | • Physical inactivity |
| • Adverse early life events, maternal and child health | • Dietary factors (saturated fats, trans fats, refined carbohydrates) |
| • Work environment, unemployment, job stress | • Excessive salt intake |
| • Transportation quality | • Low fruit, vegetable intake |
| • Social support, lack of cohesion, isolation | • Psychosocial stress, anxiety, and depression |
| • Food quality, agriculture | • Alcohol abuse |
| • Promotion of unhealthy foods | • Obesity and abdominal obesity |
| • Poverty, social exclusion, minorities | • High blood pressure and hypertension |
| • Poor sanitation | • High LDL and non-HDL cholesterol |
| • Lack of facilities for physical activity, other health promotion behaviors | • Raised triglycerides |
| • Lack of proper healthcare financing | • Lipoprotein(a) |
| | • Elevated glucose and diabetes |
| | • Genetics and genomics |

**Table 2: Risk factors identified as important in the INTERHEART and PURE studies**

| INTERHEART Study | PURE Study |
|---|---|
| High ApoB:ApoA1 ratio | High non-HDL cholesterol |
| Hypertension | Hypertension |
| Tobacco (smoking/smokeless) | Tobacco (smoking/smokeless) |
| Obesity (BMI, WHR) | Abdominal obesity |
| Diabetes | Diabetes |
| Physical inactivity | Low education |
| Unhealthy diet | Low grip strength (frailty) |
| Depression | Household pollution |
| Alcohol | Poor diet |
| | Low physical activity |
| | Depression |

identification of CV health and fitness.[10] This review aims to summarize the epidemiology of cardiovascular health, importance of physical activity, and interventions for promotion of physical fitness among populations and individuals.

## CARDIOVASCULAR HEALTH

According to the latest guidelines of the European Cardiology Society (ESC) CVD prevention, the focus is on the population approach to prevention, on disease-specific interventions, female population, younger individuals, and ethnic minorities with life-course approach to prevention.[2] The focus has also shifted from CV risk factors to CV fitness and health factors. American Heart Association (AHA) developed a 7-point metrics for assessment of CV health which could be used for population-based surveillance and promotion of individual health.[10] The health metrics includes three positive behaviors: (i) non-smoking, (ii) moderate or vigorous leisure-time or work-related physical activity, and (iii) low-fat, high-fruit-vegetable diet. The four biological measures are: (iv) body mass index (BMI) <25 kg/m$^2$, (v) untreated blood pressure (BP) <120/80 mmHg, (vi) total cholesterol <200mg/dl and (vii) fasting glucose <100 mg/dl.[10]

The US National Health and Nutrition Evaluation Surveys (NHANES) reported a gradual increase in health factors from initial surveys in 1999-2010 to the more recent ones.[11] A community-based study in France among 366,270 adults from 1992-2011 (20 years) reported ideal CV health in 3.5% at baseline.[12] This study reported that prevalence of ≥5 ideal CV health factors increased from 6.7% in 1992-96 to 15.0% in 2007-11. The increase was more in younger individuals and was the highest among the most affluent group. A study of more than a million individuals in China reported that prevalence of ideal health factors was in 1.5%, intermediate in 33.9%, and poor in 64.6%.[13]

In the India Heart Watch study, the prevalence of CV health

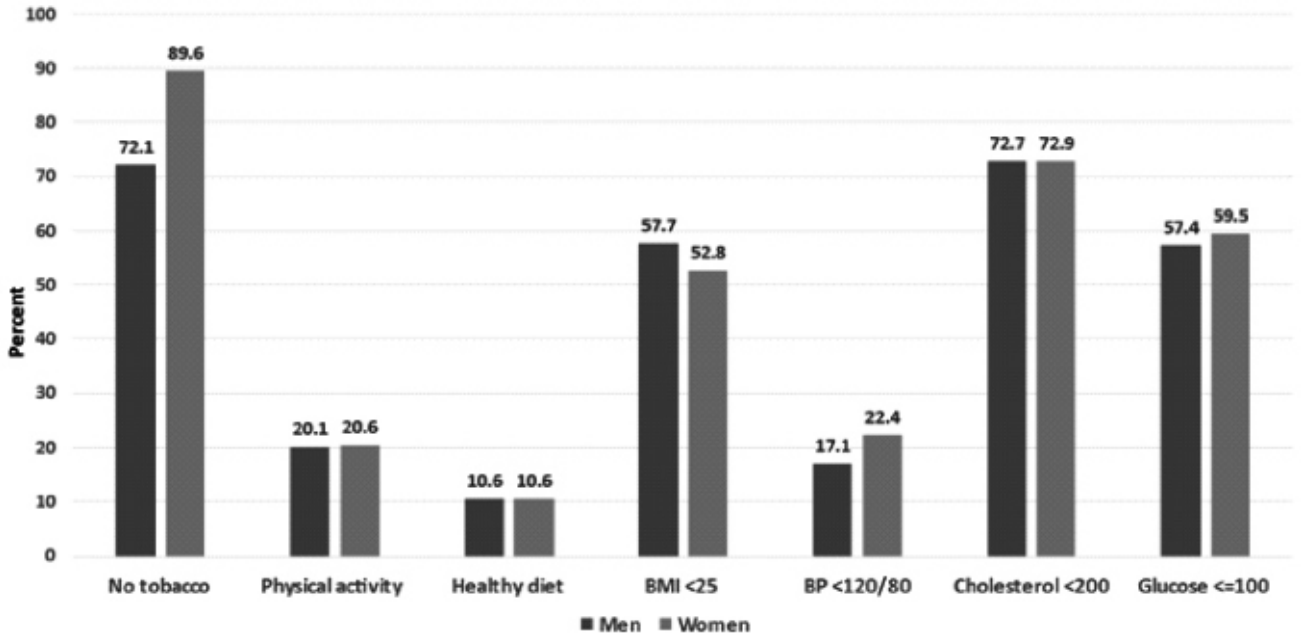


**Figure 1: Prevalence of cardiovascular health factors in India Heart Watch.**

factors was determined in 6198 (men 3426, women 2772) middle-class urban individuals 20-75 years of age in 11 cities across the country.[14] Age adjusted prevalence of CV health factors in men and women, respectively were, no-tobacco use in 72.0 and 89.6%, moderate physical activity in 20.1 and 20.6%, healthy diet in10.6 and 10.6%, normal BMI in 57.7 and 52.8%, normotension in 72.4 and 72.7%, and normoglycemia in 57.4 and 59.3% (Figure 1). Cardiovascular fitness as determined by the AHA metric in men and women was good (≥6 factors) in only a very small proportion (men 3.5%, women 3.6%), average CV health (4-5 factors) was in 34.1% men and 41.5% women while poor CV health (1-3 factors) was in the majority (men 62.4%, women 54.9%). A study in a semi-urban population in Nepal among 2310 participants reported slightly better CV health, compared to our study, with good CV health in 14.3%, intermediate in 67.0%, and 18.7%.[15] Similar data are available from other lower-middle income countries.[16]

A meta-analysis of observational studies evaluated the association between ideal CV health and CV events and reported significant linear dose-response relationship with CV and all-cause mortality.[17] Compared to the most with the least category of CV health, the relative risk of CV mortality in the most healthy was 0.22 (95% CI, 0.11-0.42). The risk decreased by 19% for each point-increase in CV health metric. The study clearly showed that better CV fitness as measured by AHA metric is associated with lower CV events and mortality. Association of individual component of CV health is shown in figure 2. The relative risk of CV and all-cause mortality show that absence of smoking/tobacco, physical activity, healthy diet, lower BP and lower glucose influence CV mortality (Figure 2). Bundy et al[18] used individual-level data from 7 US community based prospective studies (n=30447). Good CV health was identified in 7.3% (CI 6.3-8.3%). It was estimated that, low level of CV health contributed to 70.0% of CVD events and if all US adults achieved good CV fitness, 1.2 million CVD events could be prevented annually.

In the PURE study, we prospectively evaluated importance of traditional risk factors in CVD incidence in high, middle, and low-income countries.[9] Extrapolation of the risk factor data into health-factor data for CV outcomes in high, middle, and low-income countries is shown in table 3. Some of the health-factors (no-tobacco use, normotensive status, non-diabetes status and non-HDL cholesterol <124 mg/dl) have more beneficial associations as compared to physical activity alone. For India (low-income country in the PURE study) being a non-diabetic (-53% risk) and non-hypertensive (-47% risk) were more protective as comp-ared to other risk factors. However, benefits of greater physical activity (-22% risk) were greater than non-smoking (-21% risk) and healthy diet (-12% risk) in this study.

## PHYSICAL FITNESS AND PHYSICAL ACTIVITY

Cardiovascular fitness has traditionally been defined using physical fitness and physical activity based criteria.[19,20]

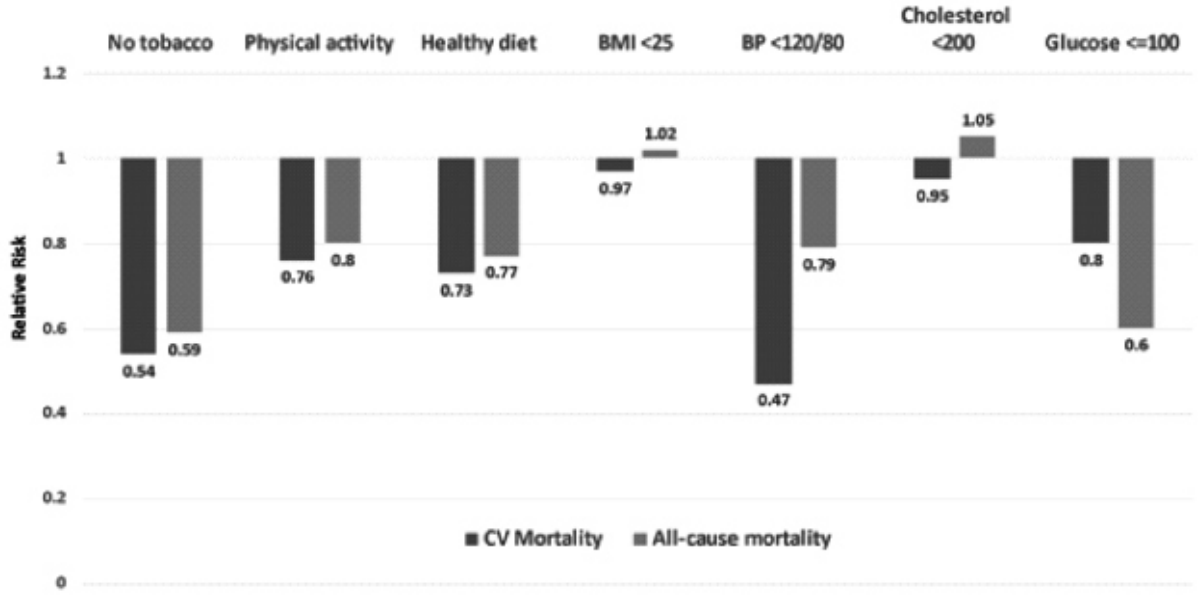


**Figure 2: Association of CV health factors with cardiovascular and all-cause mortality (relative risk as compared to presence of risk factors).[17]**

**Table 3: Health-factors and hazard ratio (95% confidence intervals) for cardiovascular outcomes in high, middle and low-income countries. Counter factuals from PURE Study[9]**

| Health factors | High-income | Middle-income | Low-income |
|---|---|---|---|
| **No tobacco use** | 0.39 (0.29-0.50) | 0.60 (0.54-0.66) | 0.79 (0.64-0.96) |
| **Healthy diet** | 0.90 (0.58-1.39) | 0.88 (0.79-0.98) | 0.88 (0.67-1.14) |
| **Moderate physical activity** | 0.72 (0.53-0.97) | 0.85 (0.77-0.94) | 0.78 (0.64-0.95) |
| **Normal waist-hip ratio** | 0.90 (0.72-1.14) | 0.80 (0.75-0.86) | 0.79 (0.67-0.93) |
| **Non-hypertension** | 0.66 (0.53-0.81) | 0.48 (0.44-0.51) | 0.53 (0.45-0.63) |
| **Non-diabetes** | 0.43 (0.34-0.55) | 0.63 (0.56-0.68) | 0.47 (0.39-0.55) |
| **Non-HDL cholesterol <125 mg/dl** | 0.61 (0.47-0.80) | 0.80 (0.73-0.88) | 0.70 (0.57-0.86) |

Hazard ratios have been calculated by comparing best versus least health status

Physical fitness is due to better physical activity and both isometric and isotonic exercises are helpful.[21] It is important to note that physical activities (PA) and exercise not only maintain physical and psychological health but also help our body to respond to the negative consequences of several diseases such as diabetes, hypertension, cardio-vascular diseases, and respiratory diseases.[22] Exercise is shown to keep other physical functions (respiratory, circulatory, muscular, nervous, and skeletal systems) intact and supports other systems (endocrine, digestive, immune, or renal systems) that are important in fighting any known or unknown threat to our body.[23,24]

## Physical Fitness

Fitness has been defined as the ability to perform moderate to vigorous activity without undue fatigue. While physical activity and fitness are moderately correlated measures, fitness may better reflect an individual's cardiovascular risk profile.[25] A number of measures of physical fitness exist and it is assessed in four key areas: (a) aerobic fitness, (b) muscular strength and endurance, (c) flexibility, and (d) body composition.[26] Physical activity levels are important measures. Association of physical fitness with CV outcomes has been studied only among limited domains of fitness.[21,25]

There have been a number of studies that have evaluated cardiovascular fitness (as estimated by standard cardiac stress test) and CV outcomes.[21] More recently, Mandsager et al[27] performed a prospective study to determine asso-ciation of cardiorespiratory fitness with long term mortality among adults undergoing exercise treadmill test. In this study of more than 122,000 individuals, greater CV fitness was associated with reduced mortality. Compared with individuals who were the most aerobically fit, the risk of mortality was 5-fold higher in those with the least

aerobic fitness. The study involved a median follow-up of 8.4 years and reported that risk-adjusted all-cause mortality was inversely proportional to cardiorespiratory fitness, both, in the highest v/s lowest fitness cohorts (hazard ratio 0.20, 95% CI, 0.16-0.24, p<0.001) and highest v/s moderately high fitness cohorts (hazard ratio 0.77, 95% CI, 0.63-0.95, p = 0.02).[28] A sample of 80,000 participants from UK Biobank study was evaluated for physical fitness using cycle ergometer test in a smaller sub-sample.[25] At median follow-up of 9.9 years, the study reported that the risk of all-cause mortality was 8% lower (95% CI 5-11%, 2670 deaths among 79,981 participants) and CV mortality was 9% lower (95% CI 4-14%, 854 deaths) with each 1-metabolic equivalent (MET) difference in CV fitness.

There are only limited long-term prospective studies that evaluated CV fitness with outcomes in India. In Jaipur Heart Watch,[29] a significantly greater survival was reported in patients with known IHD who did better on treadmill exercise test. Higher exercise duration (≥6 minutes of standard Bruce protocol) was associated with lower cardiovascular mortality at mean follow-up of 6.3 years in a cohort of 335 patients. The crude death rate was 5.73% per year in those with <6 minutes of effort tolerance as compared to 1.17% per year in those with ≥6 minute exercise tolerance (p<0.001). A recent scientific review reported impact of functional capacity and levels of physical activity in post coronary intervention patients.[30] It was concluded that both home-based and clinic-based cardiac rehabilitation programs led to better CV physical fitness as measured by multiple measures. More outcome studies are needed in India. Studies are also required where physical fitness is measured by more stringent criteria of muscle strength, aerobic capacity, flexibility, etc.

A review on cardiovascular effects of yoga and potential role of yoga as a component of comprehensive cardiac rehabilitation concluded that yoga has a providing role as a useful lifestyle intervention that can be incorporated into CVD management algorithm.[31] Yoga based interventions are hypothesized to improve CV fitness via benefits in physical fitness including muscle strength, aerobic capacity and other mechanisms.[31] Yoga-Care trial investigators recruited 3959 post-acute myocardial infarction patients from 24 centers in India.[28] Patients were individually randomized to yoga-based physical activity program (n=1970) and compared to standard care (n=1989). At a median follow up of 22 months, major acute coronary events were lower (not statistically different) in yoga group compared to usual care (hazard ratio 0.90, 95% CI, 0.70-1.15, p=0.41). However self-perceived health was better in yoga-based group. Smaller studies have reported benefit of yoga-based interventions in normal as well as CVD patients in improving physical fitness.[32] Larger studies are needed.

**Physical Activity**

The CVD risk is increased by 1.5 times in people living sedentary lifestyle. Physical inactivity causes 2 million deaths per year and 22% of all ischemic heart disease.[2] Physical activity is defined as any bodily movement produced by contraction of skeletal muscles that increases energy expenditure above resting levels and comprises routine daily tasks such as commuting, occupational tasks, or household activities, as well as purposeful health enhancing movements/activities.[33] Greater physical activity, denoting better physical fitness, is known to be associated with better CV health and reduced CV outcomes.[19-21] It is also associated with longer lifespan, better quality of life, and decreased IHD incidence. Systematic reviews and meta-analyses (based largely on epidemiological studies) have demonstrated a dose-response relationship between sedentariness and premature mortality.[34] The relationships between physical activity and health outcomes are generally curvilinear such that marked health benefits are observed with relatively minor volumes of physical activity.[21,32]

Meta-analyses have reported that physical activity is beneficial in primary as well as secondary IHD prevention.[19,20] Cleven et al[35] performed a review of studies that evaluated influence of physical activity and fitness on IHD incidence. The authors included nine observational studies from 2012-2019. Overall, there was an association between higher levels or amount of physical activity and decreased risk of incident IHD. Seven out of nine studies reported a reduced risk of new onset of IHD with increasing activity levels as compared to low or no physical activity, whereas one study reported decreased IHD risk only for vigorous intensity activity. Two out of nine studies examined the impact of change in physical activity levels over time as predictor variables and failed to detect a significant association with incident IHD.

In the PURE study, an association of recreational and non-recreational physical activity on CVD events and mortality was reported in 17 high, middle, and low-income countries.[32] Participants with pre-existing CVD were excluded and the study reported outcomes in 130,843

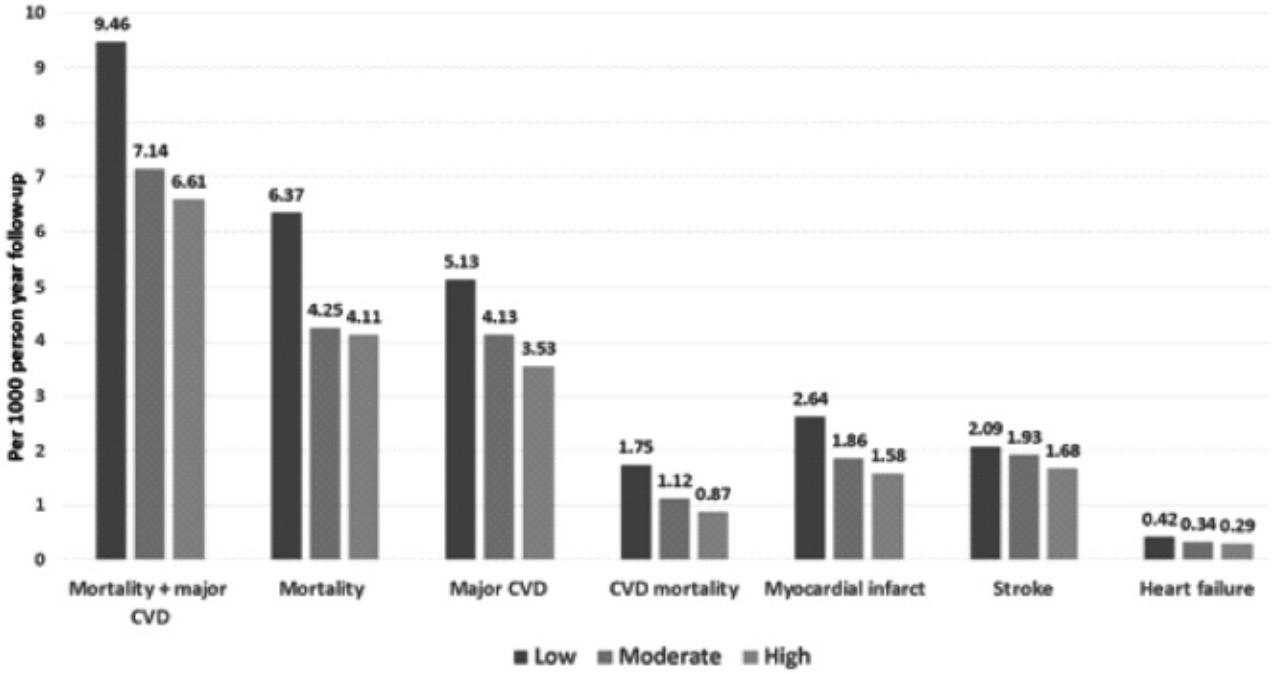


**Figure 3: Influence of low, moderate, and high physical activity intensity on fatal and non-fatal events in PURE Study.**

participants. As compared to low physical activity (<150 minutes/week), participants with moderate intensity (150-750 minutes/ week) and high intensity (>750 minutes/week) physical activity had lower hazard of mortality and major CVD (Figure 3). The hazard ratios were maintained after adjustment for multiple demographic and socio-economic variables. For the combined outcome of all-cause mortality and major CVD events the hazard ratio for high v/s moderate intensity activity was 0.85 (95% CI, 0.80-0.91) and for high v/s low intensity activity was 0.73 (95% CI, 0.68-0.71) ($p<0.0001$). Similarly, hazard ratio for major CVD events for high v/s moderate intensity activity was 0.86 (95% CI, 0.78-0.93) and high v/s low intensity activity was 0.75 (95% CI, 0.96-0.82) ($p<0.0001$). There was a significant dose-response association of physical activity with outcomes to weekly physical activity level of 750 minutes/week, and the benefit did not increase with increasing exercise beyond this level. The study clearly demonstrated CV benefit of physical activity (combined recreational and non-recreational) on outcomes and showed inverse association of physical fitness as measured by physical activity duration in developed as well as developing countries. This is an important message for CVD prevention for India and other South Asian countries.

A meta-analysis reported an increased cardiometabolic risk (hypertension, diabetes, metabolic syndrome, IHD) among inactive South Asian adults. The risk was 34% (range, 10-63%) higher among inactive people compared to those with moderate or higher physical activity.[36] A US Preventive Services Task Force reviewed 88 studies (n= 121190), of benefits and harms of randomized clinical trials of behavioral counselling for primary prevention of CV risk and CV disease and reported small and statistically significant group mean differences in systolic BP, diastolic BP, total and LDL cholesterol and body mass index in intervention cohorts. The long term CV outcomes were not significantly affected by the interventions.[37] On the other hand, an updated review of 94 studies (n=52174) of CVD prevention in individuals with CV risk factors reported significant benefit of physical activity among people with raised BP and lipid levels in reducing cardiovascular events.[38] Regular physical activity is protective and has many benefits: it directly affects the reduction of already existing vascular lesions and reduces other risk factors (reduces body weight, reduces lipid levels, blood sugar, reduces arterial pressure) and thus decreases the incidence of IHD.[25] It reduces the progression of atherosclerosis, protects the patient from oxidative stress, increases insulin sensitivity, decreases the incidence of malignant arrhythmias, balances the vegetative system thereby reducing total as well as CV mortality.[2]

## PROMOTION OF PHYSICAL FITNESS

The most effective approach to improve physical fitness is through increase in physical activity.[39] This can be done by

a number of interventions.[39,40] The WHO and multiple international societies recommend at least 150 minutes of weekly moderate intensity physical activity for promotion of physical fitness.[7,19-21,41,42] Regular exercise is important in both primary and secondary CVD prevention. Before starting the exercise and to determine the intensity of the exercise, it is important to stratify the CV risk to prevent possible unwanted cardiovascular events. ESC guidelines[2] recommend the following:

- Healthy adults of all ages: 2.5-5 hours/week of moderate physical activity or 1-2.5 hours/week of intense physical activity.
- Healthy adults who lead a sedentary lifestyle should be encouraged to start with light exercise intensity.
- Patients with IHD (myocardial infarction, after aortic coronary bypass or coronary intervention with stable angina pectoris, with stable heart failure) need 3 or more times a week moderate to intense aerobic exercise for 30 minutes.
- Patients with coronary heart disease conducting a sedentary lifestyle should begin with light exercise after CVD risk assessment.

A recent US-CDC guidance recommends a combination of aerobic physical activity and muscle strengthening exercise.[41] The interventions could be at the level of society and the individual and involve multiple approaches (Table 4). None of these approaches work in isolation and should be used in combinations to be most effective.[42] WHO has reported that 23% of adults >18 years are insufficiently physically active; women are less active than men and older persons are less active than younger. It has also recommended multi-sectoral collaboration and partnership and focused on comprehensive set of policy options to improve physical activity and fitness.[42] Core physical activity recommendations (gleaned from all the guidelines),[7] are similar to the WHO recommendations and include:

- 30-45 minutes of moderate intensity physical activity, at least 5 days a week, and
- 10-15 minutes of muscle strengthening exercises, at least 2 days/week.

**Social Determinants**

Addressing social determinants and other upstream CVD risk factors (Table 1) is important for promotion of physical fitness with main focus on increased physical activity. Community level hindrances are urban downtown residence, poor access to open spaces, lack of enjoyable scenery and aesthetics, poor street connectivity and street lighting, unsafe neighborhoods, safety of parks and trails, lack of sidewalks, cycle lanes and paths, unruly traffic and low walkability and others.[7,40] We have previously highlighted importance of social determinants' approach to improve population and individual level physical activity.[7] In this context, focus on UN Sustainable Development Goals (Table 4) is important. Promotion of some of the goals (SDG's 3, 4, 11, 13, 15 and 17) need a strong political commitment. Important are planned urbanization, healthy climate, and target oriented interventions. Some of the approaches are listed (Table 4). The modification of each of these goals needs political will, legal action, and bureaucratic implementation to be successful.[7,43]

**Population Level Interventions**

Increasing population levels of physical activity is a public health priority and the WHO aims to reduce physical inactivity by 15% by 2030. Important population-level interventions to improve physical activity are listed in table 4. Few have been modified from US Centre for Disease Control and WHO guidance.[41] The strategies are informational approaches, behavior, and social modification approaches, school-based strategies, and environmental and policy approaches. Focused population-level interventions include advertisements, distribution of flyers, local media, word-of-mouth, and involvement of churches and community centers.[7] Newer modes include e-mails or web-based formats. There could be multi-component interventions.[7]

A systematic review using studies from year 2003-2010 reported that evidence of mass media campaign effectiveness for physical activity was limited.[44] However, a subsequent review reported that quality of evidence had improved with better designed clustered randomized, cohort, quasi-experimental and cross-sectional studies and confirmed usefulness of mass media campaigns for physical activity promotion.[45] Another systematic review of such studies supported the effectiveness of community-based physical activity interventions in high-quality studies, with positive outcomes in approximately half.[34] Most studies reported significant benefits on proximate (activity levels) as well as distal (health benefits) outcomes.

A systematic review and meta-analysis of data of 46 randomized controlled trials involving approximately

**Table 4: Approaches for improving physical fitness**

| Domain | Interventions | Relative Benefit |
|---|---|---|
| **Social determinants** | • Promotion of UN Sustainable Development Goals focused on health and fitness (SDG-3),quality education (SDG-4), sustainable cities, and communities (SDG-11), climate action (SDG-13), healthy land use (SDG-15) and promotion of partnerships (SDG-17).<br>• Planned urbanization: Traffic management, better air quality, and reduced air pollution, outdoor areas free of crime and violence, and provision for parks, sidewalks and sports facilities.<br>• Target oriented interventions: multicomponent, school-based, and short-term (up to six months) interventions, which are primarily focused on adolescents, can promote physical activity in children and adolescents. | +++ |
| **Population level** | • Informational approaches: community-wide and mass media campaigns, short physical activity messages targeting key community sites<br>• Behavioural and social approaches: introducing social support for physical activity within communities and worksite.<br>• School-based strategies: physical education, classroom activities, after-school sports, and active transport to school<br>• Environmental and policy approaches: creation and improvement of access to places for physical activity with informational outreach activities, community-scale, and street-scale urban design and land use, active transport policy and practices, community-wide policies and planning. | ++ |
| **Individual level** | • Social networking to improve activity<br>• Point-of-decision prompts to encourage use of stairs<br>• Individually adapted health behavior change programs<br>• Adoption of transportation and travel policies and practices<br>• Identify personal physical activity barriers and develop long term adherence<br>• Set physical activity goals, self-monitor, evaluate progress and self-correct | +++ |
| **Clinic based** | • Target oriented physical activity and assessment of targets at every visit<br>• Non-physician healthcare worker led programs<br>• Promotion of technology-based measures including use of pedometers and mobility tracker apps in smart phones and smart watches.<br>• Support, encouragement and incentives | +++ |

16,000 participants worldwide were conducted to study the effectiveness of physical activity interventions delivered or prompted by primary care settings. The study concluded that these physical activity interventions increased moderate to vigorous intensity physical activity by 14 minutes/week. Such interventions should be considered for routine implementation to increase levels of physical activity.[46]A systematic review which included randomized controlled trials (RCT) that compared any type of physical activity intervention against a usual-care control in IHD patients. The studies used three main types of interventions, including programs designed to increase physical activity, aerobic fitness and health related quality of life and compared physical activity intervention and control interventions in people with IHD. The authors concluded that although there were only small improvements in CV risk factors and small to no improvements in quality of life, there were no severe adverse events related to the interventions.[47] Comparisons by mode of intervention delivery suggest that interventions delivered through personal contact as well as tailored interventions appeared most effective and that newer approaches (electronic) appeared to add relatively little to intervention effectiveness compared to more traditional ones. The overall effectiveness of community-based physical activity promoting interventions differs by sex, ethnicity and characteristics of study design.[48] Multiple pathways are available to increase physical activity.[40] Population-level physical activity promotion is important but more studies are required for assessing effectiveness of such interventions.

### Individual-Level Interventions

Individual level motivation is the key for promotion of physical activity and fitness. A number of strategies are possible and all involve behavior change (Table 4). Identification of personal barriers is important. Frequently cited barriers include (but are not limited to) lack of time,

lack of enjoyment, reduced self-efficacy, low social support, companionship, safety and a misconception regarding type, intensity, and duration of beneficial physical activity.[49] A greater emphasis should be placed on any form of physical activity and seek support of health practitioners who can guide behavior change interventions.

Some of the interventions include, participation in community wide programs, social networking to support and catalyze physical exercises and individually adapted health behavior change programs (table 4). It is important to identify personal physical activity barriers with the support of physicians, non-physician health workers and the patients themselves to promote long term adherence. Setting of physical activity goals, self-monitor by wearable devices and evaluation of progress are useful. Developing sustained physical activity behaviors are highly dependent on an individual's self-regulatory skill that encompass: (a) an awareness of the goal an individual is trying to accomplish, (b) the ability to self-monitor behavior, (c) acquisition of feedback and information about progress towards each goal, (d) self-evaluation of progress, and (e) ability to correct behavior that leads to progress toward their goal.[50] Physicians and other medical staff are crucial for their support to the individual person and the patients.

**Technology and Personalized Medicine**

Technology is now ubiquitous. It has changed the ways in which medicine is practiced at primary care as well as tertiary care. Use of technology has become more widespread during the COVID-19 epidemic. Technology has led to a new type of personalized clinical approaches to risk detection and risk management.[51] In traditional healthcare paradigm, focus has been on clinical trials to identify useful interventions and then use technology to deliver meaningful healthcare. Widespread availability of medically unproven technologically has turned this approach upside down and currently technology is widely used before its efficacy and effectiveness are established. For example, use of wearable devices and easy availability of personal genetic data have led to availability of big-data of questionable value.[51,52] Whether such data would be useful in preventive medicine or clinical practice awaits further research.[53]

A meta-analysis reported that self-monitoring physical activity through popular technologies contributed to 2500 daily step increase from baseline.[54] Such self-monitoring technological capabilities have been merged with prompts to nudge patients towards better behavior using artificial intelligence algorithms.[49] However, it should be realized that most of the studies of technology-based interventions have been performed over a short-term, 6-12 months, and longer and larger studies are needed to confirm benefits. Enrollment in formal cardiac rehabilitation programs with supervised exercise training, behavioral activation, and

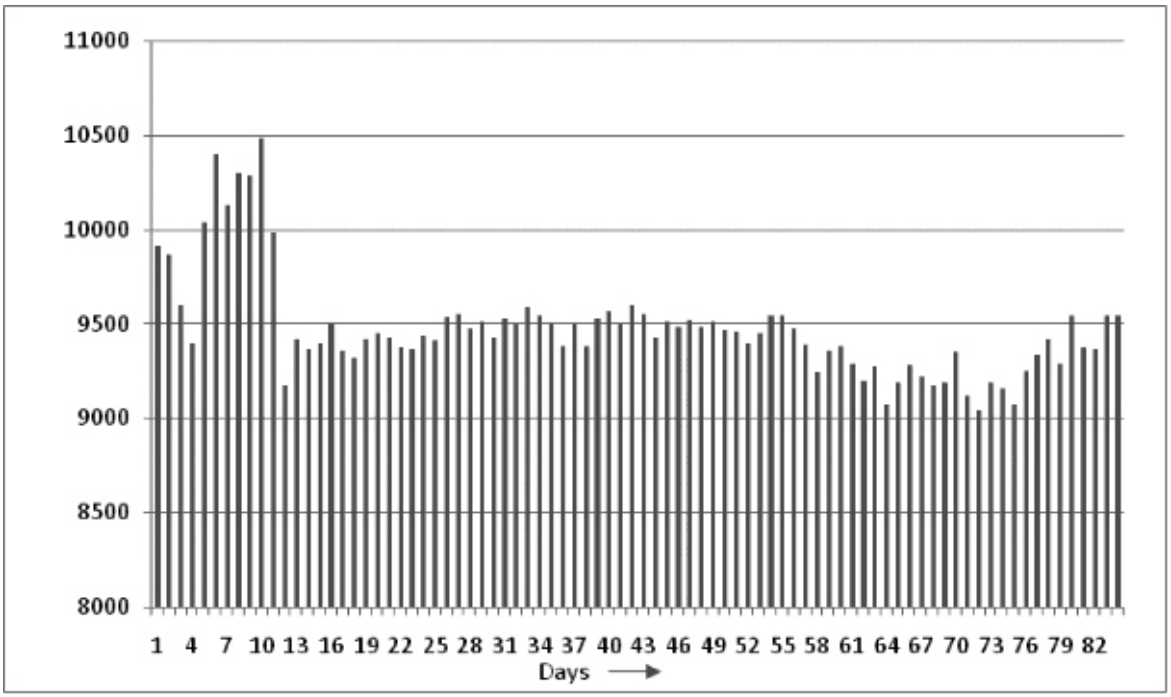


**Figure 4: Real-time data on influence of counselling on step counts/day in a smartphone-based pedometer app in patients with hypertension over a 12-week period (n=192).[58]**

psychosocial support[31], promote physical activity and other health behaviors that reduce secondary events and mortality. The study concluded that technology-based pilot mHealth intervention provides promising results on a pragmatic and contemporary approach to promote physical activity by increasing daily step counts after completing cardiac rehabilitation.[55] Technology could be harnessed to improve physical activity and promote physical fitness around the globe.[56] There is a significant variation of evidence-based interventions in physical activity in different regions of the world.[57] It is recommended that focus on social, environmental, and architectural determinants of physical activity should be combined with appropriate technologies to change behaviors.

We performed a study to explore the effect of moderate intensity physical activity (10,000 steps per day) (Figure 4) intervention using smart phone based pedometer app in patients with hypertension. The intervention resulted in reduction in blood pressure, obesity indices, hyperglycemia, dyslipidemia, and the overall Framingham Risk Score as compared to baseline. These findings have significant clinical implications.[58]

## CONCLUSIONS

Low levels of physical fitness and physical activity are widespread globally.[56] It is also widely prevalent in India.[16] Prospective studies have reported significant association of low physical fitness and physical inactivity with cardiovascular events and deaths. Physical fitness can be improved by regular physical activity. Regular walking and muscle-strengthening exercises lead to multiple benefits for prevention of mortality in general population as well as patients with cardiovascular disease, IHD and heart failure. Regular exercise leads to improvement of fitness, better quality of life, reduction in blood pressure, dyslipidemias, metabolic syndrome, inflammation and obesity indices; better blood rheology and decreased CVD and all-cause morbidity and mortality.[49] Interventions to improve physical fitness should be directed to promote physical activity as well as for muscle strengthening. Multisectoral and multifactorial interventions are crucial in this regard and can be at level of social determinants, populations, and individuals (Table 4). Studies have highlighted the critical role that health professionals in primary care can have in supporting the public to increase their physical activity. Use of technology is important. Personalized approaches that include gene-based specific interventions with technological support need further studies.

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