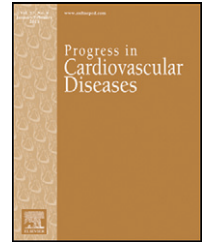




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Running as a Key Lifestyle Medicine for Longevity



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ABSTRACT

Running is a popular and convenient leisure-time physical activity (PA) with a significant impact on longevity. In general, runners have a 25%–40% reduced risk of premature mortality and live approximately 3 years longer than non-runners. Recently, specific questions have emerged regarding the extent of the health benefits of running versus other types of PA, and perhaps more critically, whether there are diminishing returns on health and mortality outcomes with higher amounts of running. This review details the findings surrounding the impact of running on various health outcomes and premature mortality, highlights plausible underlying mechanisms linking running with chronic disease prevention and longevity, identifies the estimated additional life expectancy among runners and other active individuals, and discusses whether there is adequate evidence to suggest that longevity benefits are attenuated with higher doses of running.

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Abbreviations and Acronyms

ACLS = Aerobics Center Longitudinal Study
BMI = body mass index
BP = blood pressure
CCHS = Copenhagen City Heart Study
CHD = coronary heart disease
CI = confidence interval
CRF = cardiorespiratory fitness
CVD = cardiovascular disease
DM = diabetes mellitus
ECG = electrocardiogram
EEE = extreme endurance exercise
HDL-C = high-density lipoprotein cholesterol
HR = hazard ratio
HTN = hypertension
MET = metabolic equivalent
PAF = population attributable fraction
PA = physical activity
RCT = randomized controlled trial
US = United States
WHO = World Health Organization

Regular physical activity (PA) prevents chronic diseases and reduces the risk of premature cardiovascular disease (CVD) and all-cause mortality.^{1,2} There is also some evidence indicating that vigorous-intensity aerobic PA (defined as any activity requiring an energy expenditure of ≥ 6 metabolic equivalents [METs]) could be superior to moderate-intensity aerobic PA (3–6 METs) in reducing the risk of premature mortality.^{3–5} The United States (US) and World Health Organization (WHO) PA guidelines recommend 150 min/wk of moderate-intensity or 75 min/wk of vigorous-intensity aerobic PA (equal to ≥ 500 MET-min/wk).^{6,7} However, self-report data from the 2015 National Health Interview Survey indicate that only approximately 50% of Americans obtain this minimum recommended amount of PA.⁸ This estimate drops dramatically, to

5%–10%, using PA data collected via objective measures.^{9,10}

Running is among the most popular types of exercise and PA in individuals who do engage in vigorous-intensity PA.^{11,12} Running participation has grown throughout the past decade, and it peaked in 2013 when approximately 19 million individuals finished a road race of any distance.¹³ More recent reports from the 2015 race season indicated that there were 17.1 million running participants, and the total number of road races increased by 2300 between 2014 and 2015, suggesting that running remains a popular leisure-time activity.¹³ Running is an attractive mode of exercise for many reasons. Compared with other types of vigorous-intensity sports and exercises, running mitigates many barriers to being physically active. Running is easily accessible and convenient since it does not require a gym membership or specialized equipment or training. Furthermore, even slow jogging is consistently considered a vigorous-intensity PA, so it reduces the time commitment of exercise to reach the recommended levels of PA, which is often cited as the primary barrier preventing people from exercising.^{14,15} Moreover, mounting evidence suggests that running durations below the

recommended guidelines of ≥ 75 min/wk of vigorous-intensity PA offer substantial, and possibly maximal, protections against mortality.^{16,17} Running may confer superior benefits over other types of vigorous-intensity PA, since it is more strongly associated with lower body weights and smaller waist circumferences.¹⁸ Therefore, running may be an ideal exercise modality from both an individual and a public health standpoint.

Longevity benefits of running

There are several large population-based cohort studies, which have examined all-cause mortality and other health outcomes among runners compared with non-runners.^{17,19–22} Overall, these studies found that after adjusting for age and sex, runners have 30%–45% lower risk of all-cause mortality. After further controlling for smoking status, alcohol consumption, socioeconomic variables, body mass index (BMI), and other types of PA, the impact of running on reducing all-cause mortality remains substantial, reducing the risk of premature death by 25%–40%.

Running is protective against both CVD and cancer, the two leading causes of death in most developed countries including the US.²³ The risk of CVD-related mortality is reduced 45%–70% in runners compared with non-runners after adjusting for potential confounders.^{17,19,20,22} Runners also have 30%–50% reduced risk of cancer-related mortality compared with non-runners after adjusting for confounders.^{20–22} Beyond CVD and cancer, there is additional evidence that running may be protective against mortality resulting from neurological conditions, such as Alzheimer's and Parkinson's disease, and respiratory infections.²⁰

Runners also tend to engage in other healthy behaviors that contribute to their increased longevity such as maintaining a normal body weight, not smoking, and consuming light-to-moderate amounts of alcohol.²⁴ Most studies have adjusted their models to account for these confounders.^{17,19–22} However, there is evidence suggesting that it might be important to tease apart the effects of running on mortality relative to each of these covariates rather than simply controlling for them. We found that there was a greater mortality benefit in runners in both patient and healthy populations, smokers and non-smokers, and lean and overweight individuals in stratified subsample analyses of data from over 55,000 men and women aged 18–100 years (Fig 1).¹⁷ The mortality benefits of running were consistent regardless of age, sex, and alcohol consumption. In this large cohort, runners overall had 30% and 45% lower risks of all-cause and CVD mortality, respectively, compared with non-runners, after adjusting for a comprehensive set of potential confounders.

Is running more important for longevity than other lifestyle and health risk factors?

The WHO has reported that 6% of premature mortality is related to physical inactivity.²⁵ Another recent review indicated that physical inactivity causes 9% of all-cause mortality worldwide.¹ Physical inactivity has been cited as the 4th

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