

## Strong Implications But Weak Evidence for Strength Training

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The observation that exercise can improve health and longevity is nearly as old as medicine itself.<sup>1</sup> As early as the 1940s and 1950s, the potential benefits of exercise to prevent cancer were postulated and published by Potter, speaking on the “solutions to the cancer problem,” noting that the answer to cancer prevention may “consist in eating no more than we need and in keeping physically fit.”<sup>2</sup> By the 1950s, the evidence that physical activity reduced the risk of coronary heart disease was ironclad,<sup>3</sup> and in 1972, the American Heart Association began promoting physical activity in its published guidelines.<sup>4</sup> The evidence demonstrating the benefits of physical activity to prevent cancer took hold in the 1960s<sup>5</sup> and then exploded by the 1980s.<sup>6</sup> Recommendations for regular physical activity spread throughout the country after the 1996 report by the Surgeon General on “Physical Activity and Health.”<sup>1</sup> It is now well established that physical activity helps to prevent *both* cardiovascular disease (CVD) and cancer, with essentially all public health, cardiology, and cancer organizations recommending some form of routine physical activity.

However, during the years, the description and categorization of physical activity have been variable. Early on, type of employment and degree of activity typical for each vocation were used as surrogate measures of physical activity.<sup>3</sup> Later research turned to self-reported measures of physical activity, which may, of course, lead to inherent biases.<sup>7</sup> Most recently, wearable technology has been added to studies to obtain more accurate and objective data on duration of physical activity and intensity, often measuring steps walked, stairs

climbed, total aerobic activity, and achieved heart rate.<sup>8</sup> An even more objective measure, cardiorespiratory fitness, retains close correlations with physical activity, yet has stronger correlations with CVD outcomes than physical activity measures alone.<sup>9</sup> Nevertheless, there is no clear consensus on exactly what type of physical activity to recommend, or what the goal of physical activity should be, for any one individual. Although the bulk of research has focused on aerobic activity, major societies present mostly vague recommendations without a clear personalized “exercise prescription” for individuals.

Strength training did not appear in guideline recommendations for the prevention of heart disease until the 1990s<sup>10</sup> and was only added to the National Comprehensive Cancer Network guidelines in 2017.<sup>11</sup> The American Heart Association does recommend strength training (sets of 8–15 repetitions, 2 to 3 times per week in each of the major muscle groups),<sup>10</sup> although this is not the case for many other societies and organizations. Although there is strong evidence supporting aerobic physical activity for the prevention of CVD, cancer, and all-cause mortality, the data to support strength training are not as strong.

Should strength training be promoted with a recommendation of equal strength as aerobic activity? The data to help answer this question are scarce. There are some cross-sectional data to suggest that strength training may have a beneficial effect on some CVD risk factors, like body composition and hypertension, although the magnitude of benefit is small and the benefit on CVD outcomes is not well established.<sup>12</sup> One observational study of adults aged >65 years found that self-reported adherence to strength training guidelines (twice per week) was associated with lower all-cause mortality.<sup>13</sup> A similar result has been shown with objective measures of strength, with high muscular strength showing an association with lower all-cause and CVD mortality,<sup>14,15</sup> although there have been variable results seen with cancer mortality.<sup>15,16</sup>

In this issue of *JAHA*, Kamada et al provide some of the best evidence we have to date on the impact of strength training on mortality in women.<sup>17</sup> This observational epidemiologic study included 39 876 women from the Women’s Health Study. On the 96-month follow-up questionnaire, a strength training question asked the “amount of time per

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week spent in weight lifting or strength training” and time per week spent in other physical activities. The 28 879 women who were free of CVD and cancer at that time point and answered the questionnaire were included in the analysis. Participants were followed up for an average of 12 years for all-cause, CVD, and cancer mortality. The authors calculated relative risks after adjusting for the following covariates: age, trial randomization, race, education, postmenopausal status, hormone use, smoking status, parental history of myocardial infarction or cancer, dietary factors (ie, alcohol, total energy, saturated fat, fiber, and fruit and vegetable intake), screening physical examination, time per week in aerobic physical activity, body mass index, and incident hypertension, high cholesterol, CVD, diabetes mellitus, and cancer.

During follow-up, just 21% of women (6100 women) engaged in any strength training and just 10% (2894 women) spent at least 1 h/wk in strength training. In contrast, almost half of the participants participated in at least 150 minutes of aerobic activity per week ( $n=13\ 702$ ). During an average of 12 years of follow-up, there were 3055 deaths (10.6%), with almost twice as many cancer deaths (748 cancer deaths) compared with CVD deaths (411 CVD deaths). There were 603 confirmed other causes of death, and the rest have not yet been ascertained; however, there was no difference in amount of strength training in this group compared with the group with known cause of death.

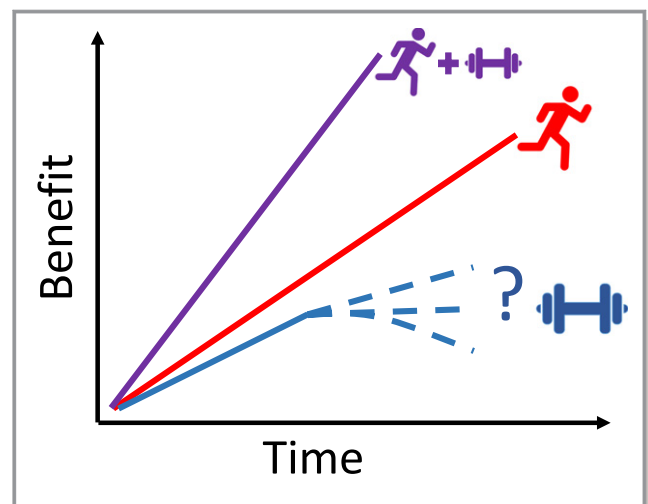
The authors reported a linear association between physical activity and all-cause mortality, consistent with prior literature. In contrast, there was no linear association between strength training and all-cause mortality. Compared with those who did no strength training, those with 1 to 19 min/wk had a 27% lower risk of death (Relative Risk (RR), 0.73; 95% confidence interval [CI], 0.65–0.82), those with 20 to 50 min/wk had a 29% lower risk of death (RR, 0.71; CI, 0.62–0.82), those with 60 to 149 min/wk had a 19% lower risk of death (RR, 0.81; CI, 0.67–0.97), and those with 150 min/wk or more had no difference in risk of death (RR, 1.10; CI, 0.77–1.56). Although there was no linear association between increasing strength training groups and death ( $P=0.36$ ), there was a significant quadratic trend ( $P<0.001$ ). Spline models were fit, which suggested a J-shaped association, with those engaging in some strength training having a mortality benefit (although the CIs are wide) and those engaging in  $>2.5$  h/wk having no benefit or an increased risk of mortality compared with women who did no strength training.

Looking specifically at the relative risk of cardiovascular-specific death, there was a 35% decreased risk of death in women who engaged in 1 to 59 min/wk of strength training compared with those who did none (RR, 0.65; CI, 0.5–0.85), with a similar point estimate of risk. There was no statistically significant difference in those with  $>60$  min/wk of strength

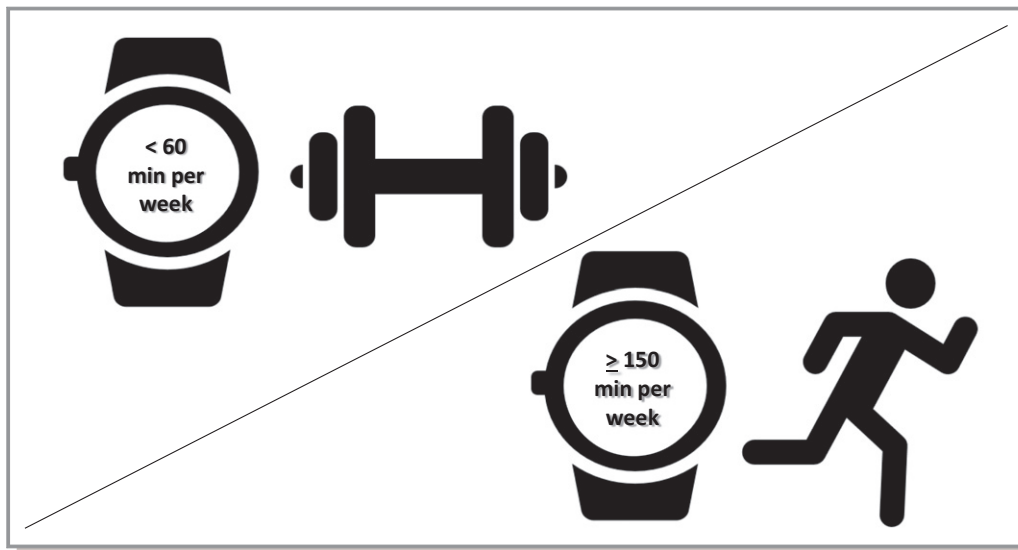
training (RR, 0.72; CI, 0.42–1.22). Like the relationship observed between strength training and all-cause mortality, there was a nonlinear relationship seen with strength training and cardiovascular death, with a decreased risk of cardiovascular death with moderate amounts of strength training but no additional benefit in risk of death with high levels of strength training when compared with those who did no strength training ( $P=0.007$  for the quadratic association). There were no associations observed between time spent in strength training and cancer mortality.

Finally, the authors looked at the combined effect of aerobic physical activity and strength training. Women who engaged in physical activity ( $\geq 150$  min/wk) and any strength training had a lower all-cause and CVD-specific mortality than those women who engaged in physical activity or strength training alone and also compared with those who did neither physical activity nor strength training. This additive benefit was not seen with cancer-related deaths. This relationship between physical activity and strength training is illustrated in Figure 1.

The study by Kamada et al<sup>17</sup> is intriguing in the suggestion that for healthy people, moderate amounts of strength training are better than no strength training but that there might be an amount that is “too much.” It also raises questions about the most appropriate recommendation for the general public. However, there are several limitations to this report. First, strength training was gathered from a *single question* on one questionnaire and is subject to biases inherent in questionnaires. In addition, it is not clear how this simple question corresponds to the current recommendations



**Figure 1.** The benefit of aerobic physical activity increases with time spent engaged in aerobic physical activity. For strength training, some is better than none, but whether there is a benefit of longer time spent in strength training is unknown. Together, the benefits of strength training and aerobic activity are greater than either alone.



**Figure 2.** Recommendations for strength training and aerobic activity.

for strength training (eg, 2 to 3 times a week), and the specific types of strength training activities are also unknown. Second, the total number of fatalities is small, especially at higher amounts of strength training ( $\geq 60$  min/wk), and the CIs are wide, so it is hard to really draw conclusions about the benefits of strength training, even in the moderate group (1–59 min/wk). Is there a real J-shaped relationship here or just fancy statistics? Finally, the population included was all women, and  $>95\%$  of participants were white, so these results may not be fully generalizable.

Overall, the benefits of strength training on mortality are still up for debate, and whether it is important in CVD, cancer, or both is still an unanswered question. On the basis of this research, there may be substantial benefits with low-level strength training both alone and when combined with aerobic activity. We think it is reasonable to continue to recommend that healthy people engage in a small amount of strength training, especially in combination with aerobic exercise, even for other reasons (eg, bone health)<sup>18</sup> (Figure 2). However, it is still premature to suggest a mortality benefit or harm for varying amounts of strength training. It is also still not clear what type of strength training should be done: is adding weights to aerobic activity enough or should resistance training be separate and in addition to another form of aerobic activity? Going forward, the incorporation of more detailed strength training questions and/or data from wearable sensors in cohort and clinical trials may help generate more information on the exposure of interest, and additional serial objective measures of strength may also be helpful in determining the effect of changes in strength training on all-cause and disease-specific mortality. Finally, we applaud the authors for considering CVD and cancer outcomes concurrently. Given the many shared risk factors between the 2

diseases and overlap in risk predictors,<sup>19</sup> it is more important than ever to consider the joint impact one risk factor may have on both diseases.

In conclusion, this is a thought-provoking article on strength training and its potential association with mortality, although the overall strength of the benefit is still not clear. Certainly, it seems that low levels of strength training can be beneficial, with a low threshold (ie,  $<60$  min/wk) associated with benefit. As such, this finding mirrors the physical activity literature, where even low levels of activity are associated with pronounced benefit. Low levels of strength training are likely achievable by many in the general population and could have an even larger impact if combined with aerobic activity.

## Disclosures

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