What is the Optimum Dose of Aerobic Exercise?

Highlights of This Article

1. **Women who exercise at moderate intensity have about double the decrease in mortality rate than women who do vigorous exercise (when compared to sedentary women).**

2. **Men who exercise at vigorous intensity have modestly lower mortality rates when compared to men that exercise at vigorous intensity.**

3. **Women reach their lowest mortality rate when they perform about 8 Met hours per week of moderate intensity exercise.**

4. **Based on research through surveys, men reach their lowest mortality rate when they perform about 8.3 Met hours per week.**

5. **Based on research done by measuring cardiorespiratory fitness, (maximal treadmill test), men's mortality rate continues to decline the higher their Met intensity level is . Even when measured at 14 Mets and higher. Note: There is not enough data on women to determine an upper limit of cardiorespiratory fitness as it relates to mortality rate.**

When I started doing research for this article I thought I was going to find a number of met hours that conveyed the greatest effect on mortality rate reduction for everyone. I was only partially right. The questions I should have been asking are much more complicated and I came to realize that I should have been asking the following: "What is

the optimum dose and *intensity* of aerobic exercise for each *sex* for the greatest effect on mortality rate reduction?" AND "What are the additional benefits (if any) of exceeding this dose? I'm going to address the first question first. As I looked up the research on this subject I found conflicting findings. Then I happened upon a study which I mentioned in my last article on HIIT vs aerobic exercise. This study at least partially explained the conflicting research results.

What was different about this study was that it separated the results of moderate intensity and vigorous intensity AND separated the results for men and women. This study was actually a pooled analysis of 6 studies and involved over 661,000 men and women over 14.2 years. So the statistical power of this study was very high. In fact it had some of the largest numbers I've seen in any fitness related study. The results of this study, for men, and especially for women, could have profound implications on how many choose to exercise and should have been in the headlines. You see it turns out that not all met hours are created equal. There is a difference in the effect on your body for the same met hours done at vigorous intensity and moderate intensity, even though the amount of energy you burn is the same. It turns out for **men**, vigorous intensity exercise, generally defined as 6.0 mets intensity or higher or 70% to 85% of maximum heart rate, has a more powerful effect on mortality rate than does moderate intensity exercise. That fact is not surprising, but what may surprise many is that no matter how much moderate intensity exercise a man does, he can never achieve the same mortality reduction benefits of a man that does about 8.3 met hours a week of vigorous intensity exercise. But even more shocking, and something I've never seen mentioned before, is that for women the opposite is true. That is a women receive their greatest mortality benefit from approximately 8 met hours of *moderate* intensity exercise and no matter how many met hours of vigorous intensity exercise she does, she can never match the mortality reduction benefits of a women doing 8 met hours of moderate intensity exercise. At least that's what would be the conclusion of anyone that reads this study.

The men achieved a mortality reduction of 31% (or what researchers call a hazard ratio (HR) of 0.69) doing between 7.5 and 15 vigorous intensity met hours a week. While the best the male moderate intensity groups could do was a mortality reduction of 27% (hazard ration 0.73) for doing substantially more met hours in the 15 to 30 met hour group. Since moderate exercising takes longer, it would take

them 3 to 4 times as many total hours and they still wouldn't match the mortality reduction of the vigorous intensity group. The good news here for male moderate exercisers is that even the 7.5 to 15 group still achieved substantial reduction in mortality at 23% (0.77 HR). By far the greatest mortality reduction per met hour was achieved by the first group who did between 0.1 to 7.5 met hours and achieved a reduction of 24%. For the women doing moderate intensity between 7.5 and 15 met hours, they achieved a mortality reduction of 32% with no significant reductions in the higher met hour groups. While the female vigorous exercisers achieved only a 17% reduction (nearly half) for the lowest met hour group with no significant differences for the higher groups, with no significant differences in mortality between the other female vigorous intensity met hour groups.
You can see the full results below:

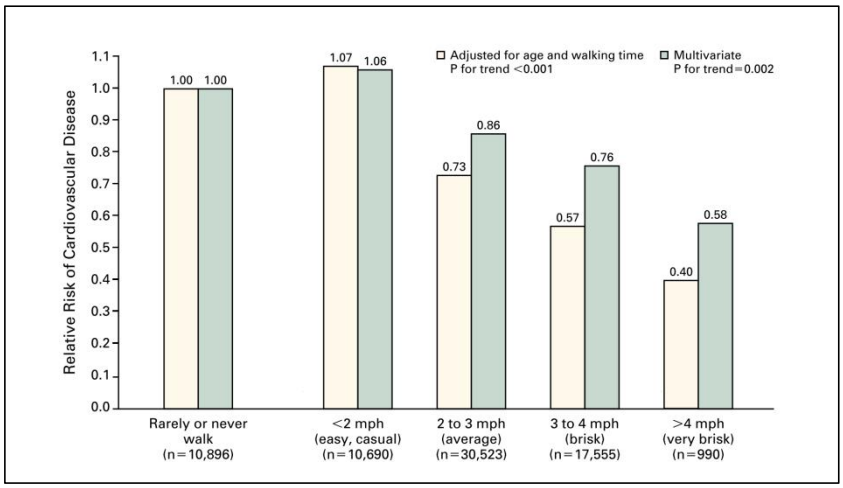
Table 2. LTPA and Mortality by Activity Intensity in 108 902 Men and 239 823 Women[a]

	LTPA Level, MET h/wk				
Intensity of Activity	0	0.1 to <7.5	7.5 to <15.0	15.0 to <30.0	≥30.0
Moderate					
Participants, No. (%)	53 376 (15.3)	122 522 (35.1)	100 687 (28.9)	59 304 (17.0)	12 836 (3.7)
Deaths, No. (%)	8359 (18.2)	16 203 (35.2)	11 667 (25.4)	8054 (17.5)	1696 (3.7)
Age-adjusted HR (95% CI)[b]	1.00	0.70 (0.68-0.72)	0.62 (0.60-0.64)	0.63 (0.61-0.65)	0.63 (0.60-0.67)
Fully adjusted HR (95% CI)[c]	1.00	0.80 (0.78-0.83)	0.73 (0.71-0.75)	0.71 (0.68-0.73)	0.72 (0.68-0.76)
Men	1.00	0.84 (0.81-0.87)	0.77 (0.74-0.80)	0.73 (0.71-0.76)	0.74 (0.69-0.79)
Women	1.00	0.76 (0.73-0.80)	0.68 (0.65-0.71)	0.67 (0.63-0.70)	0.69 (0.64-0.75)
Vigorous					
Participants, No. (%)	243 598 (69.9)	55 160 (15.8)	23 792 (6.8)	10 816 (3.1)	15 359 (4.4)
Deaths, No. (%)	40 229 (87.5)	3525 (7.7)	638 (1.4)	892 (1.9)	695 (1.5)
Age-adjusted HR (95% CI)[b]	1.00	0.75 (0.73-0.78)	0.72 (0.67-0.78)	0.71 (0.67-0.76)	0.72 (0.67-0.78)
Fully adjusted HR (95% CI)[c]	1.00	0.80 (0.78-0.83)	0.77 (0.71-0.84)	0.78 (0.73-0.83)	0.79 (0.73-0.85)
Men	1.00	0.78 (0.75-0.82)	0.69 (0.61-0.78)	0.72 (0.66-0.79)	0.77 (0.70-0.85)
Women	1.00	0.83 (0.79-0.88)	0.85 (0.77-0.94)	0.86 (0.78-0.94)	0.81 (0.72-0.91)

What this means for Women:

The mean met hours for each group was not given. However, lets estimate the mean to be close to the max at 6.0 (for the 0.1 to 7.4 group) to be sure we don't underestimate the average met hours. This means that each met hour reduced mortality by 4%. Assuming that the average decline continues at the same rate would mean that women would reach their lowest mortality reduction with just 8 met hours a week of moderate intensity exercise of 1.14 met hours a day. That means if women did a high end moderate exercise of 5.5 met intensity like very brisk walking, they could achieve this in about 15 minutes a day! This assumes reaching your met intensity level in

about 2.5 minutes or less or a heart rate between 65% to 70% of your maximum. The reason I suggest the intensity on the high end of moderate is because several studies support this speed for the lowest mortality rate. According to this study on women the very brisk walkers had the lowest mortality rate. While this study also showed lower mortality rates for the women that did vigorous exercise I would not read too much into this. In this study vigorous exercise was loosely defined as anything that made you sweat and made your heart beat fast and was limited to women women 50 to 79 years of age. Below is the walking speed graph.



This is not the only study that shows this difference. In this study on women and coronary heart disease, the women that walked just 60 to 90 minutes a week had lower levels of CHD than women that burned 500 calories or more on vigorous activities per week. With the women walking at least 3 mph achieving the best results. In still a fourth study in the UK involving 1.1 million titled "Frequent Physical Activity May not Reduce Vascular Disease Risk as Much as Moderate Activity" researchers found that moderate activity was superior to vigorous activity in reducing the occurrence of most of the 8 vascular types of illnesses they examined, including coronary heart disease. In still a fifth pooled study in the UK on both men and women which examined the effect of walking pace on mortality, once again brisk walkers had the lowest mortality rate.

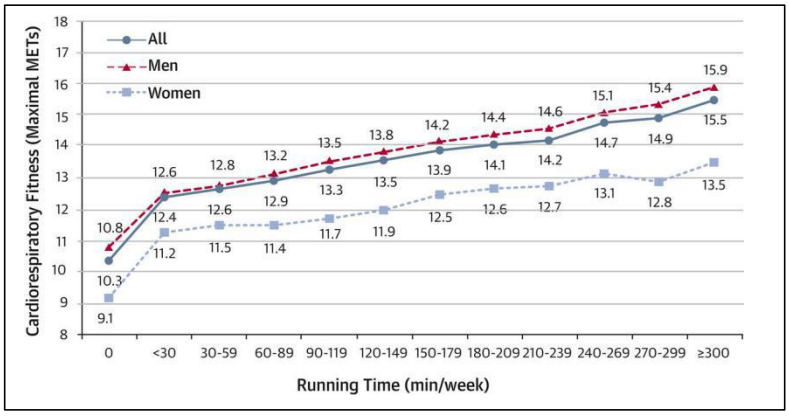
So we have 5 studies which show a remarkable consistency in showing moderate aerobic exercise is better for women than vigorous. With a the sweet spot for intensity being on the high end of moderate or around 4 mph walking speed. Or perhaps a better guide for intensity

would be using 65% to 70% of your max heart rate since this could apply to all ages. With moderate intensity exercise this is easily achievable once you are reasonably fit. In fact, since you are walking you could easily bring your morning cup of coffee (or your favorite morning beverage) with you while you get in your exercise and your daily vitamin D requirement all in 15 minutes a day! Fifteen minutes a day is something nearly everyone has time for and by making it part of your morning routine you much more likely to stick to it.

What this means for Men:

As for men, the choices become a little more complicated if you wish to avoid high impact exercises like running. Since you need to do vigorous exercises to achieve the optimum dose for mortality reduction. Non-running men's best choices are the elliptical at the gym or buying a very high quality elliptical at home. I'm going to post a detailed analysis on ellipticals in a future article so check back. As far as Met hours for men, using the same statistical technique I used for the women, men achieve maximal mortality rate reduction with 8.5 Met hours per week. That's equal to running only about 5.5 miles per week for a 160 pound man. In fact that's almost exactly what another study at the Cooper clinic found. In that study the the lowest mileage runners had about the same mortality rate reduction as all the higher mileage runners. While the study had the lowest mileage runner group as those that ran between 0.1 and less than 6 miles, I find out through other sources that the lowest mileage runners actually averaged about 5 miles per week. So we have 2 major long term studies which show about 8.5 Met hours per week maximizes mortality benefits.

In the study at the Cooper Clinic mentioned above, they also tested the aerobic fitness (expressed in max Met intensity) of the participants and found that the more they ran the greater their aerobic fitness. But they did not find lower mortality rates for the higher mileage runners. Here is the graphic below:



When I first saw the chart above I thought there was a direct conflict with some of Cooper's other studies that show a direct linear correlation between Vo2 max and mortality rates (**note: Met intensity levels are calculated by dividing Vo2 max by 3.5**). Then I saw Cooper's charts below which show the fitness rating by Vo2 max and age. When you compare the 40 to 49 age column (the median age of the subjects in the study) you will see that the men running less than 30 minutes a week (the least amount above zero) achieve an excellent rating. Even more amazing was the women in the same age and time group received a **superior** rating. This could explain why the Cooper study saw no additional mortality benefits in higher mileage runners. The lowest mileage runners were already at or just below the highest Vo2 max rating. This is an incredible realization that so little aerobic exercise can produce such great increases in Vo2 max.

Men's VO2 Max

Rating /Age	20-29	30-39	40-49	50-59	60+
Superior	>52.4	>49.4	>48	>45.3	>44.2
Excellent	46.5-52.4	45-49.4	43.8-48	41-45.3	36.5-44.2
Good	42.5-46.4	41-44.9	39-43.7	35.8-40.9	32.3-36.4
Fair	36.5-42.4	35.5-40.9	33.6-38.9	31-35.7	26.1-32.2
Poor	33-36.4	31.5-35.4	30.2-33.5	26.1-30.9	20.5-26
Very Poor	<33	<31.5	<30.2	<26.1	<20.5

Women's VO2 Max

Rating /Age	20-29	30-39	40-49	50-59	60+
Superior	>41	>40	>36.9	>35.7	>31.4
Excellent	37-41	35.7-40	32.9-36.9	31.5-35.7	30.3-31.4
Good	33-36.9	31.5-35.6	29-32.8	27-31.4	24.5-30.2
Fair	29-32.9	27-31.4	24.5-28.9	22.8-26.9	20.2-24.4
Poor	23.6-28.9	22.8-26.9	21-24.4	20.2-22.7	17.5-20.1
Very Poor	<23.6	<22.8	<21	<20.2	<17.5

The Case Doing More Aerobic Exercise

The above recommendations are based on studies using questionnaires about peoples exercise habits. However there is other research that correlates mortality rates and aerobic fitness as determined by a treadmill maximal exercise test. Several studies like this one for both men and women and this one on men only, found a direct linear correlation between the decrease in mortality rates and the level of aerobic fitness. However when looking closely at these 2 studies and converting the max Met intensity levels to Vo2 max (to correlate them with the chart above), I found that the minimum level to qualify for the second highest category in the study fell into the third highest (Good) category in the Vo2 max chart. So these 2 studies don't correlate well with the Cooper Vo2 max chart. While the studies showed lower mortality rates in the top fitness category, the next highest category was to broad, (encompassing both the good and excellent category) to draw any conclusions as to the upper limit of mortality benefits as it relates to Vo2 max.

However a third study on men showing reduced mortality even at met intensity levels of 14 and greater (Vo2 max of at least 49) and above, across all age groups of 30 years or more. (note the first 2 studies didn't measure mets that high). This study is much more closely correlated to the Vo2 max chart, hence it's good evidence that Vo2 max level even above the superior level may reduce mortality even further than the excellent level. By comparing these studies to the chart above, we can estimate the amount of time achieving these levels takes for a man doing vigorous exercise to achieve the greatest mortality reduction. That works out to about 150 minutes a week of running. Amazingly, assuming the average man in the Cooper study averaged about 6 mph, that would work out to be exactly 15 miles per week (or just over 23 Met hours for a 160 pound man). That's the same mileage that Dr. Cooper wrote in his classic book (The Aerobics Way to Total Well Being) was the

limit to the health benefits you can achieve from running. In my experience, I would have to agree. With the main benefit of running more than 15 miles a week being greater weight loss.

For **women,** the only study I could find regarding this gives the Met Intensity benefits for each age in the chart below. However, the Elite group (when compared to the high group) only saw mortality benefits in the 60 and older age ranges. Other than that, there is little evidence of additional mortality benefits a higher V02 max over that of the superior category for women. However, a serious lack of studies regarding this means a solid conclusion cannot be determined. Specifically, a study on the effects of much higher Met intensity levels in women and their effect on mortality.

Table 2. Classification of Cardiorespiratory Fitness by Age and Sex[a]

	Performance Group				
Age, y	Low	Below Average	Above Average	High	Elite
Women					
18-19	<10.0	10-11.0	11.1-12.9	13-14.9	≥15.0
20-29	<8.0	8.0-9.9	10-11.4	11.5-14.2	≥14.3
30-39	<7.7	7.7-9.3	9.4-10.8	10.9-13.6	≥13.7
40-49	<7.4	7.4-8.9	9.0-10.3	10.4-13.2	≥13.3
50-59	<7.0	7.0-8.0	8.1-9.9	10.0-12.9	≥13.0
60-69	<6.0	6.0-6.9	7.0-8.4	8.5-11.0	≥11.1
70-79	<5.0	5.0-5.9	6.0-6.9	7.0-9.9	≥10.0
≥80	<4.4	4.4-5.4	5.5-6.2	6.3-8.3	≥8.4
Men					
18-19	<10.8	10.8-12.9	13.0-13.9	14-16.2	≥16.3
20-29	<10.3	10.3-11.9	12.0-13.6	13.7-15.6	≥15.7
30-39	<10.0	10-11.1	11.2-12.9	13.0-14.9	≥15.0
40-49	<9.8	9.8-10.9	11.0-12.4	12.5-14.6	≥14.7
50-59	<8.2	8.2-9.9	10.0-11.3	11.4-13.9	≥14.0
60-69	<7.0	7.0-8.4	8.5-9.9	10.0-12.9	≥13.0
70-79	<6.0	6.0-6.9	7.0-8.4	8.5-11.4	≥11.5
≥80	<5.1	5.1-6.2	6.3-7.2	7.3-9.9	≥10.0

[a] Ranges are given in metabolic equivalents, with 1 metabolic equivalent equaling 3.5 mL/kg per minute of oxygen consumption. Classification (percentile range) is as follows: low (<25th percentile), below average (25th-49th percentile), above average (50th-74th percentile), high (75th-97.6th percentile), and elite (≥97.7th percentile).

However there are other benefits of doing more cardio over and above a longer life. This study (as described on webmd.com) showed a much larger decrease in Alzheimer disease for runners that logged more than 15.3 miles a week than for those that averaged less. Though from what I could discern this statistic was not adjusted for other factors. Also, for those seeking to lose weight, more cardio is no doubt superior to less. In this study on telomere length and amount of physical activity the authors found that women had to have at least 1375 met minutes a week and men at least 1887 in order to significantly shorten their telomeres. In addition, though not usually associated with it, this study shows that certain types of aerobic exercise, especially cycling, led to muscle hypertrophy when done in higher volumes. But perhaps the best argument for doing more cardio is simply the way it makes you feel. When I was in my 20's and running

15 miles a week I don't think I could have felt any better. I felt supercharged and I doubt I would have felt as good doing doing much less nor do I think I could have felt much better doing more. In Dr. Cooper's classic book "The Aerobics Way to Total Well Being", he states that anyone running more than 12 to 15 miles a week is doing so for something other than their health. In my experience, I would have to agree. With the main benefit of running more than 15 miles a week being greater weight loss. You will also probably find yourself thinking more clearly, being calmer, more relaxed, and sleep better.

Can Too Much Aerobic Exercise Reverse the Benefits?

In a word NO. Some years ago there were a lot of headlines claiming that running more than 20 miles a week reversed the benefits and even claimed mortality rates similar to sedentary people. These were based on flawed research and has since been proven false. In fact even doing 10 times the recommended guidelines has not shown a negative effective. The only real dispute is if there are any added benefits.

Conclusion

So where does all this info lead us?

For women doing just 15 minutes a day of high end moderate exercise (65% to 70% max heart rate) seems to lead to the greatest reduction in mortality rates. Doing more than this, if you have the time and desire, will probably lead to increased energy and a greater "feeling of well being", (as Dr. Cooper puts it) and possibly other benefits. However, except for women in their 60's there is no evidence at present that increasing your weekly Met hours over those discussed above will decrease mortality.

Men need to do *vigorous* exercise (between 70% and 85% of max heart rate) for about 8.3 met hours to receive the full benefits in mortality rate reduction. Running at just 5 mph (or the equivalent in a different vigorous exercise) has a met intensity of 8.3, so this can be

achieved in just 1 hour a week. Or just 20 minutes 3 days a week (plus warm up time). If you feel, as I do, that more than this will contribute to more energy and an enhanced sense of well being, as well as possibly other benefits, than aim for 2.5 to 3 times this amount (12 to 15 miles a week for runners).
Increasing your Vo2 max to the superior and above may have greater mortality benefits.

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