Quantile Differences in the Age-Related Decline in Cardiorespiratory Fitness Between Sexes in Adults Without Type 2 Diabetes Mellitus in the United States

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Abstract

Objective: To comprehensively assess the extent to which the decline in cardiorespiratory fitness (CRF) with age differs between sexes.

Participants and Methods: This study used data from the Aerobics Center Longitudinal Study, conducted between September 1974 and August 2006, consisting primarily of White adults from middle-to-upper socioeconomic strata restricted to adults without type 2 diabetes mellitus (33,742 men and 9,415 women). Quantile regression models were used to estimate the differences in age-associated changes in CRF between the sexes, estimated using a maximal treadmill test.

Results: For adults aged up to 45 years, significant differences in slopes relating to age and CRF between men and women were observed for all adjusted percentiles of CRF other than the 90th percentile; women reported significantly greater declines in CRF per year. For those aged 45-60 years and those older than 60 years, no significant differences in age-related declines in CRF were observed between the sexes.

Conclusion: This study found that compared with men, the onset of decline in CRF was found to occur earlier and at lower CRF percentiles in women. This is of particular concern, given that compared with men, women already tend to have lower CRF levels. These findings suggest that maintaining the levels of physical activity sufficient to maintain moderate-to-high levels of fitness is particularly important for women earlier during adulthood.

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The older population in the United States has been increasing steadily since the 1990s, with the proportion of older Americans expected to continue to grow in future years.[1] Maintaining adequate levels of physical activity and cardiorespiratory fitness (CRF) is particularly important for adults throughout the aging process because previous studies have reported that higher CRF levels reduce the risk of many noncommunicable diseases (NCDs) and mortality among US adults.[2-4] In addition, maintaining adequate CRF through participation in regular physical activities may positively impact the ability of older persons to live independently.[5]

Many studies have reported that CRF declines with age.[6,7] This decline in CRF may be partially explained by age-related reductions in cardiovascular function, subsequently increasing the prevalence of NCDs from middle-aged and older adults. However, CRF can be enhanced through participation in moderate or vigorous physical activities,[8] and consistent evidence has indicated that attaining higher CRF levels, preferably earlier in life, may diminish this age-related decline and possibly prevent or delay the onset of NCDs.[9-11]

Previous research has suggested that on average, the trajectory of age-related decline in CRF begins at or near 40 years of age.[12] However, a recent study of adult men in the

United States using quantile regression reported important differences in the age-related decline in CRF across adjusted CRF percentiles, including changes in the trend of the association between upper and lower percentiles.[13] Specifically, for men younger than 45 years without type 2 diabetes mellitus (T2DM), the expected significant age-related decline in fitness was observed only among highest-fit men (ie, 90th percentile of CRF), whereas a significant positive association was observed at the lower-to-middle adjusted CRF percentiles up to and including the median. Encouragingly, this suggests that for men with the lowest CRF levels and, correspondingly, those most at the risk of adverse health outcomes, the onset of a significant age-related decline in fitness occurs in the fifth decade of life. However, the extent to which these differences in the magnitude of and trend in age-related decline in fitness may exist in women has not been investigated. Given the accelerated age-related decline in CRF observed in men with T2DM[13] and the relatively small number of observations among women with T2DM in the study sample, only observations from participants without T2DM were included in this study. Considering that CRF is importantly and directly impacted by physical activity patterns and that physical activity is difficult to estimate objectively,[14] this study focused on assessing the changes in CRF with age. Thus, the purpose of this study was to evaluate the differences in age-related decline in CRF between sexes using quantile regression. Quantile regression is a comprehensive statistical method, which has allowed for a thorough analysis of the association between age and CRF for both sexes across many adjusted CRF percentiles.[15-17]

PARTICIPANTS AND METHODS

Study Population

The Aerobics Center Longitudinal Study is a prospective observational study of individuals who underwent comprehensive medical examinations at Cooper Clinic in Dallas, Texas.[18] The study participants came to the clinic for periodic preventive health examinations and for counseling regarding diet, exercise, and other lifestyle factors associated with an increased risk of chronic disease. Between 1974 and 2006, the participants underwent at least 1 comprehensive medical examination and maximal graded treadmill exercise test at the clinic. Most study participants were non-Hispanic White from middle-to-upper socioeconomic strata. Participants with self-reported cardiovascular disease or cancer were excluded from the analysis. The study was reviewed and approved annually by the Cooper Institute Institutional Review Board, and all participants provided written informed consent. The data set used for the current study included 33,742 men (71,371 observations; average visits, 2.88) and 9415 women (13,478 observations; average visits, 1.69).

Measures

The comprehensive health evaluation is described in detail elsewhere.[19,20] The outcome of interest in this study was CRF, which was estimated using a maximal treadmill exercise test on the basis of a modified Balke protocol.[21] Participants for whom the test was stopped by a physician because of problematic signs and symptoms or those who failed to reach 85% of the age-predicted maximal heart rate were excluded from analyses (n=1037) to ensure that near-maximal effort was achieved. The maximal oxygen consumption ($\dot{V}O_{2max}$), scaled to lean body mass was estimated from the final treadmill grade and speed using the Fitness Registry and the Importance of Exercise National Database equation: [(speed · 0.17) + (speed · grade · 0.79) + 3.5].[22] The body composition was assessed using hydrostatic weighing, the sum of 7-site skinfold measurements, or both after a standard procedure and is described in detail elsewhere.[23] The fat mass (in kilograms) was calculated as weight (in kilograms) × (percent body fat)/100. The lean body mass was calculated as weight − fat mass. The smoking status (current smoker or not) was determined using a standardized questionnaire. A birth cohort was developed on the basis of each participant's year of birth categorized into 4 groups (1930 or earlier, 1931-1940, 1941-1950, and after 1950).

Statistical Analyses

Stata (version 12) was used for all statistical analyses. Cardiorespiratory fitness (ie, $\dot{V}O_{2max}$

scaled to lean body mass) was treated as the dependent variable for all regression analyses. Quantile regression[15] was used to assess the associations between CRF and age at the 10th, 25th, 50th, 75th and 90th CRF percentiles. The smoking status and birth cohort were adjusted for in all the regression models because of their established relationship with age and/or CRF. Regression models with age treated continuously were used to assess the differences in the association between age and CRF between the sexes using 2-way interaction terms between age and sex. Previous studies suggest the decline in fitness with age shows a substantial departure from linearity.[6,7,13] To account for this, a linear spline model with knots at 45 and 60 years of age was used in the quantile regression analyses to allow the slope of the relationship between CRF and age to change at these points. The model with knots at 45 and 60 years reported a slightly better overall fit across the CRF percentiles compared with a corresponding quadratic model and other 2- and 3-knot spline models with knots placed at 5-year increments from 40 to 70 years.

To provide additional, easily interpretable, and intuitively meaningful estimates of the magnitude of the association between age and CRF for adults of both the sexes, regression models for the 10th, 50th, and 90th percentiles of CRF, treating age as a categorical predictor stratified by sex, were also used. For analyses in which age was categorized, the age was divided into 10 levels, younger than 30 years (referent level), 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, and older than 70 years. The smoking status and birth cohort were adjusted for in all the regression models because of their established relationship with age and/or CRF.

Multiple observations on the same subject are unlikely to be independent. The quantile regression estimator is consistent when data are not independent,[24] and the method of Parente and Silva[25] (implemented using the qreg2 command in Stata) was used to account for this potential nonindependence for standard error and confidence interval estimation. Quantile regression coefficients are interpreted similarly to ordinary linear regression coefficients, except that a quantile regression coefficient indicates the change in the value at the modeled percentile, not the mean, of the dependent variable.

RESULTS

The sample characteristics of the participants, including unconditional quantiles or percentiles for both CRF and age, at the first health examination are presented in Table 1 separately for both men and women. For men, the median CRF was 40.1 mL O_2/kg·per minute, whereas the interquartile range extended from 37.8 to 42.5 mL O_2/kg·per minute. For women, the median CRF was 38.2 mL O_2/kg·per minute, whereas the interquartile range extended from 35.9 to 40.6 mL O_2/kg·per minute. For both the sexes, the median age was 44 years. For men, the interquartile range for age extended from 38 to 51 years. Similarly, for women, the interquartile range age extended from 37 to 51 years.

The regression coefficients evaluating the differences in age-related changes in CRF per year between men and women are presented in Table 2. For men aged up to 45 years, the estimated slope relating CRF and age was significant and positive at the 10th, 25th and 50th CRF percentiles with the magnitude of the estimates decreasing from 0.04 to 0.02 mL O_2/kg·per minute as CRF percentiles increased. In contrast, a significant negative slope was observed at the 90th percentile. For men aged 45-60 years and those older than 60 years, the slope estimates were significant and negative for all the CRF percentiles, with the largest magnitude at the highest adjusted CRF percentiles. The estimates for the decline in CRF per year ranged from 0.07 to 0.26 mL O_2/kg·per minute, with the largest estimated declines at the highest CRF percentiles.

For women aged up to 45 years, the estimated slopes relating to CRF and age were all negative, although only estimates at the 50th and higher CRF percentiles were significant. For women aged 45-60 years and those older than 60 years, the slope estimates were significant and negative for all the CRF percentiles, with the largest magnitude at the highest CRF percentiles. The significant estimates of the decline in CRF per year ranged from 0.03 to 0.26 mL O_2/kg·per minute, with the largest estimated declines at the highest CRF percentiles.

When men and women up to the age of 45 years were compared, significant differences in the slopes relating to age and CRF were observed for all the adjusted percentiles of CRF other than the 90th, with women reporting a significantly greater decline in CRF per year. For those aged 45-60 years and those older than 60 years, no significant differences in age-related decline in CRF were observed between the sexes. The estimated slope coefficients for all the age ranges are plotted in Figures 1 and 2.

Age and CRF: Stratified Analyses by Sex

Men. The adjusted estimated differences, compared with men aged less than 30 years, in the 10th, 50th, and 90th percentiles of CRF by 5-year age groups for men are presented in Table 3. The estimated 10th percentiles of CRF for the age groups 35-39, 40-44, 45-49, and 50-54 years were significantly higher than that for men younger than 30 years, with a maximum increase of 0.77 mL O_2/kg·per minute observed among men aged 40-44 years. In contrast, the estimated 10th percentiles of CRF for the age groups 60-64, 65-69, and 70 years or older were significantly lower than that for men younger than 30 years, with a maximum decrease of 3.18 mL O_2/kg·per minute observed among men aged 70 years or older. The estimated 50th percentiles of CRF for the age groups 35-39 and 40-44 years were significantly higher than that for men younger than 30 years, with point estimates of 0.41 and 0.46 mL O_2/kg·per minute, respectively. In contrast, the estimated 50th percentiles of CRF for all age groups of 55-59 years or older were significantly lower than that for men younger than 30 years, with a maximum decrease of 3.80 mL O_2/kg·per minute observed among men aged 70 years or older. The estimated 90th percentiles of CRF for all age groups of 35-39 years or older were significantly lower than that for men younger than 30 years, with the magnitude of the estimates increasing as the age groups increased. The point estimates ranged from a decrease of 0.93 mL O_2/kg·per minute for men aged 35-39 years to 7.84 mL O_2/kg·per minute for men aged 70 years or older.

Women. The adjusted estimated differences, compared with women aged less than 30 years,

in the 10th, 50th, and 90th CRF percentiles by 5-year age groups for women are presented in Table 3. The estimated 10th percentiles of CRF for all age groups other than the 35-39 and 45-49 years age groups were significantly lower than that for women younger than 30 years, with a minimum decrease of 0.44 mL O_2/kg·per minute observed among women aged 40-44 years and a maximum decrease of 4.46 mL O_2/kg·per minute observed among women aged 70 years and older. For all the age groups, the estimated 50th percentiles of CRF were significantly lower than that for women

TABLE 1. Sample Characteristics Showing Mean, Percentile, or Number (%) of Participants at their First Medical Examination for Men and Women Separately[a,b]

Characteristic	Total (n=43157)	
	Men (n=33,742)	Women (n=9415)
$\dot{V}O_{2max}$ (mL O_2/kg·per minute)		
25th percentile	37.8	35.9
50th percentile	40.1	38.2
75th percentile	42.5	40.6
Age (y)		
25th percentile	38.0	37.0
50th percentile	44.0	44.0
75th percentile	51.0	51.0
BMI (kg/m^2)		
25th percentile	24.0	20.6
50th percentile	25.9	22.4
75th percentile	28.2	25.0
Birth cohort		
<1931 (ref)	3770 (11%)	809 (9%)
1931-1940	7068 (21%)	1634 (17%)
1941-1950	11,434 (34%)	2907 (31%)
>1950	11,470 (34%)	4065 (43%)
Smoking status		
No (ref)	28,158 (83%)	8611 (91%)
Yes	5584 (17%)	804 (9%)
Age categories (y)		
<30	1684 (5%)	676 (7%)
30-34	3386 (10%)	927 (9%)
35-39	5906 (18%)	1558 (16%)
40-44	7071 (21%)	1858 (19%)
45-49	6077 (18%)	1685 (17%)
50-54	4564 (14%)	1393 (14%)
55-59	2839 (8%)	908 (9%)
60-64	1392 (4%)	479 (5%)
65-69	558 (2%)	204 (2%)
>70	265 (1%)	96 (1%)

[a]ref, reference.
[b]The Aerobics Center Longitudinal Study data were collected in the United States from 1974 to 2006.

TABLE 2. Quantile Regression Estimates for Age Along With 2-Way Interaction Between Age And Sex and 95% Confidence Intervals For Select Cardiorespiratory Fitness Percentiles[a,b]

	Percentiles									
	10th		25th		50th		75th		90th	
Slope estimates	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Men										
Age (up to 45 y)	0.04[c]	0.03-0.05[c]	0.04[c]	0.03-0.05[c]	0.02[c]	0.01-0.04[c]	−0.01	−0.02 to 0.01	−0.09[c]	−0.12 to −0.07[c]
Age (45-60 y)	−0.08[c]	−0.09 to −0.06[c]	−0.07[c]	−0.08 to −0.06[c]	−0.07[c]	−0.08 to −0.06[c]	−0.11[c]	−0.13 to −0.10[c]	−0.19[c]	−0.21 to −0.16[c]
Age (>60 y)	−0.21[c]	−0.24 to −0.18[c]	−0.22[c]	−0.24 to −0.20[c]	−0.25[c]	−0.27 to −0.22[c]	−0.25[c]	−0.28 to −0.22[c]	−0.26[c]	−0.31 to −0.22[c]
Women										
Age (up to 45 y)	−0.01	−0.03 to 0.01	−0.01	−0.03 to 0.00	−0.03[c]	−0.05 to −0.02[c]	−0.04[c]	−0.06 to −0.02[c]	−0.07[c]	−0.11 to −0.04[c]
Age (45-60 y)	−0.07[c]	−0.09 to −0.05[c]	−0.08[c]	−0.10 to −0.06[c]	−0.09[c]	−0.11 to −0.06[c]	−0.13[c]	−0.15 to −0.10[c]	−0.15[c]	−0.18 to −0.12[c]
Age (>60 y)	−0.21[c]	−0.27 to −0.19[c]	−0.25[c]	−0.31 to −0.20[c]	−0.24[c]	−0.32 to −0.17[c]	−0.24[c]	−0.29 to −0.19[c]	−0.26[c]	−0.34 to −0.17[c]
Difference in slopes										
Age (up to 45 y)	−0.05[c]	−0.07 to −0.03[c]	−0.05[c]	−0.07 to −0.03[c]	−0.06[c]	−0.08 to −0.04[c]	−0.03[c]	−0.06 to −0.01[c]	0.02	−0.02 to 0.06
Age (45-60 y)	0.01	−0.02 to 0.03	−0.01	−0.03 to 0.02	0.02	−0.04 to 0.01	−0.01	−0.03 to 0.01	0.03	0.00-0.07
Age (>60 y)	−0.02	−0.07 to 0.03	−0.04	−0.10 to 0.02	0.01	−0.07 to 0.08	0.01	−0.05 to 0.07	0.00	−0.09 to 0.10

[a]CI, confidence interval; Est., estimate.

[b]The differences in slopes were calculated as women minus men. The estimates are in mL/minute per kilogram per year.

[c]The coefficients indicate significant findings at $P<.05$. The estimates were adjusted for smoking (yes/no) and birth cohort (1930 or earlier, 1931-1940, 1941-1950, 1951 or later). The referent level for birth cohort is the group born in 1930 or earlier. The cardiorespiratory fitness variable was scaled to lean body mass.

younger than 30 years, with the estimated reductions ranging from 0.77 to 5.60 mL O_2/kg·per minute. Similarly, the estimated 90th percentiles of CRF for all the age groups were significantly lower than that for women younger than 30 years, with the magnitude of the estimates increasing as the age groups increased. The point estimates ranged from a decrease of 1.16 mL O_2/kg·per minute for women aged 30-34 years to 6.47 mL O_2/kg·per minute for women aged 70 years or older.

DISCUSSION

The purpose of this study was to comprehensively evaluate the differences between the sexes with respect to the association between age and CRF (ie, $\dot{V}O_{2max}$ scaled to lean body mass). To our knowledge, this study is the first to report differences in age-related decline in CRF between men and women across adjusted CRF percentiles. The magnitude of the decline in CRF with advancing age up to 45 years was significantly greater for women than for men, particularly at the lower and middle percentiles of the CRF distribution. Moreover, the onset of decline in CRF was found to occur earlier and at lower CRF percentiles in women. These findings suggest that there is a window

of opportunity to offset the accelerated decline in CRF associated with aging in women, especially during earlier years of adulthood, by sustaining moderate-to-high levels of fitness.

The decline in CRF associated with aging at low-to-moderate levels of fitness in women in the earlier decades of adulthood vs the increases in CRF among men at the same relative levels of fitness up to 45 years of age uniquely distinguished these groups. These findings extend our previous work[13] evaluating the association between age and CRF among men to the female population. In a large study of the Swedish adult population, Ekblom-Bak et al[26] reported decreased fitness among both men and women over time, with men experiencing greater decrements per year than their women counterparts. However, it is important to note that Swedish women have been found to be more physically active than US women across age groups, whereas Swedish men have been reported to have increased physical activity compared with their US counterparts, only among the oldest age groups.[27] In addition, this previous study only considered changes in average $\dot{V}O_{2max}$ within sexes and age groups. An analysis focusing only on a summary measure, such as mean, cannot

capture differences across an adjusted CRF distribution. Thus, our study serves as a complement to this previous work by highlighting the sex-specific differences at various levels of fitness. The greater magnitude of decline among women in this study may be partly explained by associations between CRF and hormone alterations (eg, decreased estrogen levels) as part of the normal aging process,[28] an attenuated response to exercise-induced central and peripheral adaptations, and lower levels of physical activity.[7] Future research would benefit from investigating potential mechanisms contributing to these age-related differences at low-to-mid levels of CRF.

It is concerning that the onset of age-related decline in fitness was found to occur earlier (ie, in the third decade of life) and at lower levels of CRF in women than in men. Although some have reported that decreases in fitness begin around early-to-mid forties,[12,13] others have suggested that these decrements can be detected before the age of 30 years.[29] Younger women with lower fitness levels may be at a greater risk of adverse health outcomes, including cardiovascular disease and premature mortality.[30] Therefore, the earlier onset of and accelerated age-related decline in CRF suggests that early adulthood serves as a critical juncture to maintain higher levels of CRF for optimal function and risk reductions.

Our findings regarding the disparities in the magnitude of decline in CRF between men and women suggest that sex-specific exercise recommendations are warranted. Currently, national guidelines for aerobic exercise are generalized to all adults[31]; however, there have been calls to consider whether separate physical activities and exercise prescriptions for men and women would be more effective.[28] Sex differences in the degree of central (eg, maximal cardiac output and stroke volume) and peripheral (eg, vasodilation and arteriovenous oxygen difference) adaptations to exercise with aging, wherein women generally experience less training response, combined with our results, suggest that a uniform approach to exercise prescription does not sufficiently address the unique differences that distinguish men and women. Therefore, consideration should be given to the investigation of whether sex-specific
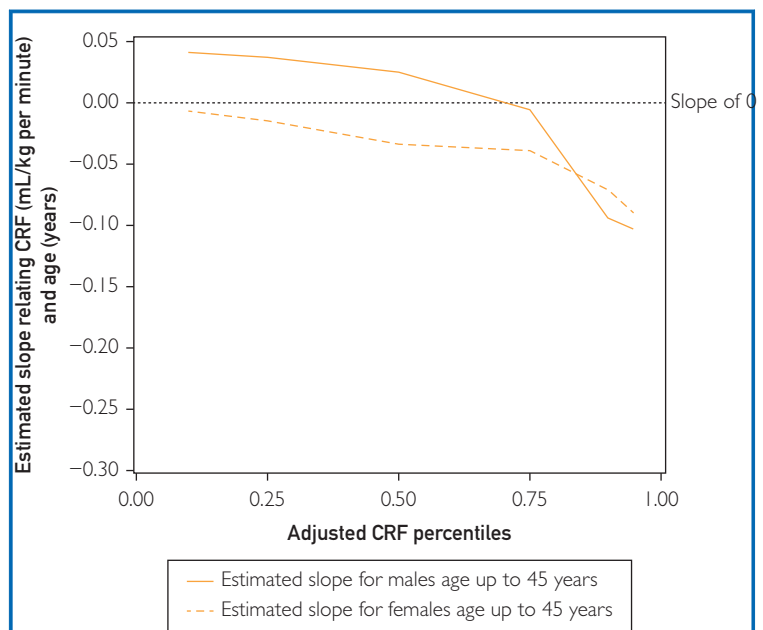
FIGURE 1. Adjusted estimated change in cardiorespiratory fitness, on the basis of a quantile regression analysis, for each year increase in age (ie, slope) up to 45 years. The estimates were adjusted for smoking (yes/no) and birth cohort (1930 or earlier, 1931-1940, 1941-1950, 1951 or later).

recommendations would be more effective for optimizing CRF across the adult lifespan and curtailing the effects of aging.

Interestingly, there were no substantial differences apparent in the extent to which CRF declined between the sexes at the age of 45 years and older. In fact, the age-related changes in CRF were nearly identical when the sexes at each percentile in the age group of 60 years and older were compared. This was unexpected, given the previous findings that CRF deteriorates at a greater rate in men than in women with each decade, particularly at the sixth decade and beyond.[6,7,32] It is likely that this was a result of differences in statistical methods applied among the studies. Indeed, the quantile effects, which included changes in the trend of significant point estimates across the quantiles, detected in this study found the utility of more-detailed statistical approaches to better understand sex differences in the association between age and CRF. Previous studies predominantly focused on the center (ie, mean or median) of the CRF distribution while examining age-related
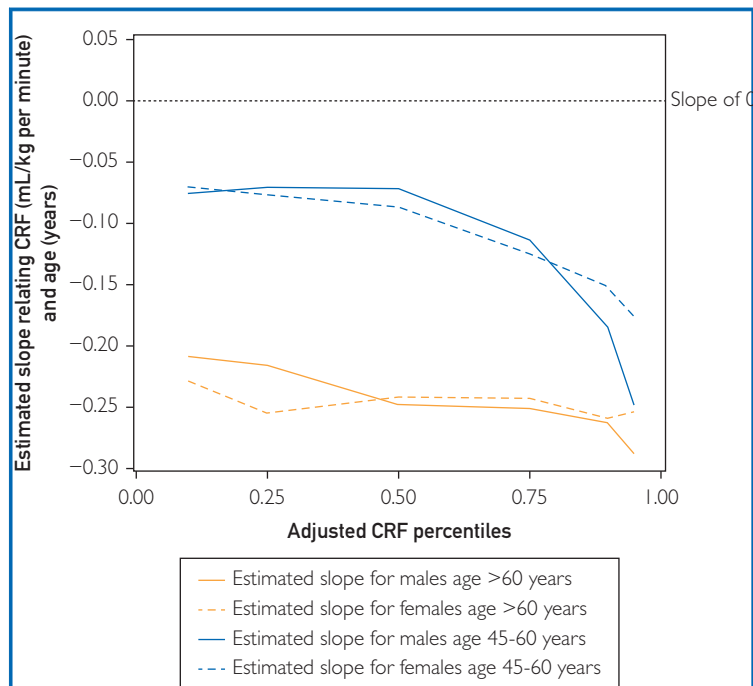
FIGURE 2. Adjusted estimated change in cardiorespiratory fitness, on the basis of a quantile regression analysis, for each year increase in age (ie, slope) for 45-60 years and older than 60 years. The estimates were adjusted for smoking (yes/no) and birth cohort (1930 or earlier, 1931-1940, 1941-1950, 1951 or later).

associations, which may not have detected potentially meaningful distinctions between subgroups. Our study makes a significant contribution to the literature by revealing important differences in the onset of decline in CRF and the magnitude of changes in CRF at various CRF percentiles. This signals a need to further examine subgroups across the CRF distribution to inform advancements in the current policy, practice, and public health messaging portals. In addition, the findings of this study may assist clinicians and health or fitness professionals in providing more precise guidance and optimization of care, particularly if incorporated into personalized activity metrics, such as personal activity intelligence,[33] and/or paired with technologies, such as wearable devices or digital activity-tracking methods, all of which offer more-detailed, less-burdensome monitoring of key physical activity and health metrics.

This study is strengthened by the large sample of adults across a large age range. Furthermore, the CRF level was objectively measured using the maximal treadmill test and estimated using the Fitness Registry and the Importance of Exercise National Database equation, which is shown to be more precise than previous conventional equations.[18] However, this study is not without limitations. Most participants identified as non-Hispanic White from middle-to-upper socioeconomic strata, and the data used in the analysis were collected from 1979 to 2006, which may have reduced the generalizability of our findings. Additionally, causal inferences cannot be made from this analysis. Moreover, there are potentially other intrinsic and extrinsic factors contributing to the association between age and CRF that warrant further exploration, such as dietary intake and environmental effects.

CONCLUSION

This study reports several observations of importance from public health and, potentially, clinical perspectives regarding differences in the decline of CRF with age between sexes among adults in the United States. First, the onset of decline in CRF was found to occur earlier and at lower CRF percentiles in women. This is of particular concern, given that women already tend to have lower CRF levels than men, and lower CRF levels are associated with a higher risk of adverse health outcomes.[34] These findings suggest that maintaining the levels of physical activity sufficient to maintain a moderate-to-high level of fitness is particularly important for women during earlier years of adulthood. Second, given the observed differences between the sexes in both the magnitude and onset of decline in CRF associated with aging in adults, sex-specific exercise or physical activity recommendations may be warranted. Finally, while assessing the age-related decline in CRF, analytic techniques focused on a comparison of means may have led to a substantial loss of pertinent information, and thus, more comprehensive techniques should be considered.

POTENTIAL COMPETING INTERESTS

The authors report no competing interests.

TABLE 3. Estimated Differences In Cardiorespiratory Fitness (Estimate) For Each 5-Year Age Group Compared With Persons Aged Less Than 30 Years Along With 95% Confidence Intervals For Select Cardiorespiratory Fitness Percentiles[a,b]

| | Percentiles | | | | | |
| | 10th | | 50th | | 90th | |
	Est.	95% CI	Est.	95% CI	Est.	95% CI
Men						
Age (30-34 y)	0.32	−0.02 to 0.67	0.06	−0.21 to 0.32	−0.42	−1.06 to 0.23
Age (35-39 y)	0.57[c]	0.24-0.89[c]	0.41[c]	0.15-0.67[c]	−0.93[c]	−1.50 to −0.36[c]
Age (40-44 y)	0.77[c]	0.44-1.09[c]	0.46[c]	0.20-0.72[c]	−1.27[c]	−1.85 to −0.70[c]
Age (45-49 y)	0.54[c]	0.21-0.88[c]	0.26	−0.01 to 0.52	−2.22[c]	−2.80 to −1.64[c]
Age (50-54 y)	0.50[c]	0.16-0.84[c]	0.00	−0.28 to 0.27	−3.09[c]	−3.68 to −2.50[c]
Age (55-59 y)	−0.03	−0.40 to 0.34	−0.30[c]	−0.59 to −0.02[c]	−3.83[c]	−4.44 to −3.22[c]
Age (60-64 y)	−0.73[c]	−1.13 to −0.32[c]	−1.01[c]	−1.32 to −0.70[c]	−4.83[c]	−5.47 to −4.19[c]
Age (65-69 y)	−1.49[c]	−1.93 to −1.05[c]	−2.08[c]	−2.43 to −1.74[c]	−6.28[c]	−6.98 to −5.58[c]
Age (>70 y)	−3.18[c]	−3.69 to −2.67[c]	−3.80[c]	−4.21 to −3.39[c]	−7.84[c]	−8.86 to −7.02[c]
Women						
Age (30-34 y)	−0.60[c]	−1.06 to −0.15[c]	−0.79[c]	−1.20 to −0.39[c]	−1.16[c]	−2.03 to −0.28[c]
Age (35-39 y)	−0.40	−0.85 to 0.05	−0.77[c]	−1.14 to −0.40[c]	−1.61[c]	−2.41 to −0.81[c]
Age (40-44 y)	−0.44[c]	−0.86 to −0.02[c]	−0.81[c]	−1.16 to −0.45[c]	−1.72[c]	−2.51 to −0.93[c]
Age (45-49 y)	−0.44	−0.88 to 0.01	−1.05[c]	−1.41 to −0.70[c]	−1.89[c]	−2.68 to −1.09[c]
Age (50-54 y)	−0.82[c]	−1.33 to −0.31[c]	−1.44[c]	−1.85 to −1.04[c]	−2.39[c]	−3.24 to −1.55[c]
Age (55-59 y)	−1.25[c]	−1.78 to −0.71[c]	−1.94[c]	−2.37 to −1.51[c]	−3.10[c]	−3.96 to −2.24[c]
Age (60-64 y)	−1.99[c]	−2.55 to −1.43[c]	−2.75[c]	−3.32 to −2.19[c]	−4.46[c]	−5.39 to −3.53[c]
Age (65-69 y)	−3.03[c]	−3.90 to −2.15[c]	−3.96[c]	−4.56 to −3.35[c]	−5.58[c]	−6.62 to −4.54[c]
Age (>70 y)	−4.46[c]	−5.18 to −3.73[c]	−5.60[c]	−7.09 to −4.10[c]	−6.47[c]	−8.21 to −4.72[c]

[a]CI, confidence interval; Est., estimate.

[b]Estimates are in mL/minute per kilogram per year.

[c]The coefficients indicate significant findings at $P<.05$. The estimates are from regression models stratified by sex and adjusted for smoking (yes/no) and birth cohort (1930 or earlier, 1931-1940, 1941-1950, 1951 or later). The referent level for birth cohort is the group born in 1930 or earlier. The sample size was 71,371 and 13,478 (number of observations) for men and women, respectively. The cardiorespiratory fitness variable was scaled to lean body mass.

Abbreviations and Acronyms: **CRF**, cardiorespiratory fitness; **NCD**, noncommunicable disease; **T2DM**, type 2 diabetes mellitus; **VO$_{2max}$**, maximal oxygen consumption

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