Obesity Paradox, Stress, Sitting, and Critical Roll of Fitness

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When Thinner Means Sicker
and Heavier Means Healthier

The
OBESITY PARADOX

CARL J. LAVIE, MD
with Kristin Loberg
Obesity and Cardiovascular Disease

Risk Factor, Paradox, and Impact of Weight Loss

Carl J. Lavie, MD, Richard V. Milani, MD, Hector O. Ventura, MD

New Orleans, Louisiana

Obesity has reached global epidemic proportions in both adults and children and is associated with numerous comorbidities, including hypertension (HTN), type II diabetes mellitus, dyslipidemia, obstructive sleep apnea and sleep-disordered breathing, certain cancers, and major cardiovascular (CV) diseases. Because of its maladaptive effects on various CV risk factors and its adverse effects on CV structure and function, obesity has a major impact on CV diseases, such as heart failure (HF), coronary heart disease (CHD), sudden cardiac death, and atrial fibrillation, and is associated with reduced overall survival. Despite this adverse association, numerous studies have documented an obesity paradox in which overweight and obese people with established CV disease, including HTN, HF, CHD, and peripheral arterial disease, have a better prognosis compared with nonoverweight/nonobese patients. This review summarizes the adverse effects of obesity on CV disease risk factors and its role in the pathogenesis of various CV diseases, reviews the obesity paradox and potential explanations for these puzzling data, and concludes with a discussion regarding the current state of weight reduction in the prevention and treatment of CV diseases.  (J Am Coll Cardiol 2009;53:1925–32) © 2009 by the American College of Cardiology Foundation

Obesity and Cardiovascular Diseases

- Obesity increasing in epidemic proportions
- Body mass index (BMI) is primarily used
- Body fatness, waist circumference (WC), waist to hip ratio (WHR), and waist to height ratio may be superior

Lavie CJ et al. JACC 2009;53:1925-1932
Obesity and Cardiovascular Diseases

- 70% of adults in US are overweight or obese
- Morbid obesity especially increased
- Obesity is second to only tobacco abuse as the #1 cause of preventable death in US
- Due to obesity, we may soon see a reversal in the steady increase in life expectancy

Lavie CJ et al. JACC 2009;53:1925-1932
Cardiovascular Diseases Associated With Obesity

- Hypertension
- Heart Failure
- Coronary Heart Disease
- Atrial Fibrillation
- Complex Ventricular Dysrhythmias
- Stroke
- Venous Thromboembolism
- OSA / SDB

Lavie CJ et al. JACC 2009;53:1925-1932
45-Year Trends in Women’s Use of Time and Household Management Energy Expenditure

Edward Archer¹, Robin P. Shook¹, Diana M. Thomas², Timothy S. Church³, Peter T. Katzmarzyk³, James R. Hébert⁴, Kerry L. McIver⁴, Gregory A. Hand⁴, Carl J. Lavie⁶, Steven N. Blair¹

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Abstract

Context: Relationships between socio-environmental factors and obesity are poorly understood due to a dearth of longitudinal population-level research. The objective of this analysis was to examine 45-year trends in time-use, household management (HM) and energy expenditure in women.

Design and Participants: Using national time-use data from women 19–64 years of age, we quantified time allocation and household management energy expenditure (HMEE) from 1965 to 2010. HM was defined as the sum of time spent in food preparation, post-meal cleaning activities (e.g., dish-washing), clothing maintenance (e.g., laundry), and general housework. HMEE was calculated using body weights from national surveys and metabolic equivalents.

Results: The time allocated to HM by women (19–64 yrs) decreased from 25.7 hr/week in 1965 to 13.3 hr/week in 2010 (P<0.001), with non-employed women decreasing by 16.6 hr/week and employed women by 6.7 hr/week (P<0.001). HMEE for non-employed women decreased 42% from 25.1 Mj/week (6004 kilocalories per week) in 1965 to 14.6 Mj/week (3486 kcal/week) in 2010, a decrement of 10.5 Mj/week or 1.5 Mj/day (2518 kcal/week; 360 kcal/day) (P<0.001), whereas employed women demonstrated a 30% decrement of 3.9 Mj/week, 0.55 Mj/day (923 kcal/week, 132 kcal/day) (P<0.001). The time women spent in screen-based media use increased from 8.3 hr/week in 1965 to 16.5 hr/week in 2010 (P<0.001), with non-employed women increasing 9.6 hr/week and employed women 7.5 hr/week (P<0.001).

Conclusions: From 1965 to 2010, there was a large and significant decrease in the time allocated to HM. By 2010, women allocated 25% more time to screen-based media use than HM (i.e., cooking, cleaning, and laundry combined). The reallocation of time from active pursuits (i.e., housework) to sedentary pastimes (e.g., watching TV) has important health consequences. These results suggest that the decrement in HMEE may have contributed to the increasing prevalence of obesity in women during the last five decades.

Household Management Energy Expenditure in Women over 5 Decades

Archer E et al. PLOS ONE 2013;8(2): e 56620
Trends over 5 Decades in U.S. Occupation-Related Physical Activity and Their Associations with Obesity

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1 Pennington Biomedical Research Center, Louisiana State University System, Baton Rouge, Louisiana, United States of America, 2 Department of Mathematical Sciences, Montclair State University, Montclair, New Jersey, United States of America, 3 Arnold School of Public Health, Departments of Exercise Science and Epidemiology/ Biostatistics, University of South Carolina, Columbia, South Carolina United States of America

Abstract

Background: The true causes of the obesity epidemic are not well understood and there are few longitudinal population-based data published examining this issue. The objective of this analysis was to examine trends in occupational physical activity during the past 5 decades and explore how these trends relate to concurrent changes in body weight in the U.S.

Methodology/Principal Findings: Analysis of energy expenditure for occupations in U.S. private industry since 1960 using data from the U.S. Bureau of Labor Statistics. Mean body weight was derived from the U.S. National Health and Nutrition Examination Surveys (NHANES). In the early 1960’s almost half the jobs in private industry in the U.S. required at least moderate intensity physical activity whereas now less than 20% demand this level of energy expenditure. Since 1960 the estimated mean daily energy expenditure due to work related physical activity has dropped by more than 100 calories in both women and men. Energy balance model predicted weights based on change in occupation-related daily energy expenditure since 1960 for each NHANES examination period closely matched the actual change in weight for 40–50 year old men and women. For example from 1960–62 to 2003–06 we estimated that the occupation-related daily energy expenditure decreased by 142 calories in men. Given a baseline weight of 76.9 kg in 1960–62, we estimated that a 142 calories reduction would result in an increase in mean weight to 89.7 kg, which closely matched the mean NHANES weight of 91.8 kg in 2003–06. The results were similar for women.

Conclusion: Over the last 50 years in the US we estimate that daily occupation-related energy expenditure has decreased by more than 100 calories, and this reduction in energy expenditure accounts for a significant portion of the increase in mean US body weights for women and men.

Occupational METs over 5 Decades

[Graph showing the decline of mean occupation-related METs and daily energy expenditure over 5 decades, with separate lines for men and women.]
Occupational EE and Obesity

Church TS et al. PLOS ONE 2011;6(5): e19657
Meta-Analysis of BMI and Survival

- 97 studies, 2.88 million individuals, >270,000 deaths

- Relative to normal weight, obesity (all grades combined) and grades 2 and 3 obesity were associated with higher all-cause mortality

- Grade 1 obesity was associated with a trend for lower mortality (HR 0.95; CI 0.88-1.01), and overweight had significantly lower mortality (HR 0.94; CI 0.91-0.96)

- In those 65 years and older, there was only a non-significant trend of 10% higher mortality, even in those with BMI 35 and higher

Flegal KM et al. JAMA 2013;309(1):71-82
“Obesity Paradox” and Cardiovascular Diseases

Although obesity has been implicated as one of the major risk factors for most CV diseases, including HTN, HF, and CHD, evidence from clinical cohorts of patients with established CV diseases indicates an “obesity paradox” because overweight and obese with these diseases tend to have a more favorable short- and long-term prognosis.

Lavie CJ et al. JACC 2009;53:1925-1932
Impact of Obesity and the Obesity Paradox on Prevalence and Prognosis in Heart Failure

Carl J. Lavie, MD,† Martin A. Alpert, MD,‡ Ross Arena, PhD, PT,§ Mandeep R. Mehra, MBBS,¶ Richard V. Milani, MD,* Hector O. Ventura, MD*

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Obesity has reached epidemic proportions in the United States and worldwide. Considering the adverse effects of obesity on left ventricular (LV) structure, diastolic and systolic function, and other risk factors for heart failure (HF), including hypertension and coronary heart disease, HF incidence and prevalence, not surprisingly, is markedly increased in obese patients. Nevertheless, as with most other cardiovascular diseases, numerous studies have documented an obesity paradox, in which overweight and obese patients, defined by body mass index, percent body fat, or central obesity, demonstrate a better prognosis compared with lean or underweight HF patients. This review will describe the data on obesity in the context of cardiopulmonary exercise testing in HF. Additionally, the implications of obesity on LV assist devices and heart transplantation are reviewed. Finally, despite the obesity paradox, we address the current state of weight reduction in HF. (J Am Coll Cardiol HF 2013;1:93–102)

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There are numerous adverse effects of overweightness and obesity, usually defined by body mass index (BMI) criteria, on general and, particularly, cardiovascular (CV) health. Obesity has been implicated as 1 of the major risk factors for hypertension (HTN) and coronary heart disease (CHD), both of which are strongly related to the development of heart failure (HF), and may be an independent predictor of the development of HF via adverse effects on cardiac structure and left ventricular (LV) systolic and, especially, diastolic function (1). However, despite the known strong association between overweight/obesity and CV risk factors

This paper describes the hemodynamic alterations of overweight/obesity and its pathological effects on arterial blood pressure (BP) and cardiac structure and function, thus contributing to its role in HTN and CHD, as well as HF. We also address the impact of obesity in the increasing incidence and prevalence of HF, as well as the evidence for an obesity paradox in overweight/obese patients with established HF. Additionally, we describe the influence of obesity on the assessment of prognosis in HF, including the use of cardiopulmonary exercise testing (CPX), the impact of obesity on various advanced therapies for HF, including
Body Composition and HF Prognosis

Lavie et al. Am J Cardiol 2003;91:891-894
Obesity Paradox and CHD

- 40 cohort studies of over 250,000 CHD patients followed for 3.8 years
- Overweight and obese had lower risk of total and CV mortality compared with underweight and “normal” weight patients
- Similar in stable CHD, PCI and CABG
- In BMI ≥ 35 kg/m², there was excess risk of CV mortality without an increase on total mortality

Body Composition and Coronary Heart Disease Mortality—
An Obesity or a Lean Paradox?

CARL J. LAVIE, MD; ALBAN DE SCHUTTER, MD; DHARMENDRAKUMAR PATEL, MD;
SURYA M. ARTHAM, MD; RICHARD V. MILANI, MD

OBJECTIVE: To determine the combined effects of body mass index (BMI) and body fat (BF) on prognosis in coronary heart disease (CHD) to better understand the "obesity paradox."

PATIENTS AND METHODS: We studied 581 patients with CHD between January 1, 2000, and July 31, 2005, who were divided into low (<25) and high BMI (≥25), as well as low (≤25% men and ≤35% women) and high BF (>25% in men and >35% in women). Four groups were analyzed by total mortality during the 3-year follow-up by National Death Index: low BF/low BMI (n=119), high BF/low BMI (n=26), low BF/high BMI (n=125), and high BF/high BMI (n=311).

RESULTS: During the 3-year follow-up, mortality was highest in the low BF/low BMI group (11%), which was significantly (P<0.001) higher than that in the other 3 groups (3.9%, 3.2%, and 2.6%, respectively); using the high BF/high BMI group as a reference, the low BF/low BMI group had a 4.2-fold increase in mortality (confidence interval [CI], 1.76–10.23; P=0.001). In multivariate logistic regression for mortality, when entered individually, both high BMI (odds ratio [OR], 0.79; CI, 0.69–0.90) and high BF (OR, 0.89; CI, 0.82–0.95) as continuous variables were independent predictors of better survival, whereas low BMI (OR, 3.60; CI, 1.37–9.47) and low BF (OR, 3.52; CI, 1.34–9.23) as categorical variables were independent predictors of higher mortality.

CONCLUSION: Although both low BF and low BMI are independent predictors of mortality in patients with CHD, only patients with combined low BF/low BMI appear to be at particularly high risk of mortality during follow-up. Studies are needed to determine optimal body composition in the secondary prevention of CHD.

Many large studies of cohorts with CHD have demonstrated this obesity paradox, which has also been demonstrated in a large meta-analysis by Romero-Corral et al from Mayo Clinic who analyzed 40 cohort studies totaling more than 250,000 patients with CHD grouped according to BMI.

Although BMI is the most frequently used method to assess overweightness obesity, especially in large epidemiologic studies, this method has been criticized because BMI does not always reflect true body fatness. Some investigators have theorized that at least part of the inconsistent relationship between obesity and major CV disease events, including mortality, may be due to the inaccurate diagnosis of obesity by the BMI assessment and that defining obesity by other methods, including waist circumference, waist/hip ratio, as well as percent body fat (BF) may be more accurate. We have recently demonstrated this obesity paradox in a cohort of CHD patients using both BMI and BF determinations.

To our knowledge, no prior studies have determined the independent effects of both BMI and BF on mortality in a cohort of CHD patients. Therefore, in the current evaluation, we determined the combined and independent impact of both BMI and BF on mortality in a cohort with stable CHD.

PATIENTS AND METHODS

We retrospectively reviewed the case records of 581 consecutive patients with stable CHD who were referred for potential entry into formal cardiac rehabilitation programs between January 1, 2000, and July 31, 2005, and who had baseline anthropometric, lipid, and clinical data, as we have previously described. Patients were divided into low (<25) and high (≥25).
The "Obesity Paradox" in CHD

Survival (%)

Time to Event (Days)

- High BF/High BMI
- High BF/Low BMI
- Low BF/High BMI
- Low BF/Low BMI

*p<0.0001 compared with other groups

Body Composition and Survival in Stable Coronary Heart Disease

Impact of Lean Mass Index and Body Fat in the “Obesity Paradox”

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New Orleans, Louisiana; Weston, Florida; Philadelphia, Pennsylvania; and Baton Rouge, Louisiana

Objectives
Our goal was to determine the impact of lean mass index (LMI) and body fat (BF) on survival in patients with coronary heart disease (CHD).

Background
An inverse relationship between obesity and prognosis has been demonstrated (the “obesity paradox”) in CHD, which has been explained by limitations in the use of body mass index in defining body composition.

Methods
We studied 570 consecutive patients with CHD who were referred to cardiac rehabilitation, stratified as Low (≤25% in men and ≤35% in women) and High (>25% in men and >35% in women) BF and as Low (≤18.9 kg/m² in men and ≤15.4 kg/m² in women) and High LMI, and followed for 3 years for survival.

Results
Mortality is inversely related to LMI (p < 0.0001). Mortality was highest in the Low BF/Low LMI group (15%), which was significantly higher than in the other 3 groups, and lowest in the High BF/High LMI group (2.2%), which was significantly lower than in the other 3 groups. In Cox regression analysis as categoric variables, low LMI (hazard ratio [HR]: 3.1; confidence interval [CI]: 1.3 to 7.1) and low BF (HR: 2.6; CI: 1.1 to 6.4) predicted higher mortality, and as continuous variables, high BF (HR: 0.91; CI: 0.85 to 0.97) and high LMI (HR: 0.81; CI: 0.68 to 1.00) predicted lower mortality.

Conclusions
In patients with stable CHD, both LMI and BF predict mortality, with mortality particularly high in those with Low LMI/Low BF and lowest in those with High LMI/High BF. Determination of optimal body composition in primary and secondary CHD prevention is needed.

(J Am Coll Cardiol 2012;60:1374–80) © 2012 by the American College of Cardiology Foundation

Lavie CJ et al. JACC 2012;60: 1374-1380.
Lean Mass Index and CHD Mortality

Lavie CJ et al. JACC 2012;60: 1374-1380
Body Fat, Lean Mass Index and CHD Mortality

* = p<0.0001 compared with other 3 groups
+ = p=0.003 vs High BF / Low LMI; p=0.03 vs Low BF / High LMI

Lavie CJ et al. JACC 2012; 60: 1374-1380
Obesity has been increasing in epidemic proportions, with a disproportionately higher increase in morbid or class III obesity, and obesity adversely affects cardiovascular (CV) hemodynamics, structure, and function, as well as increases the prevalence of most CV diseases. Progressive declines in physical activity over 5 decades have occurred and have primarily caused the obesity epidemic. Despite the potential adverse impact of overweight and obesity, recent epidemiological data have demonstrated an association of mild obesity and, particularly, overweight on improved survival. We review in detail the obesity paradox in CV diseases where overweight and at least mildly obese patients with most CV diseases seem to have a better prognosis than do their leaner counterparts. The implications of cardiorespiratory fitness with prognosis are discussed, along with the joint impact of fitness and adiposity on the obesity paradox. Finally, in light of the obesity paradox, the potential value of purposeful weight loss and increased physical activity to affect levels of fitness is reviewed. (J Am Coll Cardiol 2014;63:1345-54)
The Obesity Paradox, Cardiorespiratory Fitness, and Coronary Heart Disease

Paul A. McAuley, PhD; Enrique G. Artero, PhD; Xuemei Sui, MD; Duck-chul Lee, PhD; Timothy S. Church, MD, MPH, PhD; Carl J. Lavie, MD; Jonathan N. Myers, PhD; Vanesa España-Romero, PhD; and Steven N. Blair, PED

Abstract

Objective: To investigate associations of cardiorespiratory fitness (CRF) and different measures of adiposity with cardiovascular disease (CVD) and all-cause mortality in men with known or suspected coronary heart disease (CHD).

Patients and Methods: We analyzed data from 9563 men (mean age, 47.4 years) with documented or suspected CHD in the Aerobics Center Longitudinal Study (August 13, 1977, to December 30, 2002) using baseline body mass index (BMI) and CRF (quantified as the duration of a symptom-limited maximal treadmill exercise test). Waist circumference (WC) and percent body fat (BF) were measured using standard procedures.

Results: There were 733 deaths (348 of CVD) during a mean follow-up of 13.4 years. After adjustment for age, examination year, and multiple baseline risk factors, men with low fitness had a higher risk of all-cause mortality in the BMI categories of normal weight (hazard ratio [HR], 1.60; 95% confidence interval [CI], 1.24-2.05), obese class I (HR, 1.38; 95% CI, 1.04-1.82), and obese class II/III (HR, 2.43; 95% CI, 1.55-3.80) but not overweight (HR, 1.09; 95% CI, 0.88-1.36) compared with the normal-weight and high-fitness reference group. We observed a similar pattern for WC and percent BF tertiles and for CVD mortality. Among men with high fitness, there were no significant differences in CVD and all-cause mortality risk across BMI, WC, and percent BF categories.

Conclusion: In men with documented or suspected CHD, CRF greatly modifies the relation of adiposity to mortality. Using adiposity to assess mortality risk in patients with CHD may be misleading unless fitness is considered.
Impact of Fitness on All-Cause Mortality in CHD

BMI

<table>
<thead>
<tr>
<th>Patients (deaths)</th>
<th>Normal BMI</th>
<th>Overweight I</th>
<th>Obese I</th>
<th>Obese II/III</th>
</tr>
</thead>
<tbody>
<tr>
<td>2718 (206)</td>
<td>3093 (156)</td>
<td>531 (15)</td>
<td>28 (2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>568 (97)</td>
<td>1555 (158)</td>
<td>786 (76)</td>
<td>284 (23)</td>
</tr>
</tbody>
</table>

| Reference        | 0.84 (0.68-1.03) | 1.60 (1.24-2.05) | 1.38 (1.04-1.82) |
| Hazard ratio of all-cause mortality |

Waist Circumference

<table>
<thead>
<tr>
<th>Patients (deaths)</th>
<th>Low WC</th>
<th>Middle WC</th>
<th>Upper WC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2802 (182)</td>
<td>2198 (132)</td>
<td>1370 (65)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>539 (82)</td>
<td>875 (86)</td>
<td>1779 (186)</td>
</tr>
</tbody>
</table>

| Reference        | 0.89 (0.71-1.19) | 0.77 (0.58-1.02) | 1.67 (1.28-2.18) | 1.74 (1.07-1.67) |
| Hazard ratio of all-cause mortality |

% Body Fat

<table>
<thead>
<tr>
<th>Patients (deaths)</th>
<th>Low % BF</th>
<th>Middle % BF</th>
<th>Upper % BF</th>
</tr>
</thead>
<tbody>
<tr>
<td>2760 (168)</td>
<td>2233 (123)</td>
<td>1377 (88)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>468 (72)</td>
<td>882 (99)</td>
<td>1843 (183)</td>
</tr>
</tbody>
</table>

| Reference        | 0.85 (0.74-1.25) | 0.96 (0.68-1.08) | 1.79 (1.35-2.38) | 1.28 (0.99-1.67) | 1.26 (1.01-1.57) |
| Hazard ratio of all-cause mortality |
Impact of Cardiorespiratory Fitness on the Obesity Paradox in Patients With Heart Failure

Carl J. Lavie, MD; Lawrence P. Cahalin, PhD, PT; Paul Chase, MEd; Jonathan Myers, PhD; Daniel Bensimhon, MD; Mary Ann Peberdy, MD; Euan Ashley, MD; Erin West, MS; Daniel E. Forman, MD; Marco Guazzi, MD, PhD; and Ross Arena, PhD, PT

Abstract

Objective: To determine the impact of cardiorespiratory fitness (FIT) on survival in relation to the obesity paradox in patients with systolic heart failure (HF).

Patients and Methods: We studied 2,066 patients with systolic HF (body mass index [BMI] ≥ 18.5 kg/m²) between April 1, 1993 and May 11, 2011 (with 1,784 [86%] tested after January 31, 2000) from a multicenter cardiopulmonary exercise testing database who were followed for up to 5 years (mean ± SD, 25.0 ± 17.5 months) to determine the impact of FIT (peak oxygen consumption < 14 vs ≥ 14 mL O₂ · kg⁻¹ · min⁻¹) on the obesity paradox.

Results: There were 212 deaths during follow-up (annual mortality, 4.5%). In patients with low FIT, annual mortality was 8.2% compared with 2.8% in those with high FIT (P < .001). After adjusting for age and sex, BMI was a significant predictor of survival in the low FIT subgroup when expressed as a continuous (P = .03) and dichotomous (< 25.0 vs ≥ 25.0 kg/m²) (P = .01) variable. Continuous and dichotomous BMI expressions were not significant predictors of survival in the overall and high FIT groups after adjusting for age and sex. In patients with low FIT, progressively worse survival was noted with BMI of 30.0 or greater, 25.0 to 29.9, and 18.5 to 24.9 (log-rank, 11.7; P = .003), whereas there was no obesity paradox noted in those with high FIT (log-rank, 1.72; P = .42).

Conclusion: These results indicate that FIT modifies the relationship between BMI and survival. Thus, assessing the obesity paradox in systolic HF may be misleading unless FIT is considered.
Fitness, Mortality, Obesity Paradox in Heart Failure

Lavie CJ et al. Am Heart J 2013
All-Cause Mortality by Changes in Fitness and BMI

Adjusted for age, examination year, parental CVD, BMI, and maximal METs at baseline, changes in each lifestyle factor (smoking status, alcohol intake, and physical activity) and each medical condition (abnormal electrocardiogram, hypertension, diabetes, and hypercholesterolemia) between the 2 examinations, and the number of clinic visits between the 2 examinations.

Low Weight and Overweightness in Older Adults: Risk and Clinical Management

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\textsuperscript{b}Department of Preventive Medicine, Pennington Biomedical Research Center, Louisiana State University System, Baton Rouge, LA

\textbf{A R T I C L E   I N F O}

\textbf{Keywords:}
Obesity
Elderly
Mortality
Cardiovascular disease

\textbf{A B S T R A C T}

The prevalence of individuals who are overweight or obese is growing exponentially in the United States and worldwide. This growth is concerning, as both overweightness and obesity lead to impaired physical function, decreased quality of life, and increased risk of chronic diseases. Additionally, overweightness and obesity are related to increased mortality among young and middle-aged adults. This weight-related risk of mortality is more ambiguous among older adults. In fact, obesity may be protective in this population, a relationship described as the “obesity paradox”. In this review we discuss the effects of overweightness and obesity among the elderly on cardiovascular disease and all-cause mortality, along with the risks of low weight. We conclude by discussing the goal of weight management among older adults, focusing particularly on benefits of preserving lean body mass and muscular strength while stabilizing body fat. Ideally, overweight or mildly obese elderly individuals should devise a plan with their physicians to maintain their weight, while increasing lean body mass through a plan of healthy diet, behavioral therapy, and physical activity.

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How does fitness protect overweight/obese individuals and those with diabetes from CVD?
## Exercise and CRF is Pleiotropic

### Physiological Benefits

<table>
<thead>
<tr>
<th>Improved heart rate variability</th>
<th>Reduced systemic inflammation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced blood pressure</td>
<td>Improved insulin sensitivity</td>
</tr>
<tr>
<td>Improved endothelial function</td>
<td>Decreased myocardial oxygen demand</td>
</tr>
<tr>
<td>Increased myocardial function</td>
<td>Maintains lean mass</td>
</tr>
<tr>
<td>Decreased platelet aggregation</td>
<td>Increased fibrinolysis</td>
</tr>
<tr>
<td>Reduced blood and plasma viscosity</td>
<td>Increased capillary density</td>
</tr>
<tr>
<td>Increased mitochondrial density</td>
<td>Reduced visceral adiposity</td>
</tr>
<tr>
<td>Better sleep</td>
<td>Improved mood and reduced anxiety</td>
</tr>
</tbody>
</table>

**Reduced risk of developing:**

<table>
<thead>
<tr>
<th>Hypertension</th>
<th>Osteoporosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic syndrome</td>
<td>Osteoarthritis</td>
</tr>
<tr>
<td>Depression</td>
<td>Breast and colon cancer</td>
</tr>
<tr>
<td>Type 2 diabetes</td>
<td>Dementia and Alzheimer’s disease</td>
</tr>
</tbody>
</table>
Stress and CVD

Psychosocial Stress

- May trigger acute cardiac events
- Is a significant CAD risk factor
- Is highly prevalent in cardiac practice
- Forms a barrier to medical interventions
- Is linked to behavioral & cardiovascular risk factors
- Commonly masquerades as cardiac symptoms
“It is Exercise Alone that Supports the Spirit, and Keeps the Mind in Vigor.”

- Cicero
Adverse Behavioral Factors in Young and Elderly

Baseline

- Depression: Young (23%), Elderly (19%)
- Anxiety: Young (28%), Elderly (14%)
- Hostility: Young (13%), Elderly (5%)

*p<0.01

Lavie CJ, Milani RV. Arch Int Med 2006;166:1878-1883
Benefits of Cardiac Rehabilitation

Anxiety

Lavie CJ, Milani RV. Arch Int Med 2006;166:1878-1883
Benefits of Cardiac Rehabilitation

Hostility

<table>
<thead>
<tr>
<th>Prevalence, %</th>
<th>Before Rehab</th>
<th>After Rehab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (n=104)</td>
<td>13% (p&lt;0.01)</td>
<td>6%</td>
</tr>
<tr>
<td>Elderly (n=260)</td>
<td>5%</td>
<td>2% (p&lt;0.05)</td>
</tr>
</tbody>
</table>

Lavie CJ, Milani RV. Arch Int Med 2006;166:1878-1883
Benefits of Cardiac Rehabilitation

Depression

- **Before Rehab**
  - Young (n=104): 23%
  - Elderly (n=260): 19%
  - Differences are significant at p<0.0001

- **After Rehab**
  - Young (n=104): 4%
  - Elderly (n=260): 6%
  - Differences are significant at p<0.0001

**Lavie CJ, Milani RV.** Arch Int Med 2006;166:1878-1883
Cardiac Rehabilitation and Depression

Mortality (%)

Depressed: 22%
Non-depressed: 4%

p = 0.0004

Cardiac Rehabilitation and Depression


The bar chart shows a comparison of mortality rates between control depressed and active depressed groups. The p-value is 0.0005, indicating a statistically significant difference.
Cardiac Rehabilitation and Depression

**VO₂ Loss**
- n=102
- Mortality = 15%
- p=NS

**Mild VO₂ Gain**
- n=135
- Mortality = 6%*
- p=0.004

**High VO₂ Gain**
- n=285
- Mortality = 4%*
- p<0.001

Actually it is not fitness we are concerned about but rather LOW fitness
Implications for Health Care Professionals: Moving Patients Out of the Least Fit, “High-Risk” Cohort

Blair SN et al. JAMA 1996;276:205
Williams PT Med Sci Sports Exerc 2001;33:754
Dose-dependent Effects of Daily Exercise

Leisure-Time Running Reduces All-Cause and Cardiovascular Mortality Risk

Duck-chul Lee, PhD,* Russell R. Pate, PhD; Carl J. Lavie, MD;† Xuemei Sui, MD, PhD;‡ Timothy S. Church, MD, PhD;§ Steven N. Blair, PED∥

ABSTRACT

BACKGROUND Although running is a popular leisure-time physical activity, little is known about the long-term effects of running on mortality. The dose-response relations between running, as well as the change in running behaviors over time, and mortality remain uncertain.

OBJECTIVES We examined the associations of running with all-cause and cardiovascular mortality risks in 55,137 adults, 18 to 100 years of age (mean age 44 years).

METHODS Running was assessed on a medical history questionnaire by leisure-time activity.

RESULTS During a mean follow-up of 15 years, 3,413 all-cause and 1,217 cardiovascular deaths occurred. Approximately 24% of adults participated in running in this population. Compared with nonrunners, runners had 30% and 45% lower adjusted risks of all-cause and cardiovascular mortality, respectively, with a 3-year life expectancy benefit. In dose-response analyses, the mortality benefits in runners were similar across quintiles of running time, distance, frequency, amount, and speed, compared with nonrunners. Weekly running even <51 min, <6 miles, 1 to 2 times, <506 metabolic equivalent-minutes, or <6 miles/h was sufficient to reduce risk of mortality, compared with not running. In the analyses of change in running behaviors and mortality, persistent runners had the most significant benefits, with 29% and 50% lower risks of all-cause and cardiovascular mortality, respectively, compared with never-runners.

CONCLUSIONS Running, even 5 to 10 min/day and at slow speeds <6 miles/h, is associated with markedly reduced risks of death from all causes and cardiovascular disease. This study may motivate healthy but sedentary individuals to begin and continue running for substantial and attainable mortality benefits. (J Am Coll Cardiol 2014;64:472-81)

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### Running and All-Cause Mortality

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Hazard Ratio (95% CI) of All-Cause Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>0.71 (0.64-0.78)</td>
</tr>
<tr>
<td>Women</td>
<td>0.61 (0.45-0.85)</td>
</tr>
<tr>
<td>Age &lt;50 yr</td>
<td>0.72 (0.62-0.82)</td>
</tr>
<tr>
<td>Age ≥50 yr</td>
<td>0.71 (0.63-0.81)</td>
</tr>
<tr>
<td>BMI &lt;25 kg/m²</td>
<td>0.73 (0.64-0.83)</td>
</tr>
<tr>
<td>BMI ≥25 kg/m²</td>
<td>0.74 (0.65-0.84)</td>
</tr>
<tr>
<td>Healthy individuals</td>
<td>0.82 (0.70-0.95)</td>
</tr>
<tr>
<td>Unhealthy individuals</td>
<td>0.69 (0.61-0.77)</td>
</tr>
<tr>
<td>Nonsmokers</td>
<td>0.77 (0.70-0.85)</td>
</tr>
<tr>
<td>Smokers</td>
<td>0.51 (0.39-0.65)</td>
</tr>
<tr>
<td>Nonheavy alcohol drinkers</td>
<td>0.71 (0.64-0.79)</td>
</tr>
<tr>
<td>Heavy alcohol drinkers</td>
<td>0.66 (0.54-0.81)</td>
</tr>
<tr>
<td>Excluded first 3 years of deaths</td>
<td>0.71 (0.65-0.78)</td>
</tr>
<tr>
<td>Excluded BMI &lt;18.5 kg/m²</td>
<td>0.70 (0.64-0.77)</td>
</tr>
<tr>
<td>Excluded abnormal ECG</td>
<td>0.70 (0.64-0.78)</td>
</tr>
<tr>
<td>Overall</td>
<td>0.70 (0.64-0.77)</td>
</tr>
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Lee DC, Pate RR, Lavie CJ, et al. JACC 2014;64:472-481
### Running and Cardiovascular Mortality

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<tr>
<td>Men</td>
<td>0.56 (0.47-0.67)</td>
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<tr>
<td>Women</td>
<td>0.32 (0.16-0.64)</td>
</tr>
<tr>
<td>Age &lt;50 yr</td>
<td>0.51 (0.39-0.68)</td>
</tr>
<tr>
<td>Age ≥50 yr</td>
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<td>0.58 (0.48-0.70)</td>
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<tr>
<td>Nonsmokers</td>
<td>0.62 (0.52-0.70)</td>
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<tr>
<td>Smokers</td>
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Lee DC, Pate RR, Lavie CJ, et al. JACC 2014;64:472-481
Running Persistence and All-Cause and CVD Mortality

Lee DC, Pate RR, Lavie CJ, et al. JACC 2014;64:472-481
Running Time and Fitness Level

Lee DC, Pate RR, Lavie CJ, et al. JACC 2014;64:472-481
Running Dose and All-Cause and CVD Mortality

Lee DC, Pate RR, Lavie CJ, et al. JACC 2014;64:472-481
Exercising for Health and Longevity vs Peak Performance: Different Regimens for Different Goals

Everything in excess is opposed to nature. Hippocrates

Accumulating evidence suggests that exercise practices that are ideal for promoting health and longevity may differ from the high-volume, high-intensity endurance training programs used for developing peak cardiac performance and superb cardiorespiratory fitness (CRF). Studies consistently show that regular moderate-intensity physical activity (PA) is highly beneficial for long-term cardiovascular (CV) health. Improving the CRF from low to moderate to high will progressively improve CV prognosis and overall survival. However, the survival benefits from improvements in

Exercise and Survival: The Reverse J-Curve Pattern

Williams and Thompson, reporting in the current issue of the Mayo Clinic Proceedings, used the National Walkers’ and Runners’ Health Studies database, through which they followed 2,377 survivors of myocardial infarction to assess the dose-response relation between exercise and CV disease—related mortality during long-term follow-up. Chronic running or walking was associated with progressively lower CV mortality risks up to a point, beyond which much of the benefit of exercise on CV longevity was lost (in a reverse J-curve pattern). Remarkable dose-dependent reductions of up to 65% in CV mortality were seen among cohorts who were running less than 30 miles (50 km) per week or
Increased Cardiovascular Disease Mortality
Associated With Excessive Exercise in Heart
Attack Survivors

Paul T. Williams, PhD, and Paul D. Thompson, MD

Abstract

Objective: To test whether greater exercise is associated with progressively lower mortality after a cardiac event.

Patients and Methods: We used Cox proportional hazard analyses to examine mortality vs estimated energy expended by running or walking measured as metabolic equivalents (3.5 mL O₂/kg per min per day or metabolic equivalent of task-h/d [MET-h/d]) in 2377 self-identified heart attack survivors, where 1 MET-h/d is the energy equivalent of running 1 km/d. Mortality surveillance via the National Death Index included January 1991 through December 2008.

Results: A total of 526 deaths occurred during an average prospective follow-up of 10.4 years, 376 (71.5%) of which were related to cardiovascular disease (CVD) (International Statistical Classification of Diseases, 10th Revision codes I00-I99). CVD-related mortality compared with the lowest exercise group decreased by 21% for 1.07 to 1.8 MET-h/d of running or walking (P = .11), 24% for 1.8 to 3.6 MET-h/d (P = .04), 50% for 3.6 to 5.4 MET-h/d (P = .001), and 63% for 5.4 to 7.2 MET-h/d (P < .001) but decreased only 12% for ≥7.2 MET-h/d (P = .68). These data represent a 15% average risk reduction per MET-h/d for CVD-related mortality through 7.2 MET-h/d (P < .001) and a 2.6-fold risk increase above 7.2 MET-h/d (P = .009). Relative to the risk reduction at 7.2 MET-h/d, the risk for ≥7.2 MET-h/d increased 3.2-fold (P = .006) for all ischemic heart disease (IHD)—related mortalities but was not significantly increased for non—IHD-CVD, arrhythmia-related CVD, or non—CVD-related mortalities.

Conclusion: Running or walking decreases CVD mortality risk progressively at most levels of exercise in patients after a cardiac event, but the benefit of exercise on CVD mortality and IHD deaths is attenuated at the highest levels of exercise (running: above 7.1 km/d or walking briskly: 10.7 km/d).
Exercise Dose and Mortality in Post-MI Survivors


Exercise Dose and CVD-Mortality in Post-MI Survivors

Decline in risk per MET-h/d
HR=0.846
P<.001

Increased risk for ≥7.2 MET-h/d
HR: 2.62
P=.009

Potential Adverse Cardiovascular Effects From Excessive Endurance Exercise

James H. O'Keefe, MD; Harshal R. Patil, MD; Carl J. Lavie, MD; Anthony Magalski, MD; Robert A. Vogel, MD; and Peter A. McCullough, MD, MPH

Abstract

A routine of regular exercise is highly effective for prevention and treatment of many common chronic diseases and improves cardiovascular (CV) health and longevity. However, long-term excessive endurance exercise may induce pathologic structural remodeling of the heart and large arteries. Emerging data suggest that chronic training for and competing in extreme endurance events such as marathons, ultramarathons, ironman distance triathlons, and very long distance bicycle races, can cause transient acute volume overload of the atria and right ventricle, with transient reductions in right ventricular ejection fraction and elevations of cardiac biomarkers, all of which return to normal within 1 week. Over months to years of repetitive injury, this process, in some individuals, may lead to patchy myocardial fibrosis, particularly in the atria, interventricular septum, and right ventricle, creating a substrate for atrial and ventricular arrhythmias. Additionally, long-term excessive sustained exercise may be associated with coronary artery calcification, diastolic dysfunction, and large-artery wall stiffening. However, this concept is still hypothetical and there is some inconsistency in the reported findings. Furthermore, lifelong vigorous exercisers generally have low mortality rates and excellent functional capacity. Notwithstanding, the hypothesis that long-term excessive endurance exercise may induce adverse CV remodeling warrants further investigation to identify at-risk individuals and formulate physical fitness regimens for conferring optimal CV health and longevity.


Regular exercise is one of the cornerstones of therapeutic lifestyle changes for producing optimal cardiovascular (CV) and overall health. Physical exercise, though not a drug, possesses many traits of a powerful pharmacological agent. A routine of daily physical activity (PA) stimulates a number of beneficial physiologic changes in the body and can be highly effective for prevention. Similarly, a 15-year observational study of 52,000 adults found that runners had a 19% lower risk of all-cause mortality compared with nonrunners, with U-shaped mortality curves for distance, speed, and frequency. Running distances of about 1 to 20 miles per week, speeds of 6 to 7 miles per hour, and frequencies of 2 to 5 days per week were associated with lower all-cause mortality, whereas higher mileage, faster...
CV Damage
Due to Excessive Endurance Exercise
If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health.

Hippocrates
Dangers of Sitting
All-Cause Mortality (n=17,013) : Categories of Daily Sitting Time
Canada Fitness Survey, 1981-1993
Leisure Time Spent Sitting and Physical Activity in Relation to All-Cause Mortality in Men

Sitting Time and All-Cause Mortality Risk in 222 497 Australian Adults: Only Healthy at Baseline

Sitting Time and All-Cause Mortality Risk in Australian Adults: CVD or Diabetes at baseline (n = 52,229)

Is Sitting More Unhealthy Than Smoking?

1 hour of sitting is as unhealthy as smoking 2 cigarettes

1 hour of sitting decreases your life expectancy by 21.8 minutes

Men with 23 hours of sedentary activity per week are 64% more likely to die of heart disease

It only takes 90 minutes for the blood flow in the backs of your knees to slow by 50%

Infographic made with easel.ly
"Sitting Disease" by the numbers

Our modern sedentary lifestyles, both at home and in the workplace, are costly for us and for our employers.

Average hours of seated commute + average hours of seated home life = too much sitting!

A 2008 Vanderbilt University study published in the American Journal of Epidemiology estimated that the average American spends 56% of waking time (7.7 hours per day) in sedentary behaviors such as sitting.

94% more likely to die

The 2010 American Cancer Society study published in the American Journal of Epidemiology followed 133,316 individuals (69,716 women and 63,600 men) from 1986–2006. The summary result:

- Women who were inactive and sat over 6 hours a day were 94% more likely to die (during the time period studied) than those who were physically active and sat less than 3 hours a day.
- Men who were inactive and sat over 6 hours daily were 48% more likely to die than their standing counterparts.

Findings were independent of physical activity levels; the negative effects of sitting were just as strong in people who exercised regularly.

A January 2010 British Journal of Sports Medicine article suggests that people who sit for long periods of time have an increased risk of disease.

In 2010, the University of Queensland, Australia, School of Population Health reported, “Even when adults meet physical activity guidelines, sitting for prolonged periods can compromise metabolic health.”


3 out of 4

Full-time Employees of Large Companies Wish They Didn’t Spend Most of Their Working Hours Sitting (Rays study)

62% of U.S. office workers with their employers offered them desks that could be adjusted so they could work either seated or standing (Rays study)

Standing a little more each day tones muscles, improves posture, increases blood flow, ramps up metabolism and burns extra calories.

Join the Uprising at www.juststand.org
SITTING SO MUCH SHOULD SCARE YOU

People across the U.S. are sitting almost all day, living an excessively sedentary lifestyle. They don't like it, they know it's bad for them, but they are doing it anyway.

How Sedentary is the Typical American Each Day?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>21</td>
</tr>
<tr>
<td>Active</td>
<td>3</td>
</tr>
</tbody>
</table>

- Sleeping: 8 Hours
- Sitting at Work: 7.5 Hours
- Watching TV: 1.5 Hours
- Leisure Time: 1.5 Hours
- On Home Computer: 1.5 Hours
- Eating: 1 Hour
- Active/Standing: 3 Hours
HOW SITTING WRECKS YOUR BODY

As Soon As You Sit:
- Electrical activity in the leg muscles **shuts off**
- Calorie burning drops to **1 per minute**
- Enzymes that help break down fat drop **90%**

After 2 Hours:
- Good cholesterol drops **20%**

People with **sitting jobs** have **twice the rate** of cardiovascular disease as people with standing jobs.
Goals to Combat the “Sitting Disease”

• Minimize the amount of daily sitting
  – Preferably < 8 hours
• Stand up at least every 30 minutes
• Increase the level of Physical Activity and Fitness
Summary and Conclusions

Obesity and Obesity Paradox

• Although obesity may have some adverse impact on health, an “obesity paradox” exists
• Fitness is more important than fatness for long-term health
• Increasing regular physical activity is the best way to increase fitness and prevent weight gain
Summary and Conclusions
Stress, CVD and Fitness

• Stress is extremely common and increases the risk of CVD and mortality
• Avoiding “stress” would be ideal, but probably involves “wishfull thinking”
• The best way to handle stress and reduce the adverse effects of stress is increasing PA and Fitness
Summary and Conclusions
Sitting, CVD/Mortality and Fitness

• Prolonged sitting has adverse impact on CVD and survival
• In some ways, “Sitting is the New Smoking”
• Try to avoid prolonged sitting (at least < 8 hours per day total) and try to get up and move at least every 30 minutes
• Increasing PA and Fitness at least partly negates some of the toxicity of sitting
“Give it to me straight, Doc. How long do I have to ignore your advice?”
“What fits your busy schedule better, exercising a day or being dead 24 hours a day?”

30 minutes
Obesity Paradox, Stress, Sitting, and Critical Roll of Fitness

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Medical Director, Cardiac Rehabilitation and Preventive Cardiology
Director, Exercise Laboratories
John Ochsner Heart and Vascular Institute
Ochsner Clinical School-The UQ School of Medicine
New Orleans, La