EXERCISE PRESCRIPTION

James C. Puffer, M.D.
Professor Emeritus of Clinical Family Medicine
Division of Sports Medicine
David Geffen School of Medicine at UCLA

The Case of Mr. H

Mr. H is a 50 yr. old male who is in good health except for being overweight. His family history is remarkable for a father and uncle with Type 2 Diabetes, and he recently saw you for a complete physical examination, which was unremarkable. His laboratory work was also unremarkable, and specifically demonstrated no evidence of glucose intolerance. At that visit you suggested he begin an exercise program. He has thought about your recommendation and returns today for guidance on how to begin his program.

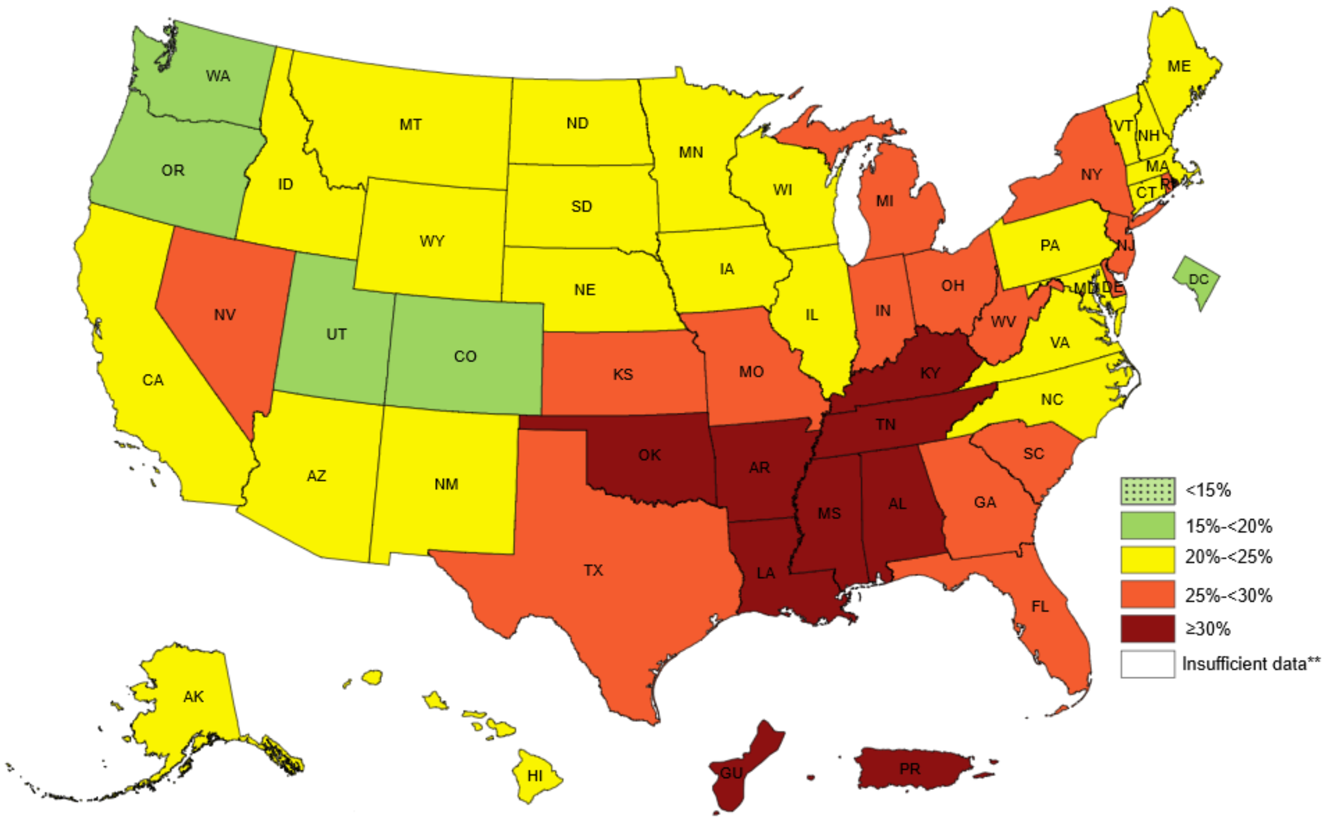
Exercise Prescription

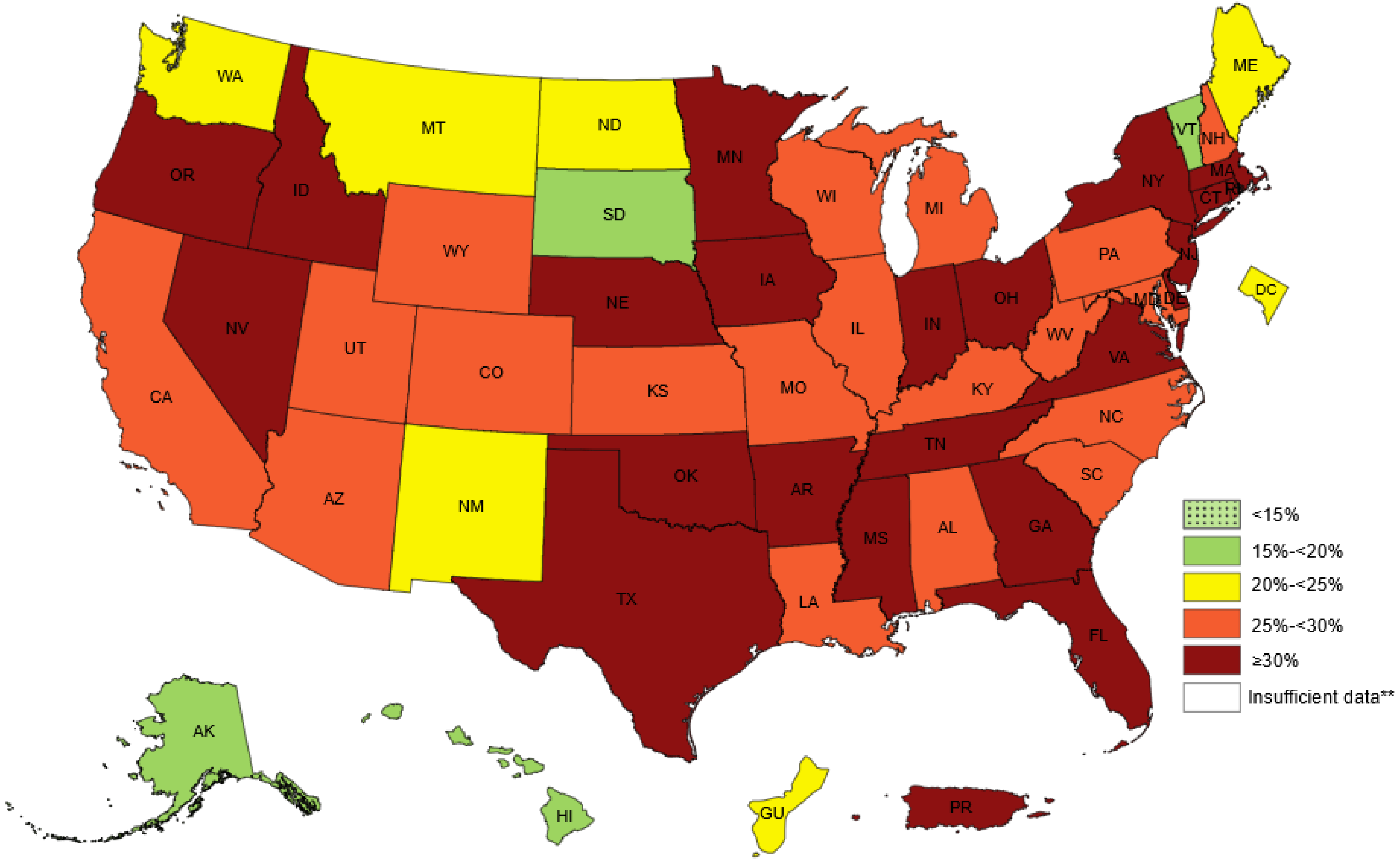
- Population at Risk
- Benefits of Exercise
- Exercise Recommendations
- Risks of Exercise
- Developing the Exercise Prescription

EXERCISE PRESCRIPTION

Population at Risk

Self-reported Physical Inactivity in the United States

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GA
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FL
AK
HI
GU
PR
<15%
15%-<20%
20%-<25%
25%-<30%
≥30%
Insufficient data**

National Health and Nutrition Examination Survey Trends

JAMA | Original Investigation

Trends in Sedentary Behavior Among the US Population, 2001-2016

Lin Yang, PhD; Chao Cao, MPH; Elizabeth D. Kantor, MPH, PhD; Long H. Nguyen, MD, MS; Xiaobin Zheng, MD; Yikyung Park, ScD; Edward L. Giovannucci, MD, ScD; Charles E. Matthews, PhD; Graham A. Colditz, MD, DrPH; Yin Cao, MPH, ScD

Supplemental content

CME Quiz at jamanetwork.com/learning

IMPORTANCE Prolonged sitting, particularly watching television or videos, has been associated with increased risk of multiple diseases and mortality. However, changes in sedentary behaviors over time have not been well described in the United States.

OBJECTIVE To evaluate patterns and temporal trends in sedentary behaviors and sociodemographic and lifestyle correlates in the US population.

DESIGN, SETTING, AND PARTICIPANTS A serial, cross-sectional analysis of the US nationally representative data from the National Health and Nutrition Examination Survey (NHANES) among children aged 5 through 11 years (2001-2016); adolescents, 12 through 19 years (2003-2016); and adults, 20 years or older (2003-2016).

EXPOSURES Survey cycle.

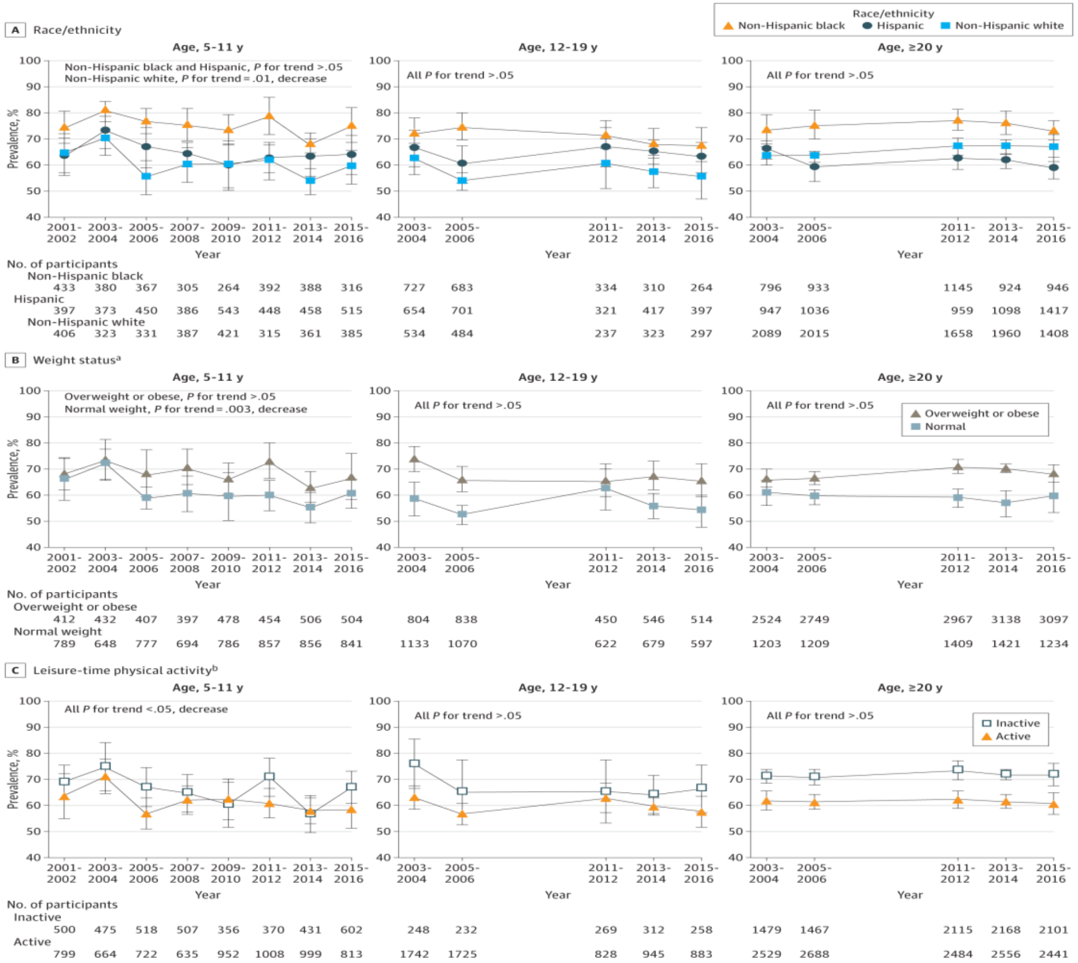
MAIN OUTCOMES AND MEASURES Prevalence of sitting watching television or videos for 2 h/d or more, computer use outside work or school for 1 h/d or more, and total sitting time (h/d in those aged ≥12 years).

RESULTS Data on 51 896 individuals (mean, 37.2 years [SE, 0.19]; 25 968 [50%] female) were analyzed from 2001-2016 NHANES data, including 10 359 children, 9639 adolescents, and 31 898 adults. The estimated prevalence of sitting watching television or videos for 2 h/d or more was high among all ages (children, 62% [95% CI, 57% to 67%]; adolescents, 59% [95% CI, 54% to 65%]; adults, 65% [95% CI, 61% to 69%]; adults aged 20-64 years, 62% [95% CI, 58% to 66%]; and ≥65 years, 84% [95% CI, 81% to 88%] in the 2015-2016 cycle). From 2001 through 2016, the trends decreased among children over time (difference, −3.4% [95% CI, −11% to 4.5%]; *P* for trend =.004), driven by non-Hispanic white children; were stable among adolescents (−4.8% [95% CI, −12% to 2.3%]; *P* for trend =.60) and among adults aged 20 through 64 years (−0.7% [95% CI, −5.6% to 4.1%]; *P* for trend =.82); but increased among adults aged 65 years or older (difference, 3.5% [95% CI, −1.2% to 8.1%]; *P* for trend =.03). The estimated prevalence of computer use outside school or work for 1 h/d or more increased in all ages (children, 43% [95% CI, 40% to 46%] to 56% [95% CI, 49% to 63%] from 2001 to 2016; difference, 13% [95% CI, 5.6% to 21%]; *P* for trend <.001;

JAMA Network™

From: **Trends in Sedentary Behavior Among the US Population, 2001-2016**

JAMA. 2019;321(16):1587-1597. doi:10.1001/jama.2019.3636



Date of download: 6/8/2020

Nongenetic Factors Contributing to Death in the United States in 1990

Tobacco	400,000 deaths
Diet and Inactivity	300,000 deaths
Alcohol	100,000 deaths
Microbial Agents	90,000 deaths
Toxic Agents	60,000 deaths

McGinness and Foege. JAMA 1993; 270:2207-2212

EXERCISE PRESCRIPTION

Benefits of Exercise

Leisure Time Physical Activity and Hazard Ratio of Mortality/Years of Life Gained after Age 40

Variable	Physical Activity Level (MET-h/wk)					
	0	0.1–3.74	3.75–7.4	7.5–14.9	15.0–22.4	22.5+
Number of participants	50,555	112,661	60,132	167,931	118,255	145,293
Number of deaths	9,754	18,352	6,968	20,428	11,814	15,149
Unadjusted HR	1.0	0.71	0.66	0.56	0.49	0.49
95% CI	Ref	0.70, 0.73	0.64, 0.68	0.55, 0.57	0.48, 0.51	0.48, 0.50
Gender-adjusted HR	1.0	0.73	0.67	0.57	0.49	0.48
95% CI	Ref	0.71, 0.75	0.64, 0.69	0.55, 0.58	0.48, 0.51	0.47, 0.50
Gender-, smoking-adjusted HR	1.0	0.77	0.70	0.61	0.54	0.53
95% CI	Ref	0.75, 0.79	0.68, 0.73	0.60, 0.63	0.53, 0.56	0.51, 0.54
Multivariable[a] HR	1.0	0.81	0.76	0.68	0.61	0.59
95% CI	Ref	0.79, 0.83	0.74, 0.78	0.66, 0.69	0.59, 0.63	0.57, 0.61
Years of life gained	—	1.8	2.5	3.4	4.2	4.5
95% CI	Ref	1.6, 2.0	2.2, 2.7	3.2, 3.6	4.0, 4.5	4.3, 4.7

Years of life expectancy gained after age 40 were derived using direct adjusted survival curves [31,32] for participants who were 40+y of age at baseline (97.5% of participants).

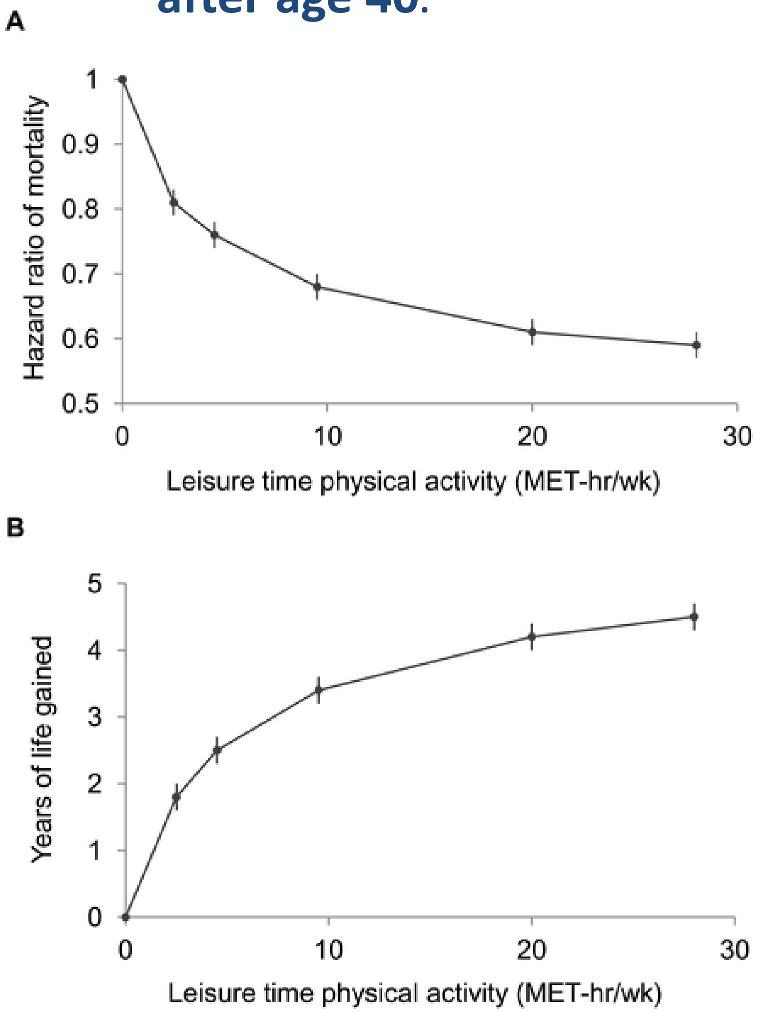
[a]HRs were calculated in models stratified by study that used age as the underlying time scale. Multivariable models were adjusted for gender, alcohol consumption (0, 0.1–14.9, 15.0–29.9, 30.0+ g/d), education (did not complete high school, completed high school, post-high-school training, some college, completed college), marital status (married, divorced, widowed, unmarried), history of heart disease, history of cancer, BMI (<18.5, 18.5–19.9, 20–22.4, 22.5–24.9, 25–27.4, 27.5–29.9, 30+ kg/m^2), and smoking status (never, former, current).

doi:10.1371/journal.pmed.1001335.t003

Moore SC, Patel AV, Matthews CE, Berrington de Gonzalez A, et al. (2012) Leisure Time Physical Activity of Moderate to Vigorous Intensity and Mortality: A Large Pooled Cohort Analysis. PLoS Med 9(11): e1001335. doi:10.1371/journal.pmed.1001335
http://www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.1001335

PLoS MEDICINE

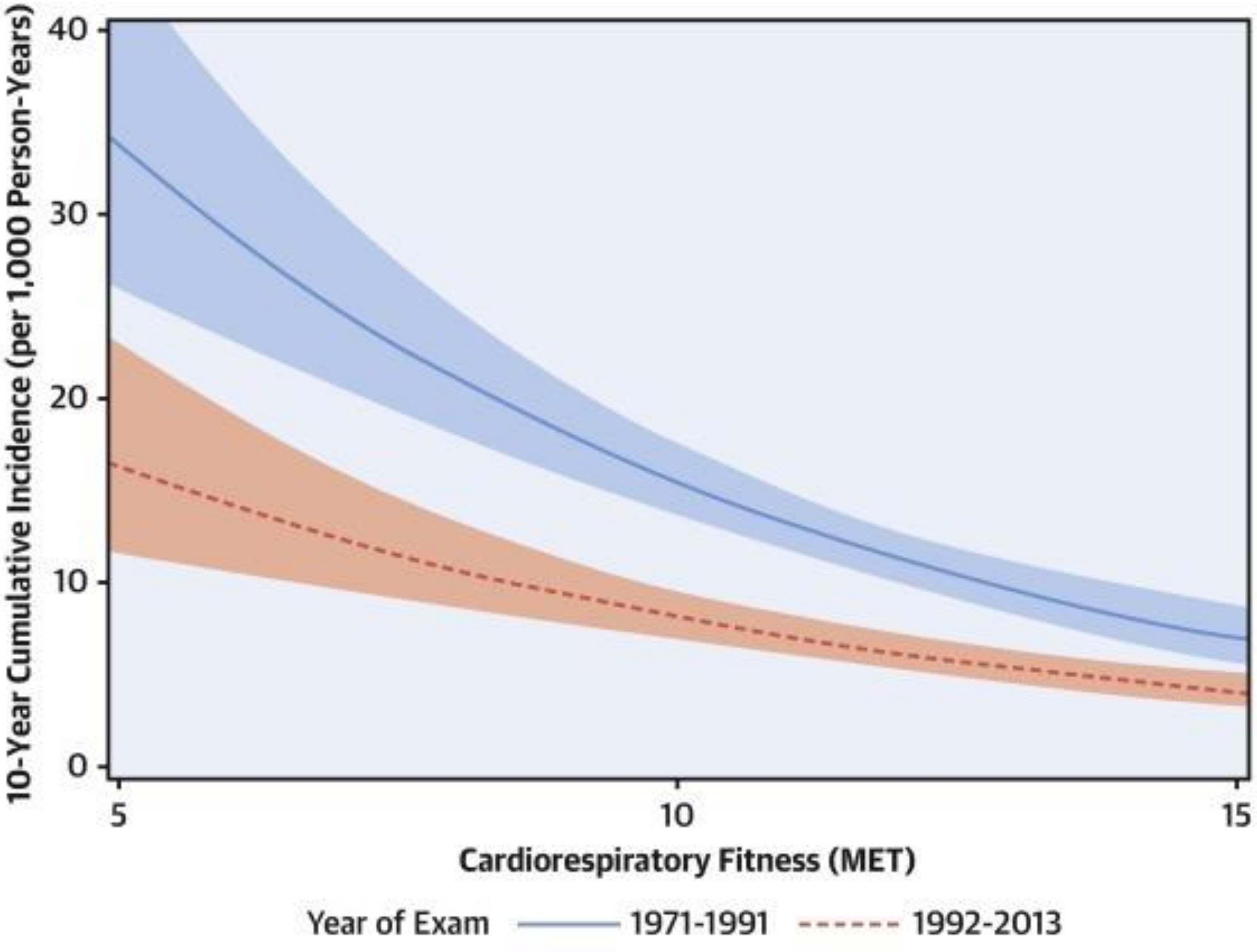
Figure 1. Leisure time physical activity level and hazard ratios for mortality and gains in life expectancy after age 40.



Moore SC, Patel AV, Matthews CE, Berrington de Gonzalez A, et al. (2012) Leisure Time Physical Activity of Moderate to Vigorous Intensity and Mortality: A Large Pooled Cohort Analysis. PLoS Med 9(11): e1001335. doi:10.1371/journal.pmed.1001335
http://www.plosmedicine.org/article/info:doi/10.1371/journal.pmed.1001335

PLoS MEDICINE

CENTRAL ILLUSTRATION: Fitness and Mortality in Men During 2 Different Eras of Medical Care



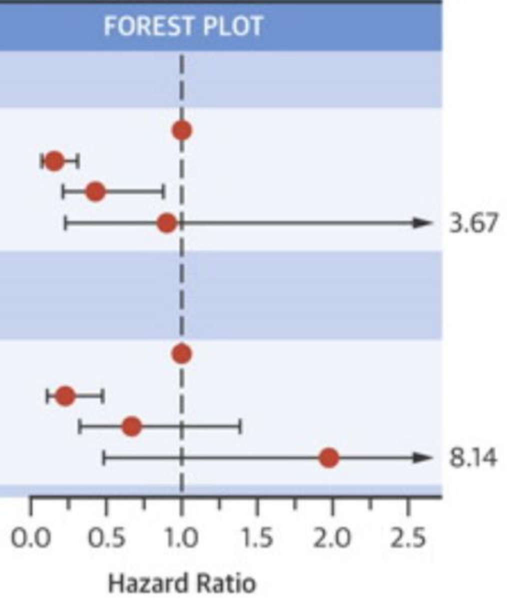
Farrell, S.W. et al. J Am Coll Cardiol. 2020;75(13):1538–47.

JACC Journals

From: Dose of Jogging and Long-Term Mortality: The Copenhagen City Heart Study

J Am Coll Cardiol. 2015;65(5):411-419. doi:10.1016/j.jacc.2014.11.023

DOSE OF JOGGING	NO. OF PARTICIPANTS	ALL-CAUSE MORTALITY DEATHS
Adjusted for age and sex		
Sedentary nonjogger (reference)	413	128
Light jogger	576	7
Moderate jogger	262	8
Strenuous jogger	40	2
Adjusted for age, sex, smoking, alcohol intake, education, and diabetes		
Sedentary nonjogger (reference)	394	120
Light jogger	570	7
Moderate jogger	252	8
Strenuous jogger	36	2



Schnohr, P. et al. J Am Coll Cardiol. 2015; 65(5):411-9.

Figure Legend:

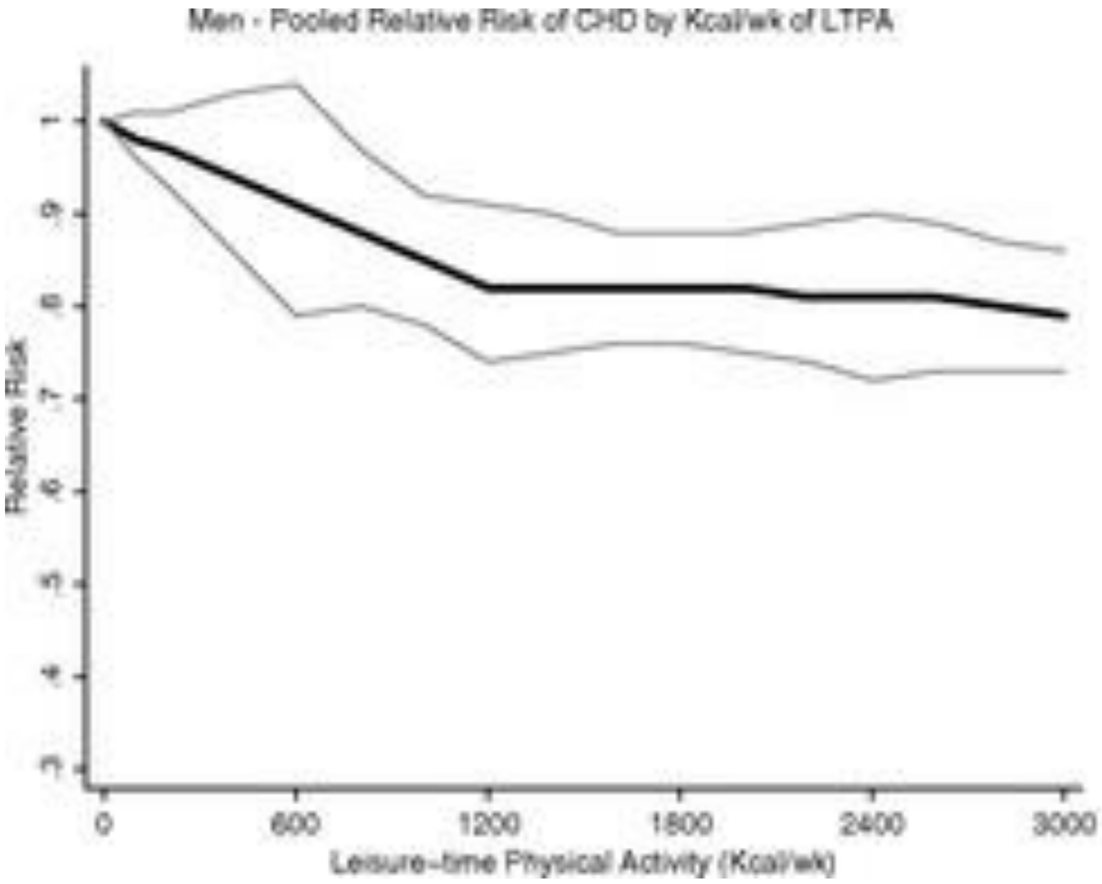
Dose of Jogging and Long-Term Mortality
Forest plot indicating all-cause mortality in light, moderate, and strenuous joggers compared with sedentary nonjoggers.

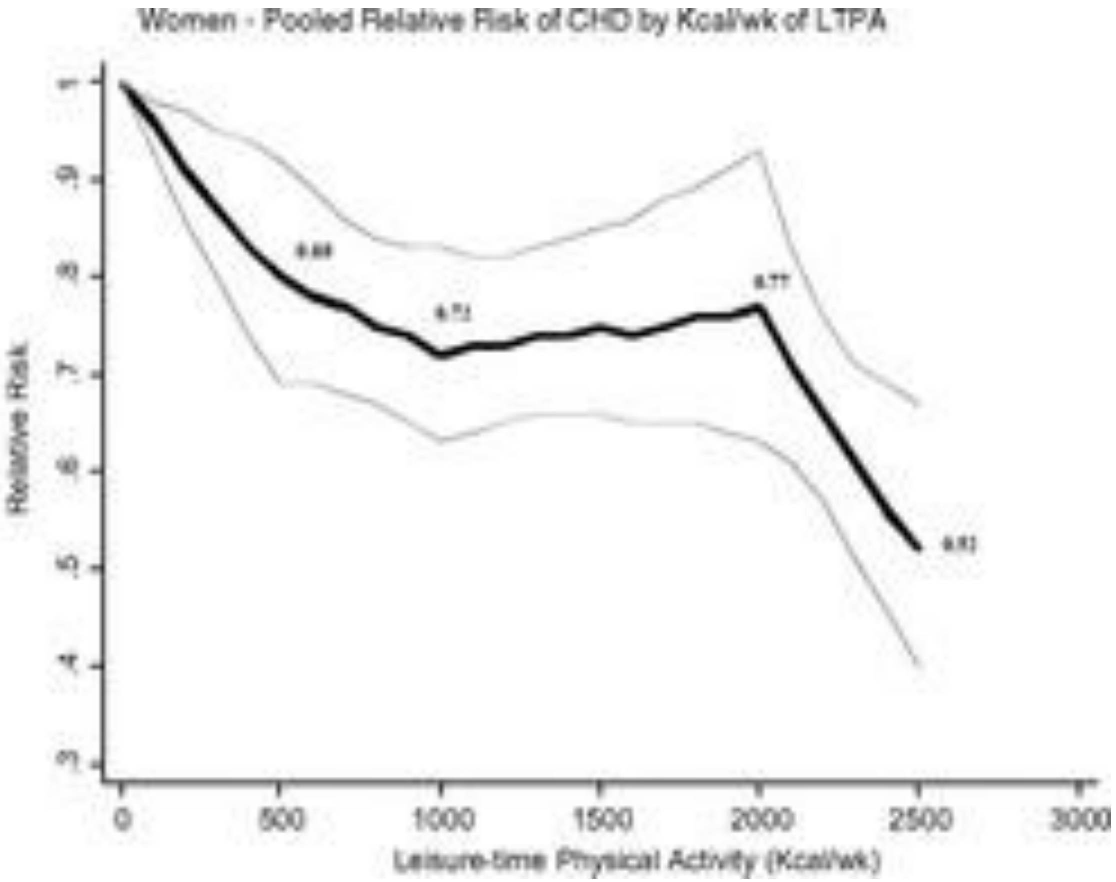
Longevity in Joggers
The Copenhagen Heart Study

Jogging Status	No. of Participants	No. of Deaths	Hazard Ratio	95% CI	Increase in Survival, years
			Adjusted for age		
Men					
Nonjoggers	7,678	5,040	1.00	Referent	0.0
Joggers	1,116	94	0.56	0.46, 0.67	6.2
Women					
Nonjoggers	9,149	5,118	1.00	Referent	0.0
Joggers	762	28	0.56	0.40, 0.80	5.6

Schnor P et al. Am J Epidem 2013; 177(7):683-689

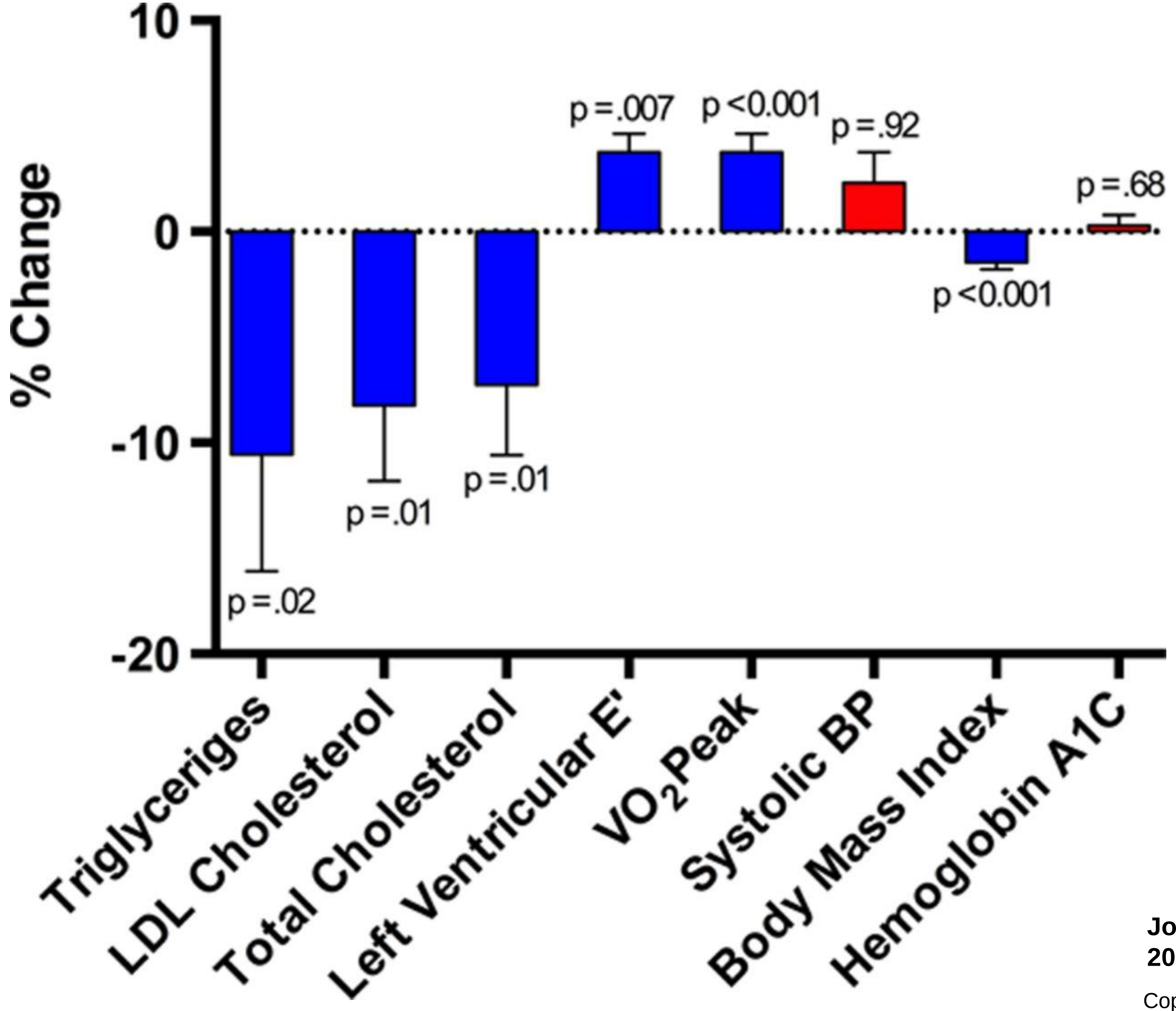
LTPA and Risk of Coronary Artery Disease





Jacob Sattelmair. Circulation. Dose Response Between Physical Activity and Risk of Coronary Heart Disease, Volume: 124, Issue: 7, Pages: 789-795, DOI: (10.1161/CIRCULATIONAHA.110.010710)

Changes in Cardiovascular Risk Factors in Response to Marathon Training



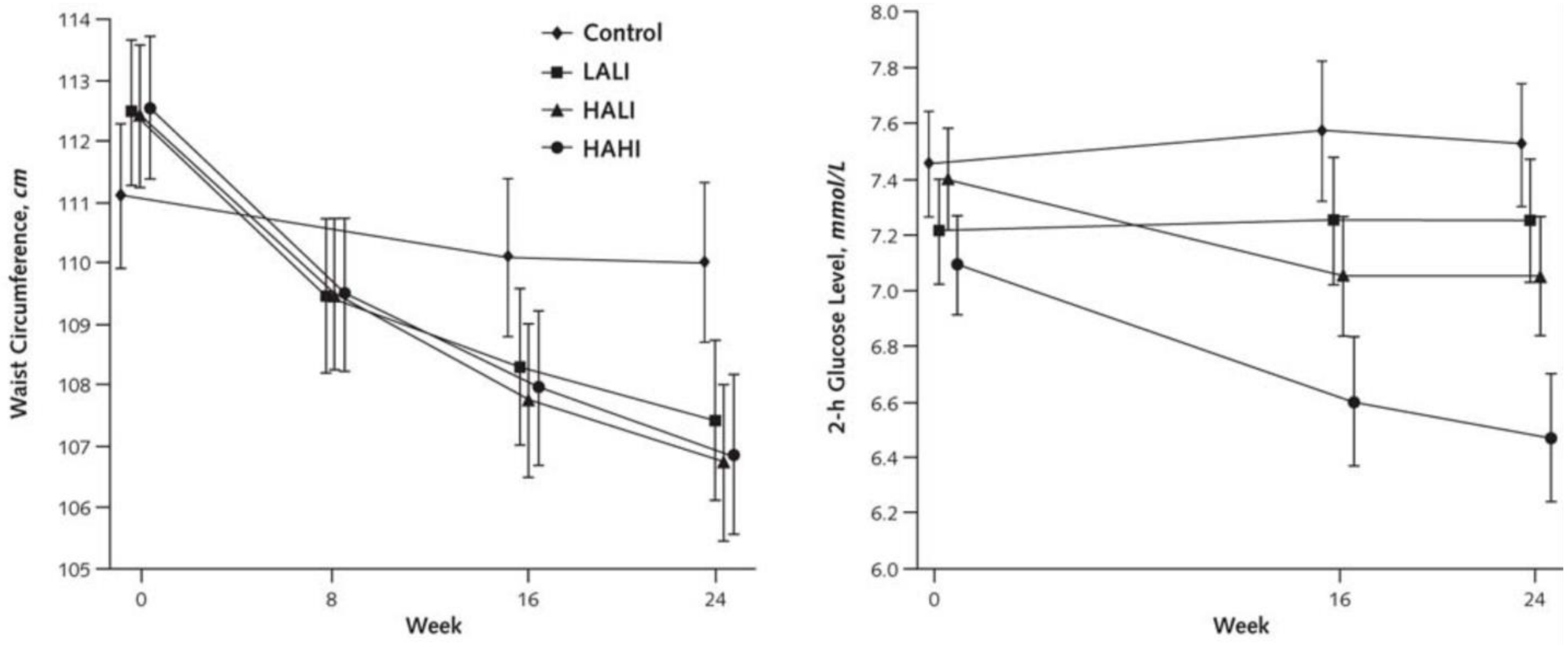
American Heart Association

Jodi L. Zilinski et al. Circ Cardiovasc Imaging. 2015;8:e002487

Annals of Internal Medicine
Established in 1927 by the American College of Physicians

From: Effects of Exercise Amount and Intensity on Abdominal Obesity and Glucose Tolerance in Obese Adults: A Randomized TrialEffects of Exercise on Obesity and Glucose Intolerance

Ann Intern Med. 2015;162(5):325-334. doi:10.7326/M14-1189

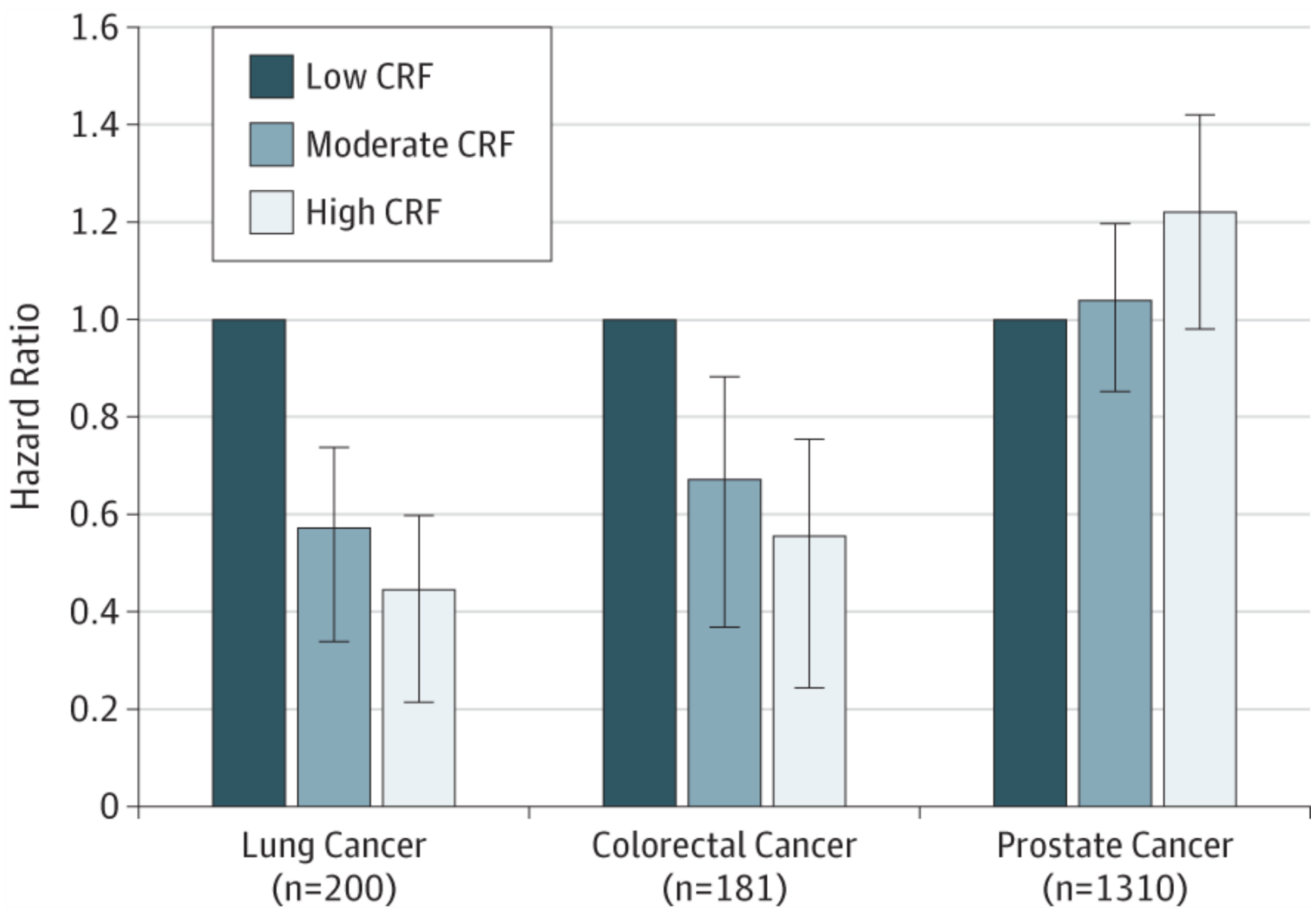


Participants with waist circumference and 2-h glucose data at each time point, *n*

Control	75	–	37	53	75	38	53
LALI	73	58	52	56	73	52	56
HALI	76	64	59	59	76	59	60
HAHI	76	55	48	49	76	49	48

From: **Midlife Cardiorespiratory Fitness, Incident Cancer, and Survival After Cancer in Men: The Cooper Center Longitudinal Study**

JAMA Oncol. Published online March 26, 2015. doi:10.1001/jamaoncol.2015.0226



From: **Midlife Cardiorespiratory Fitness, Incident Cancer, and Survival After Cancer in Men: The Cooper Center Longitudinal Study**

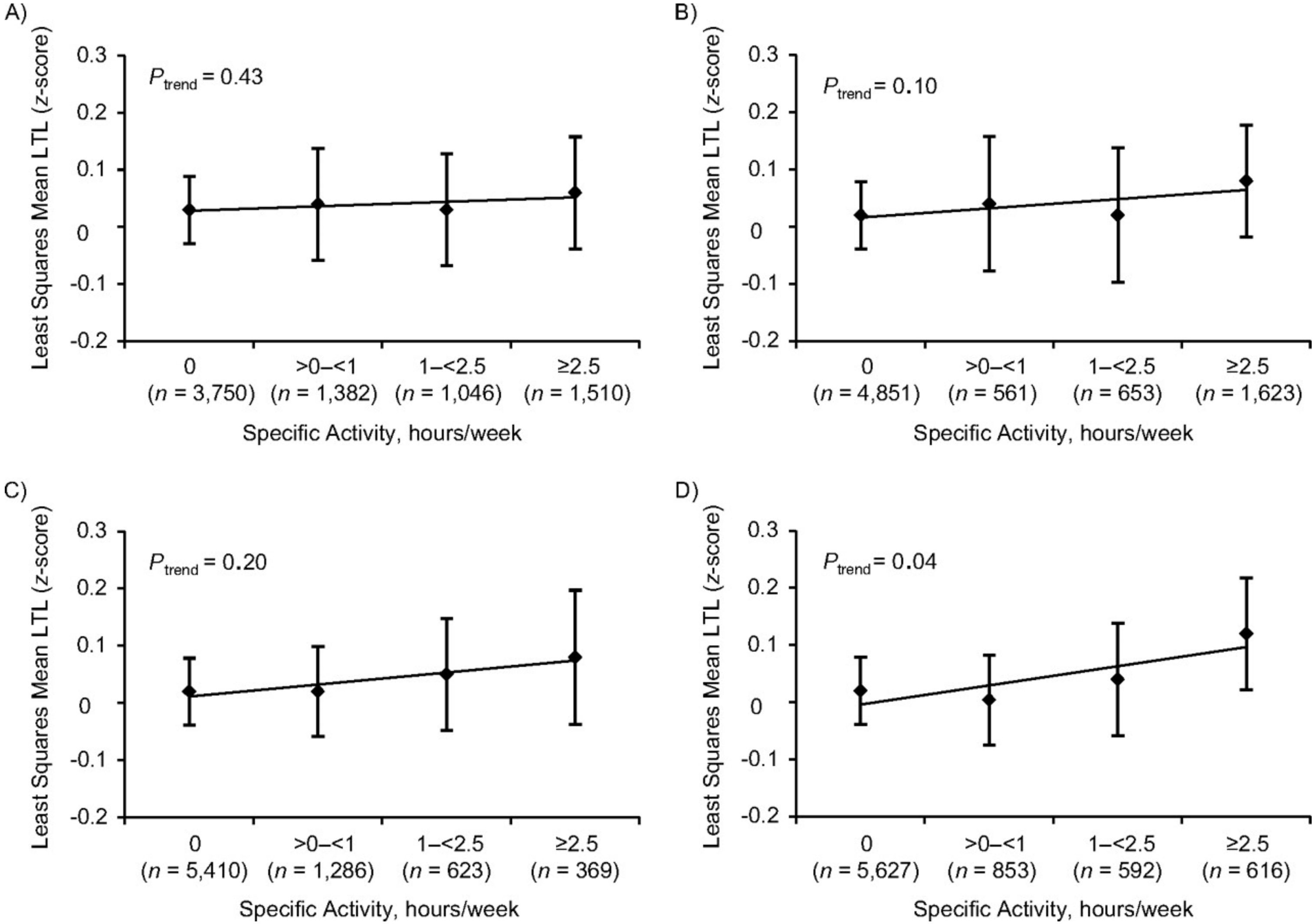
JAMA Oncol. Published online March 26, 2015. doi:10.1001/jamaoncol.2015.0226

Table 3. Association Between Midlife Cardiorespiratory Fitness (CRF) and Later-Life Incident Cancer in the Cooper Center Longitudinal Study

		Hazard Ratio (95% CI)[a]			
Cancer	Events, No.	Low CRF	Moderate CRF	High CRF	1-MET Increase
Lung	200	1 [Reference]	0.57 (0.41-0.81)	0.45 (0.29-0.68)	0.83 (0.77-0.90)
Colon	181	1 [Reference]	0.67 (0.46-0.98)	0.56 (0.36-0.87)	0.91 (0.84-0.99)
Prostate	1310	1 [Reference]	1.04 (0.88-1.23)	1.22 (1.02-1.46)	1.03 (1.00-1.06)

:

Estimated least-squares mean leukocyte telomere length (LTL) (z-score) and 95% confidence interval by hours/week of easy walking (A), brisk walking (B), biking (C), and calisthenics or aerobics (D) reported in 1988 in the Nurses' Health Study, United States.



Du M et al. Am. J. Epidemiol. 2012;175:414-422

American Journal of
EPIDEMIOLOGY

Estimated Least-Squares Mean Telomere Length (*z*-score) and 95% Confidence Interval by Total Physical Activity Reported in 1988, Nurses' Health Study, United States

	Total Activity in 1988, MET-hours/week										
	<3 (*n* = 1,605)		3–<9 (*n* = 2,005)		9–<18 (*n* = 1,680)		18–<27 (*n* = 1,037)		≥27 (*n* = 1,337)		P_{trend}[a]
	LTL	95% CI	LTL	95% CI	LTL	95% CI	LTL	95% CI	LTL	95% CI	
Age adjusted	−0.04	−0.09, 0.01	−0.02	−0.06, 0.03	0.04	−0.008, 0.09	0.05	−0.01, 0.11	0.03	−0.02, 0.08	0.02
Multivariate	−0.02	−0.09, 0.05	0.000	−0.07, 0.07	0.05	−0.01, 0.12	0.06	−0.01, 0.14	0.05	−0.03, 0.12	0.02
Multivariate + BMI	−0.01	−0.08, 0.06	−0.001	−0.07, 0.06	0.05	−0.02, 0.12	0.06	−0.02, 0.13	0.04	−0.03, 0.11	0.05

Du M et al. Am. J. Epidemiol. 2012;175:414-422

SHARE May 26, 2020; 94 (21) ARTICLE

Aerobic exercise improves cognition and cerebrovascular regulation in older adults

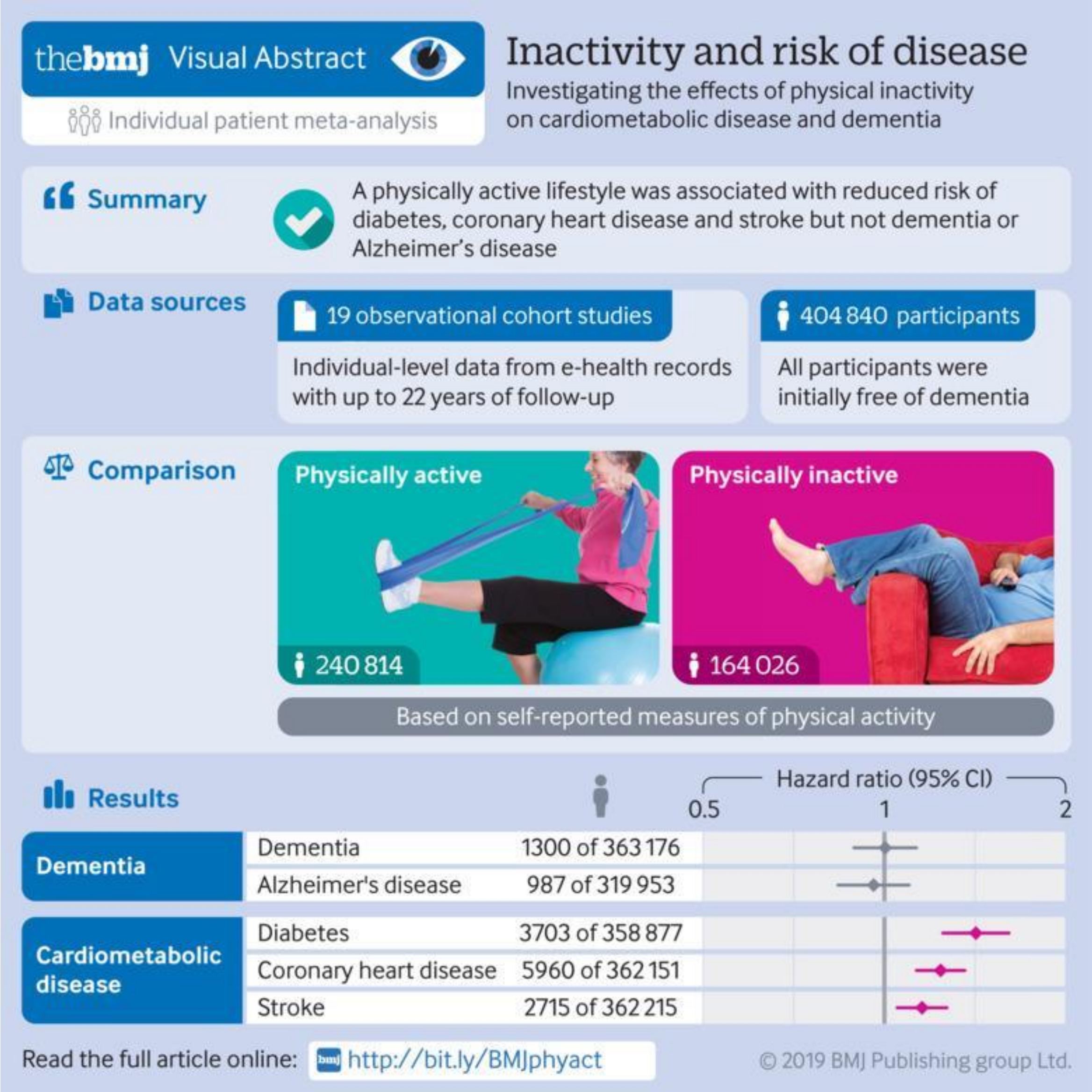
Veronica Guadagni, Lauren L. Drogos, Amanda V. Tyndall, Margie H. Davenport, Todd J. Anderson, Gail A. Eskes, R. Stewart Longman, Michael D. Hill, David B. Hogan, Marc J. Poulin

First published May 13, 2020, DOI: https://doi.org/10.1212/WNL.0000000000009478

Abstract

Objective To test the hypothesis that aerobic exercise is associated with improvements in cognition and

Physical Inactivity and Risk of Dementia



Mika Kivimäki et al. BMJ 2019;365:bmj.l1495

A national initiative led by CDC to help

27 million Americans

become more physically active by 2027. Increased physical activity can improve health, quality of life, and reduce healthcare costs.

CREATING AN ACTIVE AMERICA, TOGETHER

ACTIVE PEOPLE, HEALTHY NATION℠

EXERCISE PRESCRIPTION

Exercise Recommendations

ACSM Position Stand 2011

SPECIAL COMMUNICATIONS

Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise

AMERICAN COLLEGE of SPORTS MEDICINE

POSITION STAND

This pronouncement was written for the American College of Sports Medicine by Carol Ewing Garber, Ph.D., FACSM, (Chair); Bryan Blissmer, Ph.D.; Michael R. Deschenes, Ph.D., FACSM; Barry A. Franklin, Ph.D., FACSM; Michael J. Lamonte, Ph.D., FACSM; I-Min Lee, M.D., Sc.D., FACSM; David C. Nieman, Ph.D., FACSM; and David P. Swain, Ph.D., FACSM.

SUMMARY

The purpose of this Position Stand is to provide guidance to professionals who counsel and prescribe *individualized* exercise to apparently healthy adults of all ages. These recommendations also may apply to adults with certain chronic diseases or disabilities, when appropriately evaluated and advised by a health professional. This document supersedes the 1998 American College of Sports Medicine (ACSM) Position Stand, "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults." The scientific evidence demonstrating the beneficial effects of exercise is indisputable, and the benefits of exercise far outweigh the risks in most adults. A program of regular exercise that includes cardiorespiratory, resistance, flexibility, and neuromotor exercise training *beyond* activities of daily living to improve and maintain physical fitness and health is *essential* for most adults. The ACSM recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for ≥30 min·d^{-1} on ≥5 d·wk^{-1} for a total of ≥150 min·wk^{-1}, vigorous-intensity cardiorespiratory exercise training for ≥20 min·d^{-1} on ≥3 d·wk^{-1} (≥75 min·wk^{-1}), or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of ≥500–1000 MET·min·wk^{-1}. On 2–3 d·wk^{-1}, adults should also perform resistance exercises for each of the major muscle groups, and neuromotor exercise involving balance, agility, and coordination. Crucial to maintaining joint range of movement, completing a series of flexibility exercises for each the major muscle–tendon groups (a total of 60 s per exercise) on ≥2 d·wk^{-1} is recommended. The exercise program should be modified according to an individual's habitual physical activity, physical function, health status, exercise responses, and stated goals. Adults who are unable or unwilling to meet the exercise targets outlined here still can benefit from engaging in amounts of exercise *less than* recommended. In addition to exercising regularly, there are health benefits in concurrently reducing total time engaged in sedentary pursuits and also by interspersing frequent, short bouts of standing and physical activity between periods of sedentary activity, even in physically active adults. Behaviorally based exercise interventions, the use of behavior change strategies, supervision by an experienced fitness instructor, and exercise that is pleasant and enjoyable can improve adoption and adherence to prescribed exercise programs. Educating adults about and screening for signs and symptoms of CHD and gradual progression of exercise intensity and volume may reduce the risks of exercise. Consultations with a medical professional and diagnostic exercise testing for CHD are useful when clinically indicated but are not recommended for universal screening to enhance the safety of exercise.

Key Words: Practice Guidelines, Prescription, Physical Activity, Physical Fitness, Health, Aerobic Exercise, Resistance Exercise, Flexibility Exercise, Neuromotor Exercise, Functional Fitness

INTRODUCTION

Many recommendations for exercise and physical activity by professional organizations and government agencies have been published since the *sui generis* publications of the American College of Sports Medicine (ACSM) (10,11). The number of recommendations has escalated after the release of the 1995 Centers for Disease Control and Prevention (CDC)/ACSM public health recommendations (280) and the 1996 US Surgeon General's Report (371), and the ostensibly contradictory recommendations between these documents have led to confusion among health professionals, fitness professionals, and the public (32,155). The more recent recommendations of the American Heart Association (AHA)

0195-9131/11/4307-1334/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0b013e318213fefb

Classification of Exercise Intensity:
Relative and Absolute Exercise Intensity for Cardiorespiratory Endurance and Resistance Exercise

	Cardiorespiratory Endurance Exercise												Resistance Exercise
	Relative Intensity				Intensity ($\%\dot{V}O_{2max}$) Relative to Maximal Exercise Capacity in METs			Absolute Intensity	Absolute Intensity (MET) by Age			Relative Intensity
Intensity	%HRR or $\%\dot{V}O_2R$	$\%HR_{max}$	$\%\dot{V}O_{2max}$	Perceived Exertion (Rating on 6–20 RPE Scale)	20 METs $\%\dot{V}O_{2max}$	10 METs $\%\dot{V}O_{2max}$	5 METs $\%\dot{V}O_{2max}$	METs	Young (20–39 yr)	Middle-aged (40–64 yr)	Older (≥65 yr)	% 1RM
Very light	<30	<57	<37	<Very light (RPE < 9)	<34	<37	<44	<2	<2.4	<2.0	<1.6	<30
Light	30–39	57–63	37–45	Very light–fairly light (RPE 9–11)	34–42	37–45	44–51	2.0–2.9	2.4–4.7	2.0–3.9	1.6–3.1	30–49
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE 12–13)	43–61	46–63	52–67	3.0 to 5.9	4.8–7.1	4.0–5.9	3.2–4.7	50–69
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	62–90	64–90	68–91	6.0–8.7	7.2–10.1	6.0–8.4	4.8–6.7	70–84
Near–maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥ 18)	≥91	≥91	≥92	≥8.8	≥10.2	≥8.5	≥6.8	≥85

Table adapted from the American College of Sports Medicine (14), Howley (173), Swain and Franklin (344), Swain and Leutholtz (346), Swain et al. (347), and the US Department of Health and Human Services (370).
HR_{max}, maximal HR; $\%HR_{max}$, percent of maximal HR; HRR, HR reserve; $\dot{V}O_{2max}$, maximal oxygen uptake; $\%\dot{V}O_{2max}$, percent of maximal oxygen uptake; $\dot{V}O_2R$, oxygen uptake reserve; RPE, ratings of perceived exertion (48).

Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness in Apparently Healthy Adults: Guidance for Prescribing Exercise

Garber, Carol Ewing; Blissmer, Bryan; Deschenes, Michael R.; Franklin, Barry A.; Lamonte, Michael J.; Lee, I-Min; Nieman, David C.; Swain, David P.

Medicine & Science in Sports & Exercise43(7):1334-1359, July 2011.
doi: 10.1249/MSS.0b013e318213fefb

Department of Health and Human Services 2018 Guidelines

Children and Adolescent Recommendations

- Provide young people with the opportunities and encouragement to participate in physical activities that are enjoyable, offer variety and appropriate for age
- Children and adolescents ages 6-17 should engage in 60 minutes or more of moderate to vigorous physical activity daily

Children and Adolescent Recommendations

- Aerobic: most of the 60 minutes or more per day should be of either moderate or vigorous intensity and should include vigorous intensity activity at least three days of the week
- Muscle strengthening: Part of the 60 minutes or more of daily physical activity should include muscle strengthening activity on at least 3 days of the week
- Bone strengthening: Part of the 60 minutes or more of daily physical activity should include bone strengthening activity on at least 3 days of the week

Adult Recommendations

- Move more and sit less throughout the day
- 150-300 minutes per week of moderate intensity

OR

- 75-150 minutes per week of vigorous intensity aerobic activity

OR

- Equivalent combination of moderate and vigorous intensity aerobic activity
- Activity should preferably be spread out throughout the week

Adult Recommendations

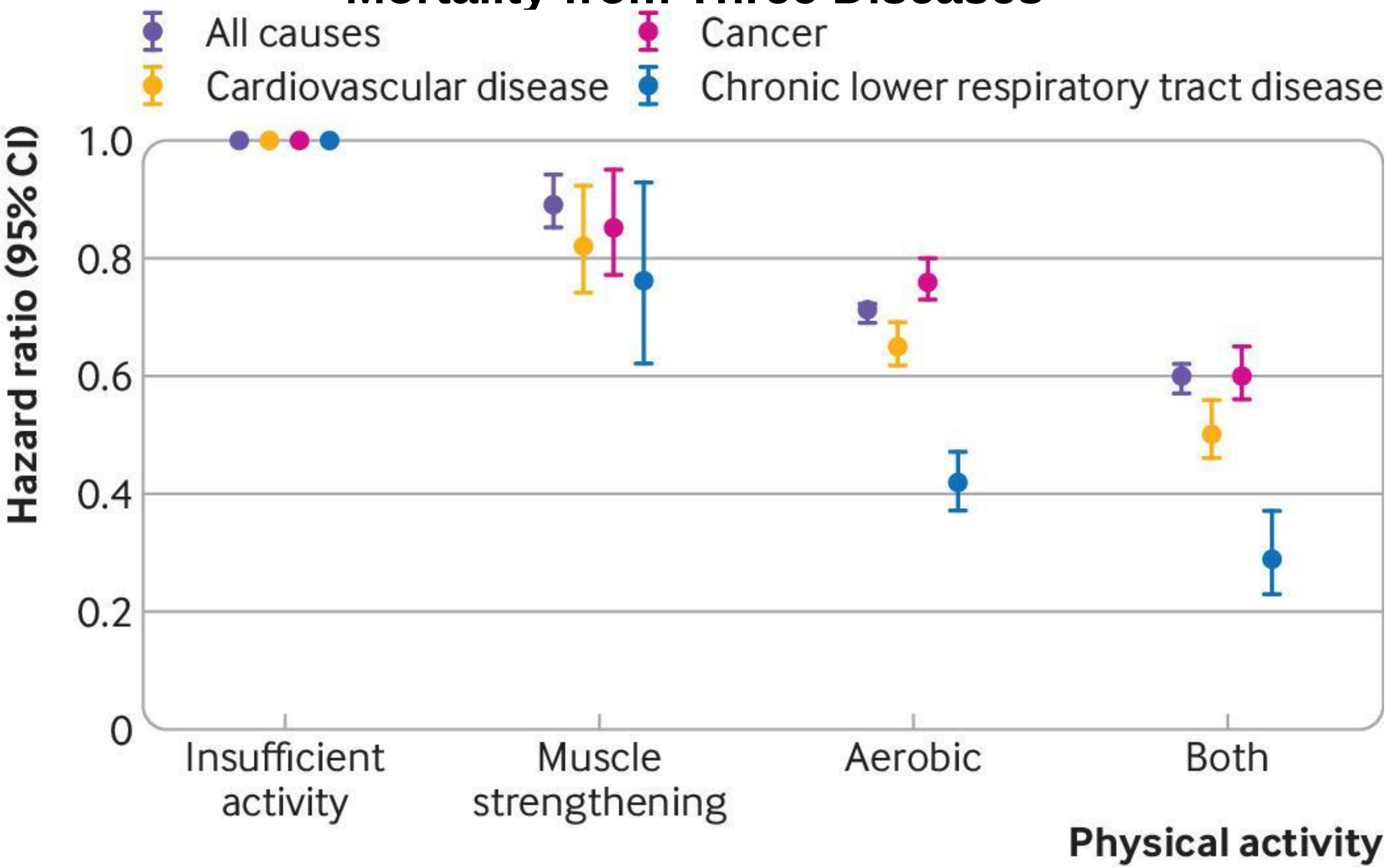
- Additional health evefits are gained by engaging in physical activity beyond the equivalent of 300 hours of moderate intensity exercise per week
- Adults should also perform muscle strengthening activities of moderate or greater intensity that involve all major muscle groups on 2 or more days per week

Older Adult Recommendations

Key guidelines for adults also apply with following additional considerations:

1. Multicomponent activity that includes balance training
2. Effort level should be guided by level of fitness
3. Chronic conditions may influence the ability to exercise safely
4. When chronic conditions limit the ability to perform 150 minutes per week of moderate intensity exercise weekly, they should be as physically active as their conditions permit

Association between Meeting the 2018 Physical Activity Guidelines for Americans and All Cause and Cause Specific Mortality from Three Diseases



Min Zhao et al. BMJ 2020;370:bmj.m2031

EXERCISE PRESCRIPTION

Risks of Exercise

Exercise-Related Acute Cardiovascular Events and Potential Deleterious Adaptations Following Long-Term Exercise Training: Placing the Risks Into Perspective–An Update: A Scientific Statement From the American Heart Association

Barry A. Franklin, Paul D. Thompson, Salah S. Al-Zaiti, Christine M. Albert, Marie-France Hivert, Benjamin D. Levine, Felipe Lobelo, Kushal Madan, Anjail Z. Sharrief, Thijs M.H. Eijsvogels, ... **Show all Authors**

Originally published 26 Feb 2020 | Circulation. ;0:CIR.0000000000000749

Evidence Summary

	Evidence Statement	Evidence Category
Health benefits	Engaging in regular exercise and reducing sedentary behavior is vital for the health of adults.	A
Reversibility of training effects	Training-induced adaptations are reversed to varying degrees over time upon cessation of a program of regular exercise.	A
Heterogeneity of response	There is considerable variability in individual responses to a standard dose of exercise.	A
Exercise regimen	Cardiorespiratory and resistance exercise training is recommended to improve physical fitness and health.	A
	Flexibility exercises improve and maintain and joint range of movement	A
	Neuromotor exercises and multifaceted activities (such as tai ji and yoga) can improve or maintain physical function, and reduce falls in older persons at risk for falling.	B
	Neuromotor exercises may benefit middle aged and younger adults	D
Exercise adoption and maintenance	Theory-based exercise interventions can be effective in improving adoption and short-term adherence to exercise.	B
	Moderate-intensity exercise and exercise that is enjoyable can enhance the affective responses to exercise, and may improve exercise adherence	B
	Supervision by an experienced health and fitness professional and enhance exercise adherence	C
Risks of exercise	Exercise is associated with an increased risk of musculoskeletal injury and adverse CHD events.	B
	The benefits of exercise far outweigh the risks in most adults.	C
	Warm-up, cool down, flexibility exercise, and gradual progression of exercise volume and intensity may reduce the risk of CVD events and musculoskeletal injury during exercise.	C
	Consultation with a physician and diagnostic exercise testing for CHD may reduce risks of exercise if medically indicated, but are not recommended on a routine basis.	C
	Consultation with a well-trained fitness professional may reduce risks in novice exercisers and in persons with chronic diseases and conditions	D
Preexercise screening	Screening for and educating about the forewarning signs or symptoms of CVD events may reduce the risks of serious untoward events.	C

Table evidence categories: A, randomized controlled trials (rich body of data); B, randomized controlled (limited body of data); C, nonrandomized trials, observational studies; D, panel consensus judgment. From the National Heart Lung and Blood Institute (263).

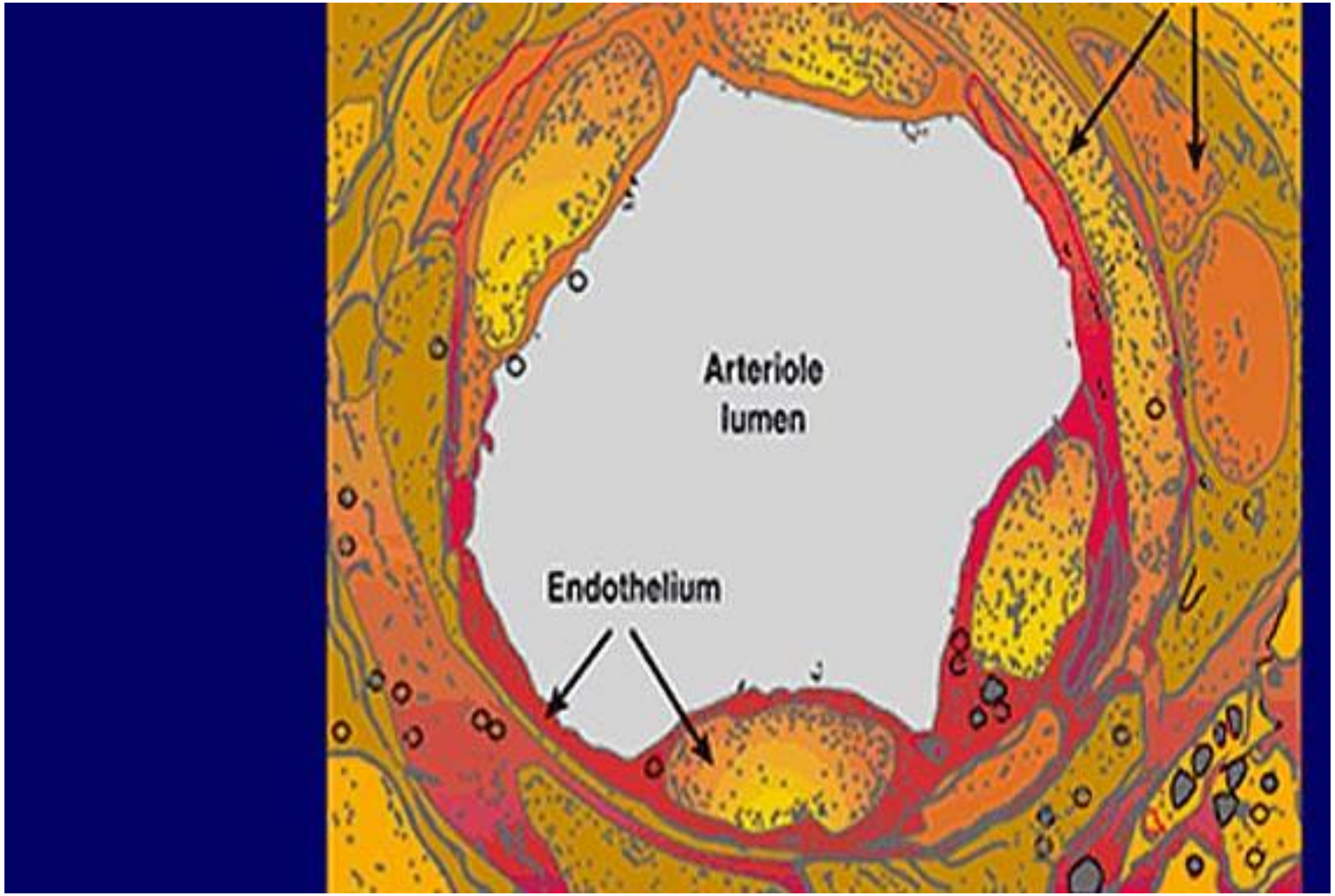
EXERCISE AND HEART DISEASE
Risk of Myocardial Infarction

- Relative risk for infarction is 6 times greater in the hour after heavy exertion
- For those exercising at least 5 times weekly the relative risk was 2.4
- The relative risk was 107 for those exercising less that once per week

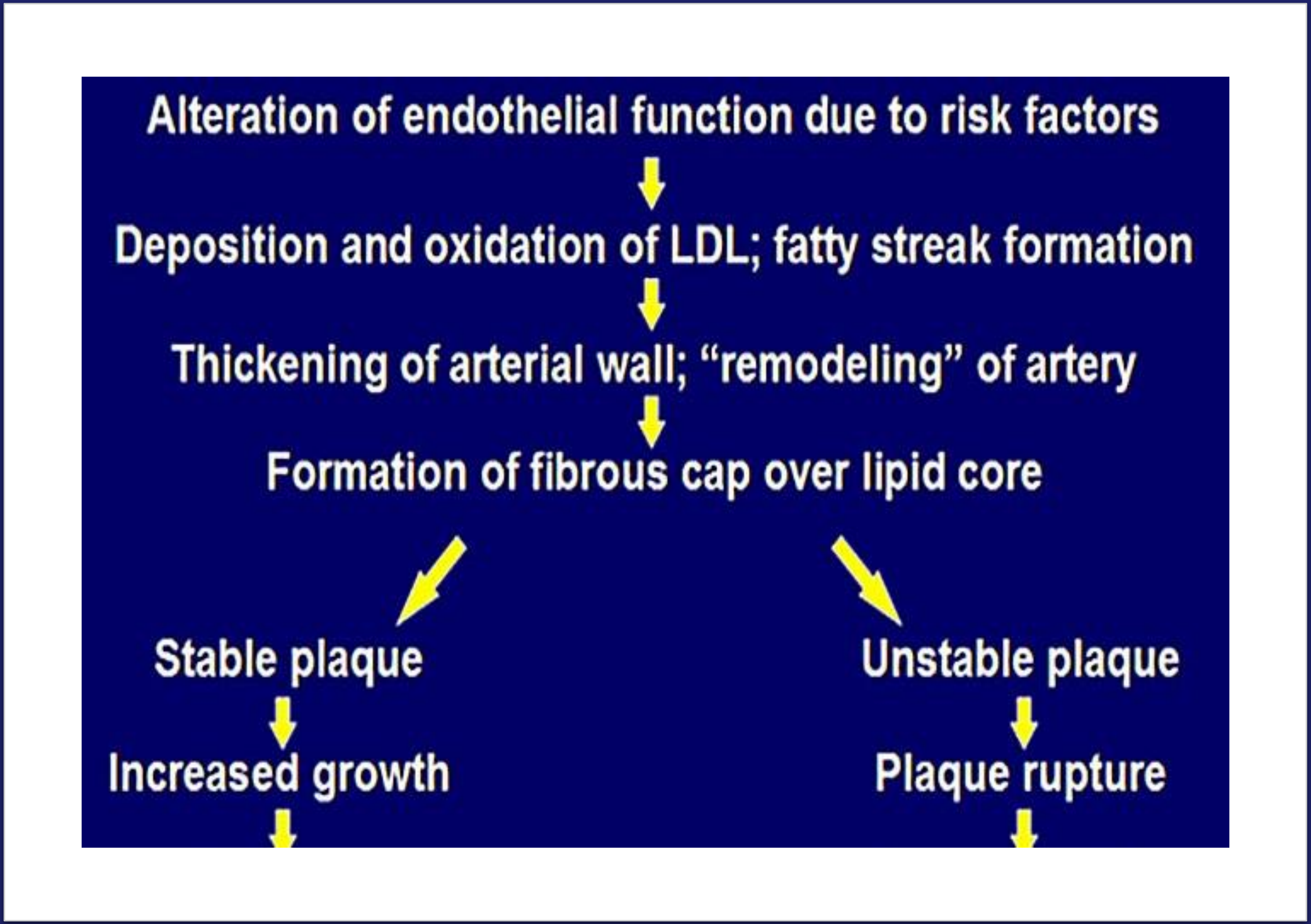
Mittleman et al. N Engl J Med 1993; 329:1677-1683

EXERCISE AND HEART DISEASE
Risk of Myocardial Infarction

- Only 4% of all infarctions were associated with heavy exertion
- After controlling for confounding factors, exercise independently predicted risk for myocardial infarction
- Static and dynamic exercise implicated
- Absolute risk low – a 50 year old nonsmoking, nondiabetic male has a one in a million chance of infarction

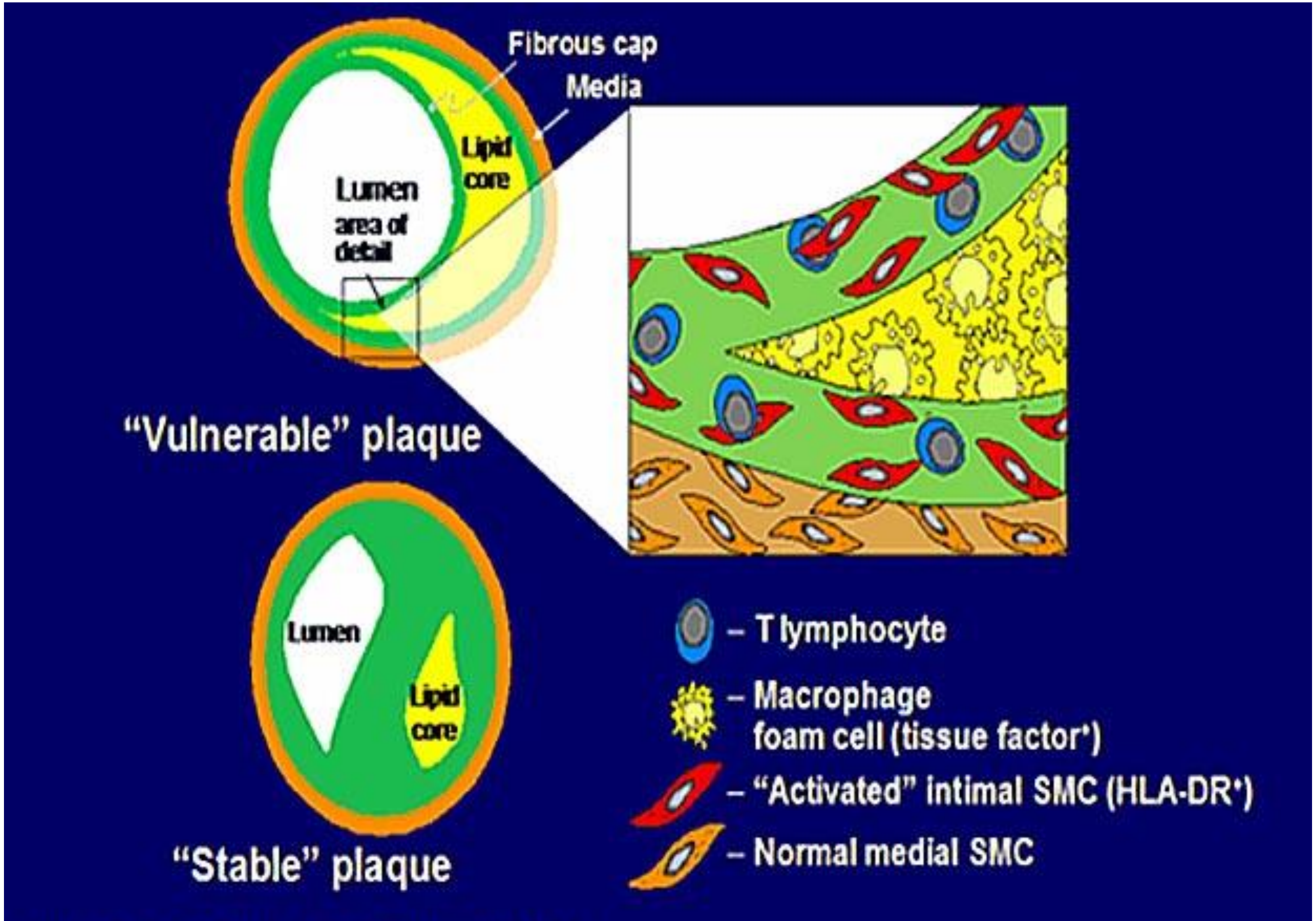


THE ENDOTHELIUM



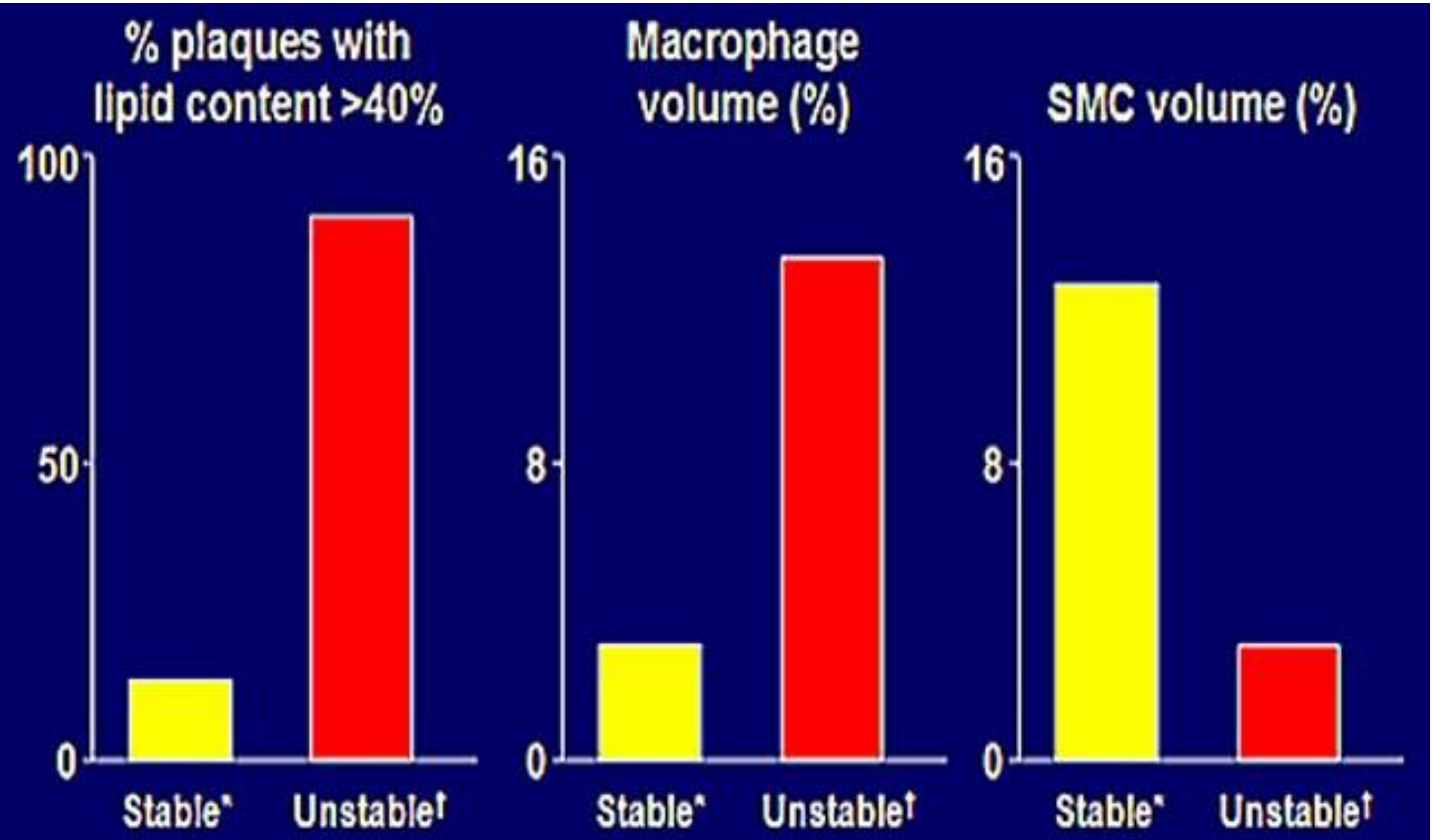
Consequences of Endothelial Dysfunction

Vulnerable Plaque



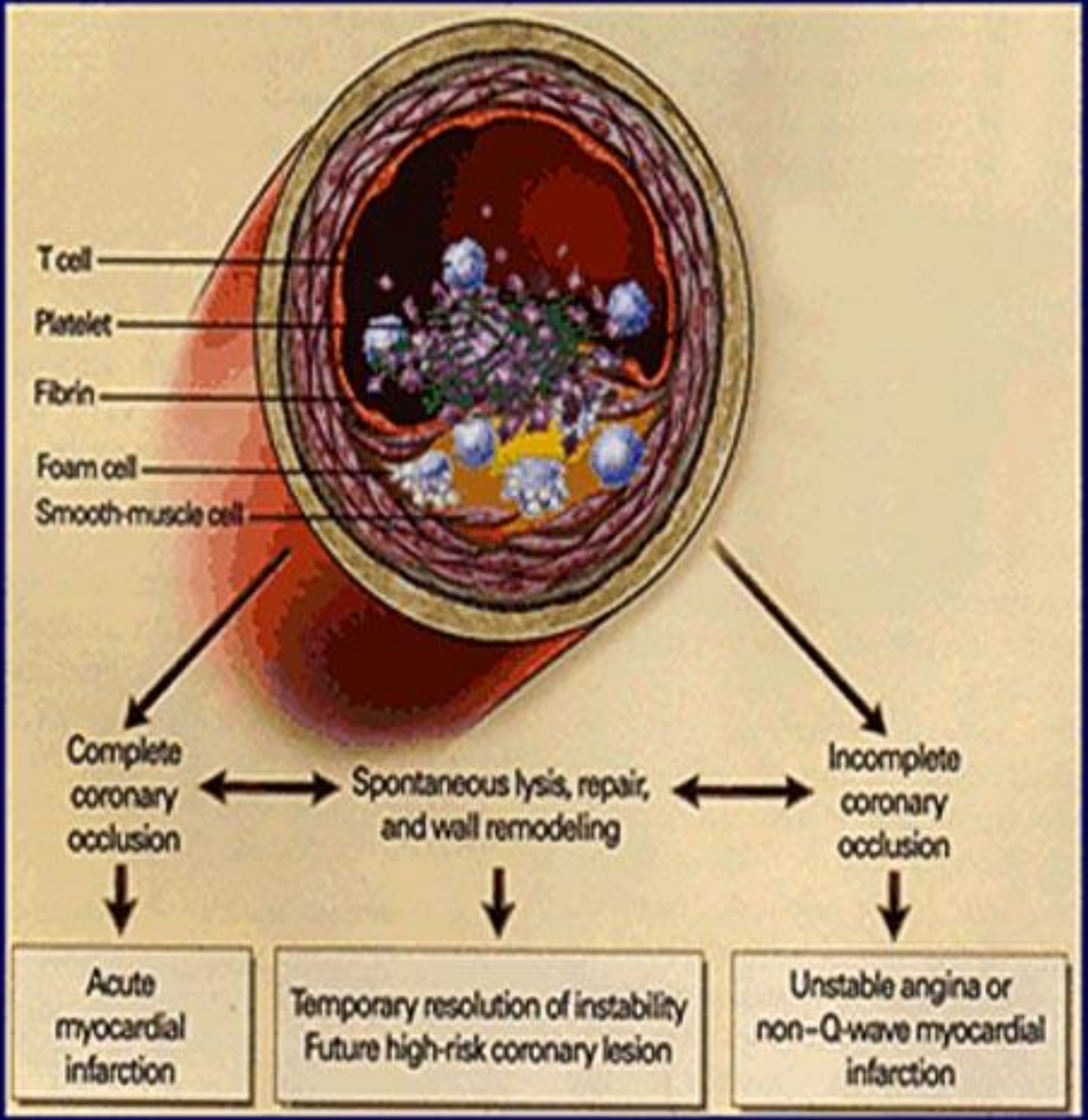
Libby P. *Am J Cardiol.* 2000;86(suppl):3J-9J.

Composition of Vulnerable Plaque



SMC = smooth muscle cell.
* Smooth surface.
† Fissured.
Davies MJ, et al. *Br Heart J.* 1993;69:377-381.

Plaque Rupture



Yeghiazarians Y, et al. *N Engl J Med.* 2000;342:101-114.

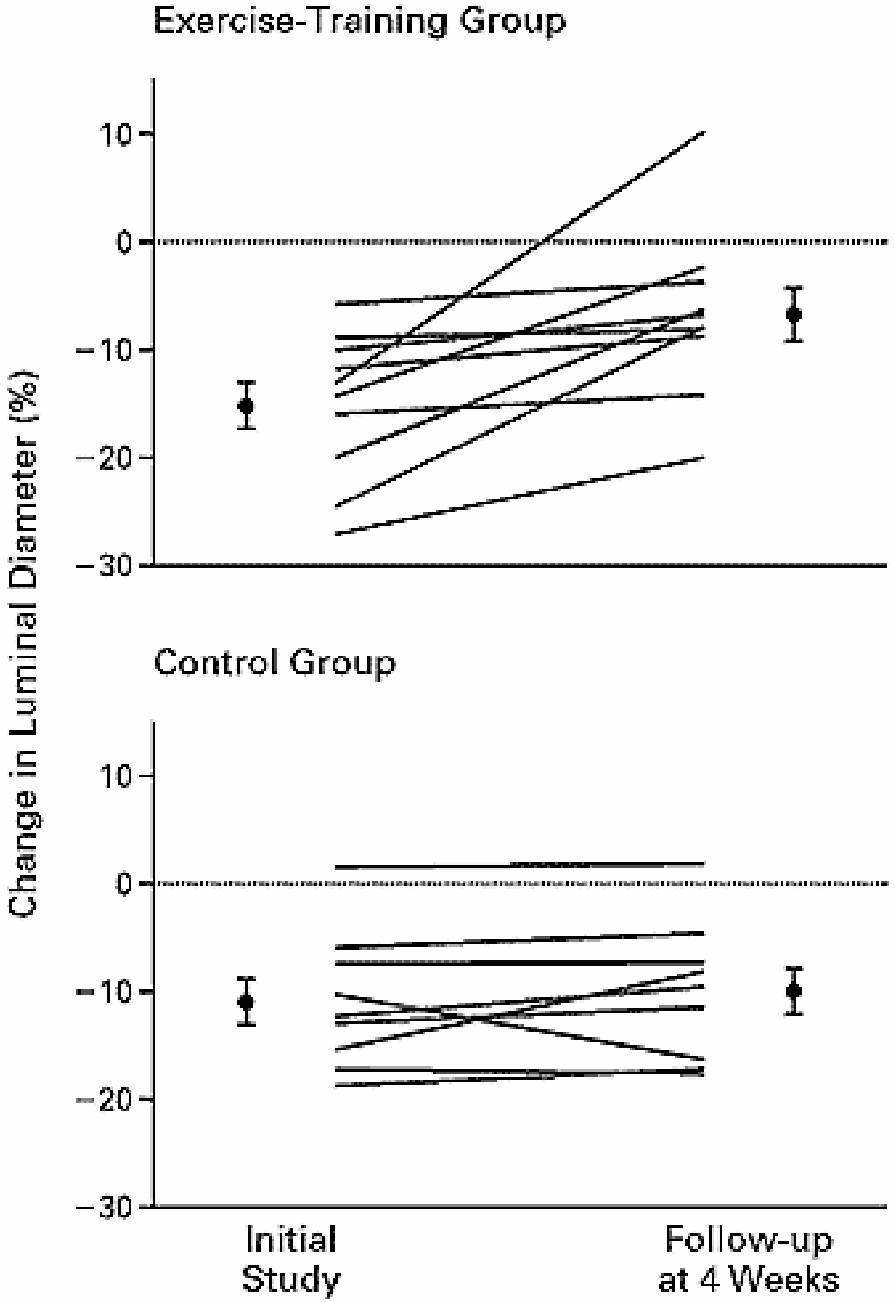
Exercise Stress Testing

- US Preventive Services Task Force 2018 recommendations advised against screening with resting or exercise electrocardiography in low-risk asymptomatic adults to prevent cardiovascular events.
- Review of randomized controlled trials of screening with exercise ECGs found no improvement in health outcomes, despite focusing on higher-risk populations with diabetes.

Curry SJ et al. *JAMA* 2018;319:2308–2314.

Effect of Exercise on Endothelial Dysfunction

Hambrecht et al. N Eng J Med 2000; 342:454-460



Effect of Exercise on Endothelial Dysfunction

Hambrecht et al. N Eng J Med 2000; 342:454-460

Table 3. Effect of Exercise Training on Mean Peak Coronary Blood-Flow Velocity.*

Drug and Dose	Exercise-Training Group		Control Group	
	Initial Study	Follow-up at 4 Weeks	Initial Study	Follow-up at 4 Weeks
	% change in mean peak flow velocity			
Acetylcholine				
0.072 μg/min	11.8±6.6	27.0±7.1	8.2±1.8	9.4±5.4
0.72 μg/min	36.4±11.1	73.0±19.0†	23.6±5.4	17.8±8.6
7.2 μg/min	78.1±15.5	141.6±27.7†	65.2±13.6	56.9±16.9
Adenosine	177.7±17.3	257.5±24.1†	241.2±26.3	228.7±21.7
Nitroglycerin	119.3±16.2	132.9±24.4	149.2±22.8	140.3±17.7

*Plus–minus values are means ±SE. Changes are expressed as the percentage change in velocity with drug administration, as compared with base-line conditions.

†P<0.01 for the comparison with the control group.

EXERCISE AND HEART DISEASE Regression Studies

Schuler studied effect of low fat diet and exercise on progression of CAD lesions.

- Significant regression noted in 7 of 18 pts. in intervention group compared to one in the controls (patients receiving usual care)
- Significant reduction in stress-induced ischemia was not limited to those with regression.

Schuler et al. J Amer Coll Cardiol 1992; 19:34-42.

EXERCISE AND HEART DISEASE Regression Studies

Hambrecht studied effect of exercise on CAD lesions.

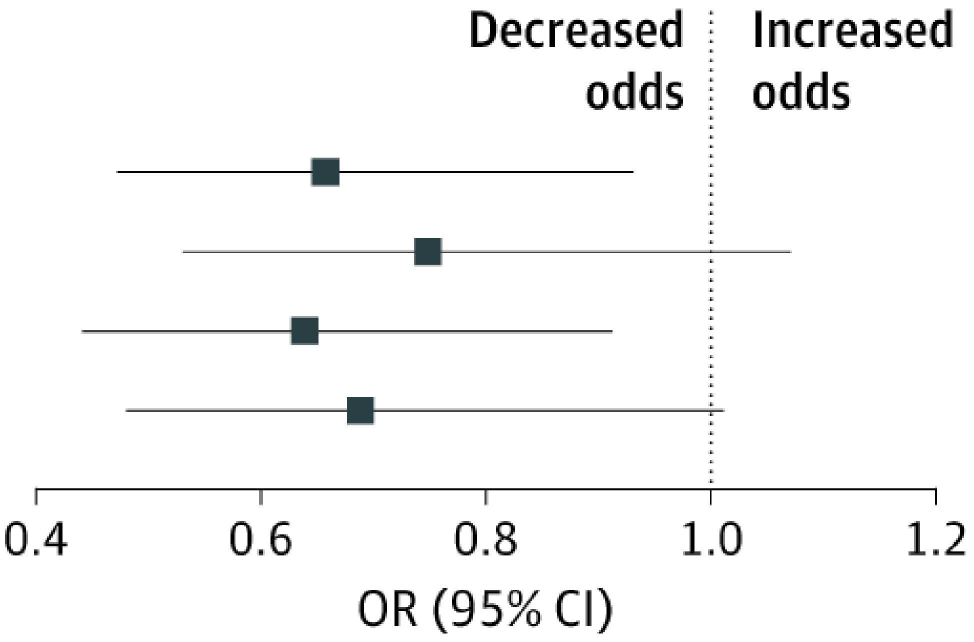
- Eight of 29 subjects demonstrated regression of disease compared to 2 of 33 controls
- Expenditure of 2200 Kcal/week necessary for regression versus 1530 Kcal/week to halt progression

Hambrecht et al. J Amer Coll Cardiol 1993; 22:466-477.

From: **Association of Long-term Strenuous Physical Activity and Extensive Sitting With Incident Radiographic Knee Osteoarthritis**

JAMA Netw Open. 2020;3(5):e204049. doi:10.1001/jamanetworkopen.2020.4049

Physical activity trajectory	OR (95% CI)
Any strenuous PA, unadjusted	0.66 (0.47-0.93)
Any strenuous PA, adjusted	0.75 (0.53-1.07)
Low to moderate strenuous PA, unadjusted	0.64 (0.44-0.91)
Low to moderate strenuous PA, adjusted	0.69 (0.48-1.01)



Associations of Weekly Strenuous Physical Activity Trajectories With 10-Year Incident Radiographic Knee Osteoarthritis. The reference group is persistently no strenuous physical activity (PA) over 8 years. A 95% CI below the value of 1.0 supports a statistically significant reduced likelihood of incident knee osteoarthritis. Adjusted indicates adjusted for age, sex, and body mass index; OR, odds ratio; unadjusted, unadjusted odds.

EXERCISE PRESCRIPTION

Developing the Prescription

Exercise Prescription
The Five A's Model

- Assess
- Advise
- Agree
- Assist
- Arrange

The Five A's Model

Assess

- Current physical activity
- Readiness for change
- Patient-oriented benefits
- Social support
- Patient's confidence that they can change behavior

Exercise Prescription

Sallis examined physical activity patterns in 1003 men and 716 women, ages 18 – 90.

- Prior exercise, or sports experience, and self-efficacy strongly predicted adoption of activity
- Women motivated by social factors
- Men influenced by convenience
- Older women more likely to drop out

Prev Med 1992; 21:237-251.

The Five A's Model

Advise

- Structured, individually tailored prescription
- Individually tailored counseling message based on stage of change
- Benefits
- Social support

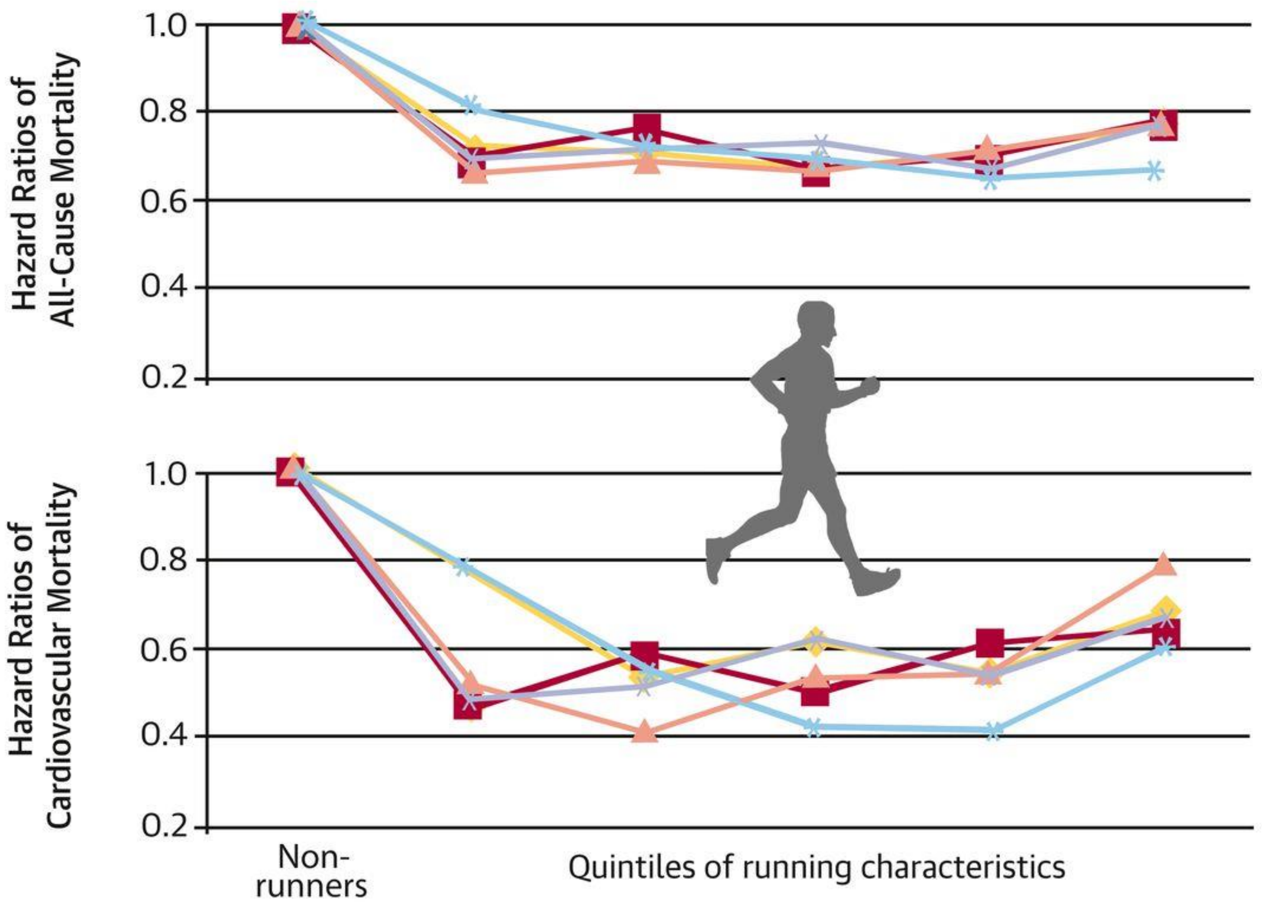
Exercise Prescription

- Frequency: Most, or preferably all, days of the week
- Intensity: Moderate (40-60% VO2 max)
- Duration: >30 minutes of continuous or accumulated physical activity per day
- Type: Primarily endurance physical activity supplemented with resistance training

Exercise Volume

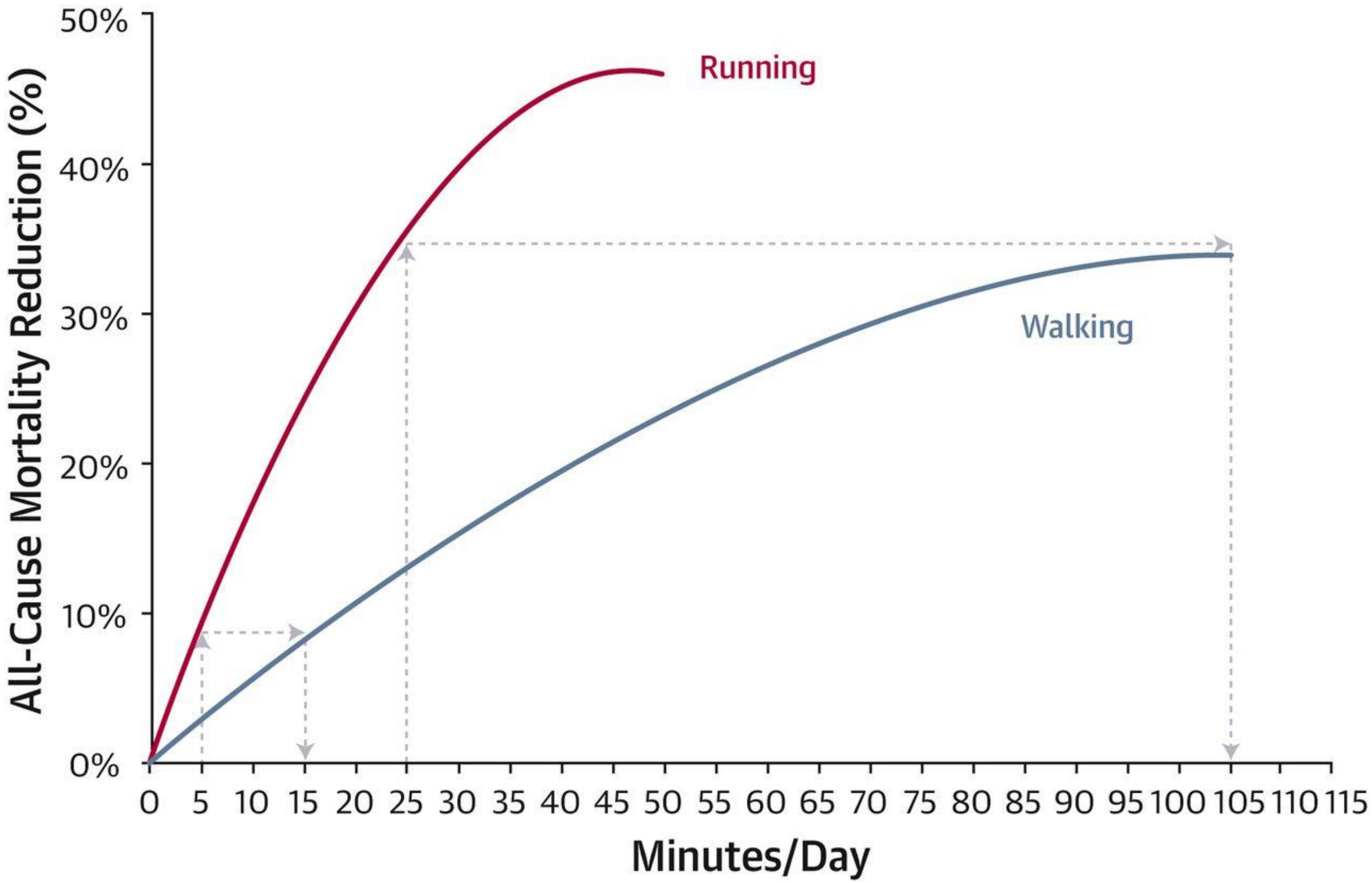
- Wen et al reviewed longitudinal data of 416,175 adults in a standard medical screening program
- Sample separated into five cohorts based upon self-reported physical activity levels
- Compared to the physically inactive group, the low activity group, which exercised 92 min/week (15 minutes per day), had a 14% reduced all cause mortality and lived on average 3 years longer
- Every additional 15 minutes per day of activity reduced all cause mortality by an additional 4%

Wen CP et al. Lancet 2011; 378:1244-53



Time (min/wk)	0	<51	51-80	81-119	120-175	≥176
Distance (miles/wk)	0	<6	6-8	9-12	13-19	≥20
Frequency (times/wk)	0	1-2	3	4	5	≥6
Total amount (MET-min/wk)	0	<506	506-812	813-1199	1200-1839	≥1840
Speed (mph)	0	<6.0	6.0-6.6	6.7-7.0	7.1-7.5	≥7.6

American College of Cardiology JACC 2014;64:1537



Chi Pang Wen et al. JACC 2014;64:482-484

The Five A's Model

Agree

- Precontemplation: permission to discuss in future
- Contemplation: discuss next steps
- Preparation: help patient make a plan and set start date
- Action/maintenance: congratulate and assess readiness to change another behavior

The Five A’s Model

Arrange

- Schedule follow-up visit
- Provide telephone or email reminders
- Patient education materials
- Internet-based counseling
- Arrange further assistance (structured programs, physical therapy, etc.)