Cardiovascular Disease in the US Fire Service: Past, Present and Future

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Photo: 1911, Library of Congress

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U.S. Department of Homeland Security

Consultant: Novartis Pharmaceuticals (2009-2010)

Paid expert witness, various entities, medico- legal reports

1860's: Fireman's Fund

San Francisco was a "Goldrush Town" whose economic growth was limited by frequent fires in its wooden buildings.

Volunteer firefighters worked without remuneration despite their risks.

Insurance companies wary of offering coverage to San Francisco-based businesses.

http://www.fundinguniverse.com/company-histories/FIREMANS-FUND-INSURANCE-COMPANY-Company-History.html

1860’s: Fireman’s Fund

In 1863 a ship's captain, William Holdredge, created Fireman's Fund Insurance Company to insure San Franciscans. Success would depend ability to protect property from fires.

To motivate firefighters, Holdredge established a retirement fund for the firemen, financed by 10% of his company's profits.

http://www.fundinguniverse.com/company-histories/FIREMANS-FUND-INSURANCE-COMPANY-Company-History.html

PAST: 1903 William Osler, MD

Photo: 1911, Library of Congress

Angina Pectoris

- Assoc. w/ Arteriosclerosis
- Predominantly Men
- Many Die Suddenly w/o Warning

Principles and Practice of Medicine, by Sir William Osler.

Kales et al

PAST: 1903 William Osler, MD

Angina Pectoris

-Tobacco abuse

Coronary Spasm
Arteriosclerosis

-Precipitants:

Exertion
Strong Emotions/ Anger
Influenza

Principles and Practice of Medicine, by Sir William Osler.

Kales et al

Early Advances in CVD


Photo: 1911, Library of Congress

1915

Mt. Sinai sets ups its electrocardiographic (EKG) laboratory under Dr. Bernard Oppenheimer.

1929

Dr. Arthur Master of Mt. Sinai develops "Master Two-Step," first standardized cardiac stress test.

http://www.mountsinai.org/patient-care/service-areas/heart/mount-sinai-heart-today/mount-sinai-firsts

Firefighters & Increased Mortality

Hunter, A. (1907-1908). Mortality among insured lives engaged in certain occupations involving additional hazard. Transactions of American Society of Actuarians, 10, 44.

Hunter, A., and Rogers, 0. H. (1920). Influence of occupation upon mortality. Transactions of the Actuarial Society of America, 21, 16.

Hunter, A. (1927). Occupational mortality. Transactions of the Actuarial Society of America, 28, 180.

Jenkins, W. A. (1930). A mortality experience of city firemen. Records of the American Institute of Actuaries, 19, 65.

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1934: First Heart & Lung Law

The IAFF assisted locals in Pennsylvania.

Passed the first Heart and Lung Act, Worker's Compensation Act, and the Occupational Disease Law.

http://iaff2498.org/visitors/history-of-iaff.html

1953:

Firefighting and Heart Disease

NATHANIEL E. REICH, M.D., F.C.C.P.*
Brooklyn, New York

"Sufficient evidence…in recent years (for) wider acceptance of firefighting as an occupational factor in the production or aggravation of certain heart diseases…"

Etiologic factors: heat/cold, exertion, stresses, "smokes and gases…to which firemen are repeatedly subjected…"

1950s era fire fighters, Texas

Dis Chest 1953;24;304-309 (http://chestjournal.chestpubs.org/content/24/3/304)

1953:

Firefighting and Heart Disease

NATHANIEL E. REICH, M.D., F.C.C.P.*
Brooklyn, New York

1950s era fire fighters, Texas

Recognized:

HTN & Arteriosclerosis as Synergistic

Acceleration of "normal" Atheromatous changes leads to premature CAD

Plaque rupture and MI can follow exertion

Dis Chest 1953;24;304-309 (http://chestjournal.chestpubs.org/content/24/3/304)

1953:

Firefighting and Heart Disease

NATHANIEL E. REICH, M.D., F.C.C.P.*
Brooklyn, New York

1950s era fire fighters, Texas

Firefighting causes marked change in CV hemodynamics

"Obvious that…underlying heart disease can be markedly affected by this change…"

Dis Chest 1953;24;304-309 (http://chestjournal.chestpubs.org/content/24/3/304)

1957-58: John P. Redmond

Joined Chicago FD in 1912

President of IAFF 1946-1957

Sudden death December 1957, "occupational heart disease"

http://iaff2498.org/visitors/history-of-iaff.html

necoem.org

1957-58: John P. Redmond

John P. Redmond Foundation established 1958

Focused on health & safety of firefighters.

Research used to lobby for statutes & benefits to firefighters with heart and lung disease.

http://iaff2498.org/visitors/history-of-iaff.html

1960's: Heart Presumption Laws

By 1960's, "Heart Presumption" laws established in most US states

Most of the laws date back to before 1965

(Melius J. 1995)

Kales et al

1960's: Modern EMS Begins

http://www.iaff4173.com/History/index.html

Kales et al

1970's: Barnard & the LA FD

Stress testing and CAD RF's in the LA FD vs. Insurance Executives (JOM 1975).

FF Less HTN >160/90 (2% vs 25%) &
Chol >260 (12% vs. 18%)

FF more smoking (32% vs 26%)

FF 10% Ischemic ETT vs. 8% of Executives

1970's: Barnard & the LA FD

Heart rate and ECG Responses of Fire Fighters (JOM 1975).

35 FF responding to 189 alarms

HR increases: mean 30 bpm above bsln in 1^{st} minute (max 80 bpm)

During fires high heart rates for extended periods.

One FF, 188 bpm for 15 minutes at a structure fire

British Journal of Industrial Medicine, 1978, **35**, 104-108

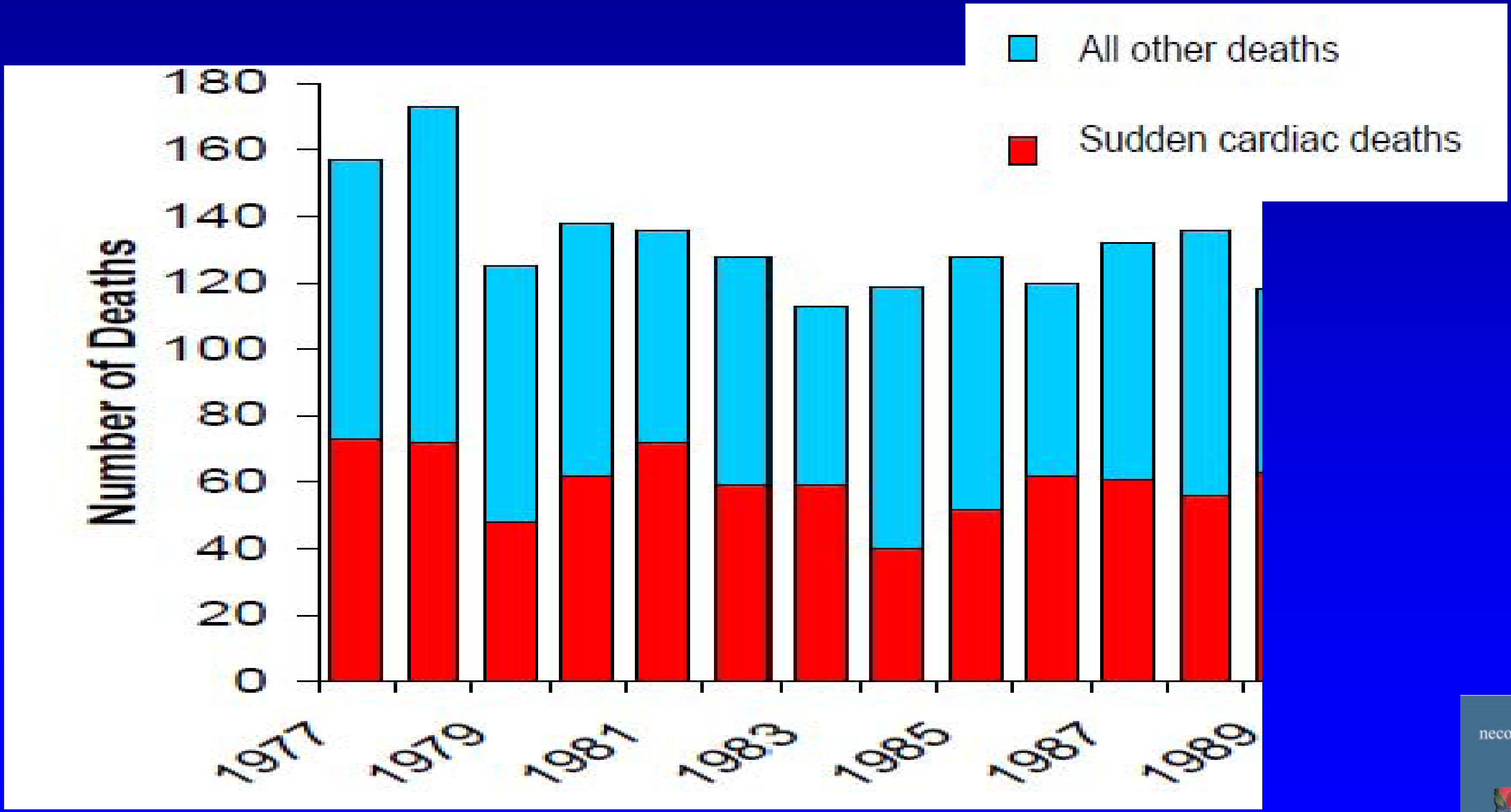
Mortality among Boston firefighters, 1915–1975*

A. W. MUSK**, R. R. MONSON, J. M. PETERS, AND R. K. PETERS

From the Departments of Physiology and Epidemiology, Harvard School of Public Health, 665 Huntington Avenue, Boston, MA 02115, USA

ABSTRACT Although the nature of firefighting involves particular health hazards, previous mortality and morbidity studies of firemen have produced inconsistent evidence for an increased risk of mortality from cardiovascular disease, respiratory disease, cancer and accidents. Mortality experience since 1915 has been examined in 5655 Boston firefighters, comprising all male members of the city fire department with three or more years of service. The observed cause of death as stated on the death certificates of 2470 deceased firefighters has been compared with the numbers expected based on rates for the male population of Massachusetts and of the United States of America. Among all firefighters, deaths from all causes were 91% of expected. The standardised mortality ratio (SMR) was markedly reduced (less than 50) for infectious disease, diabetes, rheumatic heart disease, chronic nephritis, blood diseases and suicide. The SMR was 86 for cardiovascular deaths, 83 for neoplastic deaths, and 93 for respiratory deaths. The SMR for accidents was 135 for active firefighters. The results suggest that the survival experience of firefighters is strongly influenced by strict entry selection procedures, ethnic derivation, and sociocultural attributes of membership. While excessive morbidity has been demonstrated in firefighters, there does not appear to be a strong association between occupation and cause-specific mortality.

Late 1970-1980's: CVD ~45% all Deaths



Source: NFPA.org

Heart Deaths by Occupation

	% of On-Duty Deaths caused by CVD
Firefighters	45%
Police	22%
Overall*	15%
Construction	11.5%
EMS	11%

*Average % of all Occupational Fatalities, all industries

Kales et al

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 30:331–340 (1996)

Risk Factors for Coronary Heart Disease Among Firefighters in Cincinnati

Charles J. Glueck, MD, William Kelley, MD, Ping Wang, PhD, Peter S. Gartside, PhD, Donald Black, MD, and Trent Tracy, PA

Prospective study: rate of MI's lower than in NHANES population of similar age

1.35 vs 2.07 MI's/ 1000 P-Years (NS)

CHD and MI incidence were largely explained by well-known CVD Risk Factors

Age, smoking, BP, BMI, Lipids

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necoem.org

Present

Cohort Studies vs. Presumption Laws

- Definitive evidence of an increased CHD risk in Firefighters lacking.

- Based on >/=10 cohort mortality studies Firefighters' risk of CHD Death

  SMR of ~0.9

- High proportion of CHD deaths and recognition of Cardiovascular Stressors has led to

"Heart Presumption" laws in 37 / 50 states and 2 Canadian Provinces

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Scope of the Problem

- 1977-2006: CVD ~45% on-Duty Deaths
  (~ 45 / year)

- ~ 17 Non-fatal CV events for each Fatal Event
- Morbid & Mortal CVD events 800-1000/yr
- Affects 1 in 1000-2000 per year

(If Off-duty included, Many More Affected…)

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On-Duty Events, Work-Related or Just happen at Work???

Smoke & chemical exposure

High prevalence of CV risk factors

Irregular physical exertion

psychological stressors

handling of heavy equipment

Heat stress Noise

Shift work

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Emergencies & Cardiovascular Risk

Long Stretches of relative inactivity

Brief periods of intense, unpredictable, life-threatening action

→ Adrenergic surges and high demands on CV system

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Environmental Health: A Global Access Science Source

BioMed Central

Research

Open Access

Firefighters and on-duty deaths from coronary heart disease: a case control study

Stefanos N Kales*[1,2], Elpidoforos S Soteriades[1,2], Stavros G Christoudias[1] and David C Christiani[2,3,4]

Methods: Case-control study, 52 male firefighters CHD deaths investigated by NIOSH.

Control population: 51 male firefighters on-duty trauma deaths

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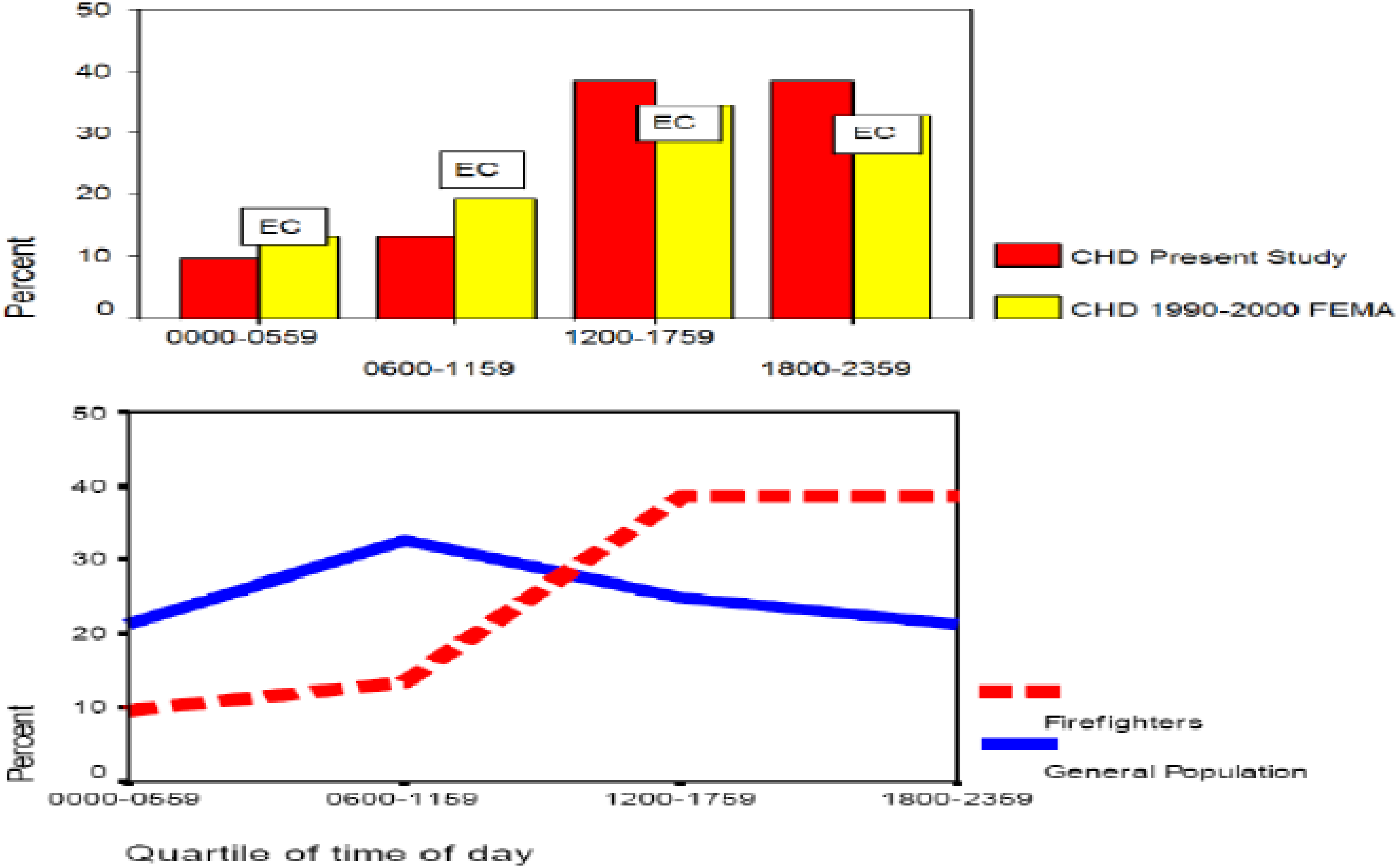
Figure One. Circadian Pattern of CHD Deaths in Firefighters versus Emergency Calls and Compared to General Population. From Kales et al, ref.14



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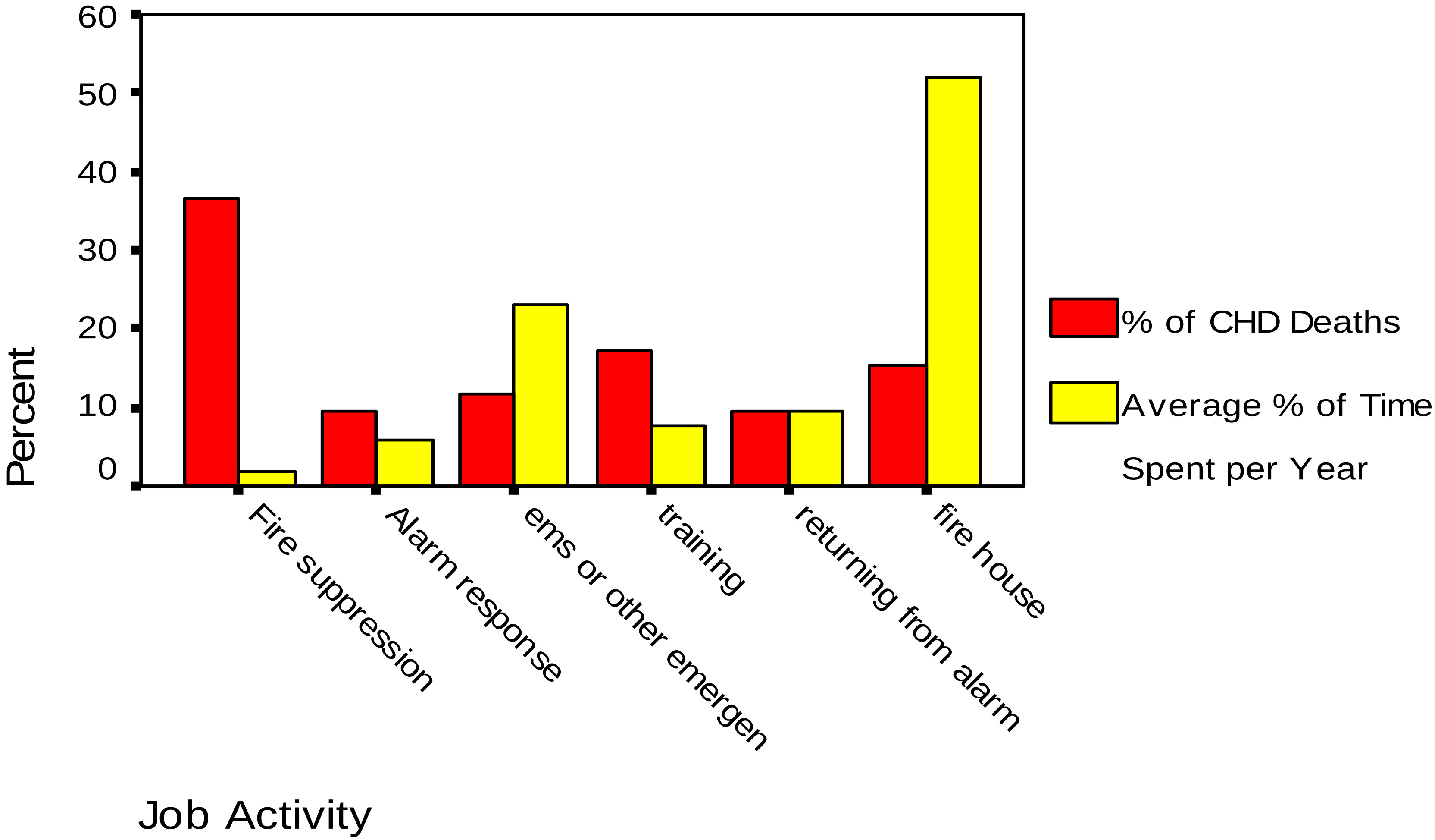
CHD Deaths vs. Time Spent in Each Activity



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ESTABLISHED IN 1812 MARCH 22, 2007 VOL. 356 NO. 12

Emergency Duties and Deaths from Heart Disease among Firefighters in the United States

Stefanos N. Kales, M.D., M.P.H., Elpidoforos S. Soteriades, M.D., Sc.D., Costas A. Christophi, Ph.D., and David C. Christiani, M.D., M.P.H.

The NEW ENGLAND JOURNAL of MEDICINE

Kales et al

Table 4. Risk of Death from Coronary Heart Disease among Firefighters Engaged in Emergency Duties and Physical Training as Compared with Firefighters Engaged in Nonemergency Duties.*

Duty	Municipal Fire Department		Large Metropolitan Fire Departments		National Data	
	Odds Ratio (95% CI)	P Value	Odds Ratio (95% CI)	P Value	Odds Ratio (95% CI)	P Value
Fire suppression	53 (40–72)	<0.001	12.1 (9.0–16.4)	<0.001	136 (101–183)	<0.001
Alarm response	7.4 (5.1–11)	<0.001	2.8 (1.9–4.0)	<0.001	14.1 (9.8–20.3)	<0.001
Alarm return	5.8 (4.1–8.1)	<0.001	2.2 (1.6–3.1)	<0.001	10.5 (7.5–14.7)	<0.001
Emergency medical services and other nonfire emergencies	1.3 (0.9–2.0)	0.16	0.5 (0.3–0.8)	<0.001	2.6 (1.8–3.9)	<0.001
Physical training	5.2 (3.6–7.5)	<0.001	2.9 (2.0–4.2)	<0.001	6.6 (4.6–9.5)	<0.001
Nonemergency duties (fire station and other)	1.0		1.0		1.0	

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Type of Duty	Kales et al 2003 (relative risk of CHD death)	Holder et al 2006 (relative risk of heart event leading to retirement)	Kales et al 2007 (relative risk of CHD death)
Fire suppression – OR** (95% CI£)	**64.1 (7.4-556)**	**51 (12-223)**	**53 (40-72)**
Physical training – OR** (95%CI£)	**7.6 (1.8-31.3)**	0.68 (0.2-2.7)	**5.2 (3.6-7.5)**
Alarm response – OR** (95% CI)	**5.6 (1.1-28.8)**	**6.4 (2.5-17)**	**7.4 (5.1-11)**
Alarm return –OR (95% CI£)	**3.4 (0.8-14.7)**	0.37 (0.07-1.8)	**5.8 (4.1-8.1)**
EMS and other non-fire emergencies – OR** (95% CI£)	1.7 (0.5-5.9)	0.75 (0.3-1.8)	1.3 (0.9-2.0)
Firehouse and other non-emergency activities – OR** (95% CI£)	**1.0**	**1.0**	**1.0**

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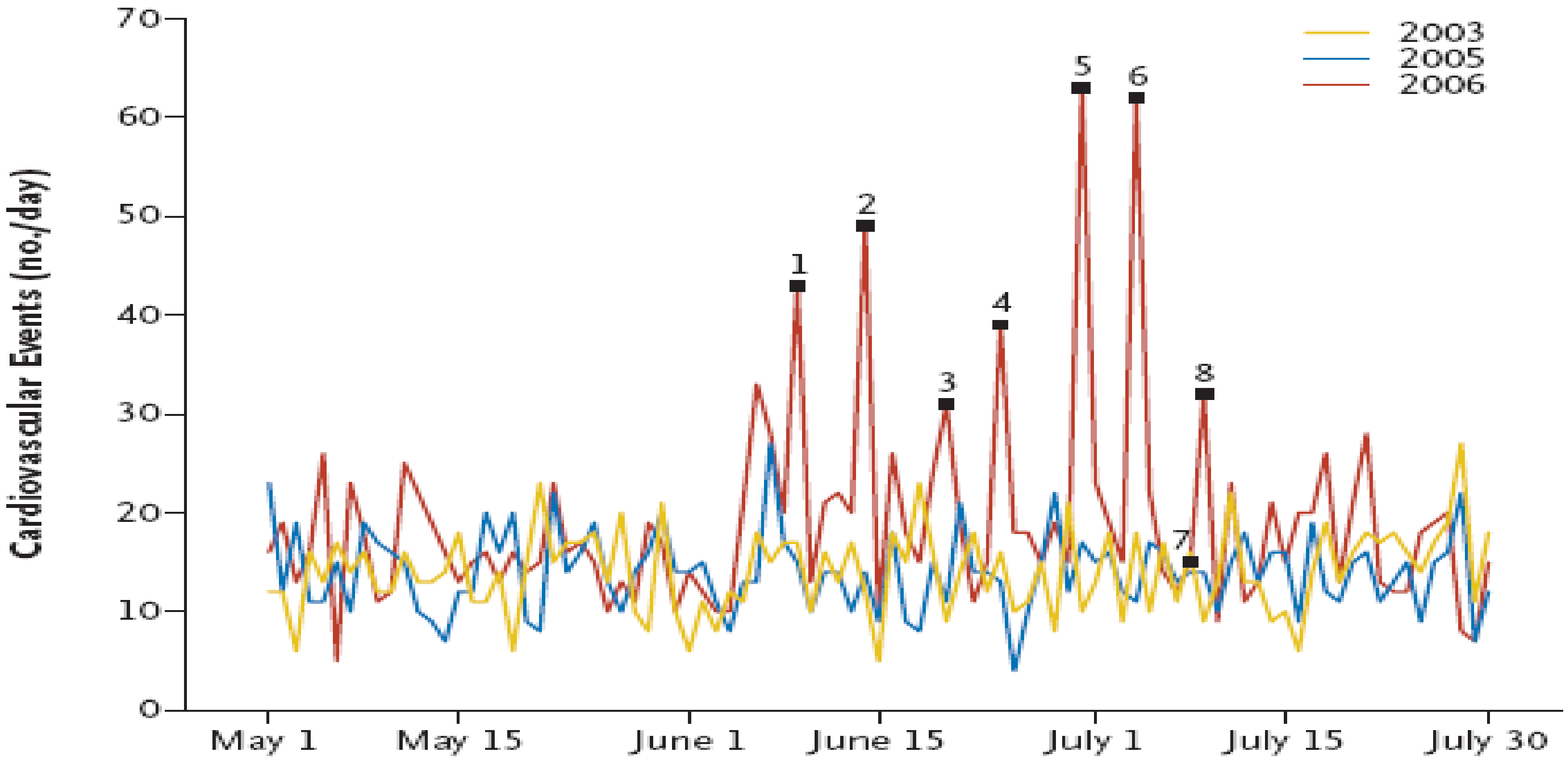


Figure 1. Daily Cardiovascular Events in the Study Population from May 1 to July 31 in 2003, 2005, and 2006.

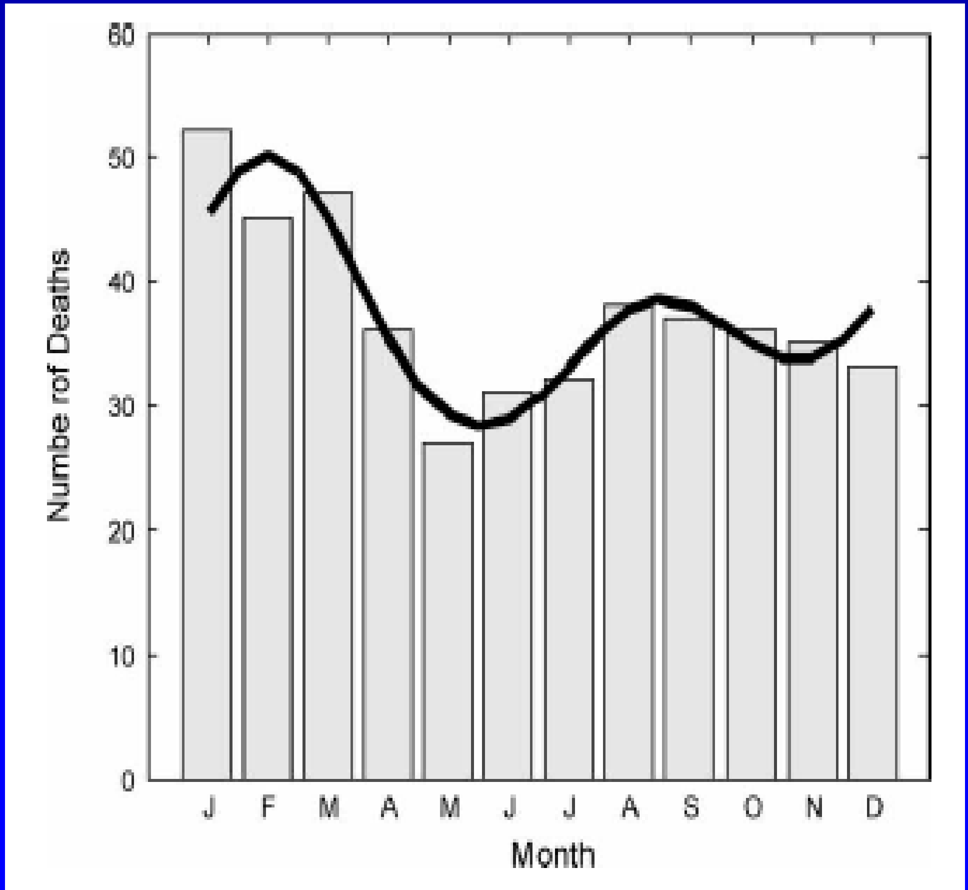
The FIFA World Cup 2006 in Germany started on June 9, 2006, and ended on July 9, 2006. The 2006 World Cup matches with German participation are indicated by numbers 1 through 7: match 1, Germany versus Costa Rica; match 2, Germany versus Poland; match 3, Germany versus Ecuador; match 4, Germany versus Sweden; match 5, Germany versus Argentina; match 6, Germany versus Italy; and match 7, Germany versus Portugal (for third-place standing). Match 8 was the final match, Italy versus France.

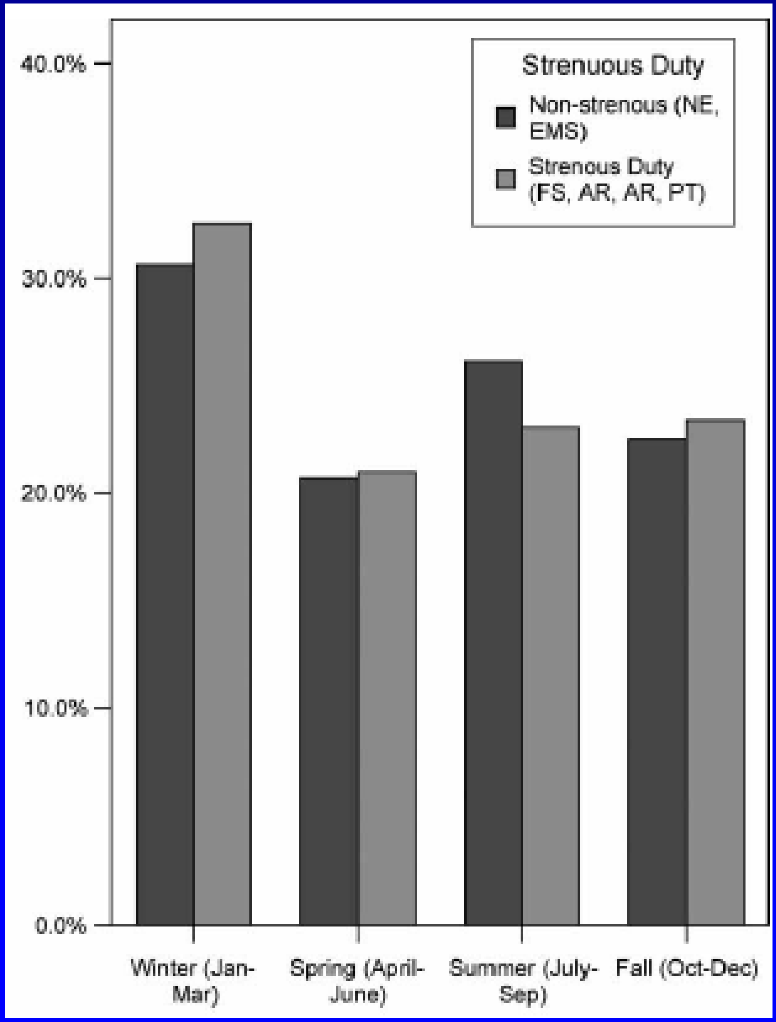
Cardiovascular Events during World Cup Soccer. Wilbert-Lampen, et al. NEJM 2008

SEASONALITY AND CORONARY HEART DISEASE DEATHS IN UNITED STATES FIREFIGHTERS

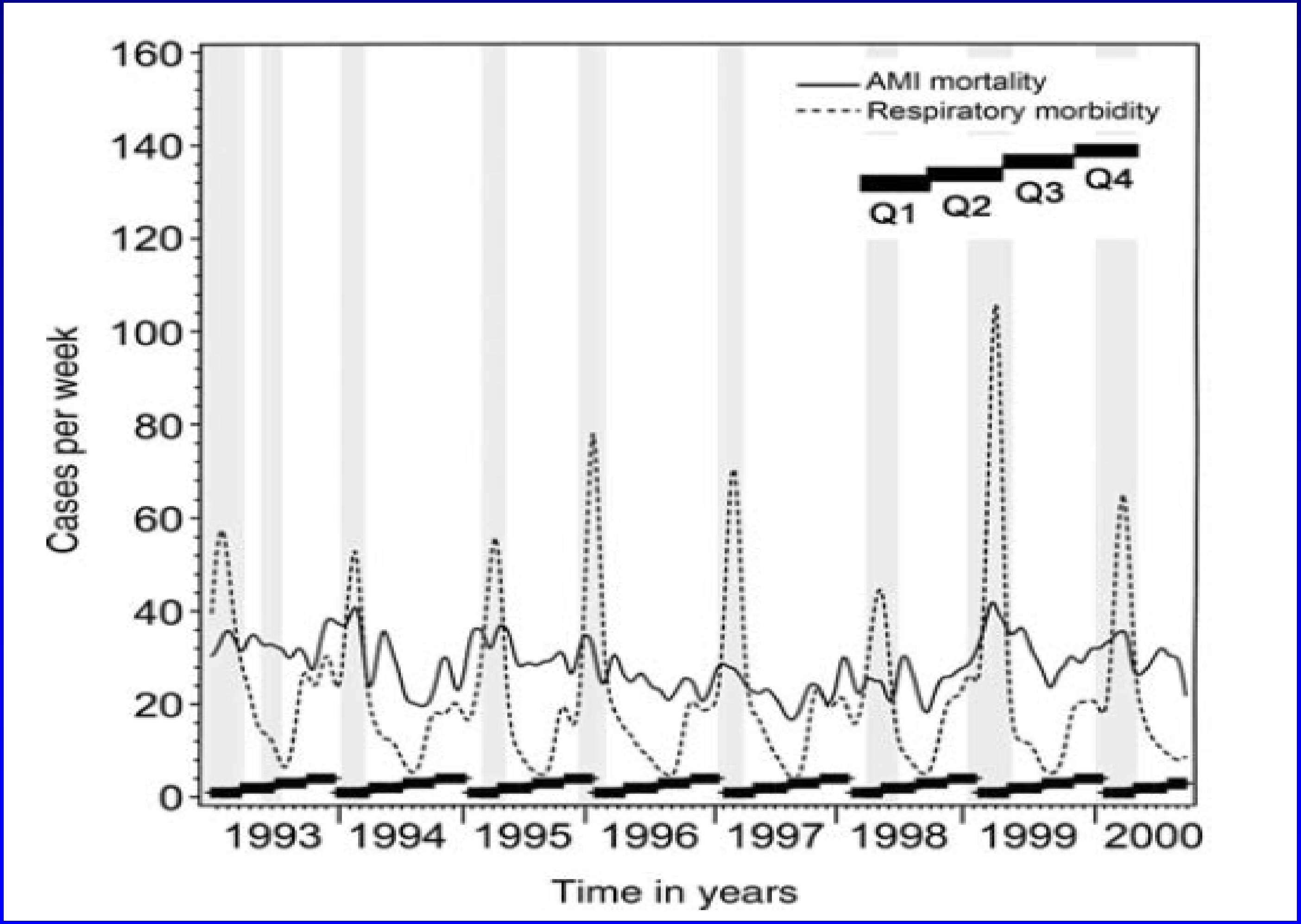
Ibeawuchi Mbanu,[1] Gregory A. Wellenius,[2] Murray A. Mittleman,[1–3] Lynne Peeples,[4] Leonard A. Stallings,[5] and Stefanos N. Kales[1,5]

2007; Vol. 24





Deaths due to Myocardial Infarction and Acute Respiratory Morbidity



Madjid, M et al European Heart Journal 2007

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Environmental Health: A Global Access Science Source

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Research

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Firefighters and on-duty deaths from coronary heart disease: a case control study

Stefanos N Kales*[1,2], Elpidoforos S Soteriades[1,2], Stavros G Christoudias[1] and David C Christiani[2,3,4]

Reviewed all completed fatality reports on NIOSH website from 1996- December 2002.

52 male firefighters who died of CHD

310 firefighters examined in 1996 and documented as professionally active in firefighting in 1998

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Firefighter Heart Presumption Retirements in Massachusetts 1997–2004

(JOEM October 2006)

Jonathan D. Holder, DO, MPH
Leonard A. Stallings
Lynne Peeples, MS
John W. Burress, MD, MPH
Stefanos N. Kales, MD, MPH

362 Heart presumption retirements

278 CHD retirements (77%)

84 Non-CHD retirements

- HTN 30 (36%)
- AFIB, Flutter or SVT 19 (23%)
- Cardiomyopathy 11 (13%)
- CVA 11 (13%)
- Syncope 5 (6%)
- Aortic Aneurysm 4 (5%)
- Other 4 (5%)

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Predictors of On-Duty Coronary Events in U.S. Male Firefighters

JR Geibe, J Holder, L Peeples,
AM Kinney, JW Burress, SN Kales

2008;101:585–589.

Case-Fatality Study

87 Acute On-Duty CHD Fatalities

compared with

113 Non-Fatal, On-Duty CHD Events

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Hypertension & CV DZ Outcomes

Endpoint	Hypertension Criteria	Adjusted OR (95% CI)	Study Design
Incident CHD	SBP > 140	6.1 (2.6-14.2) (unadjusted)	Prospective Cohort (Glueck et al)
	DBP > 90	4.9 (2.1-11.4) (unadjusted)	
CHD Retirement	>/=140/90, Dx of HTN, or Anti-HTN Medication	1.2 (0.6 –2.4)	Retrospective Case-Control
Non-CHD CVD Retirement		4.8 (1.3-17.9)	

Kales et al

Hypertension & CV DZ Outcomes

Endpoint	Hypertension Criteria	Adjusted OR (95% CI)	Study Design
On-Duty CHD Death	>/=140/90, Diagnosis of Hypertension, or Anti-Hypertensive Medication	4.7 (2.0-11.1)	Retrospective Case-Control
Case-Fatality for On-Duty CHD Events		4.2 (1.8- 9.4)	Cross-Sect. Case-Fatality

Kales et al

Left Ventricular Hypertrophy

- Independent risk factor for CVD.
- Increased Risk of Ventricular Arrhythmia
- Independent Predictor of Death
- **57% of On-Duty CHD FF Fatalities had LVH at Autopsy!!**

Kales et al

Table 4 | Baseline blood pressures for firefighters and police with and without later incident cardiovascular events

	Event (mm Hg)		No event (mm Hg)		*P* value		
Endpoint	Mean SBP	Mean DBP	Mean SBP	Mean DBP	Mean SBP	Mean DBP	Study design/population
Incident CHD[62]	140	92	125	82	<0.0001[a]	<0.0001[a]	Prospective cohort/ firefighters
Incident CHD[79]	141	88	134	84	<0.01[†]	<0.001[†]	Prospective cohort/police
Incident stroke[79]	146	91	134	84	<0.01[†]	<0.01[†]	Prospective cohort/police

CHD, coronary heart disease; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Adjusted for age, race and BMI. [b]Adjusted for age.

Kales et al

AMERICAN JOURNAL OF HYPERTENSION

SMOKING & CV DZ Outcomes

Endpoint	Smoking Criteria	Unadjusted Odds Ratio or Hazard Ratio (95% CI)	Multivariable-Adjusted Odds Ratio or Hazard Ratio (95% CI)	Study Design
Incident CHD		5.7 (2.4 – 13.1)	P=0.001	Prospective Cohort
CHD Retirement		3.9 (2.5 - 6.2)	2.9 (1.3 – 6.3)	Retrospective Case-Control
Non-CHD Cardiovascular Retirement	Current Smoking (Last 12 months)	2.5 (1.2 – 5.1)	2.9 (0.6 – 13.6)	Retrospective Case-Control
On-Duty CHD Death		8.6 (4.2-17.4)	7.0 (2.8-17.4)	Retrospective Case-Control
Case-Fatality for On-Duty CHD Events		2.1 (1.2-3.9)	3.7 (1.6- 8.4)	Retrospective Case-Fatality

Kales et al

Previously Diagnosed CHD & CV DZ Outcomes

Endpoint	CHD Definition	Unadjusted Odds Ratio or Hazard Ratio (95% CI)	Multivariable-Adjusted Odds Ratio or Hazard Ratio (95% CI)	Study Design
CHD Retirement	Prior MI, Angioplasty/ Stent, CABG, +ETT or CATH, CVA or Carotid Dz, PAD	29.6 (9.1 – 96)	8.8 (1.9 – 41.3)	Retrospective Case-Control
On-Duty CHD Death		35.0 (9.5 -128)	15.6 (3.5-69)	Retrospective Case-Control
Case-Fatality for On-Duty CHD Events		2.1 (1.1-4.1)	4.1 (1.6, 10.6)	Retrospective Case-Fatality

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Cases with Prior CHD

Median Time: initial diagnosis to final event for fatalities & survivors: 40 vs 43 months

Fatalities: 74% evidence of myocardial damage 35% of survivors (p 0.007).

Often secondary CHD events between initial and final events.

Kales et al

Lipids and Incident CHD (Glueck et al)

Lipid	22 Men Developing CHD	784 Men Free of CHD	P Value
TC	227 +/- 40	198 +/- 39	0.014
HDL	46 +/- 14	48 +/- 11	NS
LDL	148 +/- 38	127 +/- 35	0.04
TG	203 +/- 162	124 +/- 130	0.03

Obesity and CV DZ Events

Endpoint	Obesity Criteria	OR (95% CI) Or P value	Study Design
Incident CHD	BMI No CHD BMI CHD	P= 0.08	Prospective Cohort (Glueck et al)
CHD Retirement	BMI >/= 30	1.4 (1.0 – 1.9)	Retrospective Case-Control
Non-CHD CVD Retirement	BMI >/= 30	3.6 (2.0 – 6.4)	Retrospective Case-Control

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Obesity and CV DZ Events

Endpoint	Obesity Criteria	OR (95% CI)	Study Design
On-Duty CHD Death	BMI >/= 30	3.1 (1.5- 6.6)	Retrospective Case-Control
Case-Fatality for On-Duty CHD Events	BMI >/= 30	2.3 (1.0-5.4)	Retrospective Case-Control

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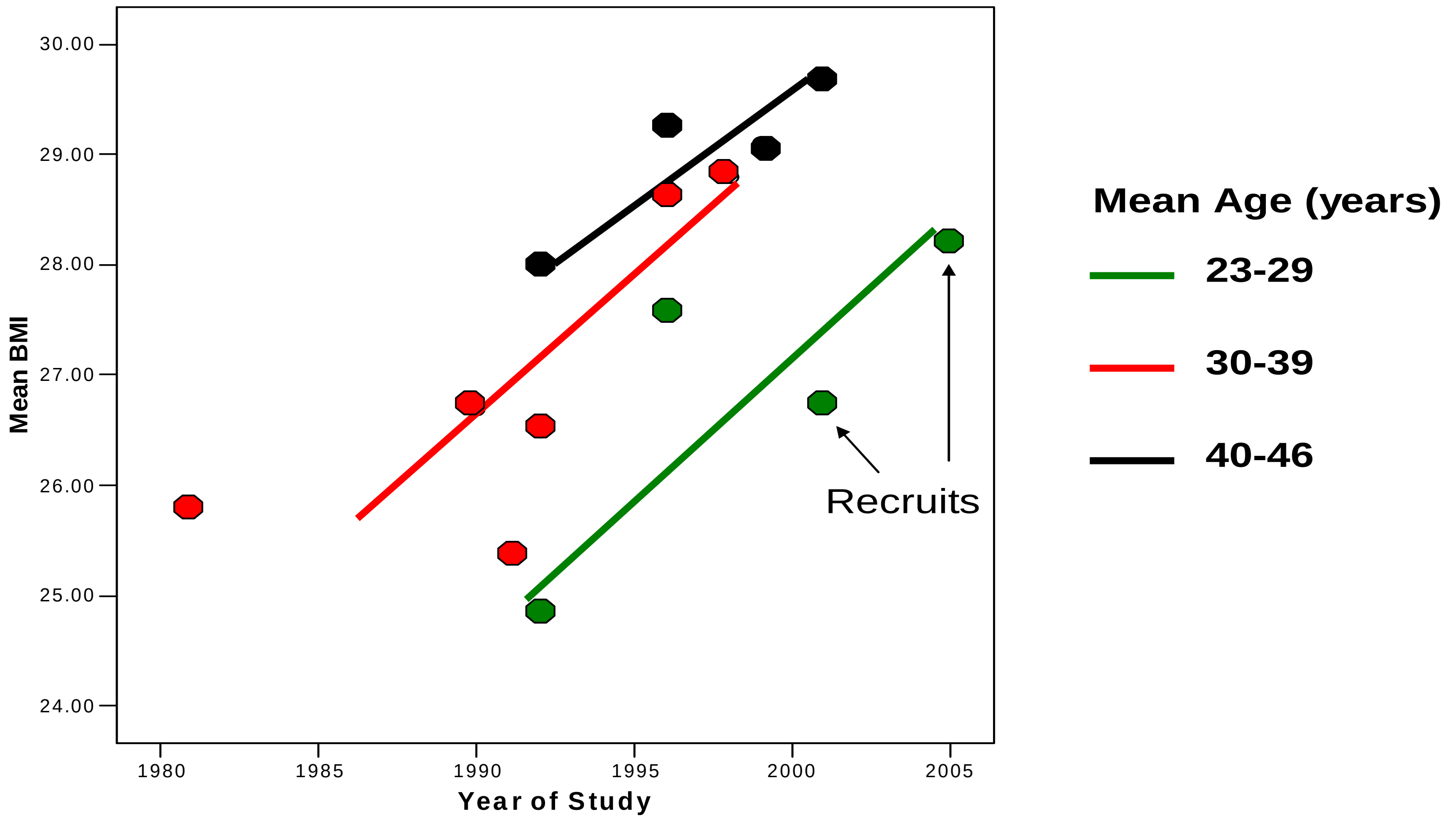
Historical BMI changes in U.S. firefighters: 1981-2005



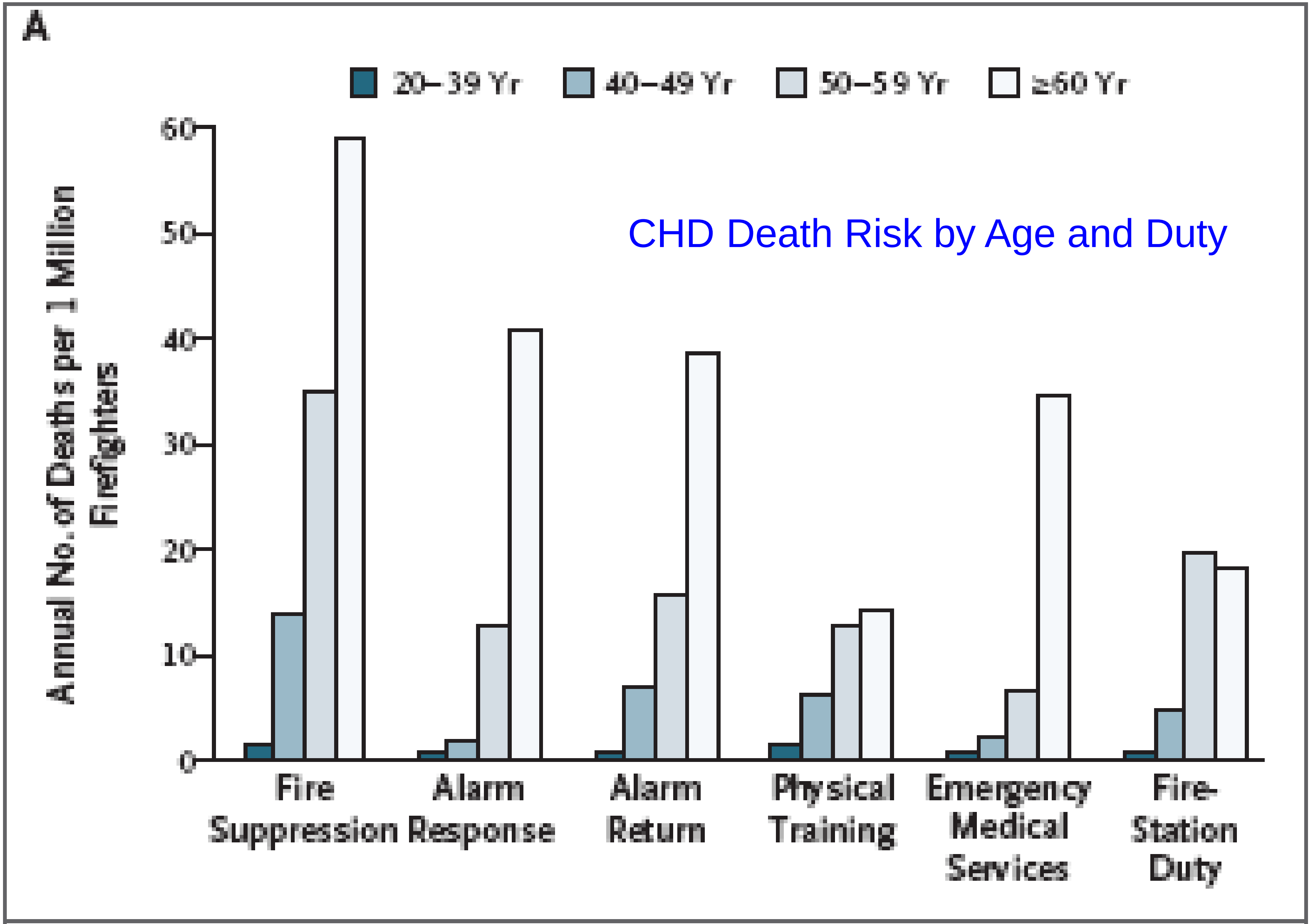

A
20–39 Yr
40–49 Yr
50–59 Yr
≥60 Yr
Annual No. of Deaths per 1 Million Firefighters
60
50
40
30
20
10
0
CHD Death Risk by Age and Duty
Fire Suppression
Alarm Response
Alarm Return
Physical Training
Emergency Medical Services
Fire-Station Duty

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Table 3. Relative risk of Cardiovascular Outcome by risk factor

	On-Duty CHD Fatalities	Non-CHD Cardiovascular Retirements OR (95% CI)	CHD Retirements OR (95% CI)
Age ≥ 45 years old	18 (8.5- 40)	26 (13 – 51)	63 (35 – 111)
Current Smoking	8.6 (4.2-17)	2.5 (1.2 – 5.1)	3.9 (2.5 - 6.2)
Hypertension	12 (5.8 – 25)	11 (6.1 – 20)	5.4 (3.7 - 7.9)
Diabetes Mellitus	10.2 (3.7 – 28)	7.7 (2.9 – 20)	13 (6.1 - 28)
Cholesterol >/= 5.18 mmol/L (200 mg/dl)	4.4 (1.5 – 13)	1.1 (0.51 – 2.24)	2.4 (1.6 – 3.6)
Prior Diagnosis of CHD	35 (9.5 -128)	NA	30 (9.1 – 96)
Obesity, BMI >/=30	3.1 (1.5- 6.6)	3.6 (2.0 – 6.4)	1.4 (0.96 – 1.93)

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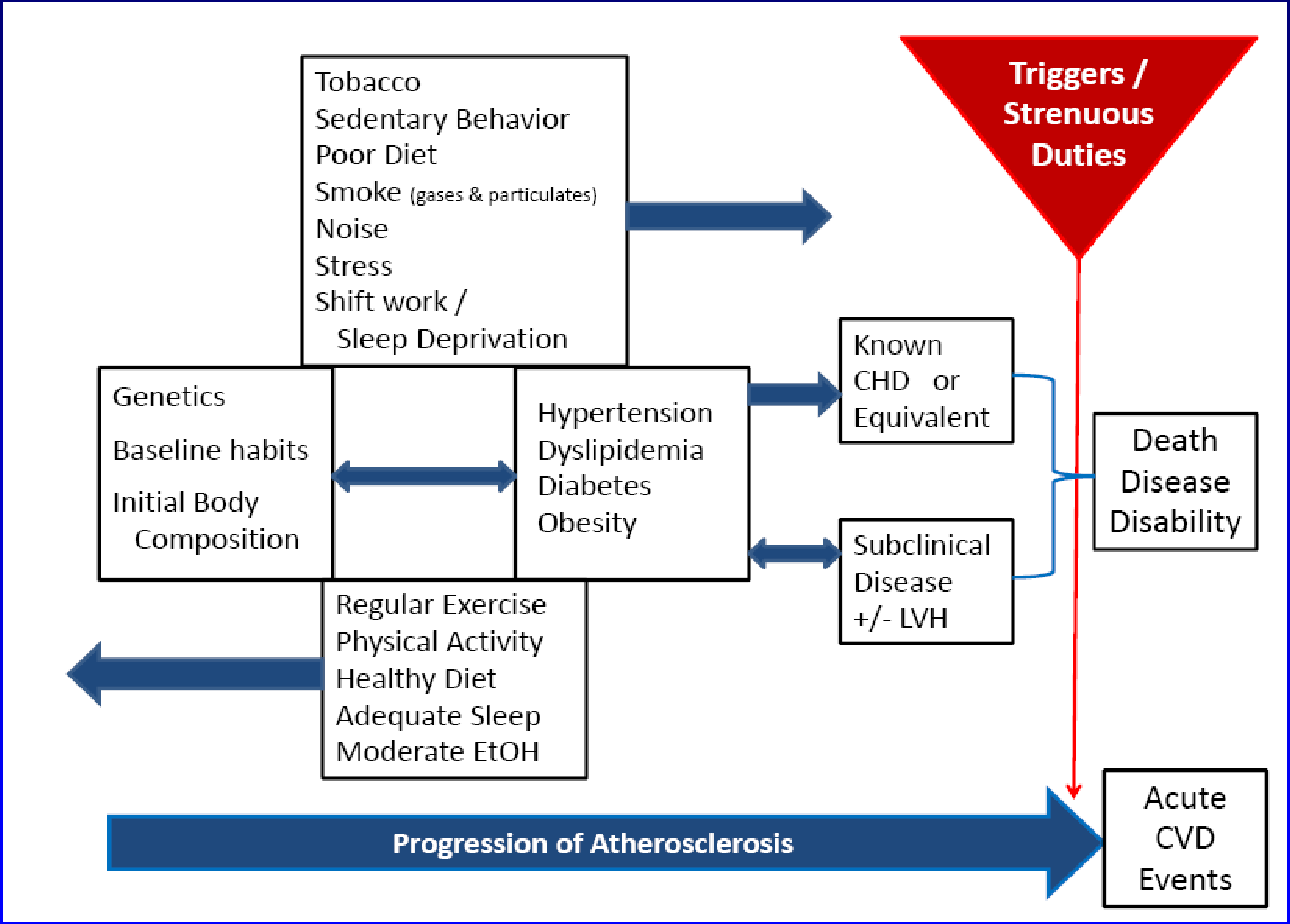
Tobacco
Sedentary Behavior
Poor Diet
Smoke (gases & particulates)
Noise
Stress
Shift work /
Sleep Deprivation
Triggers / Strenuous Duties
Genetics
Baseline habits
Initial Body Composition
Hypertension
Dyslipidemia
Diabetes
Obesity
Known CHD or Equivalent
Subclinical Disease +/- LVH
Death
Disease
Disability
Regular Exercise
Physical Activity
Healthy Diet
Adequate Sleep
Moderate EtOH
Progression of Atherosclerosis
Acute CVD Events

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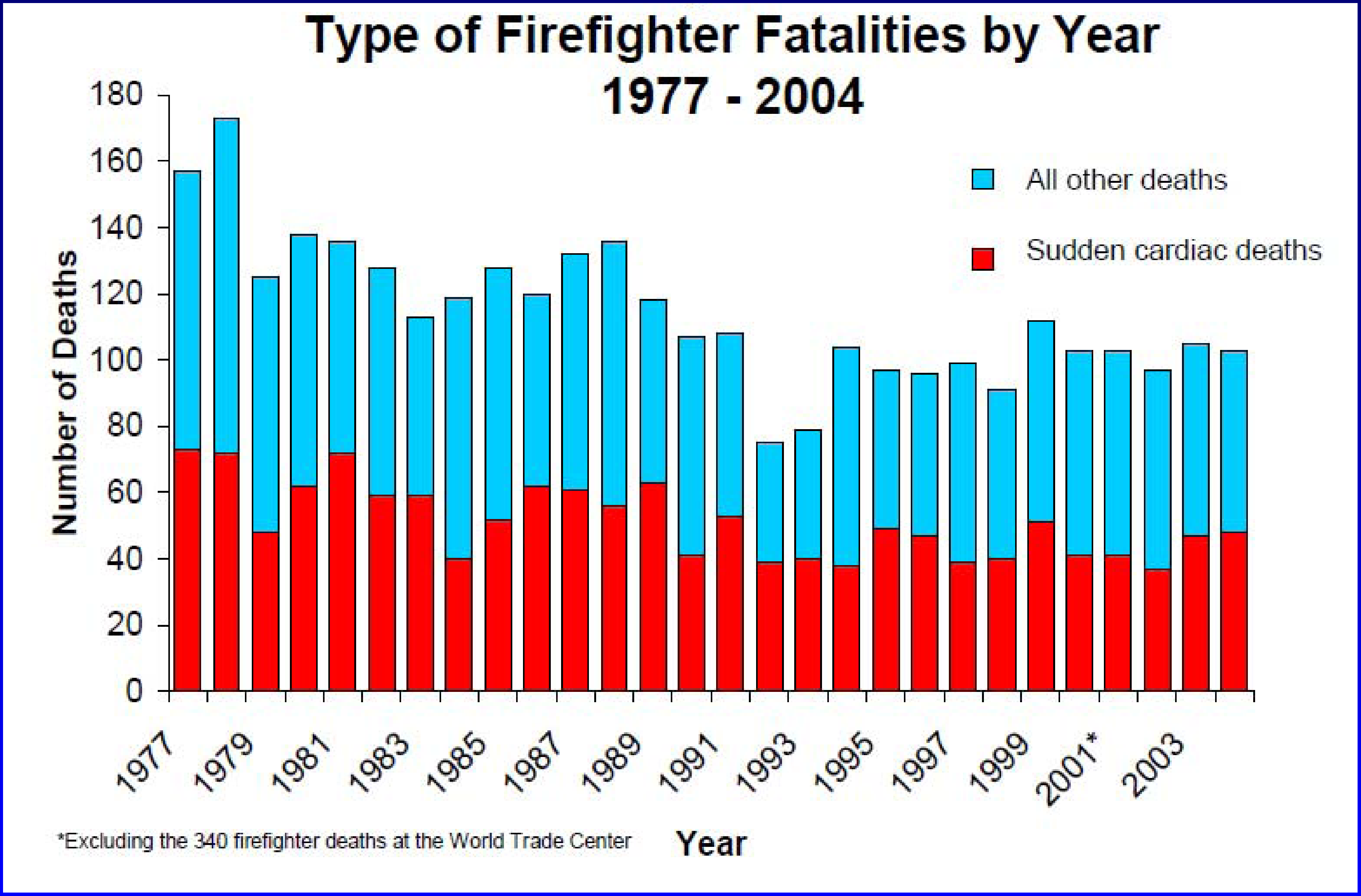
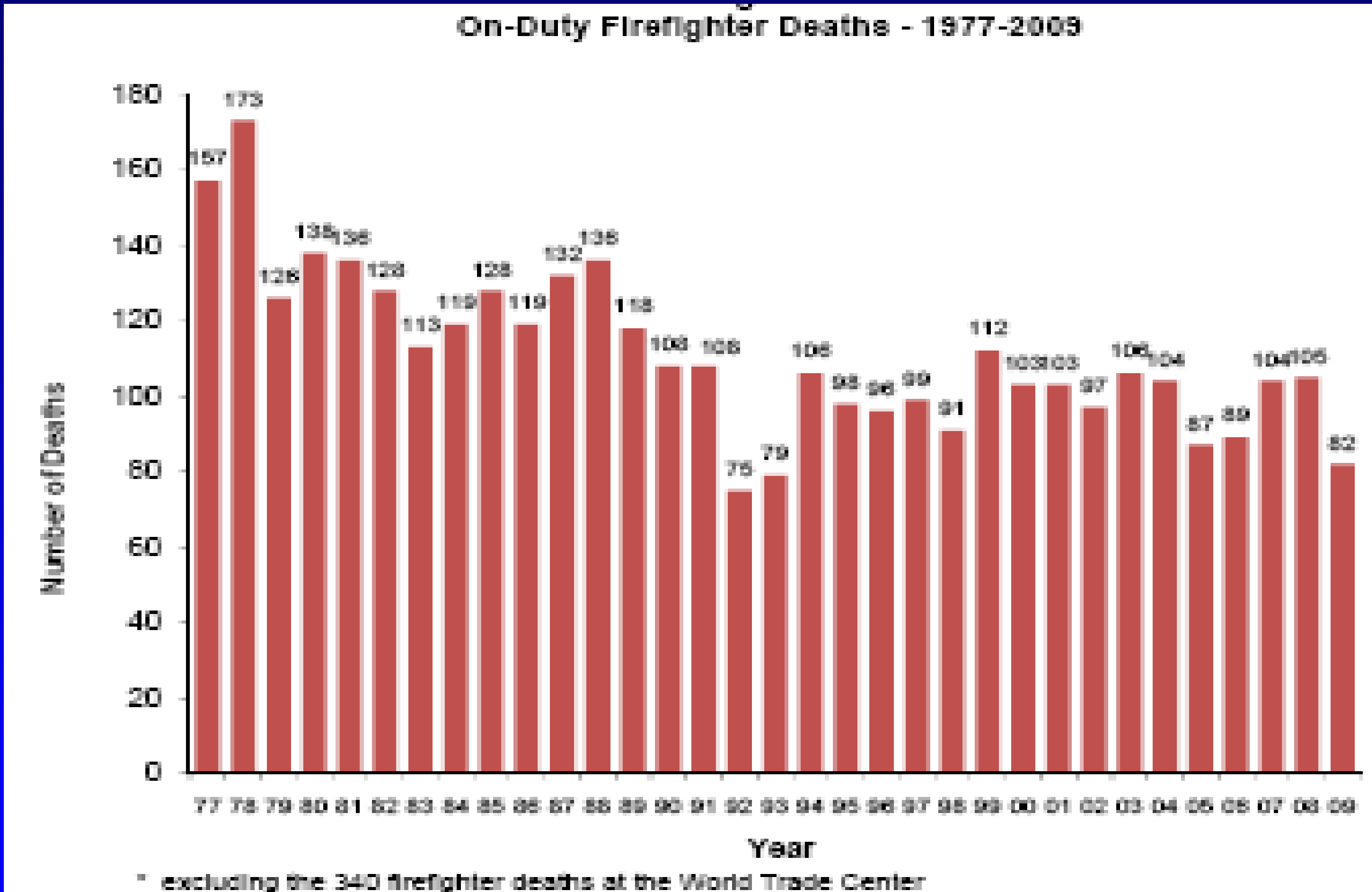


Source: NFPA.org

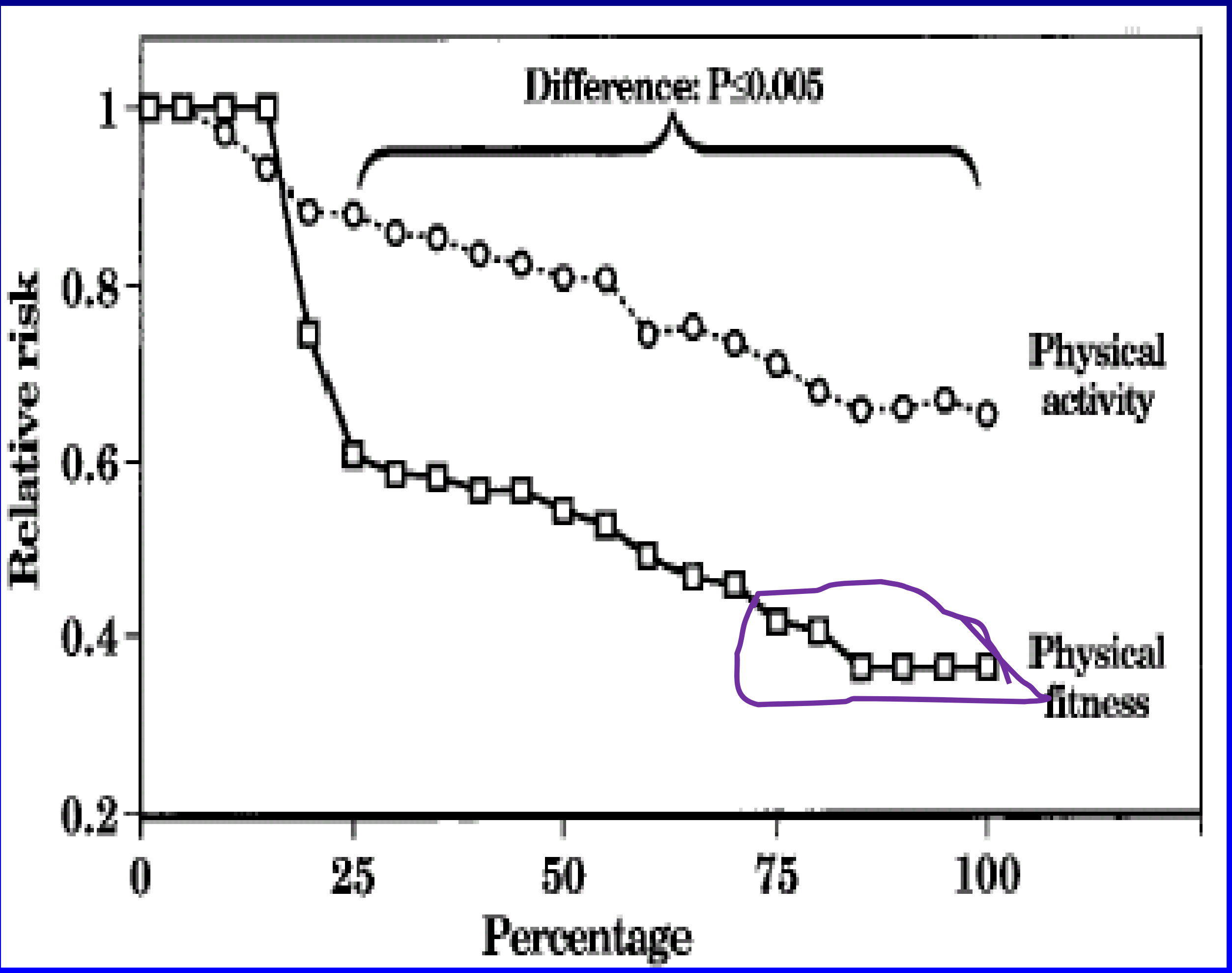


Source: NFPA.org

FUTURE

necoem.org

Physical Fitness, Activity and CHD Risk.
(Williams, 2001)



Persons in the >/=75%ile of Fitness

>/=60% Lower Risk

Williams PT. Physical fitness and activity as separate heart disease risk factors: a meta-analysis. Med Sci Sports Exerc. 2001 May;33(5):754-61

Physical demand

- Wearing 60lb PPE
- Carrying 40lb tools
- Climbing ladders
- Advancing water-filled hose lines
- Dragging victims

Maximal Oxygen Consumption

44 ml/kg/min

OR

12.5 METS

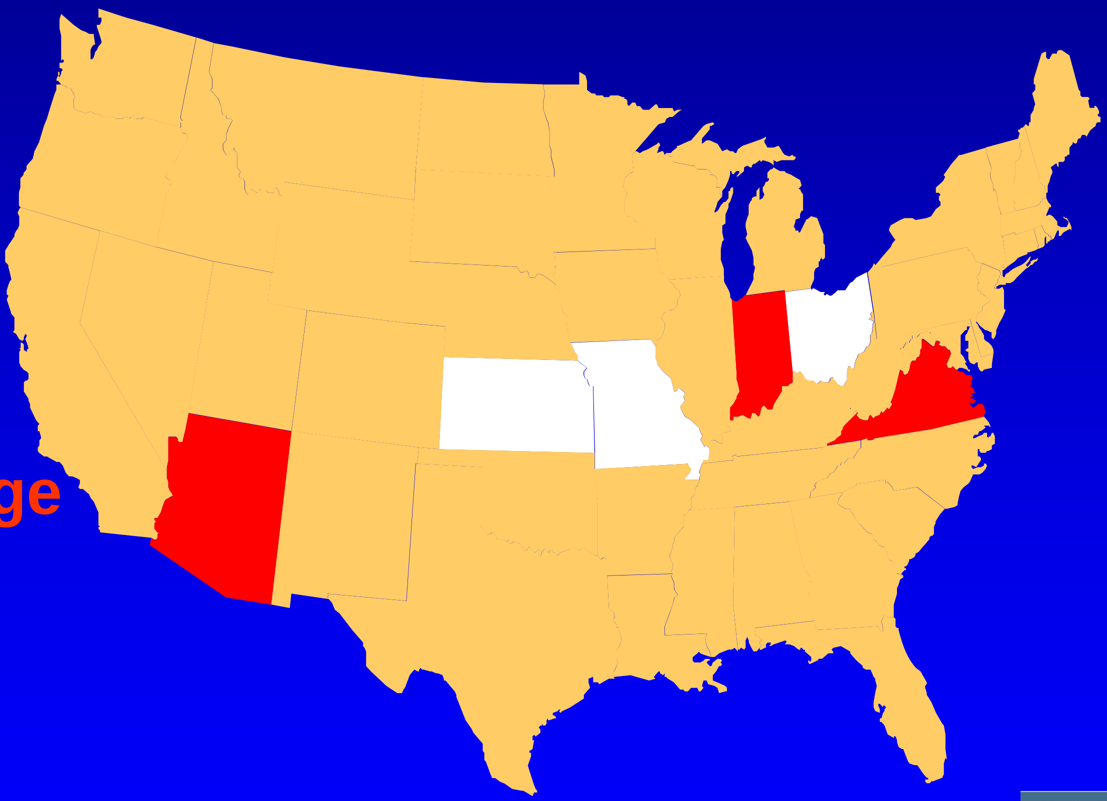
NFPA sets the minimum fit capacity at 12 METS

Thomas Hales MD MPH at NECOEM/OEMAC conference “How to reduce CV Mortality in your Fire Department”, Fall 2008

ETT/CRF and Outcomes Study Populations

Prospective – White

Goal N >/=1200
Consented: 1072
Data Entry: >1000
Prelim Anal: >900



Retrospective- Orange

N ~ 4500
Completed bsln ETT 1998-2005

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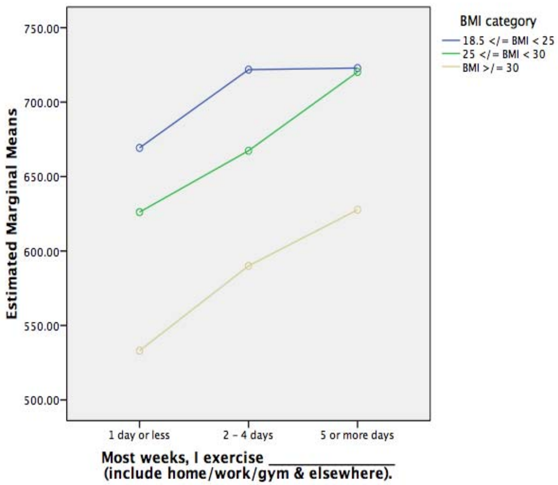
Physical Activity Components

FREQUENCY Most weeks, I exercise…(include home/work/gym & elsewhere).	1 day or less	94	17.6%
	2 - 4 days	321	60.1%
	5 or more days	119	22.3%
DURATION Most times that I do cardio or aerobic exercise (e.g., jogging, brisk walking, bike, treadmill, etc.), I do an average of…each session.	< 15 min	72	13.5%
	15 – 30 min	228	42.8%
	30 – 45 min	158	29.6%
	> 45 min	75	14.1%
INTENSITY Most times that I exercise, I sweat…on average each session.	Don't exercise too often	21	3.9%
	Light sweat	95	17.9%
	Moderate sweat	300	56.4%
	Heavy sweat	21.6	21.8%

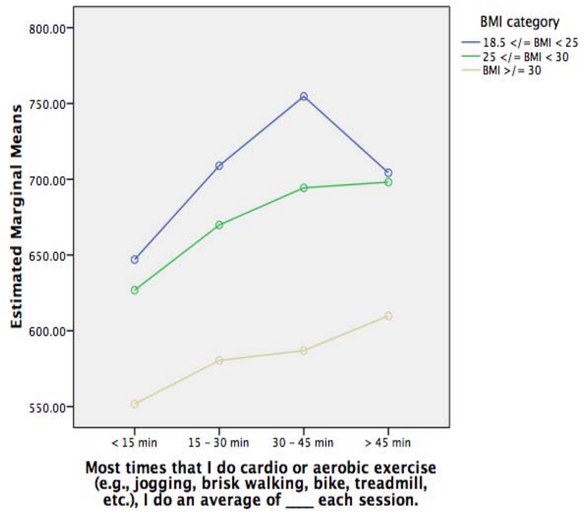
Exercise Tolerance Test Time as a f(x) of PA & BMI

Frequency



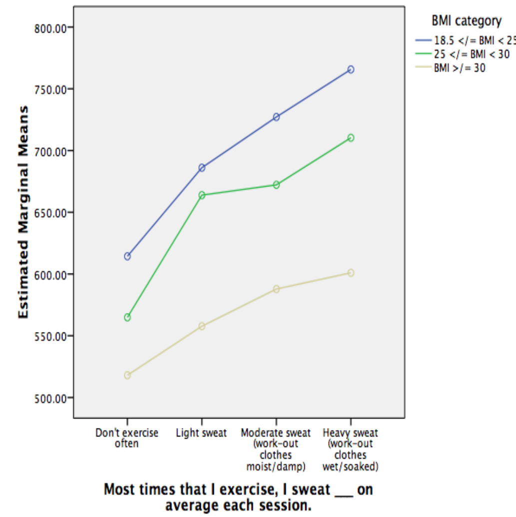
Source	Sig.
Weekly Exercise	<0.001
BMI	<0.001
Age	<0.001

Duration



Source	Sig.
Session duration	<0.001
BMI	<0.001
Age	<0.001

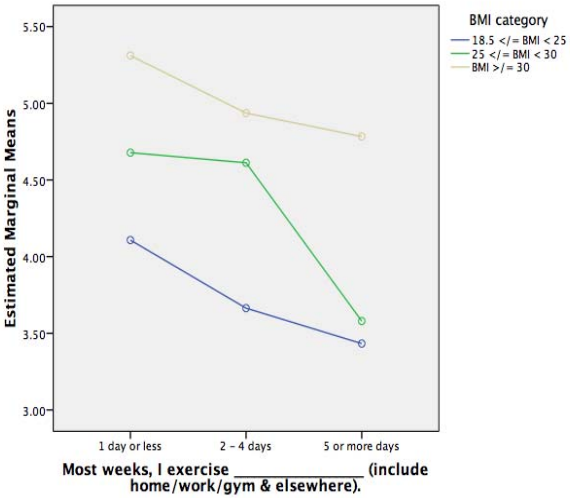
Intensity



Source	Sig.
Sweat	0.001
BMI	<0.001
Age	<0.001

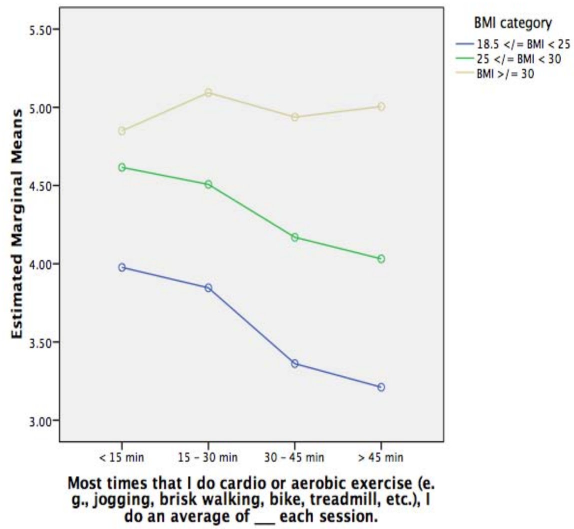
TC/HDL Ratio as a f(x) of PA & BMI

Frequency



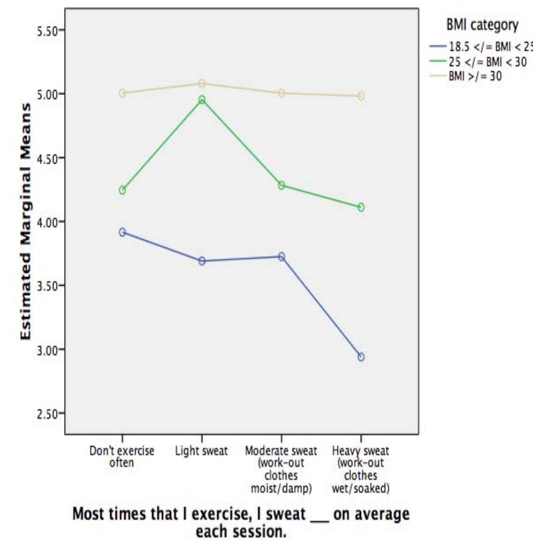
Source	Sig.
Weekly Exercise	0.006
BMI	<0.001
Age	0.13

Duration

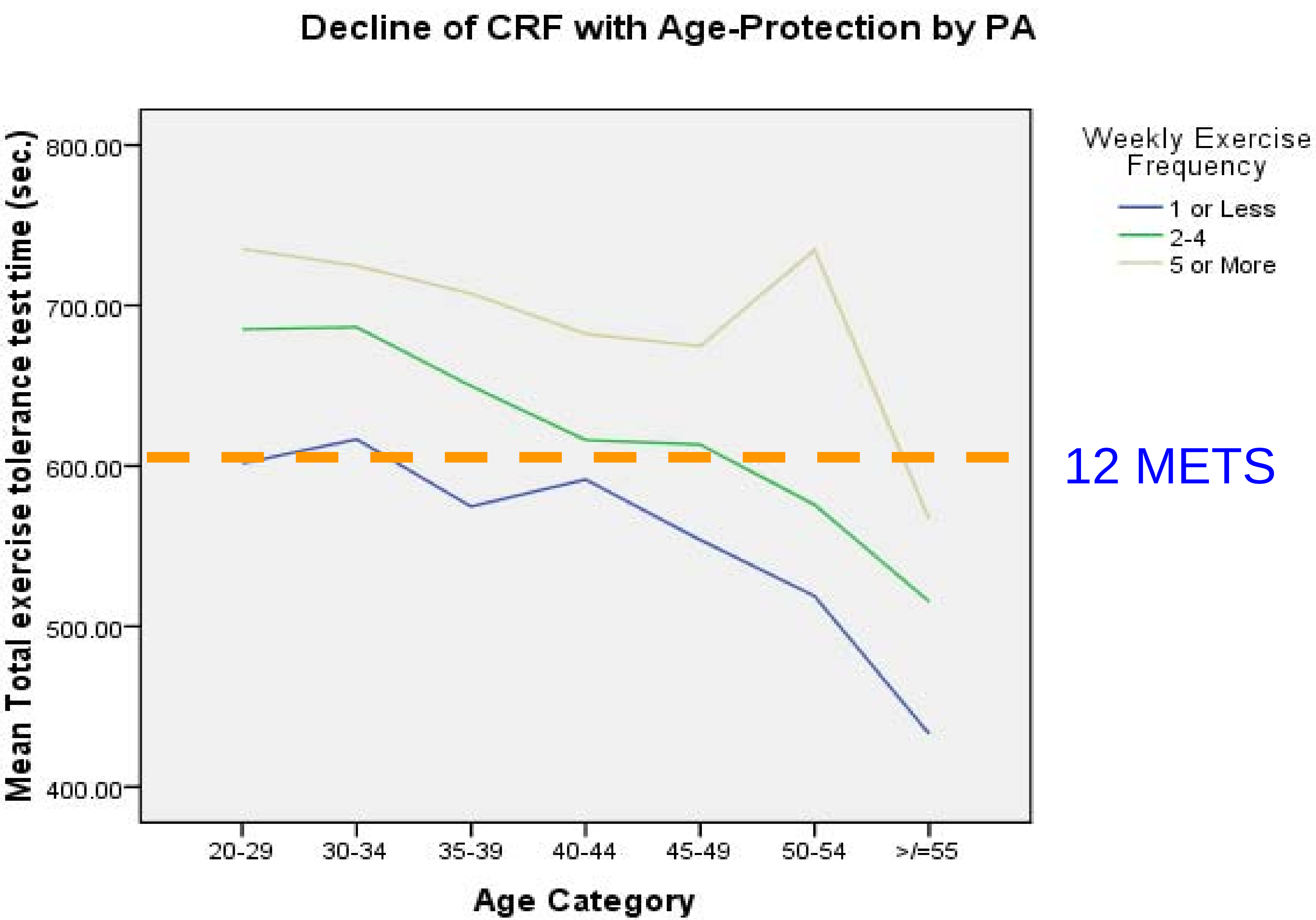


Source	Sig.
Session duration	0.11
BMI	<0.001
Age	0.24

Intensity



Source	Sig.
Sweat	0.12
BMI	<0.001
Age	0.05


Decline of CRF with Age-Protection by PA
Mean Total exercise tolerance test time (sec.)
800.00
700.00
600.00
500.00
400.00
20-29
30-34
35-39
40-44
45-49
50-54
>/=55
Age Category
Weekly Exercise Frequency
1 or Less
2-4
5 or More
12 METS

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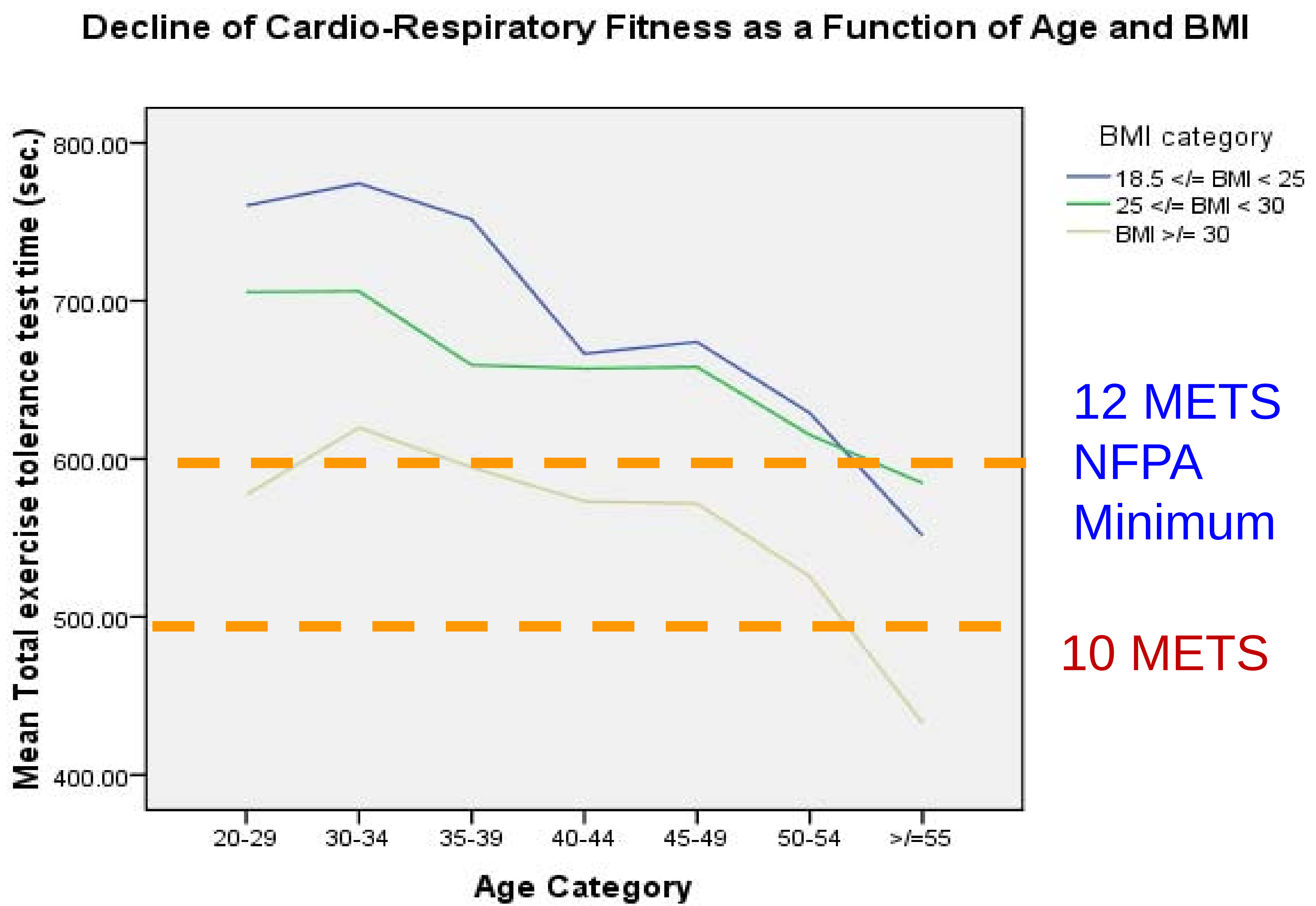
Decline of Cardio-Respiratory Fitness as a Function of Age and BMI
Mean Total exercise tolerance test time (sec.)
800.00
700.00
600.00
500.00
400.00
20-29
30-34
35-39
40-44
45-49
50-54
>/=55
Age Category
BMI category
18.5 </= BMI < 25
25 </= BMI < 30
BMI >/= 30
12 METS
NFPA
Minimum
10 METS

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CRF and CV Events / Mortality

2009 Meta-Analysis of 33 Studies

>100,000 gen. population middle-aged subjects

Each 1 additional MET conveyed

- **13% decrease in all-cause mortality**
- **15% decrease in CV events**

Kodama et al

The future of aerobic exercise testing in clinical practice: is it the ultimate vital sign?

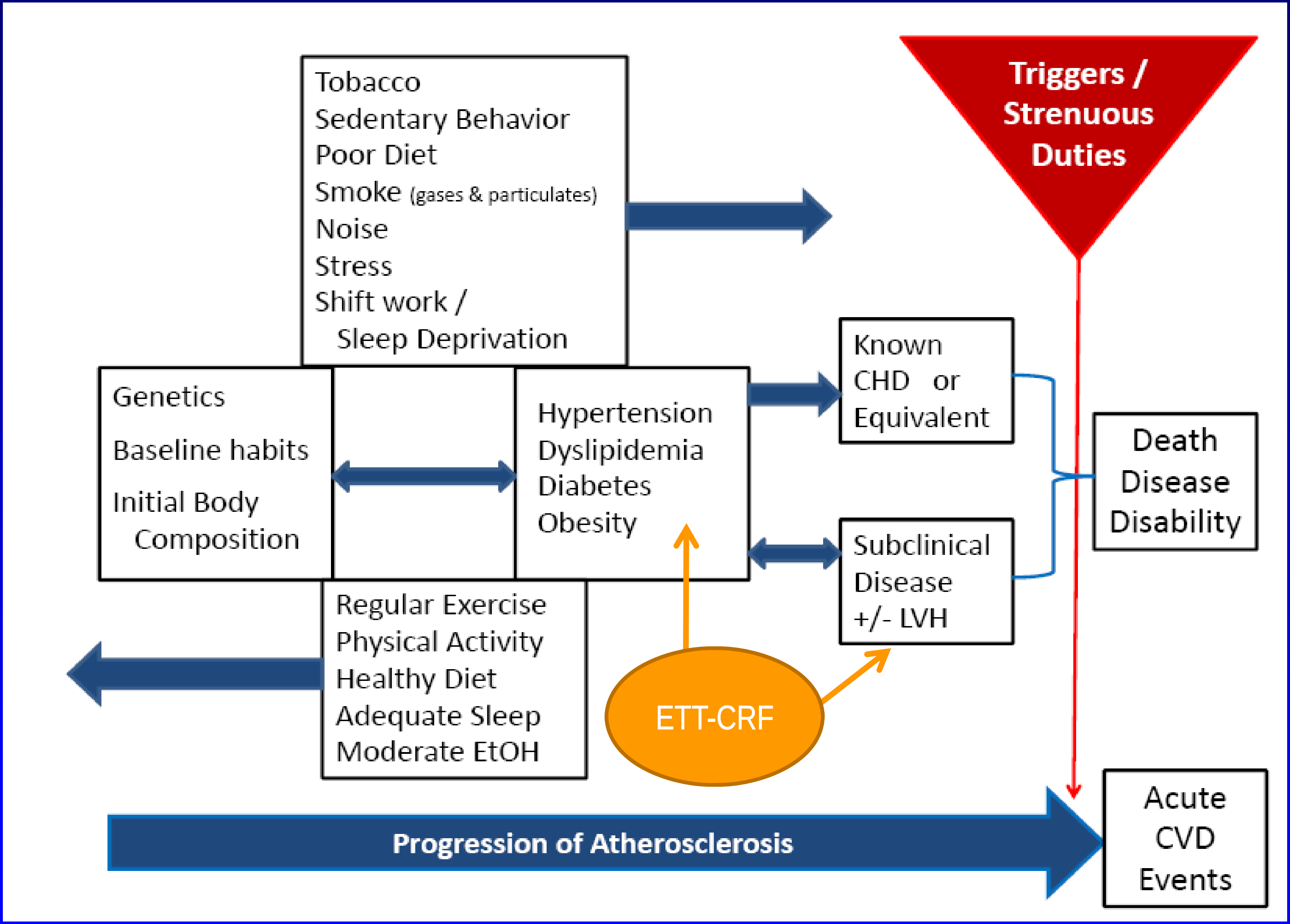
Ross Arena†, Jonathan Myers[1] & Marco Guazzi[2]

VA Palo Alto Health Care System, Cardiology Division, Palo Alto, CA, USA

University of Milano, San Paolo Hospital, Cardiology Division, Milano, Italy

Author for correspondence: Departments of Physical Therapy, Internal Medicine & Physiology, Virginia Commonwealth University, Richmond, VA, USA ■ Tel.: +1 804 628 3633 ■ Fax: +1 804 828 811

Future Cardiology 2010


Tobacco
Sedentary Behavior
Poor Diet
Smoke (gases & particulates)
Noise
Stress
Shift work /
Sleep Deprivation
Triggers / Strenuous Duties
Genetics
Baseline habits
Initial Body Composition
Hypertension
Dyslipidemia
Diabetes
Obesity
Known CHD or Equivalent
Death
Disease
Disability
Subclinical Disease +/- LVH
Regular Exercise
Physical Activity
Healthy Diet
Adequate Sleep
Moderate EtOH
ETT-CRF
Progression of Atherosclerosis
Acute CVD Events

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Risk Stratification by CRF

Very Low Fitness </=10 METS	Highest Risk
Low Fitness >10-12 Mets	Higher Risk
Medium Fitness >12-14 METS	Intermediate Risk
High Fitness >14 METS	Low Risk

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	METS >14	METS >12-14	METS >10-12	METS </=10	p-value
N	96	327	414	130	
Age	34.6 (8.0)	36.7 (8.1)	40.2 (7.4)	47.6 (7.4)	<0.001
BMI	26.0 (2.4)	28.1 (3.3)	30.0 (4.0)	32.8 (5.6)	<0.001
% Fat	16.4 (4.2)	20.4 (5.5)	20.6 (5.5)	24.7 (4.4)	<0.001
SBP	121 (12)	121 (12)	123 (12)	127 (13)	<0.001
Tot Chol	183 (33)	191 (33)	196 (39)	190 (45)	0.019
Tot Chol / HDL	3.6 (1.5)	4.3 (1.2)	5.1 (1.6)	5.2 (1.4)	<0.001
LDL	111 (33)	119 (29)	126 (33)	125 (37)	<0.001
HDL	54 (12)	47 (11)	41 (11)	38 (9)	<0.001
TGL	90 (51)	130 (96)	151 (146)	159 (119)	<0.001
Blood Glucose	89 (13)	92 (14)	95 (12)	102 (22)	<0.001
hs-CRP	1.1 (2.0)	2.1 (4.8)	3.5 (2.8)	Insuff data	0.031

	METS >14	METS >12-14	METS >10-12	METS </=10	p-value
N	96	327	414	130	
Total Treadmill Time (seconds)	804 (72)	672 (54)	584 (50)	512 (61)	<0.001
Max METS	15.0 (0.8)	13.4 (0.4)	11.1 (0.6)	9.0 (1.1)	<0.001
Heart Rate Recovery @ 1 min	35 (14)	33 (14)	27 (12)	25 (16)	<0.001
Autonomic Index (resting HR/HRR @ 1 min) (Lower- better)	2.0 (0.9)	2.6 (2.3)	2.8 (1.4)	3.4 (3.1)	<0.001
Chronotropic Insufficiency (Peak HR </=90%)	5.2 %	5.2 %	16.4 %	24.6%	<0.001
Exaggerated BP (Peak >/=220/90)	17%	23%	19%	32%	0.005

Low CRF Predicts Abnormal Exercise Testing in Firefighters

	METS >14	METS >12-14	METS >10-12	METS </=10
N	96	327	414	130
Stress EKG Abnormality	**1.0**	1.8 (0.2-15)	7.9 (1.1-58)	20 (2.7-152)
Abnormal HRR </=12 BPM @ 1 min	**1.0**	**3.3 (0.4-26)**	**4.0 (0.5-31)**	**8.8 (1.1-69)**
ETT Abnl any Criteria	**1.0**	**1.4 (0.5-4.2)**	**3.2 (1.1-9.1)**	**8.4 (2.9-24)**

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Characteristics of Low CRF METS </=12

56 % of Cohort

37% < 40 years

61% < 45 years

75 % of Obese FF’s

47% of Overweight FF’s

64% Exercised </=3x/WK

Prevalence of Trigger-Preventing Behaviors

Behavior	Recommendation	Compliant Firefighters (%)	Intervention Gap (%)
Aspirin	Daily male over 45 years	23	77
Physical exercise	30 min most days / week	23	77
Fish intake	2 servings per week	36	64
Flu vaccination	Every year	40	60
Smoking / Tobacco	Cessation	61	39

Take Home Messages

Strenuous Duties can Precipitate CV Events

CV Event victims have clinical CHD, subclinical disease & excess RF’s

Many potential victims could be identified

Risk Profiles could be modified before Clinical Events manifest

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Prevention

Known CHD and Emergencies Duties do NOT mix

Smoking should be prohibited

HTN & other RF's should be actively reduced

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Proposed Management Scheme for Emergency Responders

BP	Action	Follow-up
Normal	Unrestricted Population-Based	Annual
Prehypertension	Unrestricted Individual Education	6-12 mos per other RF's
Stage 1 Hypertension	Time-limited Clearance Rx & Evaluation	6-12 months Expect improved BP
Stage 2 Hypertension	Restricted Rx & Evaluation	Time-limited Clearance after Adequate BP Control

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AMERICAN JOURNAL OF HYPERTENSION

Prevention

Maximal Exercise Tests to assist Risk Stratification

Sleep Hygiene

? Flu Shots

? ASA

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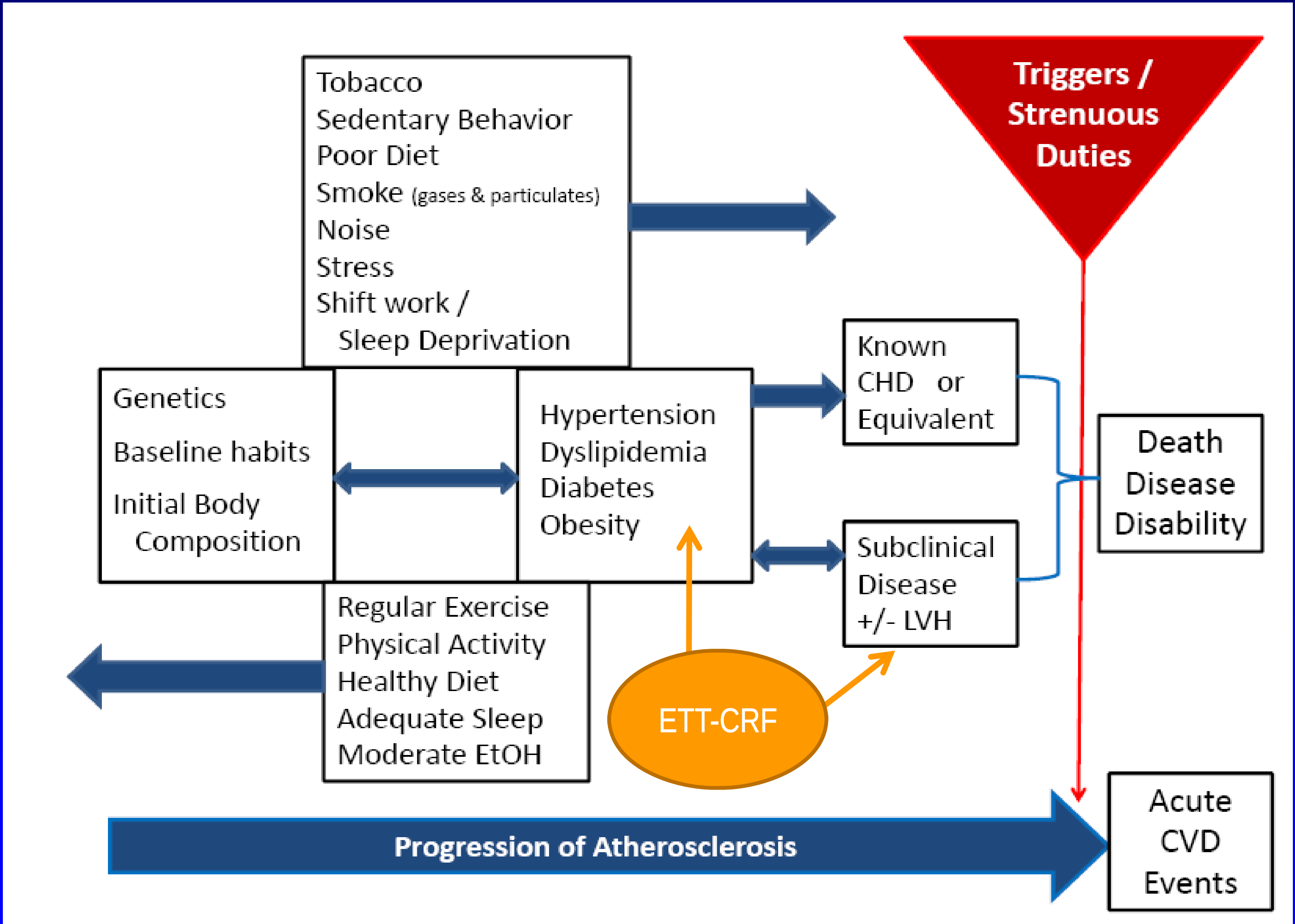
Tobacco
Sedentary Behavior
Poor Diet
Smoke (gases & particulates)
Noise
Stress
Shift work /
Sleep Deprivation
Triggers / Strenuous Duties
Genetics
Baseline habits
Initial Body Composition
Hypertension
Dyslipidemia
Diabetes
Obesity
Known CHD or Equivalent
Subclinical Disease +/- LVH
Death
Disease
Disability
Regular Exercise
Physical Activity
Healthy Diet
Adequate Sleep
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Progression of Atherosclerosis
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Discussion / Questions