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# Workplace Interventions and Changing Patterns of Cardiovascular Disease

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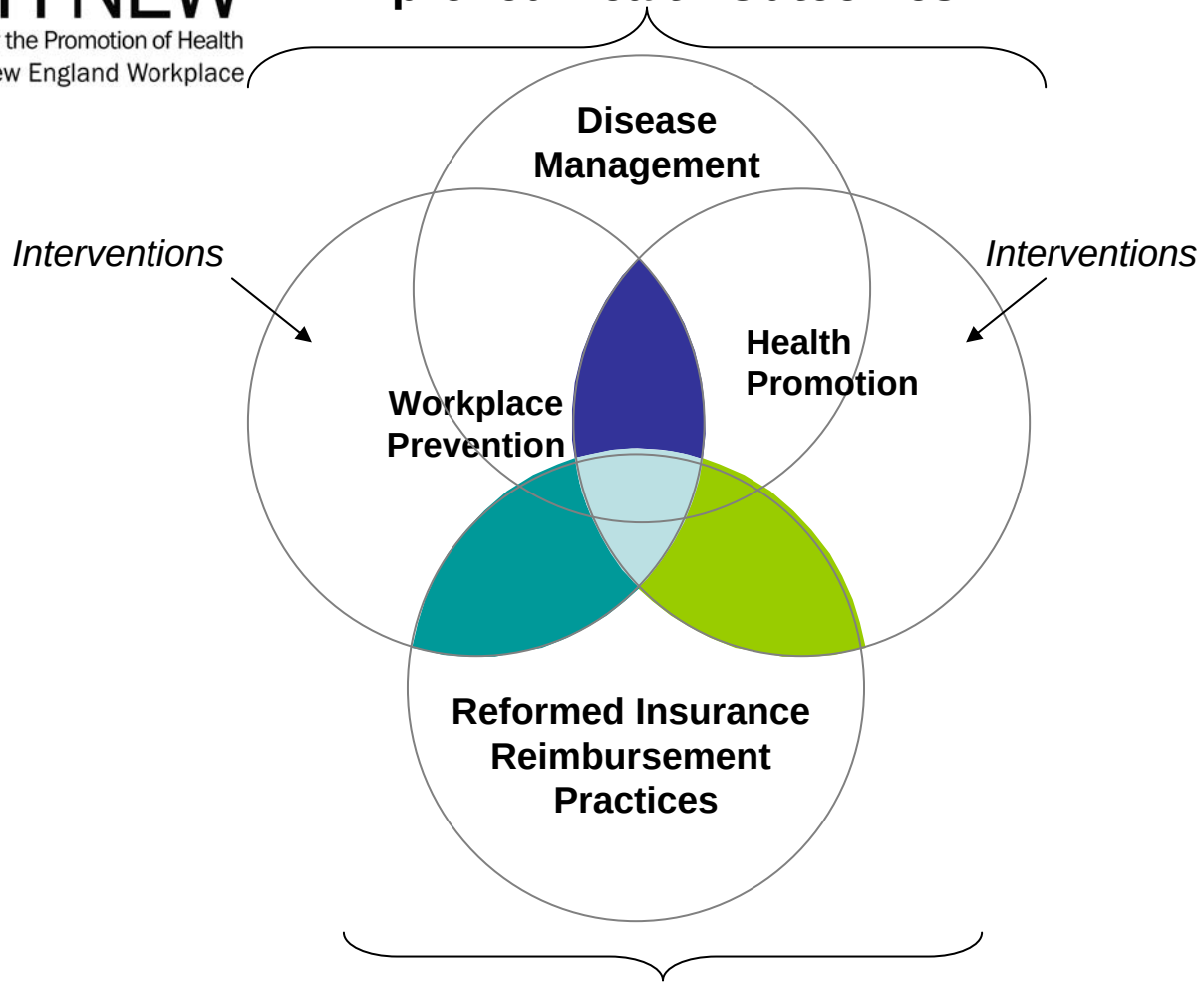
**Supported by NIOSH U 19 OH08857**

# Center for the Promotion of Health in the New England Workplace (CPH-NEW): Objectives

- Integrate two core public health areas (OHS and HPE), linking primary prevention to the workplace, and the workplace to primary prevention
- Evaluate both opportunities and obstacles to achieving this integration

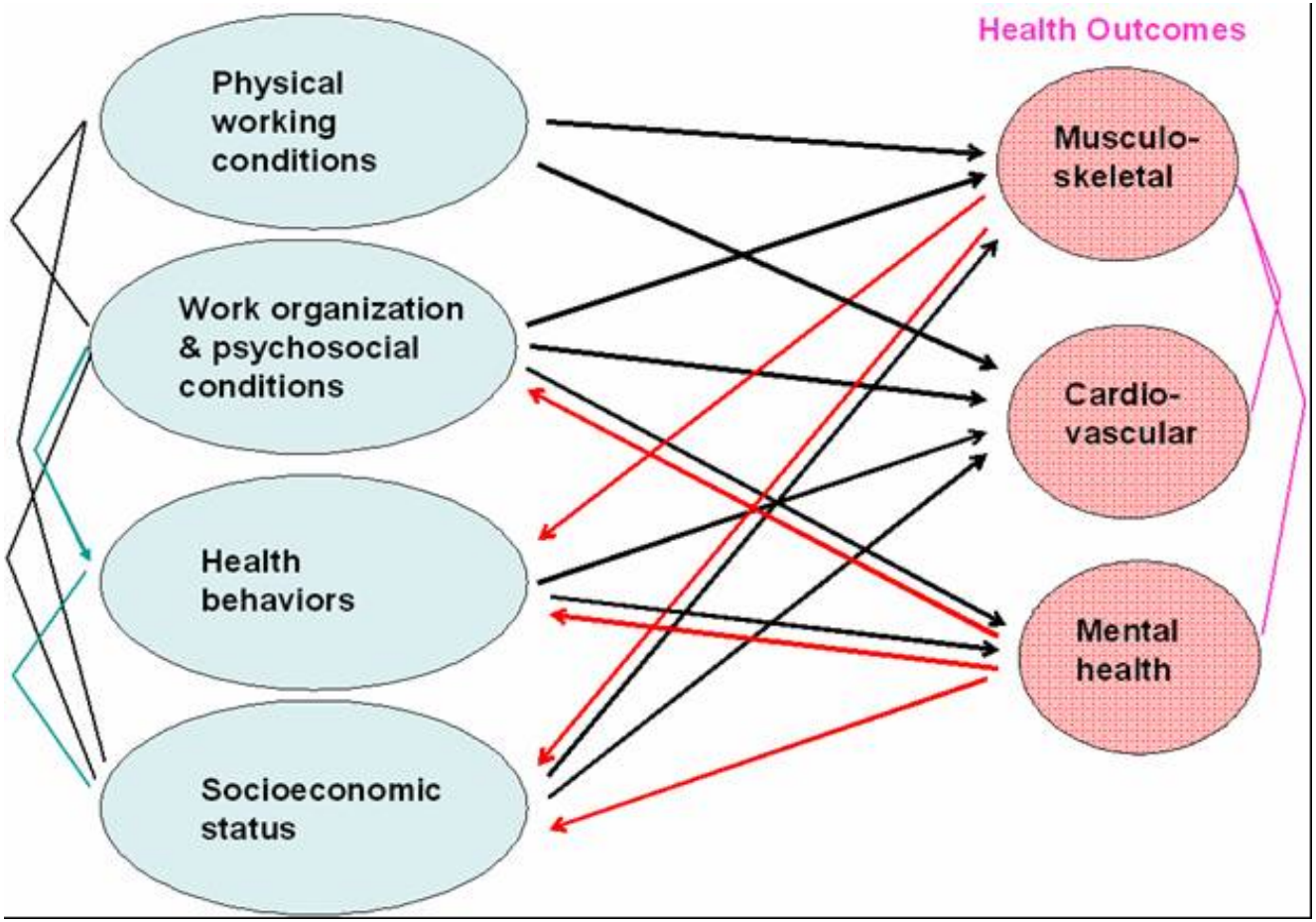
CPH-NEW
Center for the Promotion of Health in the New England Workplace

## Improved Health Outcomes




## Improved Cost Effectiveness

# Interplay of Workplace Risk Factors and Chronic Disease



# Core Projects of CPH-NEW

- **Project A**

  ***Promoting Physical and Mental Health of Caregiver through Transdisciplinary Intervention***

  Combinations of 1) Ergonomics intervention only; 2) ergonomics intervention plus health promotion, and 3) a participatory health promotion regimen integrated with the ergonomics intervention in more than 200 nursing homes

- **Project B**

  ***Health Improvement through Training and Employee Control***

  Comparisons at paired sites of traditional workplace health promotion intervention program with an experimental program featuring program development through employee participation

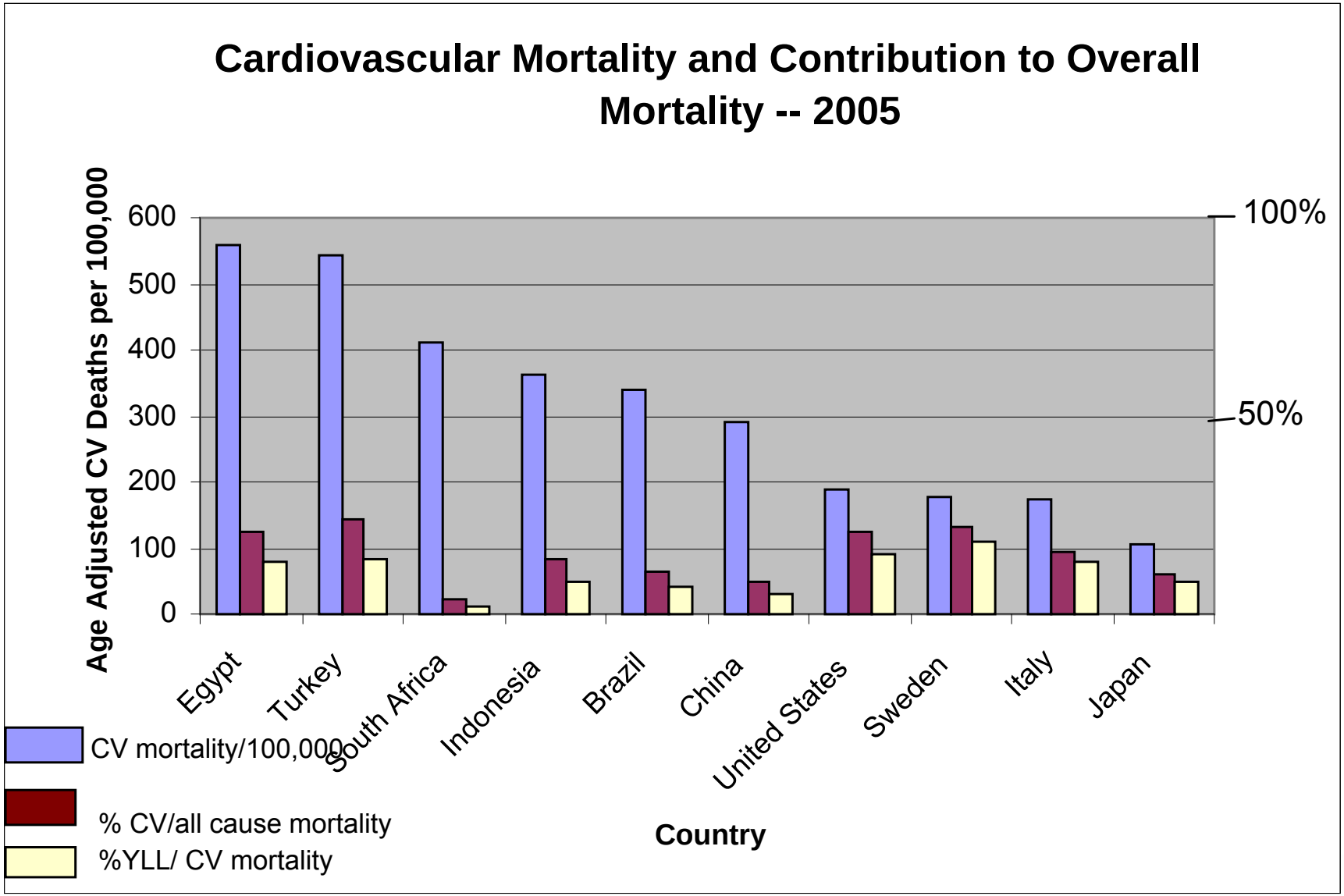
- **Project C**

  ***The Education, Communication and Dissemination Project***

  Outreach program to traditional and non-traditional practitioners to extend 1) the definition and efficacy of health promotion-occupational health and safety integration, and 2) the relationship between work-related stress and the development of heart disease and stroke

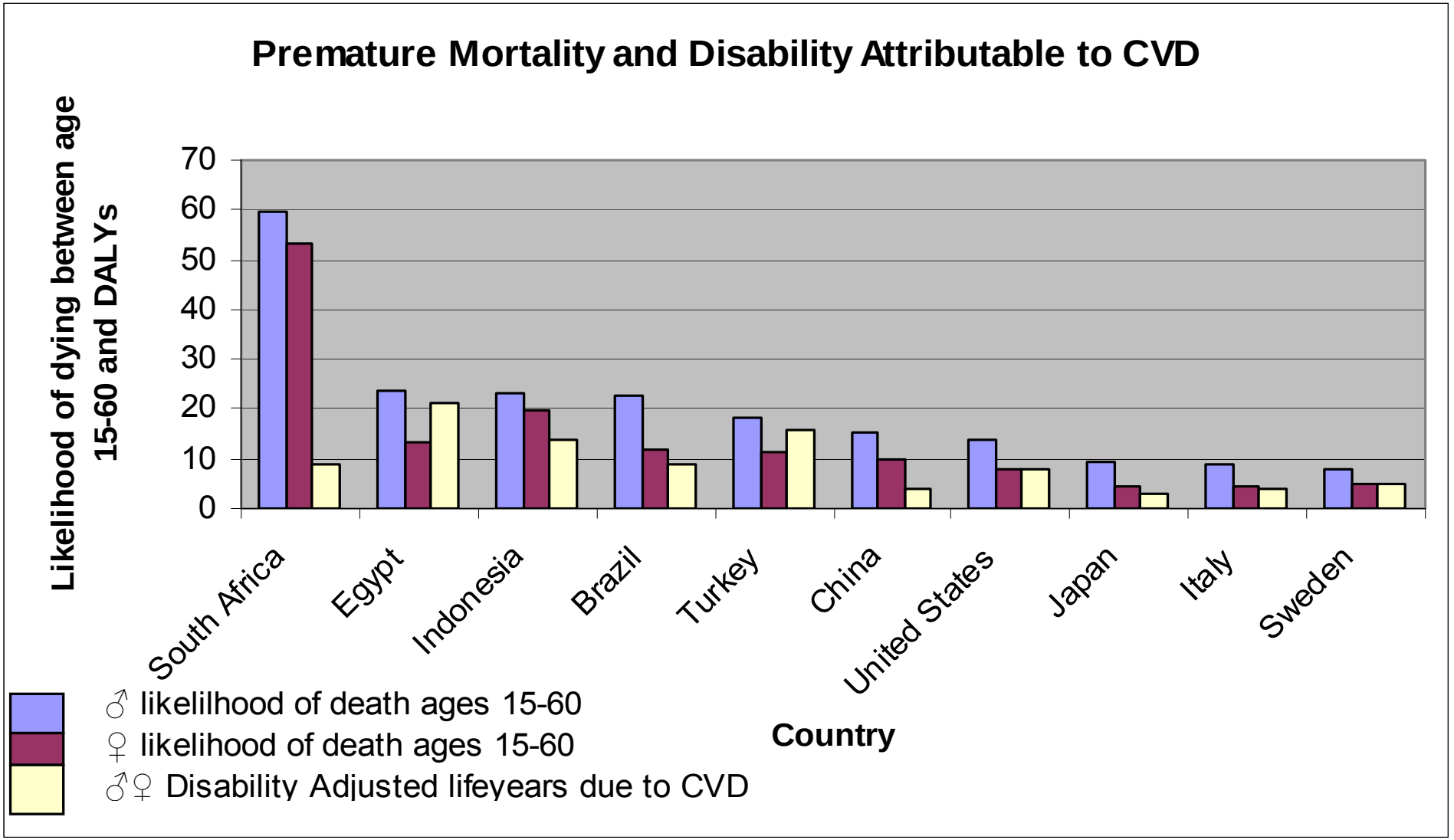
# Reasons for Diffidence from OEHS Investigators Towards Workplace-related Cardio-vascular Disease

- CVD is so highly prevalent in the general population, more distant or widespread causes are difficult to recognize through epidemiologic methods than more proximate risk factors.
- Traditional cardio toxins are relatively uncommon and play a small attributable role in CVD.
- There appears to be a cardio-selective Healthy Worker Effect in prominent cohort studies
- Variations in CVD incidence dilute the hazard-specific equivalence of toxic workplace exposures
- There is limited acceptance of CVD in worker compensation systems.
- Macro-social risk attribution creates elusive targets for specific interventions.



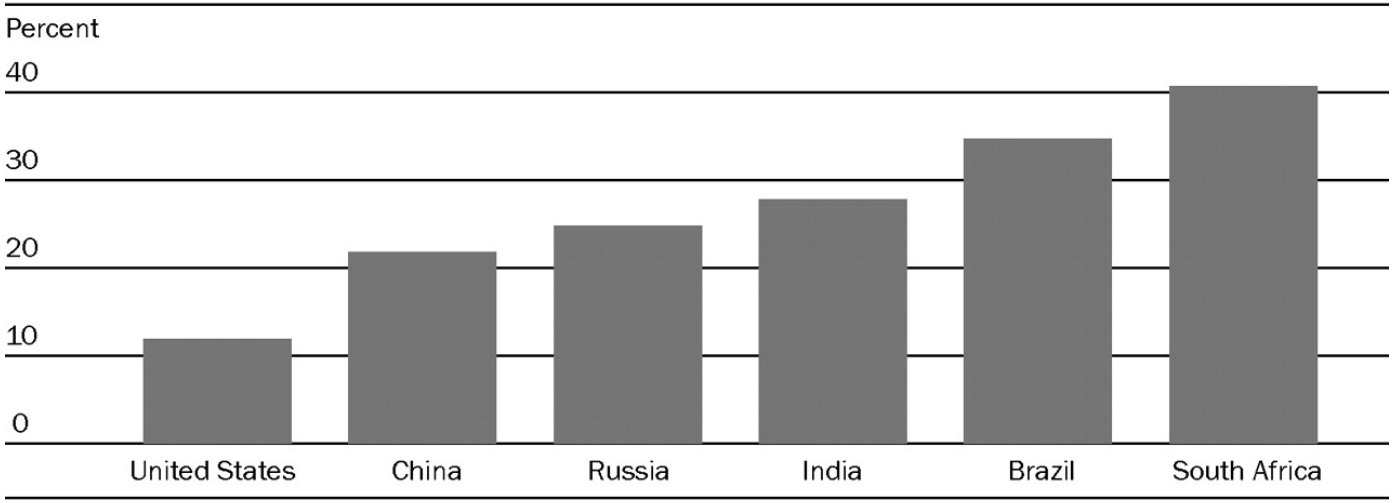

http://www.who.int/cardiovascular_diseases
resources/atlas/en/

## Premature Mortality and Disability Attributable to CVD




Source: Annex Table 1, World Health Report 2004
(www.who.int/whr)

**Proportion Of Deaths In Six Countries Attributable To Cardiovascular Disease (CVD) Among People Ages 35–64, 2000–2030**




**SOURCE:** S. Leeder et al., *A Race against Time: The Challenge of Cardiovascular Disease in Developing Countries* (New York: Trustees of Columbia University, 2004).

**Thomas A. Gaziano,**
**Reducing The Growing Burden Of Cardiovascular Disease In The Developing World,**
**Health Affairs, Vol 26, Issue 1, 13-24**

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Mortality rate ratio (95% confidence interval) comparing manual classes to non-manual classes for major groups of causes of death in men aged 45-59

| Country | All causes | Cardiovascular diseases |
|---|---|---|
| Finland | 1.48 (1.42 to 1.53) | 1.53 (1.49 to 1.56) |
| Sweden | 1.36 (1.31 to 1.40) | 1.41 (1.38 to 1.44) |
| Norway | 1.34 (1.27 to 1.40) | 1.34 (1.30 to 1.39) |
| Denmark | 1.28 (1.23 to 1.33) | 1.33 (1.30 to 1.36) |
| England and Wales | 1.52 (1.36 to 1.71) | 1.44 (1.33 to 1.56) |
| Ireland | 1.27 (1.17 to 1.38) | 1.38 (1.30 to 1.46) |
| France* | 1.35 (1.26 to 1.45) | 1.71 (1.66 to 1.77) |
| Switzerland | 1.08 (1.01 to 1.15) | 1.35 (1.29 to 1.39) |
| Italy | 1.17 (1.07 to 1.28) | 1.35 (1.28 to 1.42) |
| Spain | 1.19 (1.15 to 1.22) | 1.37 (1.34 to 1.39) |
| Portugal | 1.03 (0.97 to 1.10) | 1.36 (1.31 to 1.40) |

From Anton E Kunst, assistant professor, Feikje Groenhof, researcher, Johan P Mackenbach, professor, EU Working Group on Socioeconomic Inequalities in Health.

# Workplace Mobility and Risk of All Cause Mortality

| Men | | | |
|---|---|---|---|
| Total | Stable | Mobile within the labour market | Exited labour market through unemployment or early retirement |
| 1.72 | 2.47 | 1.53 | 3.41 |
| 1.35–2.19 | 1.48–4.13 | 1.17–2.01 | 0.66–17.62 |

| Women | | | |
|---|---|---|---|
| Total | Stable | Mobile within the labour market | Left labour market through unemployment, becoming housewife or early retirement |
| 1.39 | 2.25 | 1.32 | 2.62 |
| 0.75–2.21 | 0.85–5.99 | 0.73–2.40 | 0.33–20.61 |

from, M Cardano, G Costa, M Demaria - Soc Sci Med, 2004: Turin Longitudinal Study

# Agent Specific Occupational Exposures and CVD Mortality

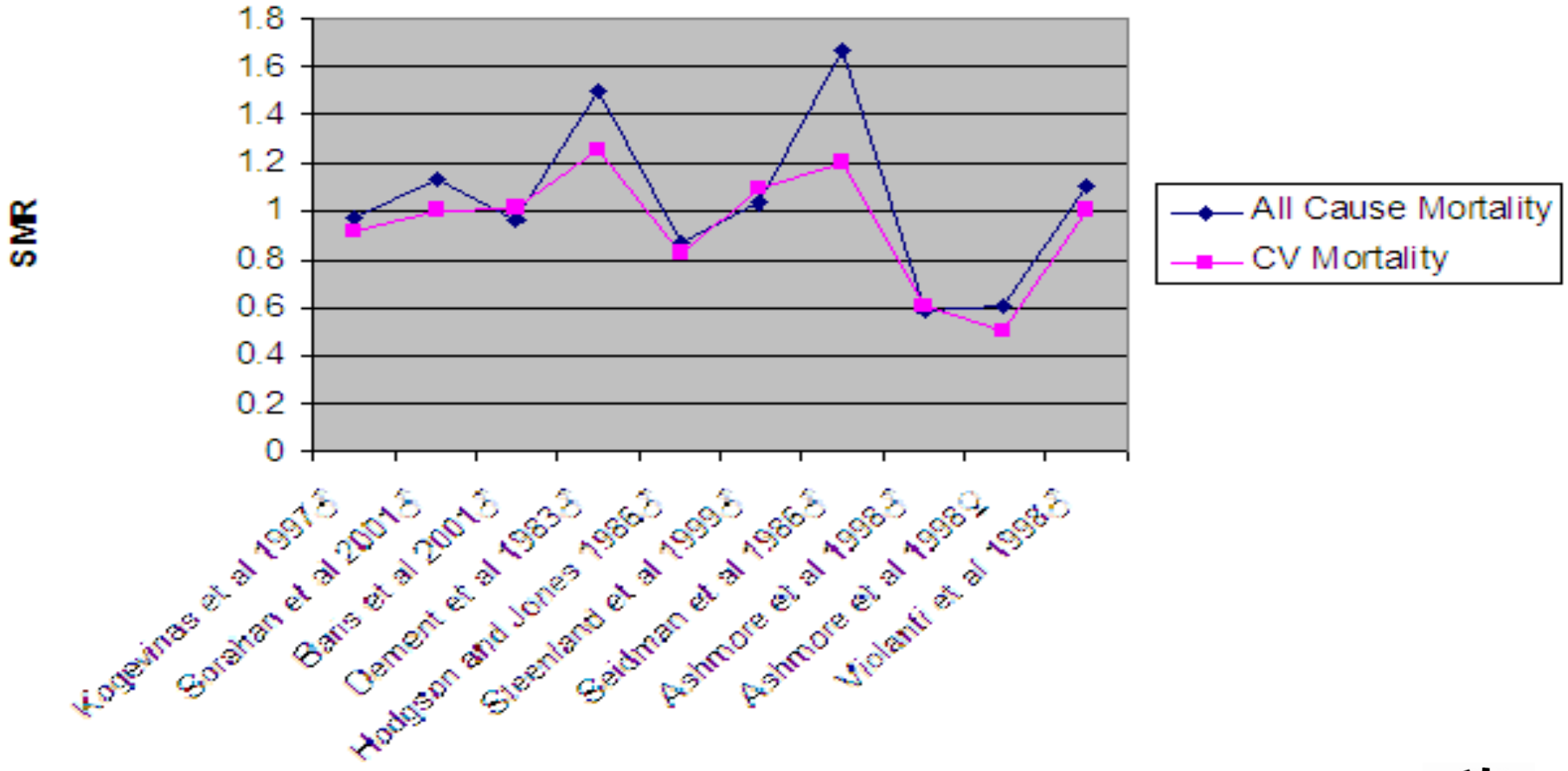
| Agent | Studies | Result | Attributable CVD Mortality Workforce Risk |
|---|---|---|---|
| 2.3.7,8-tetrachlorodibenzo-p-dioxin | Steenland et al.[13] | ~10% elevated IHD mortality | <1%<br>No significant current risk |
| Inorganic Mercury | Boffetta et al. [14]<br>Cragle et al. [77] | No IHD ↑ mortality<br>No IHD ↑ mortality | <1%<br>No evidence of risk |
| Carbon Disulfide | Tolonen et al.,[78]<br>Tolonen et al., [79]<br>Macmahon and Monson, [80]<br>Drexler et al. [16]<br>Swaen et al. [15]<br>Tan et al. [17] | 2x ↑CVD mortality<br>f/u ↑ risk of fatal MI (4-8x)<br>~40% ↑CVD mortality<br>No CV risk at current levels<br>15% ↑CVD mortality(1947-80)<br>No risk in current workforce | <1%<br>Historic risk to older workers; no measurable risk in current workplace |
| Nitrate Esters | Stayner et al. [81]<br>Levine et al. [82] | No ↑CVD mortality<br>31% ↑CVD mortality 1940-50s | <1%<br>No current risk |
| | | | |
| Noise and Vibration | Van Kempen et al. [83]<br>Bohr et al. [84]<br>Nurminen and Karjailanen [27] | 20% ↑CVD mortality per 5 db<br>1.4-2.0 OR↑MI incidence<br>20% ↑IHD risk (includingshiftwork) | 5% risk |
| Second hand smoke Small particles | Toren et al. [85] | 10% ↑IHD mortality | 2.5% risk |
| Shiftwork | McNamee et al. [28]<br>Tuchsen et al [29]<br>Knutson et al [30] | ~10%↓ mortality risk<br>33%↑CVD risk<br>5%↑all cause mortality | ↑5% mortality risk |

# Healthy Worker Effect and Cardiovascular Mortality

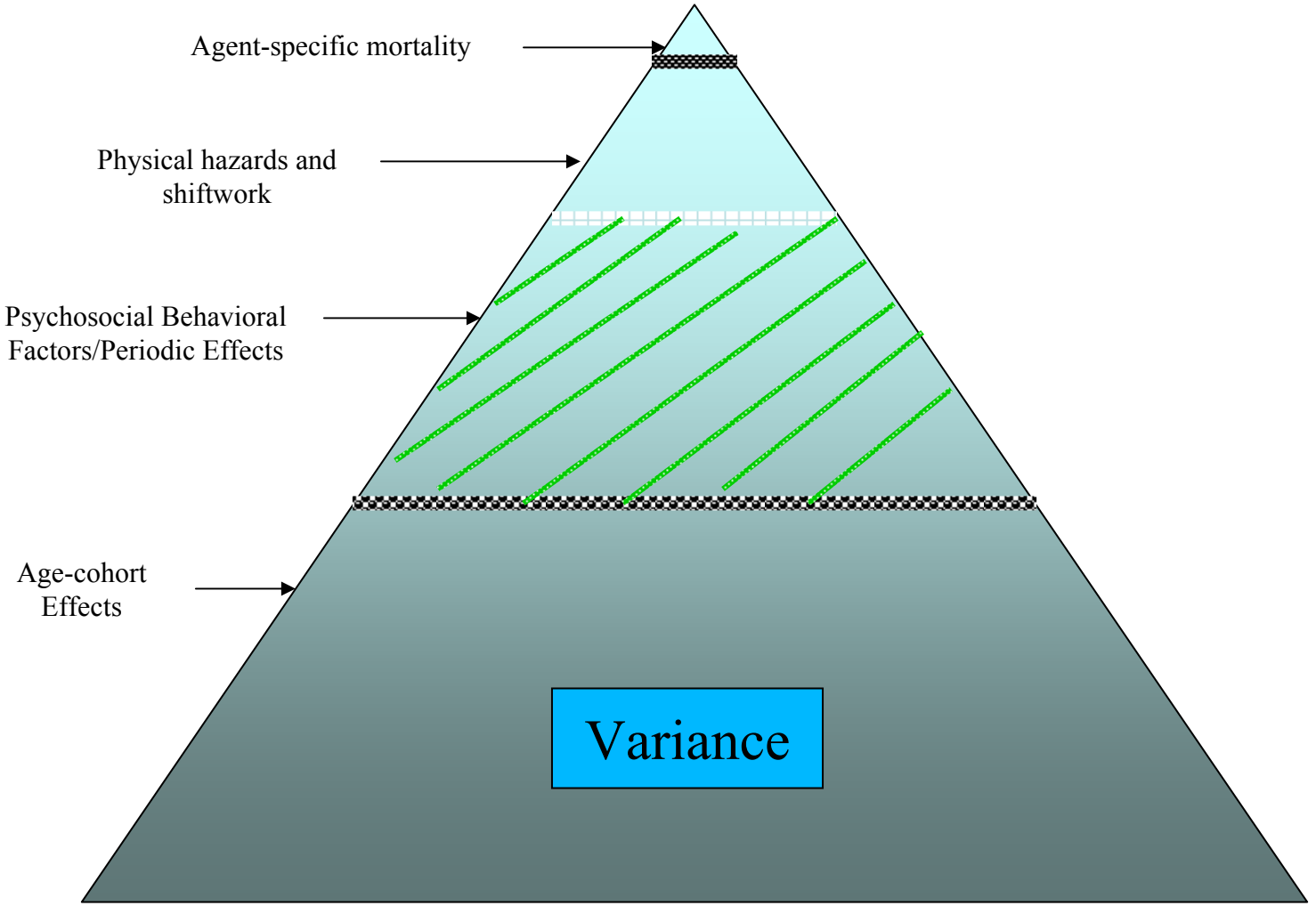
| Study | Exposure | Population | Total Deaths | All Cause Mortality - SMR | Cardiovascular Mortality – SMR ICD-9: 390-458 |
|---|---|---|---|---|---|
| Kogevinas et al 1997 | Phenoxy herbidices/ chlorophenols | 9 countries<br>36 cohorts<br>21,863 subjects | 4,026 ♂<br>133 ♀ | 0.97 [0.94-1.00] ♂<br>0.98 [0.82-1.17] ♀ | 0.91 [0.87-0.95] ♂<br>1.00 [0.73-1.32] ♀ |
| Sorahan et al 2001 | Carbon Black | 1,147♂ | 372♂ | 1.13 [1.02-1.25] ♂ | 1.00 [0.85-1.17] ♂ |
| Baris et al 2001 | Firefighting | 7,789♂ | 2,220♂ | 0.96 [0.92-0.99] ♂ | 1.01 [0.96-1.07] ♂ |
| Dement et al 1983 | Asbestos textiles | 1,261♂ | 308♂ | 1.50 ♂ | 1.25 ♂* |
| Hodgson and Jones 1986 | Asbestos | 31,150♂ | 1,128♂ | 0.87 ♂ | 0.83 ♂ |
| Steenland et al 1999 | Dioxin/chem wkrers | 5,132 ♂ | 1,444♂ | 1.03 (0.97–1.08) ♂ | 1.09 (1.00–1.20) ♂+ |
| Seidman et al 1986 | Asbestos | 820♂ | 593♂ | 1.67 ♂ | 1.20♂# |
| Ashmore et al 1998 | Ionizing radiation | 206,620<br>105,456♂<br>101,164♀ | 4,210♂<br>2,016♀ | 0.59 [0.57-0.60] ♂<br>0.61 [0.59-0.65] ♀ | 0.61 [0.59-0.64] ♂<br>0.50 [0.45-0.55] ♀ |
| Violanti et al 1998 | Police work | 2,693♂ | 1,035♂ | 1.10 [1.04–1.17]♂ | 1.00 [0.92–1.10]♂ |

*ICDA- 400-468
+ICD-9 – 410-414 (IHD)
# ICD unspecified

# Comparison of SMR for CVD and All Cause Mortality in Selected Cohort Studies



# Proportion of Cardio-Vascular Mortality Associated with Occupation



# Assessment Instruments for Weighing Risk

- Risk determination Instruments
  - Job Strain
    - 2-dimensional construction of psychological demand and decision latitude
      - **Decision Latitude:** decision authority and skill utilization)
      - **Demand:** excessive work, conflicting demands, insufficient time to work, work fast, and work hard
  - Effort Reward
    - Social Justice Model of symmetry of work demand and compensation (income, recognition)
      - **Four Dichotomous variables:** intrinsic demand, extrinsic demand, esteem reward, and status control**.**
      - **Three ERI categories:** 1=neither high effort nor low reward; 2=either high effort or low reward; and 3=both high effort and low reward used in the "full" effort/reward imbalance model

# Job Strain and Metabolic Syndrome

| | Including patients who were obese at baseline | | | Excluding patients who were obese at baseline | |
|---|---|---|---|---|---|
| | No of cases/total | Adjusted for age+employment grade | Adjusted for age+employment grade+health behaviours | No of cases/total | Adjusted for age+employment grade+health behaviours |
| **Men** | | | | | |
| No exposures | 341/3564 | 1.00 | 1.00 | 281/3407 | 1.00 |
| 1 exposure | 95/900 | **1.11 (0.73 to 1.67)** | **1.11 (0.73 to 1.69)** | 77/851 | **1.12 (0.67 to 1.87)** |
| 2 exposures | 37/252 | **1.64 (0.98 to 2.73)** | **1.57 (0.92 to 2.65)** | 31/238 | **1.56 (0.93 to 2.63)** |
| ≥3 exposures | 32/181 | **2.01 (0.88 to 4.58)** | **2.17 (0.92 to 5.09)** | 24/166 | **2.04 (0.86 to 4.85)** |
| **Women** | | | | | |
| No exposures | 150/1614 | 1.00 | 1.00 | 107/1474 | 1.00 |
| 1 exposure | 40/353 | 1.23 (0.40 to 3.74) | 1.27 (0.42 to 3.84) | 25/314 | 1.22 (0.28 to 5.37) |
| 2 exposures | 17/131 | 1.27 (0.34 to 4.83) | 1.45 (0.45 to 4.75) | 10/118 | 1.09 (0.15 to 7.94) |
| ≥3 exposures | 9/39 | 3.73 (0.88 to 15.75) | 3.72 (0.79 to 17.53) | 6/32 | 4.69 (0.79 to 27.86) |

*From Chandola et al. BMJ 2006*

# Predictor of Initial Adverse Heart Events in Men

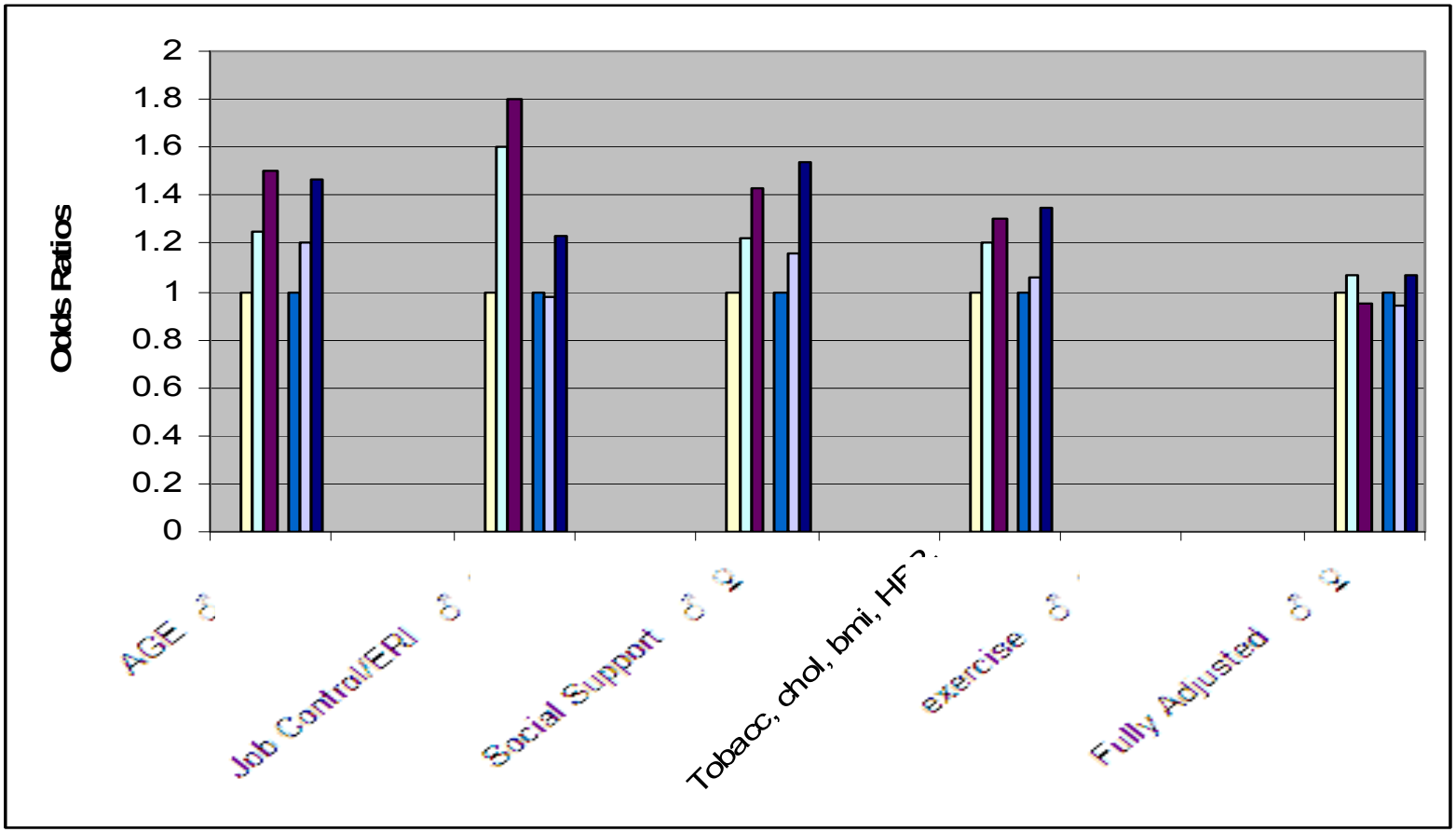
| | Angina pectoris | Severe chest pain | Diagnosed ischaemia | Any CHD event |
|---|---|---|---|---|
| **Age Adjusted** | | | | |
| High | 1·00 | 1·00 | 1·00* | 1·00* |
| Intermediate | 1·28 (0·91–1·81) | 1·11 (0·85–1·47) | 1·06 (0·71–1·58) | 1·25 (1·00–1·57) |
| Low | 1·74 (0·97–3·11) | 1·44 (0·87–2·37) | 2·27 (1·27–4·08) | 1·50 (0·98–2·29) |
| **Work adjusted†** | | | | |
| High | 1·00 | 1·00 | 1·00 | 1·00 |
| Intermediate | 1·20 (0·84–1·72) | 1·08 (0·81–1·44) | 0·96 (0·63–1·46) | 1·16 (0·92–1·48) |
| Low | 1·48 (0·77–2·86) | 1·18 (0·68–2·06) | 1·88 (0·95–3·73) | 1·18 (0·74–1·88) |
| **Fully adjusted¶** | | | | |
| High | 1·00 | 1·00 | 1·00* | 1·00* |
| Intermediate | 1·07 (0·74–1·54) | 1·01 (0·75–1·35) | 0·84 (0·55–1·30) | 1·07 (0·84–1·37) |
| Low | 1·12 (0·56–2·23) | 0·97 (0·55–1·72) | 1·49 (0·72–3·07) | 0·95 (0·59–1·54) |

† Job control and effort-reward imbalance.
¶ Early life, work, support, and risk factors.

*Significant Result

From Marmot et al. 1997

# Odds Ratios for New CHD Events in Civil Service Workers – Whitehall Studies




Low Risk
Intermediate Risk ♂
High Risk

Low Risk
Intermediate Risk ♀
High Risk

From Marmot et al., 1997

# Studies of Job Strain and Coronary Heart Disease

- 34 studies published between 1981 and 2002
  - 16 from Sweden (many using national data bases)
  - 7 from U.S. (2 using national data bases)
  - Also: Czech Republic, Denmark, England, Finland, Japa

| | Significant positive associations | Mixed positive and null associations | Total # of studies |
|---|---|---|---|
| Cohort studies | 8 | 3 | 17 |
| Case-control studies | 6 | 0 | 9 |
| Cross-sectional studies | 4 | 0 | 8 |

PAR% = 10-30%

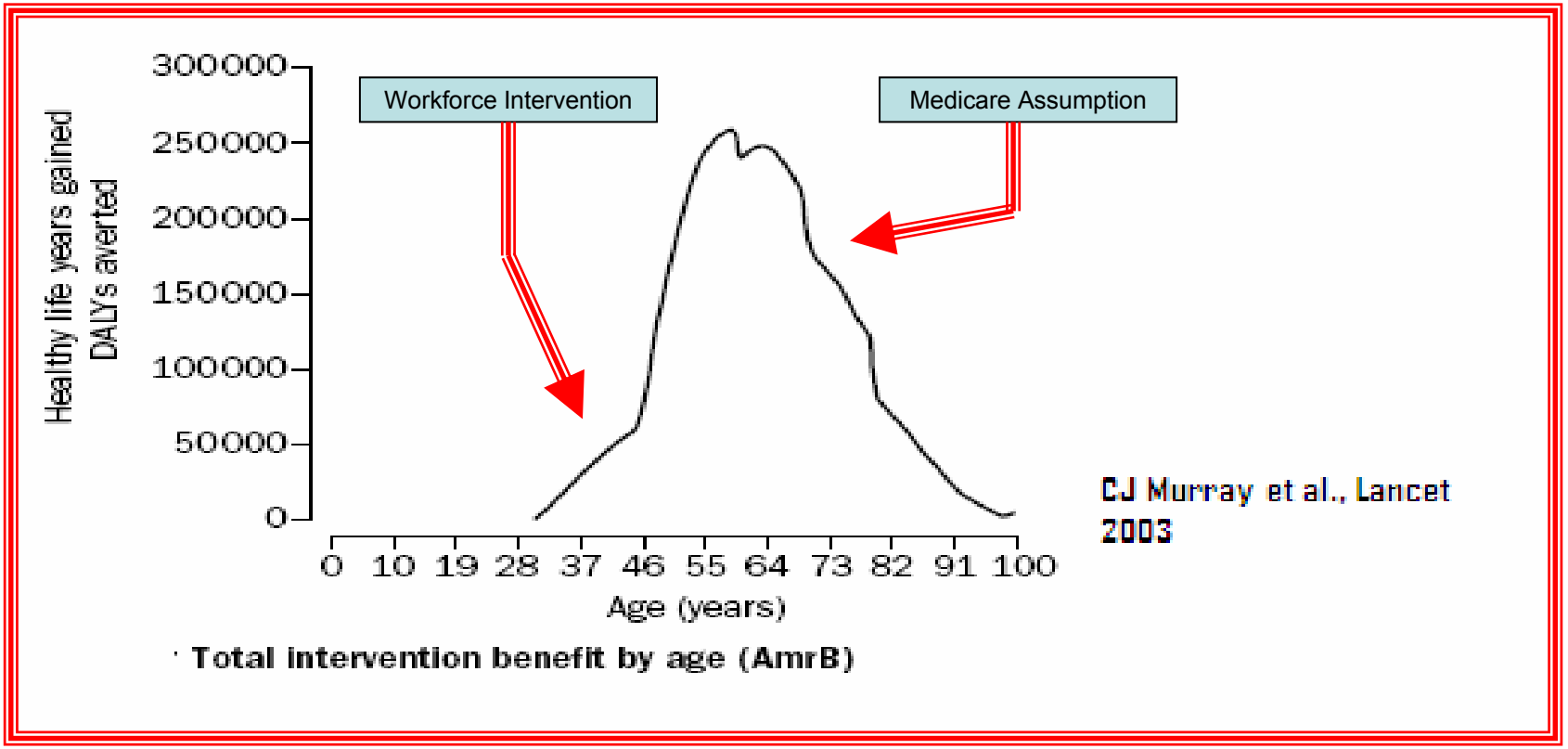
Belkić K, Landsbergis P, Schnall P, Baker D. Is job strain a major source of cardiovascular disease risk? *Scandinavian Journal of Work Environment and Health* 2004;30(2):85-128.

# Chronic Disease Intervention in the Context of Cost Pressures

- **Increasing recognition of misallocation of health resources**
  - Lack of evidence based treatment
  - Ineffective (non-procedural) management of chronic disease
- **Rapid increase in medical costs**
- **Shift in diseases and exposure recognition**
  - OH Shift from short-term chemical exposures, carcinogenesis and lung disease, due to long-term multi-factorial risk
  - Interplay of individual and social factors, including work organization, in chronic disease

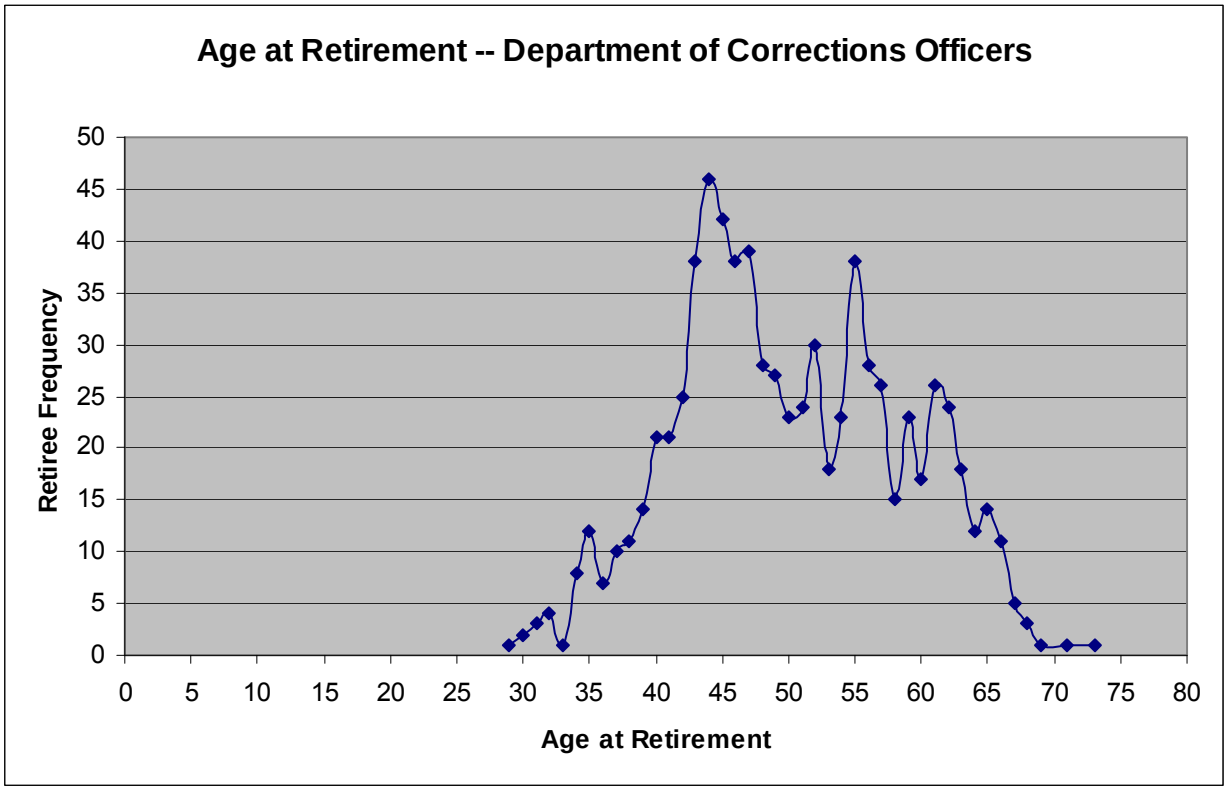
    Shift to function and performance, pre-clinical pathologies, and premature aging in workforce health
- **Recognition of Health and Productivity Relationship**
  - Movement away from crude indicators (absenteeism, lost time, health as absence of disease claims)
  - Movement towards measures of performance, high function, chronobiology, etc.
- **Recognition of the worksite as medium for healthcare administration**
  - Work environment as site for promoting disease recognition and behavioral change
  - Integration of health into workplace design

# Accounting for Chronic Disease over the Whole Life Cycle Example: Hypertension Related Health Promotion and Disease Management Effect on QOL

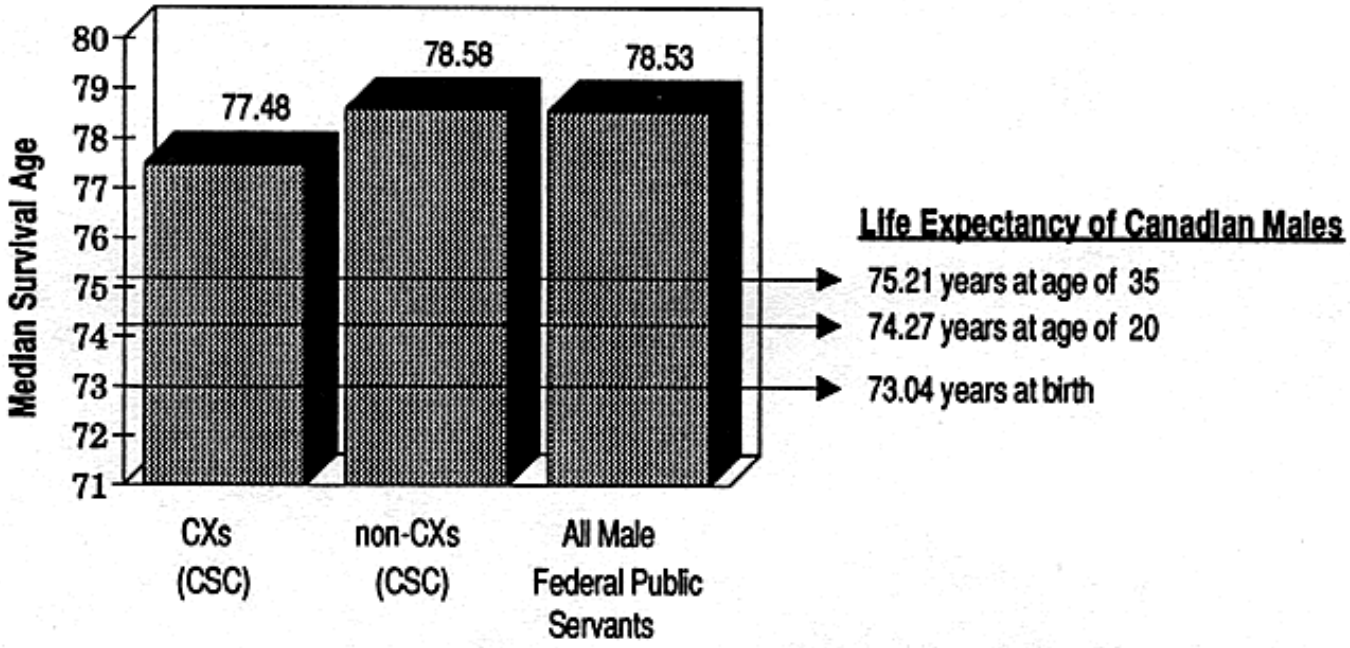



- **Limited overlap of adverse outcomes (stroke, MI) with working years**
- **Main effect after age 45**
- **Targeted approaches yield largest cost-utility value**

# Average Tenure of Retirement Corrections Officers

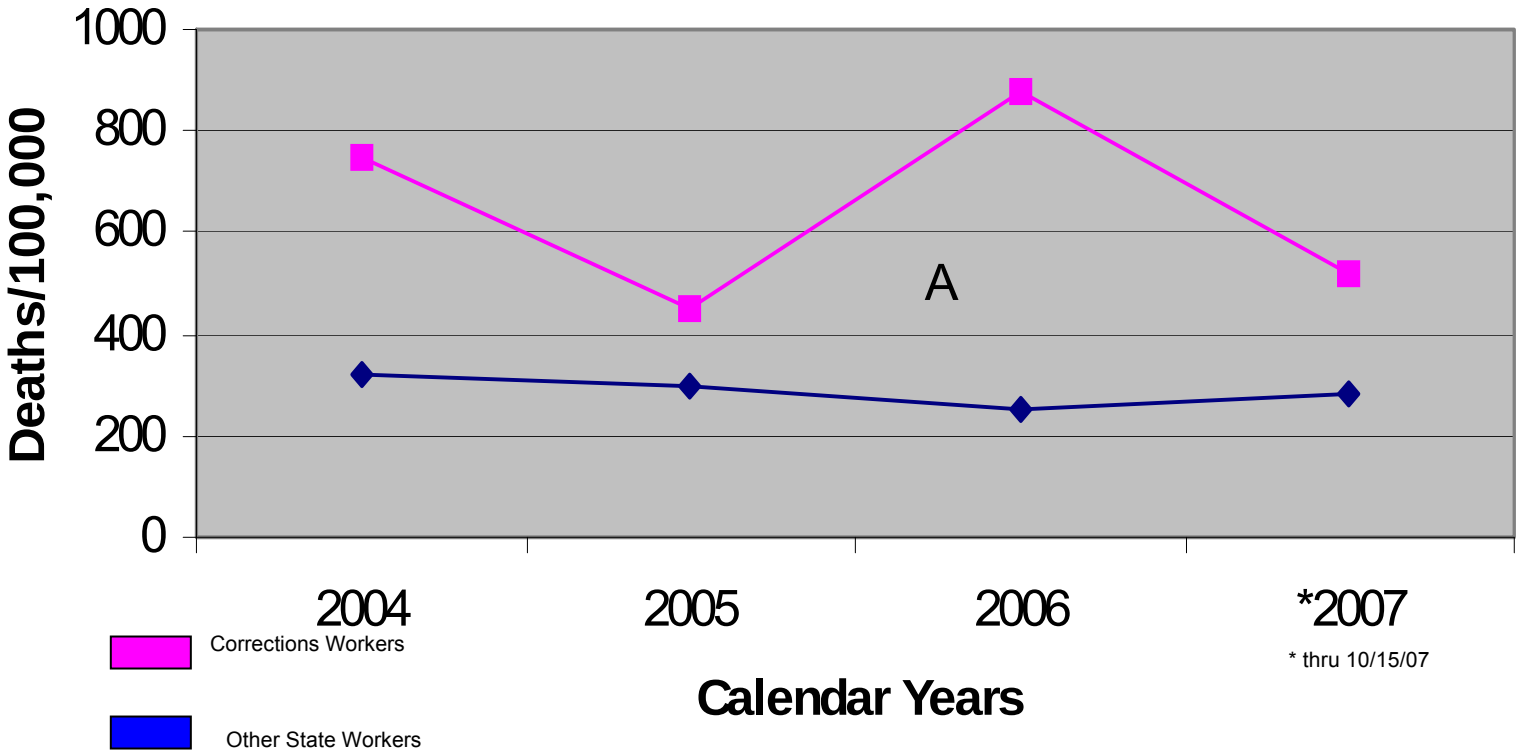

Age at Retirement -- Department of Corrections Officers
Retiree Frequency
0
5
10
15
20
25
30
35
40
45
50
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Age at Retirement

## Average (Median) Survival Times (Males Only)

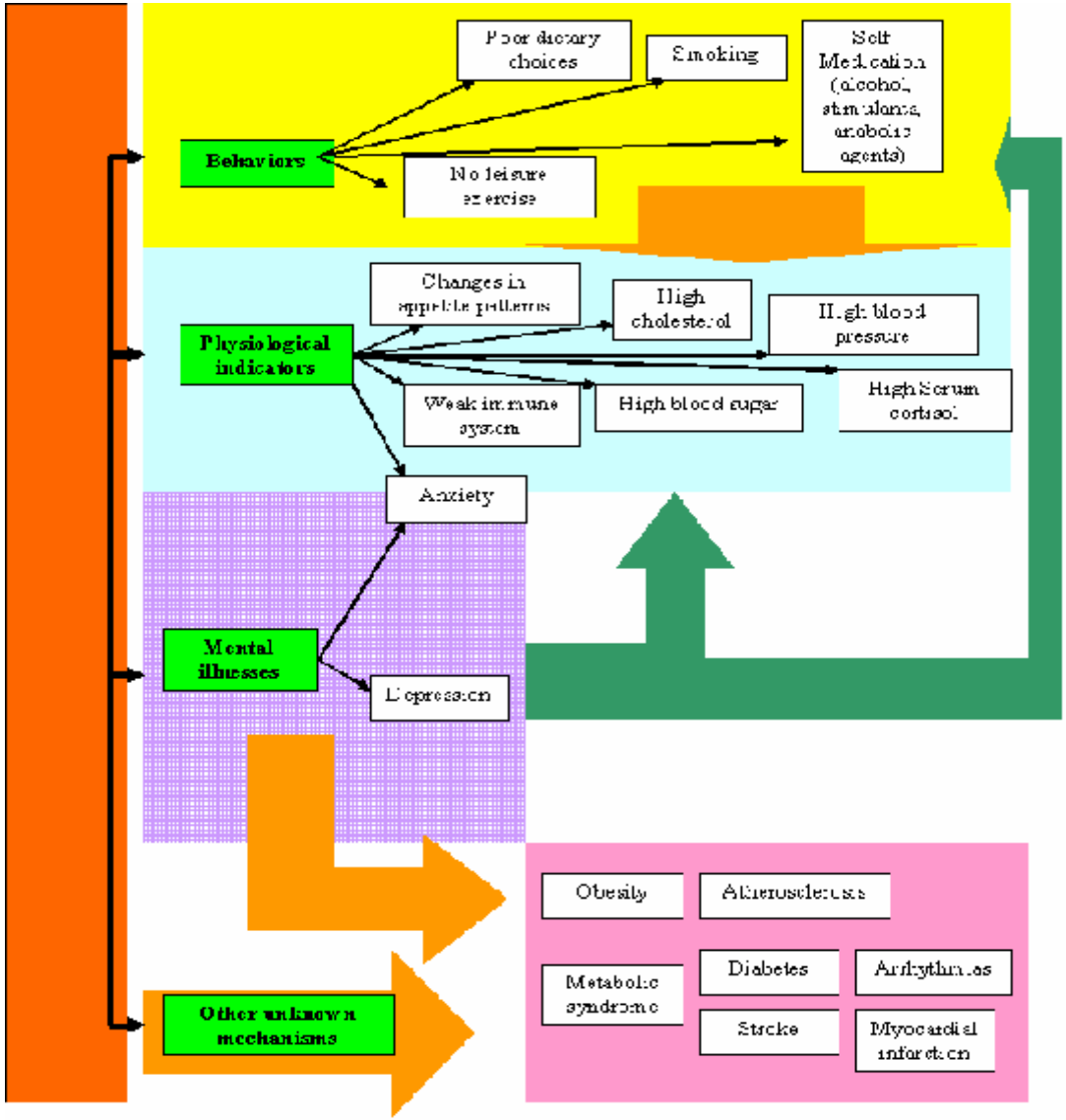



From Canadian CSC report, 1993.

# Crude Mortality Rate State Workers 2003-2007
## Ages 30-49



# The Interactive Patterns of CVD Risk



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http://www.oehc.uchc.edu/healthywork/index.asp


The Center for the Promotion of Health in the New England Workplace is supported by Grant Number 1 U19 OH008857 from the National Institute for Occupational Safety and Health. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

# Multivariate Risk and the Metabolic Syndrome

Odds ratios (95% confidence intervals) of the metabolic syndrome. Multivariate multiple imputation logistic regression models: non-retired men and women in the Whitehall II cohort at phase 5

| | Including patients who were obese at baseline | | | Excluding patients who were obese at baseline | |
|---|---|---|---|---|---|
| | No of cases/total | Adjusted for age+employment grade | Adjusted for age+employment grade+health behaviours | No of cases/total | Adjusted for age+employment grade+health behaviours |
| **Men and women:** | | | | | |
| No exposures | 491/5178 | 1.00 | 1.00 | 388/4881 | 1.00 |
| 1 exposure | 134/1253 | 1.13 (0.70 to 1.82) | 1.12 (0.70 to 1.82) | 103/1165 | 1.11 (0.69 to 2.03) |
| 2 exposures | 54/383 | 1.55 (0.85 to 2.85) | 1.53 (0.87 to 2.69) | 41/356 | 1.47 (0.74 to 2.92) |
| ≥3 exposures | 41/220 | 2.25 (1.31 to 3.85) | 2.39 (1.36 to 4.21) | 30/198 | 2.29 (1.27 to 4.12) |
| P for linear trend | | <0.01 | <0.00 | | 0.01 |
| **Men:** | | | | | |
| No exposures | 341/3564 | 1.00 | 1.00 | 281/3407 | 1.00 |
| 1 exposure | 95/900 | 1.11 (0.73 to 1.67) | 1.11 (0.73 to 1.69) | 72/851 | 1.12 (0.67 to 1.87) |
| 2 exposures | 37/252 | 1.64 (0.98 to 2.73) | 1.57 (0.92 to 2.65) | 31/238 | 1.56 (0.93 to 2.63) |
| ≥3 exposures | 32/161 | 2.01 (0.88 to 4.58) | 2.17 (0.92 to 5.09) | 24/166 | 2.04 (0.86 to 4.85) |
| P for linear trend | | 0.03 | 0.03 | | 0.04 |
| **Women:** | | | | | |
| No exposures | 150/1614 | 1.00 | 1.00 | 107/1474 | 1.00 |
| 1 exposure | 40/353 | 1.23 (0.40 to 3.74) | 1.27 (0.42 to 3.84) | 25/314 | 1.22 (0.28 to 5.37) |
| 2 exposures | 17/131 | 1.27 (0.34 to 4.83) | 1.45 (0.46 to 4.75) | 10/118 | 1.09 (0.15 to 7.94) |
| ≥3 exposures | 9/39 | 3.73 (0.68 to 15.75) | 3.72 (0.79 to 17.53) | 6/32 | 4.69 (0.79 to 27.86) |
| P for linear trend | | 0.23 | 0.11 | | 0.26 |

***From Chandola et al., BMJ 2005***

# The Spectrum of Workplace Associated Disorders

| Mixed Exposure Disorders | | Conditions for Workplace Disease Management | | Diseases Influenced by (and Working) Life | |
|---|---|---|---|---|---|
| Condition | Source | Disease | Management | Condition | Workplace Intervention |
| Asthma | Intrinsic and multiple extrinsic agents | Diabetes Mellitus | Blood sugar and treatment monitoring | Hip and Knee Arthritis | **Job design and age adjusted work** |
| Bladder Cancer 'R' | Dyes, ingested carcinogens | Colon Cancer Screening | Colonoscopy screening | Obesity | **Workplace design / diet and exercise** |
| CTS | Work-induced and aggravated | Hypertension | Ambulatory and static monitoring | Metabolic Syndrome | **See above and Disease Management** |
| Chronic Bronchitis | Dusts and fumes, smoking | Mental Health | EAP services | Sarcopenia | **Job design and age adjusted work** |
| Contact Dermatitis | Multiple irritant factors | Skin Cancer | Derm Screening | Coronary Heart Disease | **Work organization change, work design** |
| Hearing Loss | Noise, host factors | Hyperlipidemia | Blood tests and HP | Stroke | **See above** |
| Parkinson's 'R' | Heavy metals, host factors | | | Dysthymia/Depression | **Work organization and time flexibility** |
| Low Back Pain | Biomechanical strain, host factors | | | Reduced Cognitive Performance | **Control noise and repetition, adjust work hours / organization** |
| MCS 'R' | Multiple workplace and non-work triggers | | | Loss of Coordination/ Trunk Stability | **Job design and age adjusted work** |
| AML 'R' | Benzene, ionizing radiation, host factors | | | Rotator Cuff/ Impingement | **Job redesign, training and conditioning** |
| Lung Cancer | Workplace carcinogens 'R', smoking, radon | | | Entrapment Neuropathy | **Workplace diet and exercise programs and work design** |
| 'R' represents rare exposure | | | | Sleep Disturbance | **Work organization** |
| | | | | Soft Tissue Disorders | **Job design and age** |

# Incident Coronary Heart Disease and Risk Factors at Work

| Employment grade | Odds ratio for new CHD event in men (95% CI) | | | | Odds ratio for new CHD event in women (95% CI) | | | |
|---|---|---|---|---|---|---|---|---|
| | Angina pectoris | Severe chest pain | Diagnosed ischaemia | Any CHD event | Angina pectoris | Severe chest pain | Diagnosed ischaemia | Any CHD event |
| **Work adjusted**[†] | | | | | | | | |
| High | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 | 1·00 |
| Intermediate | 1·20 (0·84–1·72) | 1·08 (0·81–1·44) | 0·96 (0·63–1·46) | 1·16 (0·92–1·48) | 1·04 (0·55–1·98) | 0·90 (0·47–1·74) | 0·83 (0·24–2·86) | 0·98 (0·59–1·60) |
| Low | 1·48 (0·77–2·86) | 1·18 (0·68–2·06) | 1·88 (0·95–3·73) | 1·18 (0·74–1·88) | 0·99 (0·55–1·78) | 1·42 (0·71–2·83) | 1·57 (0·42–5·77) | 1·23 (0·72–2·09) |
| **Support adjusted**[‡] | | | | | | | | |
| High | 1·00* | 1·00 | 1·00* | 1·00* | 1·00 | 1·00* | 1·00 | 1·00* |
| Intermediate | 1·19 (0·84–1·68) | 1·12 (0·85–1·47) | 1·02 (0·68–1·53) | 1·22 (0·97–1·53) | 1·02 (0·58–1·81) | 1·09 (0·57–2·06) | 0·73 (0·22–2·40) | 1·16 (0·72–1·88) |
| Low | 1·61 (0·89–2·89) | 1·40 (0·84–2·31) | 2·17 (1·20–3·91) | 1·43 (0·93–2·19) | 1·07 (0·61–1·90) | 1·74 (0·93–3·26) | 1·37 (0·46–2·20) | 1·54 (0·96–2·49) |
| **Risk-factor adjusted**[§] | | | | | | | | |
| High | 1·00* | 1·00 | 1·00 | 1·00* | 1·00 | 1·00 | 1·00 | 1·00 |
| Intermediate | 1·25 (0·88–1·76) | 1·06 (0·81–1·40) | 1·01 (0·68–1·52) | 1·21 (0·96–1·52) | 0·92 (0·52–1·62) | 0·99 (0·52–1·87) | 0·67 (0·20–2·20) | 1·06 (0·66–1·72) |
| Low | 1·45 (0·80–2·64) | 1·27 (0·76–2·11) | 2·05 (1·11–3·79) | 1·30 (0·85–2·01) | 0·92 (0·52–1·62) | 1·56 (0·84–2·91) | 1·20 (0·40–3·62) | 1·35 (0·84–2·18) |

**Risk Factors**: § Smoking, serum cholesterol, body-mass index, hypertension, and physical activity.
**Social Support**: ‡ Confiding/emotional support, practical support, negative characteristics, social network.
**Work Factors:** +Job control and effort-reward imbalance (decision lattitude, skill discretion, and job category.

*From Marmot: Whitehall II, Lancet 1997*