The Physical Activity Health Paradox in Cardiovascular Health: Evidence and Prevention

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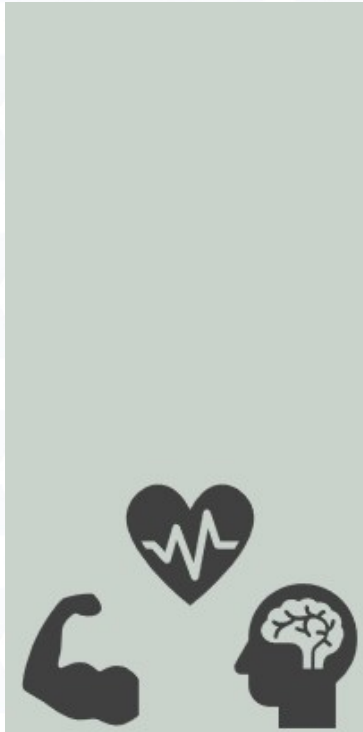
STATEMENT SLIDE

I have no conflicts of interest to disclose

INTRODUCTION: THE PARADOX



LTPA = leisure time physical activity

OPA = occupational physical activity

Original article

The health paradox of occupational and leisure-time physical activity

A Holtermann,[1] J V Hansen,[1] H Burr,[1] K Søgaard,[2] G Sjøgaard[2]

Br J Sports Med 2012;**46**:291–295. doi:10.1136/bjsm.2010.079582

CURRENT EVIDENCE

REVIEW

Curr Opin Cardiol 2013, 28:575–583
DOI:10.1097/HCO.0b013e328364289c

Physical activity and risk of cardiovascular disease: what does the new epidemiological evidence show?

Jian Li[a,b], *Adrian Loerbroks*[b,c], *and Peter Angerer*[a]

KEY POINTS

- Cumulative evidence has shown that physical activity is beneficial to the cardiovascular system.
- In line with available evidence, prospective studies published during the last 2 years support that leisure time physical activity is associated with a moderately decreased risk of CVD.
- In contrast with earlier reports, the latest studies suggest that high occupational physical activity might be associated with a slightly increased risk of CVD.

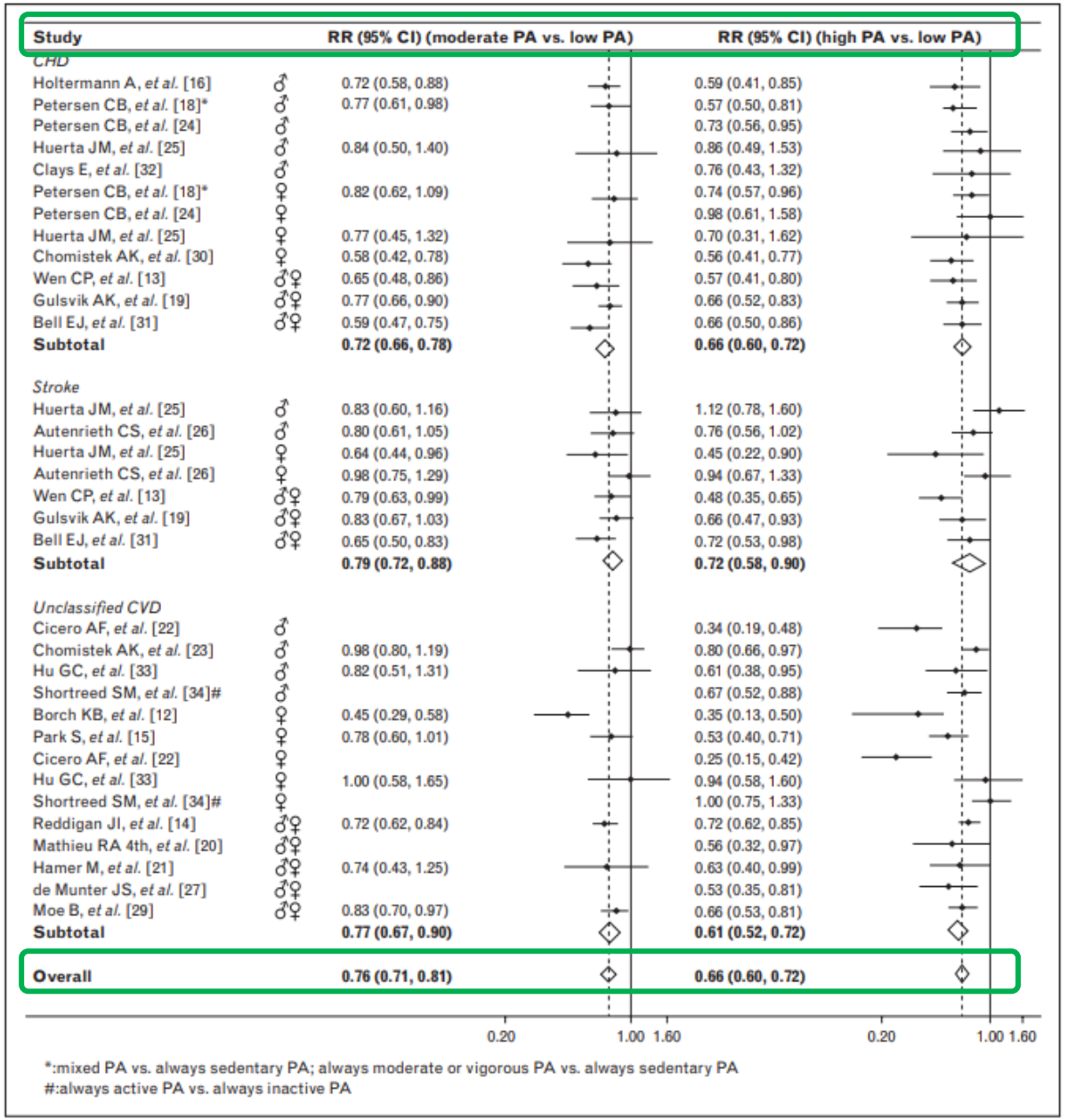


FIGURE 1. The associations between leisure time physical activity and cardiovascular disease risk. CHD, coronary heart disease; CI, confidence interval; PA, physical activity; RR, relative risk.

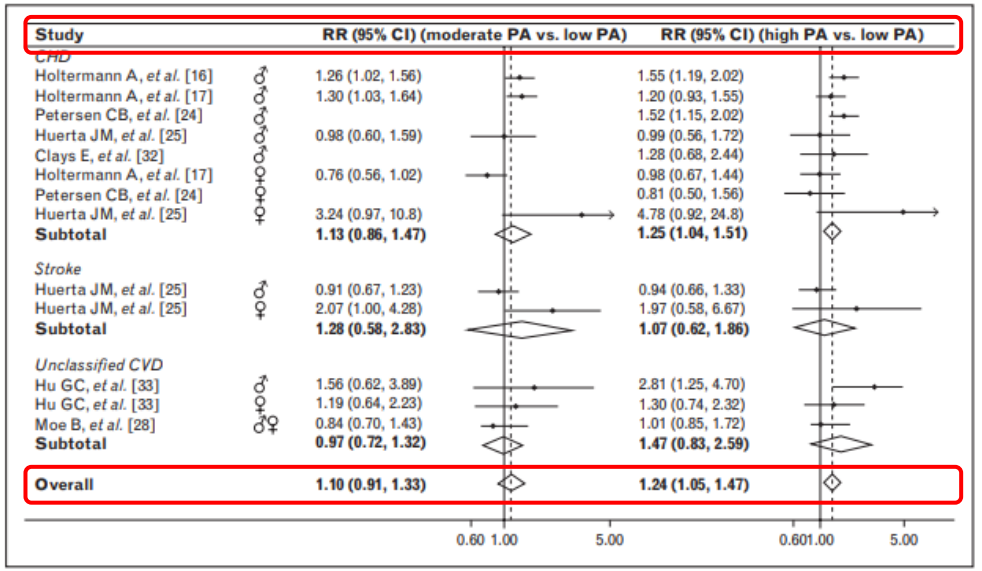


FIGURE 2. The associations between occupational physical activity and cardiovascular disease risk. CHD, coronary heart disease; CI, confidence interval; CVD, cardiovascular disease; PA, physical activity; RR, relative risk.

CURRENT EVIDENCE

Coenen P, *et al*. *Br J Sports Med* 2018;**52**:1320–1326. doi:10.1136/bjsports-2017-098540 Review

Do highly physically active workers die early? A systematic review with meta-analysis of data from 193 696 participants

Pieter Coenen,[1,2] Maaike A Huysmans,[1] Andreas Holtermann,[3,4] Niklas Krause,[5] Willem van Mechelen,[1,6,7,8] Leon M Straker,[2] Allard J van der Beek[1]

What are the new findings?

- We are the first to find evidence consistent with the physical activity paradox in a systematic review with meta-analysis, summarising evidence from 17 longitudinal studies with 1 93 696 participants.
- We showed that men engaging in high (compared with low) level occupational physical activity have a 18% increased risk of all-cause mortality, even after adjustment for relevant factors, such as leisure time physical activity.
- This evidence indicates that physical activity guidelines should differentiate between occupational and leisure time physical activity.

CURRENT EVIDENCE

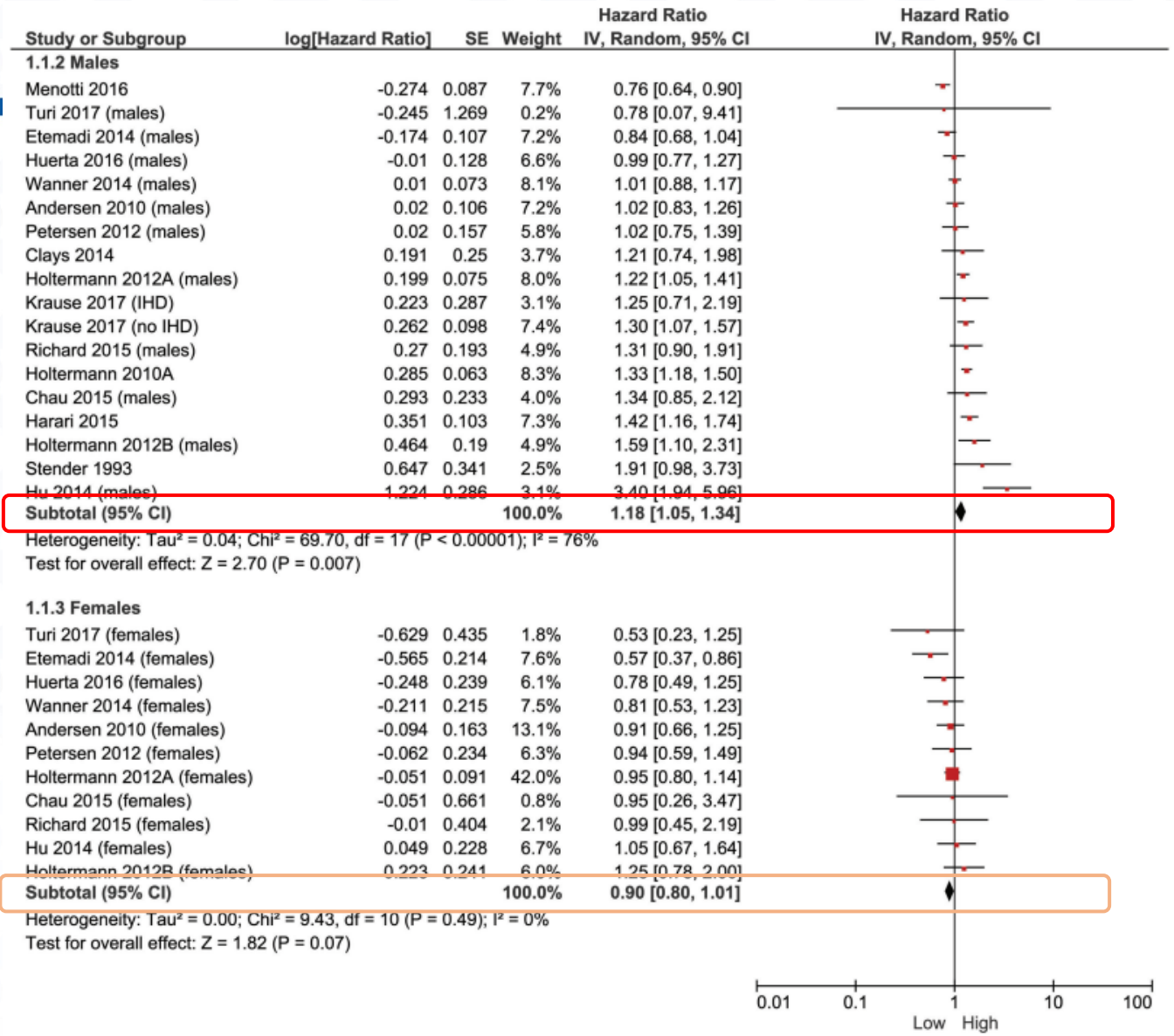


Figure 2 Forest plot of the effect of high compared with low levels of occupational physical activity on all-cause mortality, based on 17 studies with 193 696 participants. Individual study as well as pooled effects are presented. Data from men (upper panel) and women (lower panel) are shown. IV, inverse variance.

CURRENT EVIDENCE

Review

Scand J Work Environ Health. 2022;48(2):86–98. doi:10.5271/sjweh.3993

Physical activity at work may not be health enhancing. A systematic review with meta-analysis on the association between occupational physical activity and cardiovascular disease mortality covering 23 studies with 655 892 participants

by Bart Cillekens, MSc,[1] Maaike A Huysmans, PhD,[1] Andreas Holtermann, PhD,[2,3] Willem van Mechelen, PhD,[1] Leon Straker, PhD,[4] Niklas Krause, PhD,[5] Allard J van der Beek, PhD,[1] Pieter Coenen, PhD [1]

Table 1. Meta-analyses depicting the association between occupational physical activity (highest versus lowest) and cardiovascular disease mortality. Comparisons from 23 studies with 655 892 participants are depicted in the upper row. Associations are shown stratified by gender, type of mortality, occupational physical activity measurement, follow-up period, year of baseline assessment, sample size of study, adjusting for confounders. [HR=hazard ratio; CI=confidence interval; I^2=heterogeneity; LTPA=leisure time physical activity; SES=social economic status; BMI=body mass index]

Increments of occupational physical activity	Studies	N [a]	HR	95% CI	I^2%
Highest vs lowest occupational physical activity category	23	33	0.99	0.90–1.09	71
Males	18	18	1.00	0.87–1.15	80
Females	10	10	0.95	0.82–1.09	35
Type of mortality					
Overall cardiovascular mortality [b]	19	29	0.95	0.86–1.05	67
Ischemic heart disease mortality [b]	7	9	1.15	0.88–1.49	60
Occupational physical activity					

Conclusions While the beneficial association between leisure-time physical activity and CVD mortality has been widely documented, occupational physical activity was not found to have a beneficial association with CVD mortality. This observation may have implications for our appreciation of the association between physical activity and health for workers in physically demanding jobs, as occupational physical activity may not be health enhancing.

METHODOLOGICAL CHALLENGES

- **Lack of consistency in classification of OPA**
  - Global activities or postures (like standing, walking, sitting)
  - Intensity levels (MVPA)
  - Specific physically demanding tasks (e.g., lifting, repetitive movements, awkward postures)

- **Large reliance on self-report measurement of OPA**, often single-item instrument with crude categorisation → low accuracy & misclassification

  Few device-based studies:
  - DPhacto (Danish Physical ACTivity cohort with Objective measurements) study (Jørgensen et al., 2019)
  - NOMAD (New method for Objective Measurements of physical activity in Daily living) study (Gupta et al., 2014)
  - FEPA (Flemish Employees' Physical Activity) study (Ketels et al., 2019)

- **Risk of residual confounding**: SES, lifestyle factors, other physical or psychosocial occupational exposures

Cillekens et al. 2022 meta-analysis:

Adjusted for socioeconomic status (education or social class)					
No	6	6	0.89	0.67–1.17	79
Yes	17	27	1.01	0.90–1.14	76

EXPLANATORY MECHANISMS

Context	Occupational physical activity (OPA)	Leisure time physical activity (LTPA)
Characteristics	• Static load and repetitive • Low/moderate intensity • Not voluntarily • Long duration (8 hours) • Insufficient recovery	• Dynamic movements • High intensity • Voluntarily • Short duration • Sufficient recovery
Underlying mechanisms	• Elevated 24-hour heart rate and blood pressure • Elevated resting heart rate and blood pressure • No improvement in cardiorespiratory fitness	• Reduced 24-hour heart rate and blood pressure • Reduced resting heart rate and blood pressure • Improvement in cardiorespiratory fitness
Outcome	Increased cardiovascular risk and risk of mortality	Improvement of cardiovascular health and reduced risk of mortality

Figure 2. The different characteristics of OPA and LTPA on its effect on health as mediated by physiological mechanisms. Adapted from Coenen et al., 2018 and Holtermann et al., 2018.

M. Ketels. Towards a better understanding of the Physical Activity Health Paradox. The interplay between occupational and leisure time physical activity, cardiorespiratory fitness and psychosocial factors among workers with a physically active job. PhD thesis Ghent University 2024.

EXPLANATORY MECHANISMS

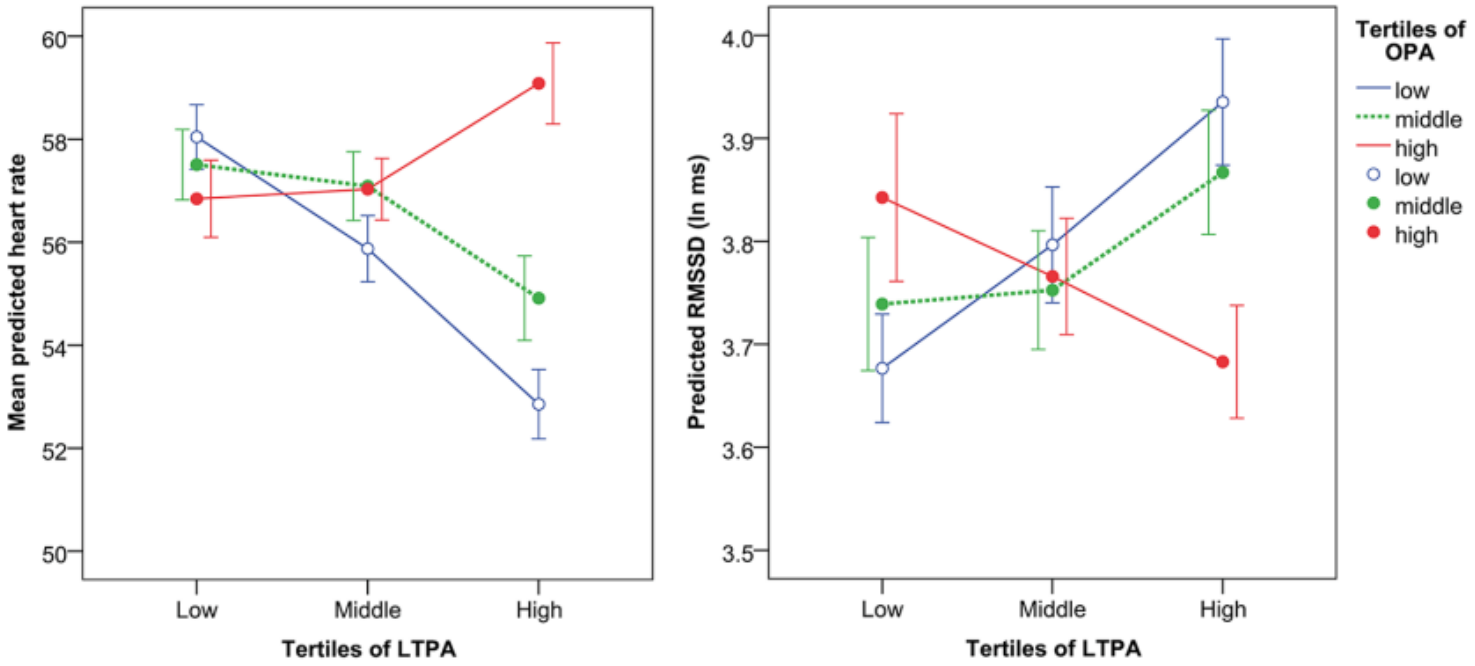


Fig 2. Mean predicted heart rate and RMSSD (parasympathetic index) across tertiles (low, middle and high) of occupational (OPA) and leisure-time physical activity (LTPA). Lines represent tertiles of OPA, and the y-axis represents tertiles of LTPA. Error bars represent 95% confidence intervals.

PLOS ONE

RESEARCH ARTICLE

On the health paradox of occupational and leisure-time physical activity using objective measurements: Effects on autonomic imbalance

David M. Hallman[1]*, Marie Birk Jørgensen[2], Andreas Holtermann[2]

1 Centre for Musculoskeletal Research, Department of Occupational and Public Health Sciences, University of Gävle, Gävle, Sweden, **2** National Research Centre for the Working Environment, Copenhagen, Denmark

EXPLANATORY MECHANISMS

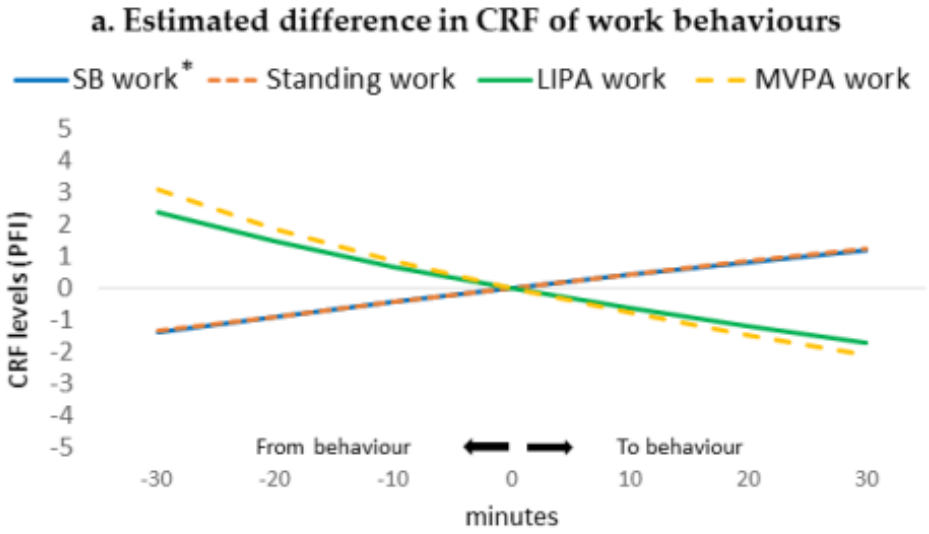
International Journal of
Environmental Research and Public Health

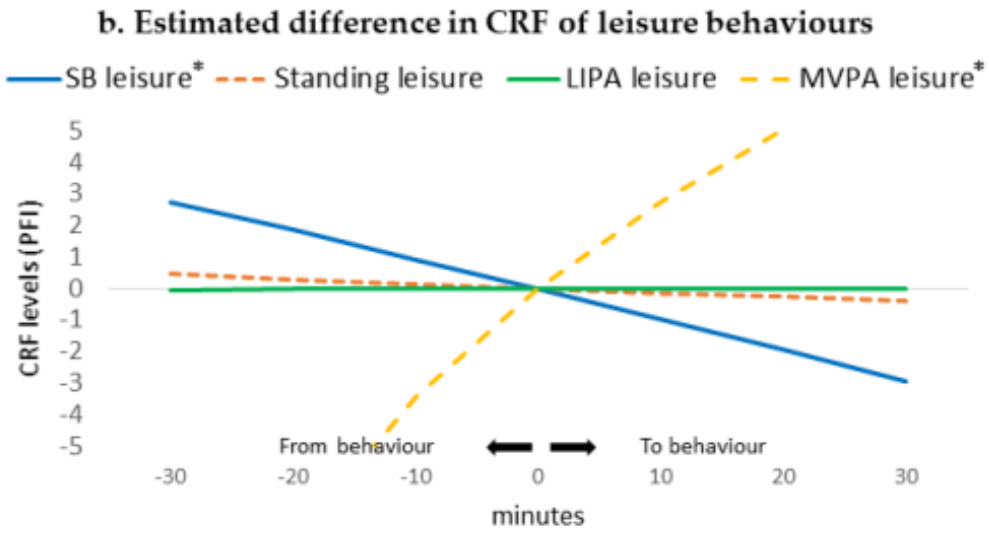
MDPI

Article

The Relation between Domain-Specific Physical Behaviour and Cardiorespiratory Fitness: A Cross-Sectional Compositional Data Analysis on the Physical Activity Health Paradox Using Accelerometer-Assessed Data

Margo Ketels [1,*], Charlotte Lund Rasmussen [2], Mette Korshøj [3], Nidhi Gupta [2], Dirk De Bacquer [1], Andreas Holtermann [2,4] and Els Clays [1]





IMPACT OF PSYCHOSOCIAL JOB RESOURCES

Int Arch Occup Environ Health (2016) 89:1299–1307
DOI 10.1007/s00420-016-1165-z

ORIGINAL ARTICLE

Do psychosocial job resources buffer the relation between physical work demands and coronary heart disease? A prospective study among men

Els Clays[1] · Annalisa Casini[2] · Koen Van Herck[1] · Dirk De Bacquer[1] · France Kittel[3] · Guy De Backer[1] · Andreas Holtermann[4]

Table 3 Crude and adjusted relations of physical work demands at work, results from multilevel Cox proportional hazards regression analyses in 14,337 men from the BELSTRESS cohort study with coronary heart disease stratified by social support at work, and of combined exposure to physical work demands and social support

	Crude results			Adjusted results: model 1[a]		Adjusted results: model 2[b]		Adjusted results: model 3[c]	
	% Events	No of events (total no of subjects)	$P(\chi^2)$	HR	95 % CI	HR	95 % CI	HR	95 % CI
Stratified analysis: low SSW									
Physical work demands			<0.01						
Low	0.6	27 (4575)		1		1		1	
High	1.6	15 (944)		**2.86**	1.50–5.46	**2.73**	1.29–5.78	**2.50**	1.13–5.50
Stratified analysis: high SSW									
Physical work demands			0.81						
Low	0.5	35 (7021)		1		1		1	
High	0.4	4 (1028)		0.78	0.27–2.20	0.72	0.25–2.08	0.40	0.09–1.70

IMPACT OF PSYCHOSOCIAL JOB RESOURCES

Int Arch Occup Environ Health
DOI 10.1007/s00420-017-1207-1

CrossMark

ORIGINAL ARTICLE

Does influence at work modify the relation between high occupational physical activity and risk of heart disease in women?

Karen Allesøe[1,2] · Andreas Holtermann[1,3] · Reiner Rugulies[3,4,5] · Mette Aadahl[2,4] · Eleanor Boyle[1,6] · Karen Søgaard[1]

IMPACT OF PSYCHOSOCIAL JOB RESOURCES

Table 3 Hazard ratio (HR) and 95% CI for ischaemic heart disease (IHD) according to interplay between physical activity at work (OPA) and influence at work (the results with a common reference group and the effects of OPA within strata of influence at work are from the same Cox PH model including an interaction term between OPA and influence at work, and therefore, some of the estimates are identical)

Combination of OPA and influence at work	No. of subjects/ no. with IHD	Common reference group for OPA and influence at work				Effect of OPA within strata of influence at work			
		Basic model 1[a]		Adjusted model 2[b]		Basic model 1[a]		Adjusted model 2[b]	
		HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
High influence at work sedentary OPA	1481/81	0.87	0.65–1.16	0.87	0.64–1.17	0.87	0.65–1.16	0.87	0.64–1.17
High influence at work moderate OPA	1598/106	1		1		1		1	
High influence at work demanding OPA	1544/124	1.18	0.91–1.53	1.13	0.86–1.49	1.18	0.91–1.53	1.13	0.86–1.49
High influence at work strenuous OPA	153/11	1.07	0.57–1.99	1.10	0.59–2.06	1.07	0.57–1.99	1.10	0.59–2.06
Low influence at work sedentary OPA	850/58	1.06	0.77–1.47	1.06	0.77–1.48	1.25	0.93–1.70	1.24	0.91–1.70
Low influence at work moderate OPA	2561/151	0.85	0.66–1.09	0.85	0.66–1.11	1		1	
Low influence at work demanding OPA	3421/283	1.13	0.91–1.42	1.14	0.90–1.46	1.33	1.09–1.63	1.34	1.08–1.66
Low influence at work strenuous OPA	485/55	1.64	1.18–2.27	1.46	1.02–2.09	1.93	1.42–2.62	1.71	1.22–2.40

12,093 female nurses from the Danish Nurse Cohort Study. 869 cases of IHD during follow-up 1993–2013

Measure of effect modification on multiplicative scale: OPA x influence at work: $p=0.184$ (Basic model 1)

BMI body mass index, *CI* confidence interval, *HR* hazard ratio, *IHD* ischaemic heart disease, *OPA* physical activity at work

[a]Model 1: age as underlying time scale

[b]Model 2: adjusted for age and risk factors for IHD (family history of IHD, diabetes, BMI, smoking and alcohol consumption), leisure time physical activity, work hours and shift work

IMPACT OF PSYCHOSOCIAL JOB RESOURCES

k for updates

European Journal of Preventive Cardiology

ESC European Society of Cardiology

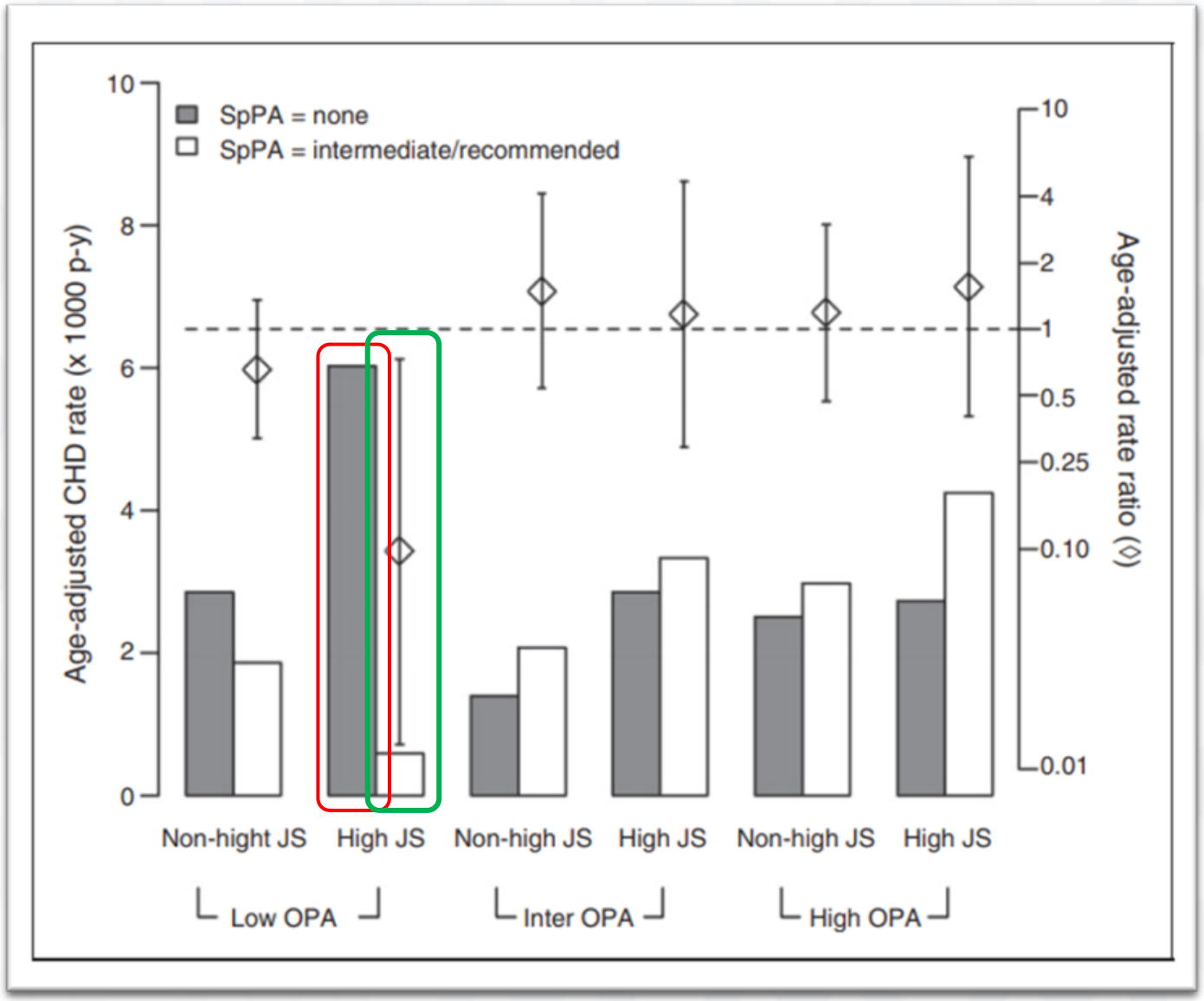
Full research paper

European Journal of Preventive Cardiology
2019, Vol. 26(17) 1877–1885

DOI: 10.1177/2047487319852186
journals.sagepub.com/home/cpr
SAGE

Exploring the interplay between job strain and different domains of physical activity on the incidence of coronary heart disease in adult men

Marco M Ferrario[1,2], Giovanni Veronesi[1], Mattia Roncaioli[3], Andreas Holtermann[4,5], Niklas Krause[6], Els Clays[7], Rossana Borchini[1,2], Guido Grassi[8] and Giancarlo Cesana[9]; on behalf of The Cohorts Collaborative Study in Northern Italy (CCSNI) Research Group



IMPLICATIONS FOR CVD PREVENTION

➢ Recommendations to protect workers from adverse OPA effects

- Limit prolonged standing (and sitting) – sufficient interruptions
- Limit extensive periods of heavy work – sufficient rest and breaks
- Aim for healthy mix & variation

➢ Some innovative intervention strategies

- **Goldilocks Principle** (Holtermann, Mathiassen & Straker, 2019)
  'Physical activity during productive work needs to be "just right" for promoting rather than deteriorating health and capacity.' → Align OPA more closely with LTPA, ultimately enhancing overall health
- **Intelligent Physical Exercise Training (IPET)** (Sjøgaard et al., 2014) → Individually tailored exercise programs (cardiorespiratory & strength) to enhance workers' physical capacities
- **Participatory ergonomics intervention** → Focussing on physical, organizational and psychosocial factors
- **Job rotation** → Organizational-level strategy, rotating workers between tasks with varying physical and psychosocial demands





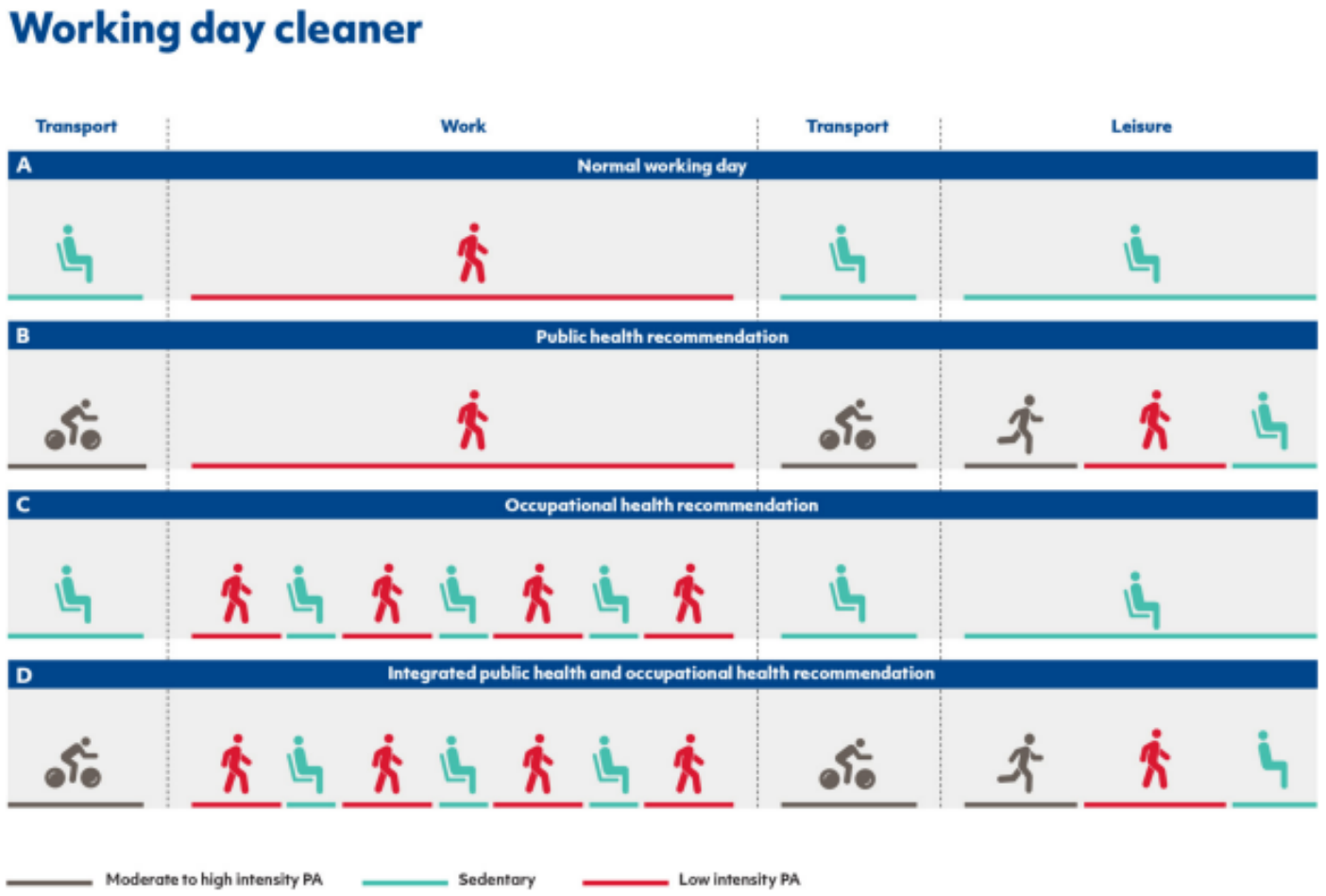

IMPLICATIONS FOR CVD PREVENTION

- Evidence underscores the need to **differentiate** PA guidelines between **OPA and LTPA**
- Call to **tailor** PA recommendations to **subgroups** facing particular needs (e.g., low SES, pre-existing CVD, low physical capacity)

Br J Sports Med December 2020 Vol 54 No 23 **Editorial**

Long overdue remarriage for better physical activity advice for all: bringing together the public health and occupational health agendas

Andreas Holtermann [1], Leon Straker [2], I-Min Lee [3], Allard J van der Beek,[4] Emmanuel Stamatakis [5]



IMPLICATIONS FOR CVD PREVENTION

Table 5: Physical environment – High level of exposure to physical risks and demands, EU27, 2021 (%)

		Men	Women	Total
Physical risks	Handling or having skin contact with chemicals	28	25	26
	Handling or being in contact with infectious materials	15	21	18
	Exposure to loud noise	37	32	34
Physical demands	Carrying or moving heavy loads	40	29	35
	Lifting or moving people	9	15	12
	Tiring or painful positions	49	51	50
	Repetitive hand or arm movements	70	72	71

Notes: *The data refer to workers who responded 'sometimes', 'often' or 'always' to each item. Italics indicates variables that were collected in Module 1 of the questionnaire, for which answers were collected from two-thirds of respondents.*
Source: *EWCTS 2021*

Eurofound (2022), *Working conditions in the time of COVID-19: Implications for the future*, European Working Conditions Telephone Survey 2021 series, Publications Office of the European Union, Luxembourg.

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Ghent, Belgium

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