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The Association between Occupational Categories and Incidence of Cardiovascular Events: A Cohort Study in Iranian Male Population

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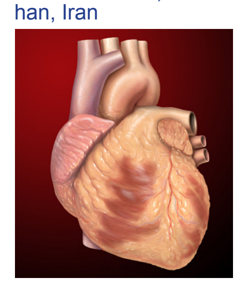

Abstract

Background: Besides the traditional cardiovascular risk factor, some novel risk factors like occupation and career can play an important role in cardiovascular disease (CVDs) incidence.

Objective: To assess the association between occupational categories and their positions with cardiovascular events (CVEs) in an Iranian male population.

Methods: We followed 2134 men aged 35–65 years for 14 years during the Isfahan Cohort Study (2001–2015) for CVEs including ischemic heart disease and stroke. Firstly, Occupations were classified into 10 categories of International Standard Classification of Occupation (ISCO). Each category was then classified into one of the 4 pre-specified categories, namely high/low skilled white collars and high/low skilled blue collars. White-collar workers referred to managerial and professional workers in contrast with blue collar workers, whose job requires manual labor.

Results: The mean age of studied participants was 46.9 (SD 8.3) years. 286 CVE incidents were recorded; unstable angina had the highest rate (46%); fatal stroke, the lowest (3%). There were no significant difference was observed between white and blue collars in terms of CVE incidence, as well as their high and low skilled subgroups. Hazard ratio analysis indicated a significantly higher risk of CVEs only for low-skilled white-collar workers (crude HR 1.47, 95% CI 1.01 to 2.13); this was not significant after adjustment for confounding variables.

Conclusion: There is no association between occupational categories and incidence of cardiovascular events among Iranian male population.

Keywords: Occupations; Risk factors; Cohort study; Occupational groups; Myocardial ischemia; Coronary artery disease; Stroke; Adult

Introduction

Cardiovascular diseases (CVDs), including ischemic heart disease (IHD) and stroke, are the leading cause of morbidity and mortality in developed and developing countries. In the meantime, atherosclerotic CVDs, as the most common pathology, is increasing worldwide due to the growth of age and

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lifestyle changes.[1,2] It is important to identify potential risk factors to prevent cardiovascular events (CVEs). In addition to traditional risk factors of CVDs, some novel risk factors, mostly related to life style and environmental changes, have become important. Among these novel risk factors are psycho-emotional and socioeconomic factors.[3] Because most CVE incidents occur in low- and middle-income countries, the role of socioeconomic status should not be overlooked. Meanwhile, occupation and career are the most important determinant of socioeconomic status. Occupational environment and its related factors may affect workers health and emotion.[4-6] Occupations are categorized based on different factors into 10 categories according to the International Standard Classification of Occupation (ISCO).[7,8] Each of these codes were then categorized into blue collars (doing manual labor) and white collars (doing non-manual labor). Each "collar" category was further grouped into high- and low-skilled occupations. Other collar colors have also been reported, but they were of least level of importance in our study; they were also rarely used in other studies.[9] Based on previous studies, the occupational categories, as a social and economic determinant, represent a fundamental role in cardiovascular disease and events incidence.[5,6,10,11] Risk of cardiovascular events among various occupational categories has been estimated differently, depending on different determinants used in risk assessment. In developed countries, lower occupational class workers experienced a higher rate of CVDs.[12] It is due to varying factors including psychosocial work stress, shift work, overtime work without salary, sedentariness, and exposure to noise and chemical fumes directly; and poor sleep and nutrition, and cigarette smoking indirectly.[4,13] In a Japanese population, managers and professionals experienced CVD more frequently in comparison with non-managerial workers in different decades due to maladaptive coping response, individual's occupational stress level, and lower physical activity.[14]

Although individual workplace and income analysis can lead to useful indices, investigation of the occupational class and specific occupational categories may lead to important results that have so far been less evaluated, to the best of our knowledge. In the present cohort study, we aimed at evaluating the association between occupational categories and CVE incidents in an Iranian male population, as a developing country.

TAKE-HOME MESSAGE

- The relationship between occupation and cardiovascular diseases varies from community to community.
- In our study, unstable angina had the highest recorded incidents of cardiovascular events the Iranian working community; fatal stroke had the lowest incidence.
- No association was found between occupational categories and the incidents of cardiovascular events in the studied population.

Patients and Methods

The Population and Data Collection

In a population-based, longitudinal cohort study of Isfahan Cohort Study (ISC), 6504 adults aged >35 years at the baseline, living in urban and rural areas of three districts in Central Iran, were enrolled. The participants were enrolled from the baseline survey of a community trial for CVDs prevention and control, entitled the Isfahan Healthy Heart Program (IHHP).[15,16] The study was approved by the Ethics Committee of Isfahan Cardiovascular Research Center (ICRC). All participants gave informed written consent to participate in the study. The baseline survey started in 2001; the participants had been followed every two years by telephone, or home interviews; physical exams and biochemical measurements and hospital events were recorded until 2015. Because the majority of females in the survey were housekeepers, the current study included only men aged 35–65 years—the age range of workers before retirement, according to the Iranian Ministry of Labor and Social Affairs. In total, 2460 men (employed and unemployed/jobless) who did not have history of IHD and stroke were followed for 14 years, from 2001 to 2015.

Demographic and metabolic characteristics of individuals including age, marital status, income, place of living, smoking habit, and presence of diabetes mellitus (DM), hypertension (HTN), dyslipidemia, metabolic syndrome, and body mass index (BMI), as well as their occupations were collected for each person.

Occupational Category

Occupations were classified into 10 categories, according to the International Standard Classification of Occupation (ISCO) categorization. Each ISCO occupation code was then classified into one of four pre-specified categories, namely high- and low-skilled white-collar and high- and low-skilled blue-collar workers. White-collar workers included managerial, professional, or educated workers; blue-collar workers included those whose job requires manual labor.[17] High-skilled white-collar workers (ISCO codes 1, 2, and 3) include legislators, senior officials and managers, professionals and technicians and associate professionals; low-skilled white-collar workers (ISCO codes 4 and 5) include clerks, service workers, and shop and market sales workers; high-skilled blue collars (ISCO codes 6 and 7) include skilled agricultural and fishery workers, and craft and related trades workers; and low-skilled blue collars (ISCO codes 8 and 9) include plant and machine operators, and assemblers and elementary occupations. The occupation category for individuals who worked in more than one category was determined with the usual work performed during most of his working life.

Follow-up

In a 14-year follow-up, the first incident of CVEs, including IHD and stroke, was evaluated. The reported events were checked monthly with the myocardial infarction (MI) and stroke registry database of the Surveillance Department, ICRC, in the above-mentioned three counties. Two panels of experts including cardiologists and neurologist confirmed the data. IHD was categorized to definite or probable acute MI, unstable angina (UA), and sudden cardiac death. The diagnosis of acute MI was based on the presence of at least two of the following criteria: 1) typical chest pain lasting more than 30 min, 2) ST-segment elevation >0.1 mV in at least two adjacent electrocardiograph leads, and 3) an increase in serum levels of cardiac biomarkers including cardiac troponins, creatine kinase (CK), and CK-MB.[18] UA was defined as typical chest discomfort lasting for >20 minutes within the 24 hours preceding hospitalization and representing a change in the usual pattern of angina or pain.[19] The diagnosis of UA might be new or based on dynamic ST-interval, or T-wave changes in at least two contiguous ECG leads. Sudden cardiac death was defined as death within one hour of onset, a witnessed cardiac arrest, or abrupt collapse not preceded by more than one hour of symptoms. Stroke was defined as a rapid-onset focal neurological disorder persisting at least 24 hours and had a probable vascular origin according to the WHO definition of stroke.[20]

Ethics

All procedures performed in studies in-

Table 1: Frequency distribution of studied socioeconomic and metabolic variables of participants stratified by occupational categories and positions

Variables	White collars (n=1050), n (%)			Blue collars (n=1410), n (%)			
	High-skilled (n=263)	Low-skilled (n=787)	p value*	High-skilled (n=1180)	Low-skilled (n=230)	p value*	p value†
Marital status							
Married	260 (98.9)	770 (97.8)	0.47	1169 (99.1)	226 (98.3)	0.063	0.15
Single	3 (1.1)	14 (1.8)		7 (0.6)	3 (1.3)		
Divorced	0	0		0	1 (0.4)		
Dead spouse	0	3 (0.4)		4 (0.3)	0		
Income							
Low	147 (55.8)	434 (55.1)	<0.001	876 (74.2)	164 (71.3)	0.002	<0.001
High	106 (40.3)	81 (10.3)		111 (9.4)	25 (10.8)		
Place of living							
Urban	228 (86.7)	650 (82.6)	0.12	665 (56.4)	177 (77.0)	<0.001	<0.001
Rural	35 (13.3)	137 (17.4)		515 (43.6)	53 (23.0)		
Diabetes mellitus	19 (7.2)	71 (9.0)	0.44	70 (5.9)	19 (8.3)	0.183	0.03
Dyslipidemia	231 (87.8)	640 (81.3)	0.01	967 (81.9)	198 (86.1)	0.153	0.87
Hypertension	49 (18.6)	175 (22.2)	0.22	278 (23.6)	35 (15.2)	0.005	0.62
Smoker							
Current	79 (30.0)	225 (28.6)	0.90	405 (34.4)	98 (42.8)	0.050	<0.001
Former	21 (8.0)	66 (8.4)		114 (9.7)	18 (7.9)		
Never	163 (62.0)	495 (63.0)		659 (55.9)	113 (49.3)		
BMI‡							
Normal	121 (46.0)	336 (42.7)	0.51	629 (53.3)	82 (35.7)	<0.001	0.002
Overweight	104 (39.5)	343 (43.6)		438 (37.1)	104 (45.2)		
Obese	38 (14.4)	108 (13.7)		113 (9.6)	44 (19.1)		
Metabolic syndrome	43 (16.3)	147 (18.7)	0.46	146 (12.4)	46 (20.0)	0.003	0.003

*Between high- and low-skilled job positions in each category
†Between white- and blue-collar workers
‡BMI: body mass index

volving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Isfahan Cardiovascular Research Center (ICRC), a

Table 2: Frequency distribution of cardiovascular events stratified by occupational categories and positions

Cardiovascular events	White collars, (n=935), n (%) High-skilled (n = 238)	White collars, (n=935), n (%) Low-skilled (n = 697)	p value*	Blue collars, (n=1199), n (%) High-skilled (n = 1008)	Blue collars, (n=1199), n (%) Low-skilled (n = 191)	p value*	p value†
Unstable angina n (%)	16 (6.7)	47 (6.7)	>0.99	56 (5.5)	13 (6.8)	0.50	0.21
Non-fatal myocardial infarction n (%)	11 (4.6)	21 (3.0)	0.30	24 (2.4)	4 (2.1)	>0.99	0.09
Fatal myocardial infarction n (%)	1 (0.4)	4 (0.6)	>0.99	7 (0.7)	1 (0.5)	>0.99	0.78
Sudden cardiac death n (%)	1 (0.4)	10 (1.4)	0.31	19 (1.9)	4 (2.1)	0.78	0.22
Non-fatal stroke n (%)	1 (0.4)	16 (2.3)	0.09	18 (1.8)	3 (1.6)	>0.99	>0.99
Fatal stroke n (%)	1 (0.4)	4 (0.6)	>0.99	4 (0.4)	0 (0.0)	>0.99	0.52

*Between high- and low-skilled job positions in each category
†Between white- and blue-collar workers

WHO collaborating center.

Statistical Analysis

IBM® SPSS® Statistics ver 23.0 for Windows® (IBM® Corp, Released 2015, Armonk, NY, USA) was used for data analysis. χ^2 or Fisher's exact test (if needed) was used to compare categorical variables. *Student's t* test for independent samples was used for comparison of normally distributed continuous variables between two groups. Cox regression analysis was used to find the association between occurrence of CVEs and occupational categories or positions. To adjust the potential confounding variables, multiple Cox regression was used. A p value <0.05 was considered statistically significant.

Results

The response rate of this cohort subsample study was around 87%. From 2001 to 2015, 2134 men with a mean age of 46.9 (SD 8.3) years were enrolled in this study. The mean age of high- and low-skilled white collar workers were 45.3 (SD 7.0) and 48.6 (SD 10.4) years, respectively (p<0.001). High- and low-skilled blue-collar workers also had a significant (p=0.001) age difference (49.3 [SD 11.0] *vs* 46.7 [8.1] years).

Although none of the demographic variables was significantly different, age, income, and the prevalence of dyslipidemia had significant differences among white-collar workers (Table 1). Among the blue-collar workers, except for the marital status, and prevalence of DM and dyslipidemia, other characteristics had significant differences. Comparing two main groups of white- and blue-collar workers revealed that except for marital status, and the prevalence of dyslipidemia and HTN, other parameters differed significantly (Table 1).

Prevalence and comparison of CVEs in occupational categories and its positions are shown in Table 2. There were no significant differences between white and blue collars as main occupational categories, and high- and low-skilled group in each category. In total, 286 incidents of CVE were recorded (mean incidence of 20.4% per year); UA had the highest recorded incidence (46%); fatal stroke had the lowest rate (3%).

No significant difference was observed in the association between incidence of CVEs and occupational categories studied

Table 3: Association between occupational categories and positions with cardiovascular events (ischemic heart disease and stroke), unadjusted and adjusted hazard ratio (HR)

Adjusted for...	Occupational categories, HR (95% CI)		Occupational positions, HR (95% CI)			
			White collars (n=935)		Blue collar (n=1199)	
	White collars (n=935)	Blue collars (n=1199)	High-skilled (n=238)	Low-skilled (n=697)	High-skilled (n=1008)	Low-skilled (n=191)
Nothing	1	1.04 (0.84 to 1.30)	1	1.46 (1.01 to 2.13)	1	1.08 (0.72 to 1.61)
Age	1	0.94 (0.75 to 1.18)	1	1.17 (0.80 to 1.72)	1	1.41 (0.93 to 2.13)
Socioeconomic status, metabolic variables and smoking	1	1.05 (0.84 to 1.33)	1	1.12 (0.76 to 1.65)	1	1.22 (0.80 to 1.85)

(Table 3). Except for the high- and low-skilled white-collar workers in univariate analysis, when the model was adjusted for one or more confounding variables, no significant difference was observed between the occupational positions studied (Table 3). Kaplan-Meir survival analysis revealed no significant difference in the risk of CVEs among the studied groups (Fig 1).

Discussion

We found that the risk of CVEs was the same in white- and blue-collar occupation categories and positions. The observed absence of disparity in the incidence of CVEs in each group might be due to different causes that made the studied workers prone to CVDs. The lower level of education, income, and harder working condition might lead to psychosocial stress coping incompetency in blue collars and, thus increase the risk of CVEs. Risks of CVDs in blue collars are more than those in white-collar workers in western developed countries.[21,22] Other studies show that morbidity and mortality of IHD and stroke in manual workers are significantly more than those in non-manual workers. It may be the result of higher prevalence of HTN, cigarette smoking, and other CVD risk factors in this group.[9,23,24] In our study, the prevalence of overweight and obesity, cigarette smoking, and metabolic syndrome was significantly higher in low-skilled blue-collar workers; the prevalence of hypertension was, however, higher in high-skilled blue collars. There were no significant difference in BMI, and the prevalence of cigarette smoking, metabolic syndrome, DM, and HTN between high- and low-skilled white collars.

A study in Japan revealed a higher tendency to increased mortality in blue collars despite equity in access to high-quality prevention and treatment for all citizens.[25,26] Another study showed that the economic crisis in the 1990s had a stronger effect on the morbidity and mortality of non-managerial participants in comparison to managerial one in Japan.[27] We hypothesized that because of the expected lower income in blue collars, they might be influenced more from CVDs. Virtanen, *et al*, revealed that low employed suffer more from psychological distress in comparison to high employed workers.[28] Another study show that high employed workers experience leisure time activity more often, and that this can lead to more CVEs.[29] Compared to blue-collar workers, white collars have a higher advantage due to their higher income and education, better work condition, and more extensive social networking.[30] On the other hand, they have more mental load and spend more working hours that may lead to increased CVEs.[28] Basically, more working hours would cause increased morbidity and mortality by increasing the risk of CVEs. Nontraditional working hours in white collars can also cause CVDs.[31-33]

A variety of psychological factors may affect the risk of CVEs. Socioeconomic stresses strongly increase CVDs and as the white collars experience more work-related stress, they are more prone to suffer from CVDs.[34] Prihartono, *et al*, reported that the prevalence of CVDs is higher among white-collar workers than blue-collar workers in an Indonesian population.[35] In fact, high job stress is a career that the employee has a little fortuity to decide or create new environmental changes and lead to an increase in all-cause mortality. White collars experience more job stress which in turn increases sudden cardiac death.[36,37] On the other hand, increasing the risk of mortality in white collars may be due to suicide and radical changes in socioeconomic conditions. Lesser physical activity and spending more sedentary work hours in white collar occupations also may lead to increased risk of CVEs.[38,39] In addition, sedentariness causes DM, HTN, and obesity, as risk factors of CVDs, which influences the risk of CVEs.[40-42]

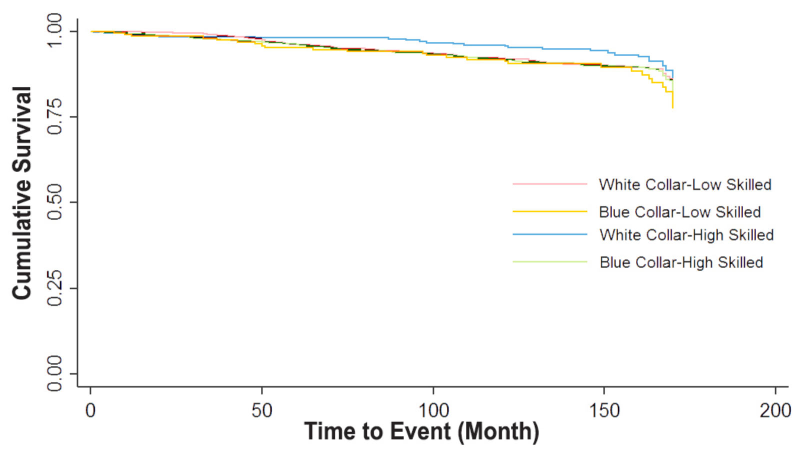

Figure 1: Kaplan-Meier survival curves for occupational categories and positions

Our study has several potential limitations. First, despite the large number of participants included in our study, the sample did not fully represent the study population. A larger sample may be needed. In addition, exclusion of female participants limited generalization of our results to the general population. Second, job switching during the follow-up period was not considered in our analyses. Third, occupational misclassification may lead to bias. Fourth, the severity of CVEs was not being assessed in the participants.

In conclusion, our findings revealed no association between occupational category and its position with incidents of CVEs; differences in skill would not influence the incidence of CVDs among men.

Conflicts of Interest: None declared.

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References

1. Barquera S, Pedroza-Tobias A, Medina C, *et al*. Global overview of the epidemiology of atherosclerotic cardiovascular disease. *Arch Med Res* 2015;**46**:328-38.

2. Hata J, Ninomiya T, Hirakawa Y, *et al*. Secular trends in cardiovascular disease and its risk factors in Japanese: half-century data from the Hisayama Study (1961--2009). *Circulation* 2013;**128**:1198-205.

3. Traghella I, Mastorci F, Pepe A, *et al*. Nontraditional cardiovascular biomarkers and risk factors: Rationale and future perspectives. *Biomolecules* 2018;**8**:40.

4. Davis-Lameloise N, Philpot B, Janus ED, *et al*. Occupational differences, cardiovascular risk factors and lifestyle habits in South Eastern rural Australia. *BMC Public Health* 2013;**13**:1090.

5. Kivimäki M, Kawachi I. Work Stress as a Risk Factor for Cardiovascular Disease. *Curr Cardiol Rep* 2015;**17**:74.

6. Virkkunen H, Kauppinen T, Tenkanen L. Long-term effect of occupational noise on the risk of coronary heart disease. *Scand J Work Environ Health* 2005;**31**:291-9.

7. Ganzeboom HBG. A new International Socio-Economic Index (ISEI) of occupational status for the International Standard Classification of Occupation 2008 (ISCO-08) constructed with data from the ISSP 2002-2007. In: Annual Conference of International Social Survey Programme, Lisbon. **2010**.

8. Ghahramani R, Aghilinejad M, Kermani-Alghoraishi M, *et al.* Occupational categories and cardiovascular diseases incidences: a cohort study in Iranian population. *J Prev Med Hyg* 2020;**61**:E290-5.

9. Marandi E, Moghaddas E. Motivation factors of Blue collar workers verses White collar workers in Herzberg's Two Factors theory. California State University East Bay, Stratford Business School. 2013, Available from *https://pdfs.semanticscholar.org/8b21/ef3d1c15c195ca1d4662ccc9e682a-8f8ab41.pdf* (Accessed May 2, 2020).

10. Steptoe A, Marmot M. The role of psychobiological pathways in socio-economic inequalities in cardiovascular disease risk. *Eur Heart J* 2002;**23**:13-25.

11. Havranek EP, Mujahid MS, Barr DA, *et al*. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. *Circulation* 2015;**132**:873-98.

12. Iso H. Changes in coronary heart disease risk among Japanese. *Circulation* 2008;**118**:2725-9.

13. McFadden E, Luben R, Wareham N, *et al*. Social class, risk factors, and stroke incidence in men and women: a prospective study in the European prospective investigation into cancer in Norfolk cohort. *Stroke* 2009;**40**:1070-7.

14. Zaitsu M, Kato S, Kim Y, *et al*. Occupational class and risk of cardiovascular disease incidence in Japan: nationwide, multicenter, hospital-based case-control study. *J Am Heart Assoc* 2019;**8**:e011350.

15. Sarrafzadegan N, Baghaei A, Sadri G, *et al*. Isfahan healthy heart program: Evaluation of comprehensive, community-based interventions for non-communicable disease prevention. *Prev Control* 2006;**2**:73-84.

16. Sarraf-Zadegan N, Sadri G, Malek-Afzali H, *et al*. Isfahan Healthy Heart Programme: a comprehensive integrated community-based programme for cardiovascular disease prevention and control. Design, methods and initial experience. *Acta Cardiol* 2003;**58**:309-20.

17. EurWORK. Coding and classification standards. 2010, Available from *www.eurofound.europa.eu/surveys/ewcs/2005/classification* (Accessed May 2, 2020).

18. Luepker RV, Apple FS, Christenson RH, *et al*. Case definitions for acute coronary heart disease in epidemiology and clinical research studies: a statement from the AHA Council on Epidemiology and Prevention; AHA Statistics Committee; World Heart Federation Council on Epidemiology and Prevention; the European Society of Cardiology Working Group on Epidemiology and Prevention; Centers for Disease Control and Prevention; and the National Heart, Lung, and Blood Institute. *Circulation* 2003;**108**:2543-9.

19. Members C, Braunwald E, Antman EM, *et al*. ACC/AHA guideline update for the management of patients with unstable angina and non-ST-segment elevation myocardial infarction--2002: summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Unstable Angina). *Circulation* 2002;**106**:1893-900.

20. Sarrafzadegan N, Talaei M, Sadeghi M, *et al*. The Isfahan cohort study: rationale, methods and main findings. *J Hum Hypertens* 2011;**25**:545-53.

21. Ikeda N, Saito E, Kondo N, *et al*. What has made the population of Japan healthy? *Lancet* 2011;**378**:1094-105.

22. Lukhaupt SE, Calvert GM. Prevalence of coronary heart disease or stroke among workers aged <55 years - United States, 2008–2012. Centers for Disease Control and Prevention. *Morbidity and Mortality Weekly Report* 2014;**60**:645-9.

23. Suadicani P, Hein HO, Gyntelberg F. Socioeconomic status and ischaemic heart disease mortality in middle-aged men: importance of the duration of follow-up. The Copenhagen Male Study. *Int J Epidemiol* 2001;**30**:248-55.

24. Emberson JR, Whincup PH, Morris RW, Walker M. Social class differences in coronary heart disease in middle-aged British men: implications for prevention. *Int J Epidemiol* 2004;**33**:289-96.

25. Wada K, Kondo N, Gilmour S, *et al*. Trends in cause specific mortality across occupations in Japanese men of working age during period of economic stagnation, 1980-2005: retrospective cohort study. *BMJ* 2012;**344**:e1191.

26. Suzuki E, Kashima S, Kawachi I, Subramanian SV. Social and geographic inequalities in premature adult mortality in Japan: a multilevel observational study from 1970 to 2005. *BMJ Open* 2012;**2**:e000425.

27. Falagas ME, Vouloumanou EK, Mavros MN, Karageorgopoulos DE. Economic crises and mortality: a review of the literature. *Int J Clin Pract* 2009;**63**:1128-35.

28. Virtanen S V, Notkola V. Socioeconomic inequalities in cardiovascular mortality and the role of work: a register study of Finnish men. *Int J Epidemiol* 2002;**31**:614-21.

29. Li Q, Morikawa Y, Sakurai M, *et al*. Occupational class and incidence rates of cardiovascular events in middle aged men in Japan. *Ind Health* 2010;**48**:324-30.

30. Armstrong DL, Strogatz D, Barnett E, Wang R. Joint effects of social class and community occupational structure on coronary mortality among black men and white men, upstate New York, 1988-92. *J Epidemiol Community Heal* 2003;**57**:373-8.

31. Virtanen M, Heikkilä K, Jokela M, *et al*. Long working hours and coronary heart disease: a systematic review and meta-analysis. *Am J Epidemiol* 2012;**176**:586-96.

32. Conway SH, Pompeii LA, Roberts RE, *et al*. Dose-response relation between work hours and cardiovascular disease risk: findings from the panel study of income dynamics. *J Occup Environ Med* 2016;**58**:221.

33. Hartley TA, Burchfiel CM, Fekedulegn D, *et al*. Health disparities in police officers: comparisons to the US general population. *Int J Emerg Ment Health* 2011;**13**:211.

34. Byrne DG, Espnes GA. Occupational stress and cardiovascular disease. *Stress Heal J Int Soc Investig Stress* 2008;**24**:231-8.

35. Prihartono NA, Fitriyani F, Riyadina W. Cardiovascular Disease Risk Factors Among Blue and White-collar Workers in Indonesia. *Acta Med Indones* 2018;**50**:96-103.

36. von Bonsdorff MB, Seitsamo J, von Bonsdorff ME, *et al*. Job strain among blue-collar and white-collar employees as a determinant of total mortality: a 28-year population-based follow-up. *BMJ Open* 2012;**2**:e000860.

37. Zhang L, Narayanan K, Suryadevara V, *et al*. Occupation and risk of sudden death in a United States community: a case-control analysis. *BMJ Open* 2015;**5**:e009413.

38. Vandelanotte C, Short C, Rockloff M, *et al*. How do different occupational factors influence total, occupational, and leisure-time physical activity? *J Phys Act Heal* 2015;**12**:200-7.

39. Parry S, Straker L. The contribution of office work to sedentary behaviour associated risk. *BMC Public Health* 2013;**13**:296.

40. Stringhini S, Carmeli C, Jokela M, *et al*. Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1·7 million men and women. *Lancet* 2017;**389**:1229-37.

41. Marshall IJ, Wang Y, Crichton S, *et al*. The effects of socioeconomic status on stroke risk and outcomes. *Lancet Neurol* 2015;**14**:1206-18.

42. Dadjou Y, Kermani-Alghoraishi M, Sadeghi M, *et al*. The impact of health-related quality of life on the incidence of ischaemic heart disease and stroke; a cohort study in an Iranian population. *Acta Cardiol* 2016;**71**:221-6.