Prevalence of cardiovascular health and its relationship with job strain: a cross-sectional study in Taiwanese medical employees

ABSTRACT

Objectives: To explore the prevalence and associated factors of cardiovascular health as defined by the AHA among different job categories in health settings.

Methods: This is a cross-sectional and hospital-based survey. A total of 1329 medical professionals with a mean age of 38 years in a regional hospital in Taiwan were recruited. Information for seven combined indicators including blood pressure, fasting sugar, blood cholesterol, body mass index, time of physical activity, dietary pattern and smoking status was obtained from the employees' health profiles and questionnaires. Degree of job strain was evaluated by the Chinese version of the Job Content Questionnaire, which was derived from Karasek's demand-control model. Three types of cardiovascular health were identified as poor, intermediate and ideal.

Results: Prevalence of cardiovascular health in this study's population was ideal in 0.2% of the sample, intermediate in 20.6% and poor in 79.2%. There was a significantly higher percentage of poor health in workers with high strain (85.1%), and in the professions of nurse (85.3%) and physician assistant (83.1%). In the multivariate analysis, the only significant factor correlated with job strain was physical inactivity. After being adjusted, workers with high strain exhibit a higher prevalence of physical inactivity compared to those with low strain (OR 1.9, 95% CI 1.38 to 2.81).

Conclusions: Physical inactivity is the only significant factor correlated with job strain and is associated with a work situation characterised by high strain and the professions of nurse and physician assistant. Strategies for workplace health promotion should focus on employee health literacy and motivation to exercise regularly.

INTRODUCTION

From epidemiological studies, cardiovascular diseases (CVD) are not only related to hypertension, dyslipidaemia and diabetes mellitus, but are also associated with unhealthy behaviour.1 A recently published population-based and prospective cohort study2 on Swedish men revealed that almost 4/5 of myocardial infarctions in men are preventable by five low-risk behaviours. These low-risk behaviours include a healthy diet, no smoking, moderate alcohol consumption, physical activity and no obesity. However, only 1% of the men under consideration presented with all of the healthy behaviours included in this study. Another meta-analysis3 with data from seven cohort studies comprising 102 128 men and women who were free of existing coronary artery disease at baseline (1985–2000), intended to measure the association of lifestyle factors and the incidence of coronary artery disease. There were four lifestyle risk factors: current smoking, physical inactivity, heavy drinking and obesity. Healthy lifestyle was defined as no risk factors, and unhealthy lifestyle was defined as 2–4 risk factors. After a mean of 7.3 years follow-up, the risk of coronary artery disease was higher in those who had an unhealthy lifestyle...
compared with those who had a healthy lifestyle (HR 2.55, 95% CI 2.18 to 2.98; population attributable risk 26.4%).

In 2010, the American Heart Association first offered ‘simple life 7’ as a goal for reducing cardiovascular risk factors and mortality.4 This approach combined seven indicators, which included four behavioural items (dietary pattern, physical activity, smoking status and body mass index (BMI)) and three risk factor items (blood pressure, blood cholesterol and fasting sugar level). Each indicator was divided into ideal, intermediate and poor statuses. Subsequently, one publication used the study’s cohort from the National Health and Nutrition Examination Survey of 1999–2002 to validate the relationship between these 7 ideal health indicators and mortality from all causes and CVD.5 The results showed that the number of ideal cardiovascular factors was significantly and inversely related to the mortality from both, all causes and CVD. Compared with participants who possess none of the ideal metrics, those meeting ≥5 indicators had a 78% (adjusted HR 0.22; 95% CI 0.10 to 0.50) reduction in the risk of all-cause mortality and an 88% (adjusted HR, 0.12; 95% CI, 0.03 to 0.57) reduction in the risk of mortality from CVD.

Except for the above seven health metrics, psychosocial stress is considered to be an emerging risk factor for CVD.1 However, the plausible mechanisms of psychosocial stress-related causes of CVD remain unclear. One hypothesis links psychosocial stress with unhealthy behaviour and cardiovascular risk factors, which subsequently lead to developing CVD.3–8 Several studies have already reported the association of psychosocial stress with some of the above factors, such as obesity, physical inactivity, smoking, diabetes, dyslipidaemia and hypertension.9–11 However, no study has elucidated the relationship between psychosocial work characteristics and cardiovascular health status as defined by the AHA’s 7 indicators.

Taiwan, as is the case in other eastern Asian countries, is notorious for overtime work requirements that are much more severe than those characteristic of Western countries.12 To improve this unfavourable work situation, Taiwan’s government has regulated weekly work hours to be less than 40 h for employees and 88 h (including duty time) for resident physicians. Even with these changes, medical staff still face highly stressful work environments. The stressors include hospital accreditation, medical malpractice lawsuits, high work load and inadequate staffing.13 14 Taiwan’s nurses and physician assistants have a higher prevalence of severe burnout than their counterparts in other countries.15

In this study, we selected job strain, which was derived from the dominant tool of Karasek’s demand-control model, to represent psychosocial stress. A great amount of evidence has shown job strain to be related to an increased risk of coronary artery disease and CVD mortality over a three decade period.16–18 In this study, we intend to examine the association of job strain and cardiovascular health among medical employees. There are several goals in this study. First, we intend to investigate the distribution of cardiovascular health factors using the AHA’s definition in four groups of job strain and in five categories of medical employees. Second, we want to examine the relationship between job strain and cardiovascular health among medical professions. Finally, we plan to explore which factors are related to high levels of job strain. We expect these results may add to our knowledge about job strain and its association with CVD and in turn may facilitate improvements in the health of hospital employees.

METHODS

Participants
The participants’ profiles were obtained from the database of a health promotion survey conducted at Sin-Lau Hospital (SLH-HPS) in 2012. The detailed descriptions can be seen in our previous reports.15 Briefly stated, a total of 1329 participants were recruited, including 101 physicians, 570 nurses, 68 physician assistants, 216 medical technicians and 374 administrators, which resulted in an 89% response rate. The questionnaire was administered voluntarily using an electronic system. All the collected data from the participants were anonymised and de-identified prior to analysis. This study was approved by the Ethics Review Board of Sin-Lau Hospital (SLH-919-104-08).

Sociodemographics and work conditions
Sociodemographic information and work conditions were evaluated through the use of a self-administered questionnaire. Sociodemographic information included gender, age, marital status, educational level and medical profession. Work conditions consisted of work duration, work type, work hours and sleep hours. Work duration refers to years in the present position. Work type was divided into fixed day work, fixed night work and shift work. Work hours were calculated as average work hours per week in the previous month, and were categorised as normal (≤44 h) and overtime (>44 h). Sleep hours were classified as <6 h, 6–8 h and >8 h per day (24 h).

Measurement of cardiovascular health status
We selected the seven cardiovascular health indicators offered by the American Heart Association as our study variables. These seven metrics include four lifestyle (smoking status, dietary pattern, physical activity and BMI) and three risk factors (fasting sugar, total cholesterol and blood pressure). The personal lifestyles information was acquired from the questionnaire. Dietary pattern was decided by the number of days of eating more than five portions of fruits and vegetables (5 per day) in 1 week. Physical activity was counted as total time engaged in moderate or strenuous exercise per week. Smoking status was classified as never smoked,
ex-smoker and current smoker. BMI was measured as body weight in kilograms divided by the square of body height in metres (kg/m²). The measurements of fasting glucose and total cholesterol were taken using routine fasting blood sampling. Blood pressure was measured by skilled technicians and followed the suggestion of the American Heart Association. At least two measurements of blood pressure were taken at each measurement session, and the average value was used as the study variable. The above seven metrics were each categorised into three levels: ideal, intermediate and poor. The detail definitions and prevalence are presented in table 1. The definition of ideal cardiovascular health was participants who had all the ideal health indicators, and poor cardiovascular health included participants who had at least one poor cardiovascular indicator. Intermediate cardiovascular health included participants who belonged to neither the ideal nor poor cardiovascular health group.

Measurement of job strain
We used the Chinese version of the Job Content Questionnaire (C-JCQ) to measure job strain. C-JCQ is well validated in the Taiwanese population, and is derived from the Karasek Demand-Control model, which is a dominant tool in the research field of job stress. Job demands represent psychosocial work load, and job control means decision latitude in work. As postulated in Karasek's model, work characterised by high job demand and low job control was classified as high strain work, which produces the highest risk of stress-related illness. On the other hand, work combined with low job demand and high job control was categorised as low strain work, which creates the lowest risk of stress-related illness. Work combined with high job demand and high job control, and work that consisted of low job demand and low job control, were classified as active and passive jobs, respectively, which have risk of stress-related illness that falls between that of high strain and low strain work. According to the C-JCQ, job demand was assessed by seven questions (fast work, hard work, excessive work, insufficient time, intensive concentration, hectic work and insufficient manpower), and job control was assessed by nine questions (learning new things, non-repetitive work, creative work, allowing one's own decisions, high level of skills, freedom to make decisions, various tasks, influential opinions and developing one's abilities). Each question was measured on a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). In this study, the job demand scores and the control were calculated separately and divided into a dichotomy by median values to indicate high (equal to or above the median) and low (below the median) values.

Statistical analysis
All the variables were recorded as numbers and/or percentages. One-wave analysis of variance was used to test
the difference between different groups regarding job
strain and medical profession. Multiple logistic regres-
sion was used to explore the association of job strain
with studying variables, and a multiple linear regression
analysis was used to identify the relationship between job
demand and job control with continuous variables. We
chose SPSS V.17 software to perform all the statistical
analysis; we set the level of signi
f
icance at p<0.05.

RESULTS

Characteristics of participants

A total of 1329 medical employees 21–64 years of age
(average 38 years) were recruited. The sociodemo-
graphic factors and job-related psychosocial factors
between four groups of job strain are summarised in
table 2. Females and younger people (age <30 years)
had a significantly greater prevalence of high strain.
Among the different medical professions under
consideration, physician assistants and nurses had a
much higher percentage of work with high strain as
compared with medical technicians, administrative staff
and physicians (27.9%, 27.2%, 14.4%, 14.7%, 2%,
p<0.0001). Jobs with high strain are more common in
fixed night work and shift work than in fixed day work.
This table also shows that longer work periods are asso-
ciated with the high strain group. The distribution of
jobs with high strain showed no differences in marital
status, education level, work duration, or hours of sleep.

Definitions and prevalence of a cardiovascular health profile

Table 1 shows the definitions of seven cardiovascular
health profiles. Most of them are similar to the AHA def-
inition, with the exception of diet pattern and BMI. We
chose to use more simple criteria (a healthy diet consist-
ing of five fruits and vegetables per day) that was more

| Variable            | Low strain | Passive | Active | High strain | p Value |
|---------------------|------------|---------|--------|-------------|---------|
| Gender (n, %)       |            |         |        |             | ≤0.001  |
| Male                | 115 (50.4) | 53 (23.2)| 38 (16.7)| 22 (9.6)    |         |
| Female              | 325 (29.5) | 347 (31.5)| 189 (17.2)| 240 (21.8)  |         |
| Age, in years (n, %)| ≤0.001     |         |        |             |         |
| ≤30                 | 50 (23.9)  | 55 (26.3)| 45 (21.5)| 59 (28.2)   |         |
| 31~40               | 190 (31.6) | 175 (29.1)| 102 (16.9)| 135 (22.4)  |         |
| 41~50               | 138 (36.5) | 124 (32.8)| 64 (16.9)| 52 (13.8)   |         |
| >50                 | 62 (44.6)  | 45 (32.4)| 16 (11.5)| 16 (11.5)   |         |
| Marriage (n, %)     | 0.243      |         |        |             |         |
| Single/others       | 156 (31.3) | 150 (30.1)| 81 (16.2)| 112 (22.4)  |         |
| Married             | 284 (34.2) | 250 (30.1)| 146 (17.6)| 150 (18.1)  |         |
| Education (n, %)    | ≤0.085     |         |        |             |         |
| High school         | 52 (38.8)  | 33 (24.6)| 25 (18.7)| 24 (17.9)   |         |
| College             | 137 (36.1) | 124 (32.6)| 52 (13.7)| 67 (17.6)   |         |
| University          | 251 (30.8) | 243 (29.8)| 150 (18.4)| 171 (21.0)  |         |
| Profession (n, %)   | ≤0.001     |         |        |             |         |
| Physician           | 62 (61.4)  | 13 (12.9)| 24 (23.8)| 2 (2.0)     |         |
| Physician assistant | 19 (27.9)  | 21 (30.9)| 9 (13.2)| 19 (27.9)   |         |
| Nurses              | 142 (24.9) | 143 (25.1)| 130 (22.8)| 155 (27.2)  |         |
| Medical technician  | 95 (44.0)  | 64 (29.6)| 26 (12.0)| 31 (14.4)   |         |
| Administrative Staff| 122 (32.6) | 159 (42.5)| 38 (10.2)| 55 (14.7)   |         |
| Work, in years (n, %)| 0.748    |         |        |             |         |
| <5                  | 129 (32.6) | 115 (29.0)| 70 (17.7)| 82 (20.7)   |         |
| 5~10                | 92 (33.2)  | 76 (27.4)| 48 (17.3)| 61 (22.0)   |         |
| >10                 | 219 (33.4) | 209 (31.9)| 109 (16.6)| 119 (18.1)  |         |
| Work shift (n, %)   | ≤0.000     |         |        |             |         |
| Day shift           | 267 (41.8) | 191 (29.9)| 97 (15.2)| 83 (13.0)   |         |
| Night shift         | 9 (19.6)   | 14 (30.4)| 11 (23.9)| 12 (26.1)   |         |
| In shift            | 164 (25.4) | 195 (30.2)| 119 (18.4)| 167 (25.9)  |         |
| Work time (n, %)    | ≤0.000     |         |        |             |         |
| Normal              | 357 (34.8) | 347 (33.8)| 130 (12.7)| 193 (18.8)  |         |
| Overtime            | 83 (27.5)  | 53 (17.5)| 97 (32.1)| 69 (22.8)   |         |
| Sleeping hours (n, %)| 0.877    |         |        |             |         |
| <6                  | 195 (34.5) | 161 (28.4)| 102 (18.0)| 108 (19.1)  |         |
| 6~8                 | 230 (32.2) | 223 (31.2)| 116 (16.2)| 145 (20.3)  |         |
| >8                  | 15 (30.6)  | 16 (32.7)| 9 (18.4)| 9 (18.4)    |         |
suitable to the body size of a Taiwanese individual (BMI ≥27 instead of BMI ≥30 as a poor category). The prevalence of the ideal healthy diet and level of physical activity were found to be very low (13.2% and 5.2%, respectively) in this study population. On the other hand, the prevalence of never having smoked and ideal BMI were relatively high (95.3% and 70.2%, respectively).

**Distribution of cardiovascular health factors**

Table 3 shows the distribution of the seven cardiovascular health metrics among the four groups of job strain. It can be seen that there are no significant differences regarding healthy diet, smoking status, BMI, total cholesterol and fasting glucose. All the participants had a low percentage of physical activity of more than 150 min/week (3.5–7%). The high strain group had the highest percentage of no regular physical activity (76.3%), which was significantly different from the other groups (p<0.001). On the contrary, the high strain group had a significantly lower percentage of hypertension and diabetes than the other groups (p=0.031 and p=0.045, respectively).

Online supplementary table S1 shows the distribution of the seven cardiovascular health metrics among the five groups of medical professions. Physicians had the highest percentage of current smoking, obesity and hypercholesterolemia, but they also had the highest prevalence of ideal physical activity compared to the other medical professions. These cardiovascular factors all exhibited significant differences among the medical professions. It is worthy of notice that a lack of physical activity is a very common phenomenon among medical professionals. The worst affected group is nurses, among whom only 1.9% exercised more than 150 min/week and 78.4% had no physical activity. There were no statistical differences regarding healthy diet, blood pressure and fasting glucose.

**Cardiovascular health status in the job strain and medical professional groups**

Figure 1 shows the cardiovascular health status among the four groups of job strain. The results showed that the prevalence of poor cardiovascular health status from high to low was high strain, active strain, passive strain and low strain (85.1%, 83.7%, 79.5% and 73.2%, respectively) (p=0.002). Figure 2 shows the cardiovascular health status among the five medical professions.
The results demonstrated that nurses had the highest percentage of poor cardiovascular health (85.3%) among the five medical professions, and physician assistants (82.4%) were second to nurses. Similarly, there was a statistical significance among these five medical professions (p=0.0001). The total population exhibiting ideal cardiovascular health was 0.2%, intermediate was 20.6% and poor cardiovascular health was 79.2%.

**Associations between cardiovascular health factors and job strain**

The relationship between job demands, job control and job strain to the seven cardiovascular health factors is demonstrated in table 5. Through a multivariate analysis, the only significant factor that correlated with job demand, job control and job strain was physical inactivity (regression coefficients 0.412, 0.258 and 0.499, respectively). This indicates that high job demands, low job control and high strain jobs are associated with a lack of physical activity. After being adjusted by age and gender, the prevalence of physical inactivity in a comparison of high strain, active and passive to low strain resulted in an OR of 1.9 (95% CI 1.38 to −2.81), 1.4 (95% CI 1.00 to −2.03) and 1.2 (95% CI 0.93 to −1.67) (see table 6).

**DISCUSSION**

This is the first study to explore the relationship between job strain and cardiovascular health among medical employees. The main findings show that (1) high job strain was associated with a greater prevalence of poor cardiovascular health; (2) nurses and physician assistants had the highest percentage of poor cardiovascular health in a hospital setting; (3) physical inactivity is the only factor related to work characterised by high job demand, low job control and high strain. Employees who have high strain work had 90% greater physical inactivity compared to those who worked in low strain jobs; and (4) the prevalence of an ideal healthy diet and physical inactivity was rare (13.2% and 5.6%, respectively) among the studied populations.

Previous studies have established the association of seven cardiovascular health indicators with the incidence and mortality of CVD. Folsom et al reported on the prevalence of ideal cardiovascular health as defined by the American Heart Association from four communities in America, with a total sampling of 15 792 middle-aged participants from 1987 to 1989 as well as the incidence rate of CVD in a 20-year period. They found only 0.1% of participants had ideal cardiovascular health; 17.4% had intermediate cardiovascular health and 82.5% had poor cardiovascular health. CVD incidence rates showed a good correlation with the three categories of health and with the number of ideal health metrics. Coronary artery disease incidence rates were much lower in those with the six ideal health metrics (3.9/1000 person-years) compared with those with zero ideal health metrics.

| Number of health factors | Total, % (N=1329) | Job strain | Low strain, % (N=440) | Positive, % (N=400) | Active, % (N=227) | High strain, % (N=262) | p Value |
|--------------------------|------------------|------------|-----------------------|---------------------|------------------|-----------------------|---------|
| 0                        | 0.1              | 0.0        | 0.2                   | 0.0                 | 0.0              | 0.0                   | 0.091   |
| 1                        | 1.2              | 1.4        | 1.5                   | 1.3                 | 0.4              |                       |         |
| 2                        | 8.0              | 11.1       | 5.0                   | 10.1                | 5.3              |                       |         |
| 3                        | 25.4             | 24.5       | 27.0                  | 25.1                | 24.4             |                       |         |
| 4                        | 42.1             | 40.0       | 43.5                  | 41.9                | 43.5             |                       |         |
| 5                        | 2.9              | 20.9       | 20.5                  | 18.5                | 23.7             |                       |         |
| 6                        | 2.3              | 1.8        | 2.2                   | 2.6                 | 2.7              |                       |         |
| 7                        | 0.2              | 0.2        | 0.0                   | 0.4                 | 0.0              |                       |         |
| Mean (n)                 | 3.8              | 3.7        | 3.8                   | 3.8                 | 3.9              |                       |         |

Table 4 Number of cardiovascular health factors by job strain

Figure 1 Prevalence of cardiovascular health status among the four groups of job strain.

Figure 2 Prevalence of cardiovascular health status among five medical professions.
European countries. However, 64.3% of our study included a large-scale study from 14 prospective cohorts and eight European cohorts, which was much higher than the European (7% to 38%) and American 73% to 38%) population, which was much higher than the European proportion of those engaged in physical activity. Another important finding in this study was that nurses and physician assistants also exhibited the highest percentage of poor cardiovascular health among the medical professions under consideration. The possible reason for this is that more nurses and physician assistants belong to the high strain group, so there may be a link to more adverse cardiovascular health.

After being adjusted for important demographic factors, physical inactivity was the only factor positively related to high job demands, low job control and high job strain. Also, after being adjusted by age and gender, employees with high strain and active strain are 90% and 40% more likely to be physically inactive as compared to those with low strain (OR 1.9; 95% CI 1.38 to 2.82 and OR 1.4; 95% CI 1.00 to 2.03, respectively). This finding is compatible with the results of a large-scale study from 14 prospective cohorts and eight European countries. However, 64.3% of our study population had no physical activity, which was much higher than the European (7% to 38%) and American (24% in 2005) samples. Ranking behind high blood pressure, smoking and high blood glucose, physical inactivity was the fourth most important risk factor for non-communicable chronic diseases, as reported by the WHO. Moreover, physical inactivity contributes to population-attributable risk that is only lower than the risk factor associated with smoking. Therefore, a sedentary lifestyle has not only become a worldwide phenomenon, but has also become a major public health burden. As O’Keefe argued, ‘sitting is the new smoking.’

Physical inactivity has been reported to increase the relative risk of coronary artery disease, stroke, hypertension and osteoporosis by 45%, 60%, 30% and 59%, respectively. On the other hand, regular physical activity will provide several substantial benefits to overall health. A large-scale prospective study observed 55,137 participants with a mean age of 44 years and follow-up of 15 years. They concluded that running, even running 5–10 min/day at slow speeds, <6 miles/h, was associated with markedly reduced (30% and 45%) risk of death from all causes and CVD, respectively. Exercise also has benefits related to several CVD risk factors. Aerobic physical activity reduces low-density lipoprotein by an average of 3–6 mg/day, reduces systolic blood pressure by an average of 2–5 mm Hg and reduces diastolic blood pressure by 1–4 mm Hg, lowers blood sugar and increases insulin sensitivity, is dose-responsive to overall health.

| Cardiovascular risk factors | Job demand (high vs low) | Job control (low vs high) | Job strain (high strain vs others) |
|----------------------------|--------------------------|---------------------------|-----------------------------------|
| Unhealthy diet†            | 0.012 (0.199)            | 0.300 (0.192)             | 0.277 (0.229)                     |
| Physical inactivity†       | 0.401 (0.129)*           | 0.262 (0.121)*            | 0.506 (0.165)*                    |
| Smoking†                   | 0.728 (0.421)            | 0.312 (0.409)             | 0.608 (0.555)                     |
| Body mass index (kg/m²)‡   | 0.007 (0.004)            | −0.001 (0.004)            | 0.000 (0.003)                     |
| Systolic blood pressure (mm Hg)‡ | 0.000 (0.001)     | 0.000 (0.001)             | −0.001 (0.001)                    |
| Diastolic blood pressure (mm Hg)‡ | −0.002 (0.002)   | −0.001 (0.002)            | −0.002 (0.002)                    |
| Glucose (mg/dL)‡           | 0.000 (0.000)            | −0.001 (0.001)            | 0.000 (0.000)                     |
| Cholesterol (mg/dL)‡       | 0.000 (0.000)            | 0.000 (0.000)             | 0.000 (0.000)                     |

*p<0.05, †Controlled for age, gender, education, profession by multiple logistic regression.‡Controlled for age, gender, education, profession, health diet, physical activity, smoking by multiple linear regression.

**Table 5** Regression coefficients (SEs) indicating the associations of job demand, job control and job strain, respectively, with cardiovascular risk factors.

---

| Job strain | Number of Participants | Physical inactivity (%) | Crude OR (95% CI) | Adjusted† OR (95% CI) |
|------------|------------------------|-------------------------|-------------------|----------------------|
| Low strain | 440                    | 55.9                    | 1                 | 1                    |
| Passive    | 400                    | 64.0                    | 1.4 (1.06 to 1.85)*| 1.2 (0.93 to 1.67)   |
| Active     | 227                    | 67.4                    | 1.6 (1.17 to 2.28)*| 1.4 (1.00 to 2.03)*  |
| High       | 262                    | 76.3                    | 2.5 (1.81 to 3.58)*| 1.9 (1.38 to 2.81)*  |

*p<0.05; †Adjusted by age, gender.

---

Table 6 OR of physical inactivity in association with types of job strain.
to weight loss, reduces systemic inflammation and has a beneficial association with subclinical atherosclerosis, including coronary artery calcification and intima-media thickness.31

This study confirmed that high job strain is significantly related to poor cardiovascular health status, which in this study’s groups is mainly due to low physical activity. And this study may also be the first report that nursing professionals and physician assistants have the worst cardiovascular status among medical staff. Furthermore, we comprehensively adjusted the demographic factors and found that physical inactivity was the most prevalent factor impacting the participants’ cardiovascular health. Importantly, we recruited most of the medical employees (89%) and had moderate case numbers in this study, both of which may have increased the reliability of our results.

Although we added new information in this research, several limitations should be addressed. First, we amalgamated seven healthy indicators together to represent cardiovascular health status, but the risk of CVD was different for each factor. It makes sense, if an individual has two unhealthy factors—physical inactivity and obesity—for that individual to possess a different risk of CVD in the future than one who has the paired risks of hypertension and diabetes mellitus. But, as in Rose’s theory for a population-level intervention strategy, using aggregated data seemed to be a more simple and feasible method than using individual profiles.32 Second, grouping poor cardiovascular health based simply on the presence of at least one poor cardiovascular indicator seems to lead to a major loss of information, which should be further validated. Third, the participants in this study were sampled from medical employees; therefore the results should not be extended to other occupational workers. Fourth, this study was based on questionnaires; selective bias should be taken into consideration. Take, for example, an employee with high strain work characteristics who may have avoided or not had the time to participate in this study. This may have resulted in an underestimation of the prevalence of employees with high work load and burnout. However, the high response rate will limit the magnitude of this discrepancy. Finally, this study can only ascertain the association between job strain and cardiovascular health status, but not the causal relationship, due to the inherent shortcoming of a cross-sectional study. Therefore, further longitudinal study is needed to confirm these relationships.

CONCLUSIONS

This study demonstrates that lack of physical activity is more common among medical employees who work with high strain. This risk factor creates a possibility of raising the incidence of CVD. Thus, in strategies for workplace health promotion, employers should improve unfavourable work characteristics by carrying out improvements such as reducing work load, stipulating realistic working hours and focusing on high risk groups, in order to increase employees’ health literacy and motivation to exercise regularly.

Acknowledgements The authors would like to thank the participants of SLH-HS for their dedication to this study. Miss Lo MY had full access to all of the data in the study and assisted in making the tables and figures. Mr Rod contributed to revisions of the English in this paper.

Contributors All the authors participated in the interpretation of data, and wrote and critically reviewed the paper. L-PC and C-CT designed and conducted the study, and wrote the draft; C-YL was our statistical consultant, who revised and interpreted the tables; SCH directed the entire study and completed the manuscript.

Competing interests None declared.

Ethics approval Ethics Committee of the Sin-Lau Hospital (SLH-919-104-08).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

Open Access This is an Open Access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

REFERENCES

1. Yusuf S, Hawken S, Ounpuu S, et al., INTERHEART Study Investigators. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancer 2004;364:937–52.
2. Akesson A, Larsson SC, Discacciati A, et al. Low-risk diet and lifestyle habits in the primary prevention of myocardial infarction in men: a population-based prospective cohort study. J Am Coll Cardiol 2014;64:1299–306.
3. Kivimäki M, Nyberg ST, Fransson EI, et al., IPD-Work Consortium. Associations of job strain and lifestyle risk factors with risk of coronary artery disease: a meta-analysis of individual participant data. CMAJ 2013;185:763–9.
4. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association’s strategic Impact Goal through 2020 and beyond. Circulation 2010;121:586–613.
5. Ford ES, Greenlund KJ, Hong Y. Ideal cardiovascular health and mortality from all causes and diseases of the circulatory system among adults in the United States. Circulation 2012;125:987–95.
6. Pieper C, LaCroix AZ, Karasek RA. The relation of psychosocial dimensions of work with coronary heart disease risk factors: a meta-analysis of five United States data bases. Am J Epidemiol 1989;129:483–94.
7. Adler N, Matthews K. Health psychology: why do some people get sick and some stay well? Annu Rev Psychol 1994;45:529–59.
8. Hemingway H, Marmot M. Evidence based cardiology: psychosocial factors in the aetiology and prognosis of coronary heart disease. Systematic review of prospective cohort studies. BMJ 1999;318:1460–7.
9. Kang MG, Koh SB, Cha BS, et al. Job stress and cardiovascular risk factors in Male workers. Prev Med 2005;40:583–8.
10. Nyberg ST, Fransson EI, Heikkinä K, et al., IPD-Work Consortium. Job strain and cardiovascular disease risk factors: meta-analysis of individual-participant data from 47,000 men and women. PLoS ONE 2013;8:e67323.
11. Kivimäki M, Singh-Manoux A, Nyberg S, et al. Job strain and risk of obesity: systematic review and meta-analysis of cohort studies. Int J Obes (Lond) 2015;39:1597–600.
12. OECD. Average annual hours actually worked per worker. Organization for Economics Cooperation and Development, 2014.
13. Ho HC, Chang SH, Tsao JY, et al. The relationship between job stress and physical-mental health among hospital staff. Chin J Occup Med 2010;17:239–52.
14. Heinen MM, van Achterberg T, Schwendimann R, et al. Nurses’ intention to leave their profession: a cross sectional
observational study in 10 European countries. *Int J Nurs Stud* 2013;50:174–84.

15. Chou LP, Li CY, Hu SC. Job stress and burnout in hospital employees: comparisons of different medical professions in a regional hospital in Taiwan. *BMJ Open* 2014;4:e004185.

16. Karasek R, Baker D, Marxer F, et al. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. *Am J Public Health* 1981;71:694–705.

17. Backé EM, Seidler A, Latza U, et al. The role of psychosocial stress at work for the development of cardiovascular diseases: a systematic review. *Int Arch Occup Environ Health* 2012;85:67–79.

18. Kivimäki M, Nyberg ST, Batty GD, et al. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet* 2012;380:1491–7.

19. Pickering TG, Hall JE, Appel LJ, et al., Council on High Blood Pressure Research Professional and Public Education Subcommittee, American Heart Association. Recommendations for blood pressure measurement in humans: an AHA scientific statement from the Council on High Blood Pressure Research Professional and Public Education Subcommittee. *J Clin Hypertens (Greenwich)* 2005;7:102–9.

20. Yeh W-Y, Cheng Y, Chen C-J, et al. Psychometric properties of the Chinese version of Copenhagen burnout inventory among employees in two companies in Taiwan. *Int J Behav Med* 2007;14:126–33.

21. Yeh W, Cheng Y, Chen M, et al. Development and validation of an occupational burnout inventory. *Taiwan J Public Health* 2008;27:349–64.

22. Karasek RA Jr. Job demands, job decision latitude, and mental strain: Implications for job redesign. *Adm Sci Q* 1979;24:285–308.

23. Pan WH, Yeh WT. How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations. *Asia Pac J Clin Nutr* 2008;17:370–4.

24. Folsom AR, Yatsuya H, Nettleton JA, et al. Community prevalence of ideal cardiovascular health, by the American Heart Association definition, and relationship with cardiovascular disease incidence. *J Am Coll Cardiol* 2011;57:1690–6.

25. Fransson EI, Heikklä K, Nyberg ST, et al. Job strain as a risk factor for leisure-time physical inactivity: an individual-participant meta-analysis of up to 170,000 men and women: the IPD-Work Consortium. *Am J Epidemiol* 2012;176:1078–89.

26. Centers for Disease Control and Prevention (CDC). Trends in leisure-time physical inactivity by age, sex, and race/ethnicity—United States, 1994-2004. *MMWR Morb Mortal Wkly Rep* 2005;54:991–4.

27. World Health Organization. *Mortality and burden of disease estimates for WHO Member States in 2004* Geneva: World Health Organization, 2009.

28. O’Keefe JH, Lavie CJ. Run for your life… at a comfortable speed and not too far. *Heart* 2013;99:516–9.

29. Booth FW, Lees SJ. Fundamental questions about genes, inactivity, and chronic diseases. *Physiol Genomics* 2007;28:146–57.

30. Lee DC, Pate RR, Lavie CJ, et al. Leisure-time running reduces all-cause and cardiovascular mortality risk. *J Am Coll Cardiol* 2014;64:472–81.

31. Wong ND, Amsterdam EA, Blumenthal RS. *ASPC Manual of Preventive Cardiology: Physical Activity*. Ahmed HM, Ndumele CE., Demos Medical Publishing LLC. 2015:163–5.

32. Rose G. Sick individuals and sick populations. *Int J Epidemiol* 2001;30:427–32.