Original research

Long working hours, sedentary work, noise, night shifts and risk of ischaemic heart disease

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/heartjnl-2022-320999).

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Received 16 February 2022
Accepted 6 July 2022
Published Online First 8 August 2022

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heart.bmj.com

Linked

► http://dx.doi.org/10.1136/heartjnl-2022-321427

Check for updates

To cite: Eng A, Denison HJ, Corbin M, *et al*. *Heart* 2023;**109**:372–379.

ABSTRACT

Objective Ischaemic heart disease (IHD) is a leading cause of death in Western countries. The aim of this study was to examine the associations between occupational exposure to loud noise, long working hours, shift work, and sedentary work and IHD.

Methods This data linkage study included all New Zealanders employed and aged 20–64 years at the time of the 2013 census, followed up for incident IHD between 2013 and 2018 based on hospitalisation, prescription and death records. Occupation and number of working hours were obtained from the census, and exposure to sedentary work, loud noise and night shift work was assessed using New Zealand job exposure matrices. HRs were calculated for males and females using Cox regression adjusted for age, socioeconomic status, smoking and ethnicity.

Results From the 8 11 470 males and 7 83 207 females employed at the time of the census, 15 012 male (1.9%) and 5595 female IHD cases (0.7%) were identified. For males, there was a modestly higher risk of IHD for the highest category (>90 dBA) of noise exposure (HR 1.19; 95% CI 1.07 to 1.33), while for females exposure prevalence was too low to calculate an HR. Night shift work was associated with IHD for males (HR 1.10; 95% CI 1.05 to 1.14) and females (HR 1.25; 95% CI 1.17 to 1.34). The population attributable fractions for night shift work were 1.8% and 4.6%, respectively. No clear associations with working long hours and sedentary work were observed.

Conclusions This study suggests that occupational exposures to high levels of noise and night shift work might be associated with IHD risk.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Ischaemic heart disease (IHD) is a leading cause of death in Western countries. Common occupational exposures such as loud noise, long working hours, shift work and sedentary work have been associated with increased IHD risks, but evidence is conflicting.

WHAT THIS STUDY ADDS

⇒ This study of the entire employed population of New Zealand found a modestly higher risk of IHD for the highest category (>90 dBA) of noise exposure (HR 1.19; 95% CI 1.07 to 1.33) in males. It also found that night shift work was associated with IHD for males (HR 1.10, 95% CI 1.05 to 1.14) and females (HR 1.25; 95% CI 1.17 to 1.34).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ When assessing and managing patients' risk of IHD, clinicians should consider the possible higher risk associated with night shift work and work-related exposure to high levels of noise.

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of death globally, and work-related exposures may play a role. While psychosocial factors have been studied most frequently, there is also evidence for loud noise[1] and shift work.[2] A recent meta-analysis of studies on loud noise reported a relative risk (RR) of 1.29 (95% CI 1.15 to 1.43) for incident ischaemic heart disease (IHD) but concluded that the evidence is limited.[1] Earlier reviews reported increases in risk of 10%–30% for shift work and 40% for night shift work,[3] and more recent reviews showed duration–response associations.[2 4] Other risk factors for which there is some, although inconsistent, evidence include long working hours[5] and both physically strenuous[6] and sedentary occupations.[7] Most studies have focused on males; evidence for occupational risk factors in females is limited. The role of socioeconomic status (SES) remains unclear, with the impact of SES in the relationship between long working hours and CVD having recently been debated.[5 8]

In recent decades, the nature of work has changed due to globalisation and technology advances making sedentary work and non-standard patterns of work increasingly common. About 1/3 of workers in New Zealand (NZ) also report exposure to loud noise at work ≥25% of the time.[9] We previously studied associations between occupational exposures and IHD in two NZ workforce surveys (NZWS),[10] but power for sedentary work, noise, long hours, and night shifts was low. This data linkage study aimed to elucidate associations between these prevalent workplace exposures and incident IHD for the entire employed population of NZ, stratified by sex and SES.

METHODS

This longitudinal data linkage study used Statistics New Zealand's (Stats NZ) Integrated Data Infrastructure (IDI), a longitudinal meta-dataset of routine datasets administered by government agencies (eg, health, social, economic), Stats NZ surveys (including the 2013 census) and non-government organisations. The study population consisted of all NZ residents aged 20–64 years and employed at the time of the 2013 census.

Exposure

2013 national census

We used data from the 2013 NZ Census of Population and Dwellings, which aimed to enumerate everyone in NZ on 5 March 2013. Occupation was coded using the NZ Standard Classification of Occupations 1999. Working hours '*How many hours, to the nearest hour, do you usually work each week*?' were categorised into four categories: <35, 35–45, 46–54 and 55+ hours with the 35–45 hours category as the reference. Information was also available on sex, date of birth, ethnicity ('*which ethnic group do you belong to?*' see table 1 for categories), smoking status '*do you smoke cigarettes regularly (one or more a day)*' and '*Have you ever been a regular smoker of one or more cigarettes a day*?' and the 2013 NZ Deprivation Index (NZDep), a census-based index with a relative deprivation score assigned to each geographical meshblock of residence.

Job exposure matrices (JEMs)

A JEM is an exposure assessment tool that is a cross-classification of jobs and exposures to which persons carrying out the job may be exposed and assigns an exposure category to each individual based on their occupation. The category is based on the estimated percentage exposed above a threshold within each occupation.

Sedentary work

We created a JEM using prevalence data of the proportion of time spent sitting at work from the NZWS[9] and the Finnish Job Exposure Matrix (FINJEM)[11] for sedentary work, in combination with expert assessment. Sedentary work was defined as work carried out in a seated position. Experts (DM, AtM and HD) independently scored each occupation, discrepancies were discussed and consensus was reached. An occupation was considered exposed if ≥50% of workers in that occupation spent ≥50% of their working time seated. For exposed jobs, sedentary work was categorised as low (50%–70%), medium (71%–90%) or high (>90% of the time).

Noise

We created a JEM using NZ-specific prevalence data on the proportion of time exposed to noise from two NZWS,[10] FINJEM[11] and a US Noise JEM.[12] Experts (IL and DM) independently scored each occupation, discrepancies were discussed and consensus was reached. An occupation was considered exposed if ≥50% of workers in that occupation were exposed to an average of ≥80 A-weighted decibels (dBA) categorised as low (≥80–84), medium (85-90) or high (>90). An additional dichotomous variable defined only the highest category as exposed.

Night shifts

We created a JEM using prevalence data from two NZWS.[10] Experts (DM, AtM and AE) independently scored each occupation as described previously. Night shift work was defined as work for pay, profit or income for ≥3 hours between midnight and 05:00 in the last 4 weeks. An occupation was considered exposed if >10% of workers undertook night shifts. For exposed jobs, the proportion of workers exposed was categorised as low (11%–30% exposed) or high (>30% exposed).

Ischaemic heart disease

IHD cases were identified based on mortality, hospital discharges and pharmaceutical dispensings applying the definition used in previous NZ linkage studies.[13] International Classification of Diseases codes were used to identify deaths from mortality records and cases from public hospital discharges and procedures for IHD (online supplemental table 1). If individuals had ≥2 pharmaceutical dispensings of antianginals within a 12-month period, they were also identified as cases (online supplemental table 1). The date of first IHD event was identified.

Follow-up

The follow-up for incident IHD was from 6 March 2013 to 31 December 2018. Participants with IHD before the census date were excluded. Lost to follow-up included those who died from causes other than IHD or migrated overseas (identified from immigration data).

Statistical analysis

Cox proportional hazards regression was used to estimate cause-specific HRs stratified by sex and adjusted for age group (20-34; 35-44; 45-54; 55-64), deprivation group (1–2 (least); 3–4; 5–6; 7–8; 9–10 (most)), smoking (ever/never at time of census) and ethnicity (NZ European, Māori, Pacific, Asian and other) and the four occupational exposures (as yes/no variables). Analyses were also stratified by deprivation (NZDep 1–2, 3–8 and 9–10 and therefore not adjusted for deprivation). Population attributable fractions (PAFs) were calculated using the formula: PAF=[p*(HR−1)] / [p*(HR−1)+1] (where p=prevalence). Additional analyses were conducted to assess test for trend for categorical exposures. Heterogeneity in effect between deprivation groups (NZDep1-2 vs NZDep3-8 and NZDep1-2 vs NZDep9-10) was tested by fitting an interaction term between exposure and deprivation.

The proportional hazards assumptions were investigated using Schoenfeld residuals, which were satisfied for all variables but age group. Adding an interaction term between age group and time to event did not make a difference. As the study involved multiple comparisons, we assessed whether the difference in expected and observed statistically significant findings was itself significantly ($p<0.05$) different overall using the method described previously[10]: 'we determined, via the binomial theorem, the probability of s_0 or more successes from a sequence of k Bernoulli trials given the probability of success for each test is p. This overall probability is:

$$p_0 = \sum_{s \geq s_0}^{k} {}_kC_s p^s (1-p)^{k-s}$$

where ${}_kC_s$ is the number of ways of choosing s items from k. Here p is set to 0.05. Evaluation of this sum is straightforward for any s and k and can proceed iteratively because the ratio of the $(s+1)^{\text{th}}$ to the s^{th} term in the expansion is $\{(k-s)p\} / \{(s+1)(1-p)\}$. The procedure is a variation of the multiple comparison adjustment method of Šidák,[14] except that, rather than setting p_0 and solving for p, here p is set and the corresponding p_0 is determined'.

Analyses were conducted using SAS Enterprise Guide V.7.1.

Patient and public involvement

No patients were involved.

Table 1 Description of study population

	Males						Females					
			Exposure prevalence						Exposure prevalence			
	Total	Incident IHD	Long hours 55+ hours*	Sedentary ≥50%†	Loud noise >50% exposed mean >90 dBA‡	Night shift ≥10%§	Total	Incident IHD	Long hours 55+ hours¶	Sedentary ≥50%†	Loud noise >50% exposed mean >90 dBA‡	Night shift ≥10%§
	N		%	%	%	%	N		%	%	%	%
Total	1 029 156	20 310					1 137 291	9735				
Missing for job question	12 492	261					6192	87				
Not in employment	205 194	5034					347 892	4053				
Job code assigned	811 470	15 012	13.2	32.9	1.9	20.7	783 207	5595	4.5	41.3	0.10	19.7
Age group (years)												
20–34	256 119	318	10.0	26.4	2.1	20.3	230 202	120	3.4	37.3	0.06	18.8
35–44	200 397	1797	13.9	36.7	1.8	20.0	193 779	627	4.1	45.0	0.09	17.9
45–54	205 548	5349	15.3	36.2	1.9	21.4	213 663	1932	5.2	42.9	0.08	20.5
55–64	149 406	7551	14.9	34.4	1.7	21.6	145 563	2916	5.7	40.4	0.06	22.3
Ethnicity												
Missing	3468	72	15.1	27.4	2.5	20.1	2241	21	5.7	34.3	S	23.0
NZ European	565 035	10 572	14.6	34.9	1.8	18.3	554 697	3918	4.6	43.9	0.05	17.5
Māori	86 205	1743	13.2	26.0	3.0	29.7	87 516	912	4.7	35.2	0.22	25.8
Pacific	36 903	696	7.4	22.4	3.1	43.2	33 123	300	3.4	33.5	0.19	35.0
Asian	92 268	1416	8.0	35.5	1.1	22.6	87 084	312	3.9	38.1	0.06	23.8
Other	27 594	516	16.1	39.2	1.6	23.3	18 546	126	5.8	46.3	0.06	22.7
Smoking												
Missing	22 164	438	13.9	28.5	2.5	22.3	21 522	189	4.8	36.3	0.08	23.2
Ever	315 756	7518	14.9	31.0	2.6	24.9	284 043	2898	4.6	43.0	0.12	23.7
Never	473 553	7059	13.3	37.6	1.6	20.0	477 645	2508	4.8	44.4	0.06	19.1
Deprivation Index 2013												
Missing	573	12	12.5	30.4	3.1	19.4	525	S	7.1	40.6	S	23.4
1–2 (least deprived)	193 449	3474	14.2	43.3	1.2	15.6	186 594	1068	4.8	49.7	0.03	14.6
3–4	182 997	3294	15.2	35.3	1.5	17.5	177 372	1113	4.9	44.4	0.06	16.7
5–6	170 445	3123	13.9	30.7	1.9	20.6	164 541	1173	4.6	40.3	0.06	19.4
7–8	150 600	2784	11.5	27.5	2.4	24.2	145 815	1188	4.2	36.6	0.09	23.4
9–10 (most deprived)	113 406	2325	9.7	22.9	3.1	30.7	108 357	1050	3.7	30.6	0.18	29.3

*Working hours information missing for 20 073 males.
†Working in an occupation in which >50% of workers spent ≥50% of their working time seated.
‡Working in an occupation in which >50% of workers are exposed to noise >90 dBA.
§Working in an occupation in which >10% of the workers undertook night shifts.
¶Working hours information missing for 17 751 females.
S, suppressed (counts under six and associated statistics are suppressed according to IDI protocol).

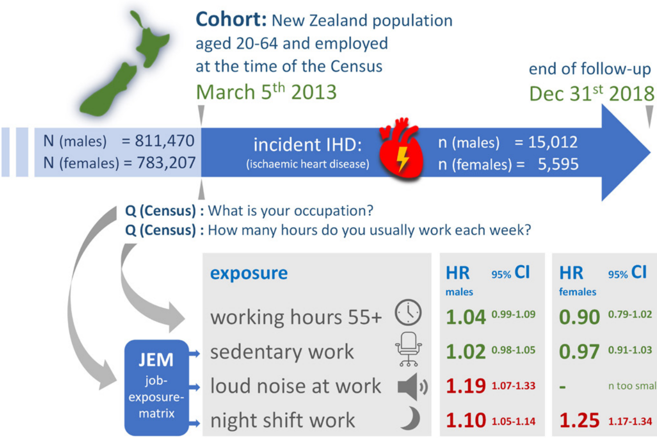

Figure 1 Summary figure of the design and main findings of the study. JEM, job exposure matrix.

RESULTS

Overall, 2 207 385 individuals aged 20–64 years with census information were in the resident population in 2013. For 40 941 individuals, an IHD event occurred before the census and were excluded. Of the remainder, 1 594 677 were employed at the census, and a job code had been assigned (811 470 males and 783 207 females, table 1).

During the follow-up (median 5.8 years) incident IHD occurred for 1.9% of males (n=15 012) and 0.7% of females (n=5595). Most IHD cases were identified through hospital discharge records (81% males; 75% females), and 15% of male cases and 24% of female cases were identified based on pharmaceutical data only. The prevalence of the four exposures was similar across age groups and smoking status (table 1). Māori and Pacific workers had a higher prevalence of working in occupations exposed to loud noise and night shift and a lower prevalence of working in sedentary occupations. Men and women in the least deprived group had a higher prevalence of working in sedentary occupations, whereas the most deprived group had a higher prevalence of working in jobs with exposure to loud noise and night shift.

The demographic characteristics for exposed and unexposed workers for each of the exposures is available in online supplemental table 2.

HRs for the dichotomous variables for each exposure are provided for males and females in figure 1 (and online supplemental tables 3–6). This indicated elevated IHD risks associated with loud noise ($HR_{(males)}$ 1.19; 95% CI 1.07 to 1.33) and night shift work ($HR_{(males)}$ 1.10; 95% CI 1.05 to 1.14; $HR_{(females)}$ 1.25; 95% CI 1.17 to 1.34). The PAF for loud noise (>90 dBA) for males was 0.3%, and the PAFs for night shift for males was 1.8% and 4.6% for females. HRs were adjusted for age, smoking, ethnicity, deprivation and the JEM-assessed occupational exposures. Further adjustment for working hours did not affect the results. Excluding participants aged <45 years made little difference.

HRs for the categorical variables for each exposure are presented in figures 2–5 for males and females and also stratified by deprivation. The full results including analyses adjusted for age only are presented in online supplemental tables 3–6.

Working ≥55 hours/week (13% males, 5% females; figure 2) was associated with an HR of 0.90 (95% CI 0.79 to 1.02) for females and 1.04 (95% CI 0.99 to 1.09) for males. For males, heterogeneity between deprivation groups was observed: for the least deprived males (NZDep1-2) the highest risk was observed for the longest working hours category (55+; HR 1.12; 95% CI 1.02 to 1.23) (NZDep1-2 vs NZDep3-8 $p_{(interaction)}=0.02$), while for the most deprived males (NZDep9-10), the highest risk was observed for the shortest working hours category (<35; HR 1.25; 95% CI 1.11 to 1.40) (NZDep1-2 vs NZDep9-10 $p_{(interaction)}=0.05$). Changing the reference category to 35–40 hours made little difference to the results.

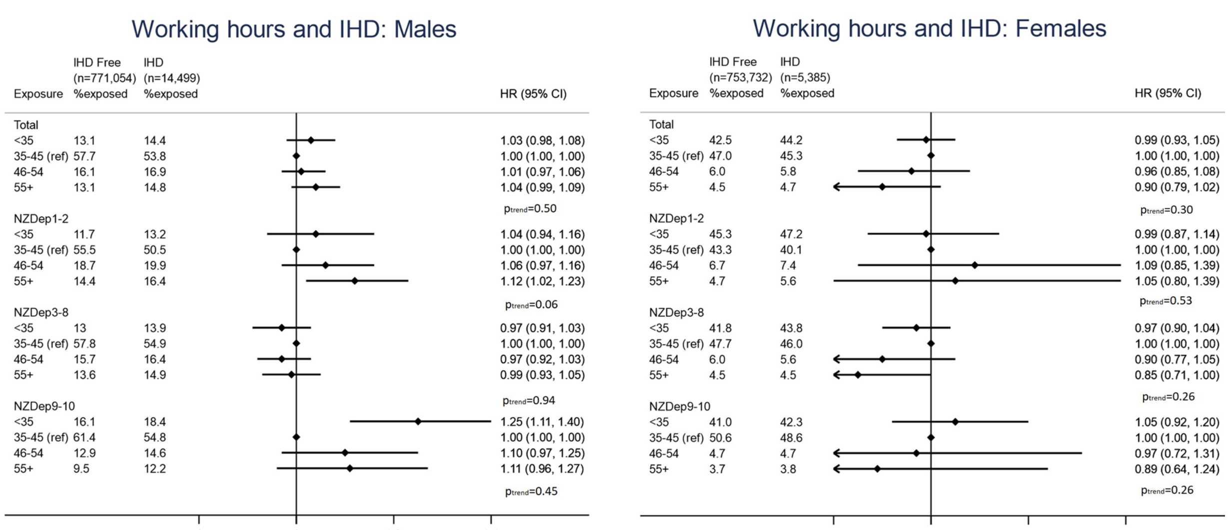

Figure 2 In compliance with the confidentiality requirements for reporting of results from Stats NZ's IDI, all frequencies were rounded to the nearest multiple of 3, and percentages were calculated from the rounded counts. All total numbers exclude individuals with missing information on ethnicity, smoking and deprivation. Model adjusted for age groups, NZDEP, smoking status, ethnicity and exposures (dichotomous for noise, sedentary and night shift). IDI, Integrated Data Infrastructure; IHD, ischaemic heart disease; NZ, New Zealand.

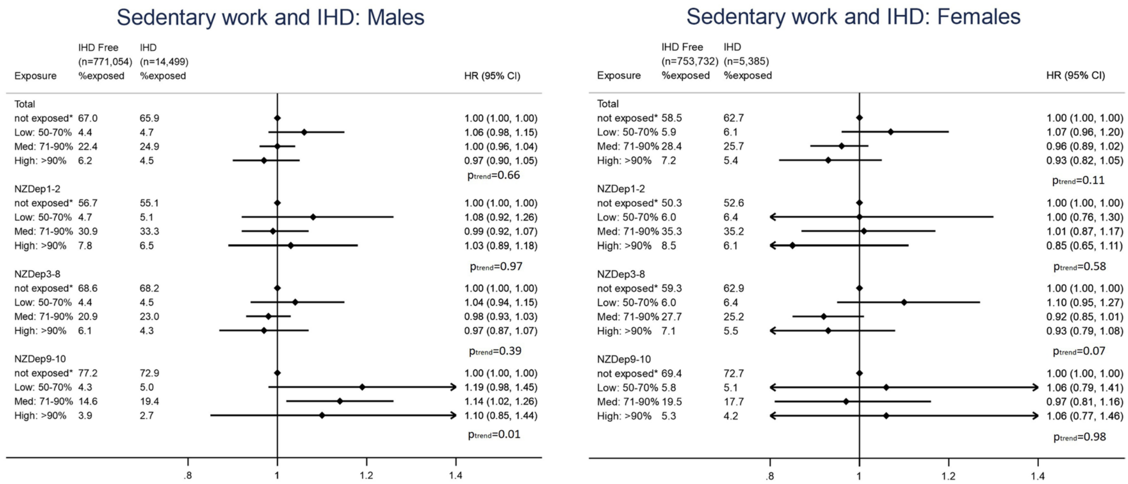

Figure 3 In compliance with the confidentiality requirements for reporting of results from Stats NZ's IDI, all frequencies were rounded to the nearest multiple of 3, and percentages were calculated from the rounded counts. All total numbers exclude individuals with missing information on ethnicity, smoking and deprivation. Model adjusted for age groups, NZDEP, smoking status, ethnicity and exposures (dichotomous for noise and night shift). *Working in an occupation in which <50% of workers spends at least 50% of the time seated. IDI, Integrated Data Infrastructure; IHD, ischaemic heart disease; NZ, New Zealand.

Sedentary occupations were more common for females (41%) than males (33%) (figure 3). There was no significant association between IHD and sedentary work, but for males, heterogeneity in effect between deprivation groups was observed. For males in the least/medium deprived groups, sedentary work was not associated with IHD, while for the most deprived males (NZDep9-10), it was associated with a higher IHD risk (NZDep1-2 vs NZDep9-10 $p_{(interaction)}=0.06$), but this did not increase with a higher proportion of working time spent sitting (HR-low: 1.19; HR-medium: 1.14; HR-high: 1.10) despite the trend being significant ($p_{trend}=0.01$).

Approximately 2% of males and 0.1% of females were exposed to loud noise (>90 dBA) (figure 4). For males, this was associated with a higher risk (HR 1.16; 95% CI 1.04 to 1.30), while risk was not higher for 80–84 dBA (HR 0.94; 95% CI 0.90 to 0.99) or 85–90 dBA (HR 0.97; 95% CI 0.93 to 1.02). The higher risk for exposure >90 dBA was consistent across all deprivation groups. For females, there were too few cases in

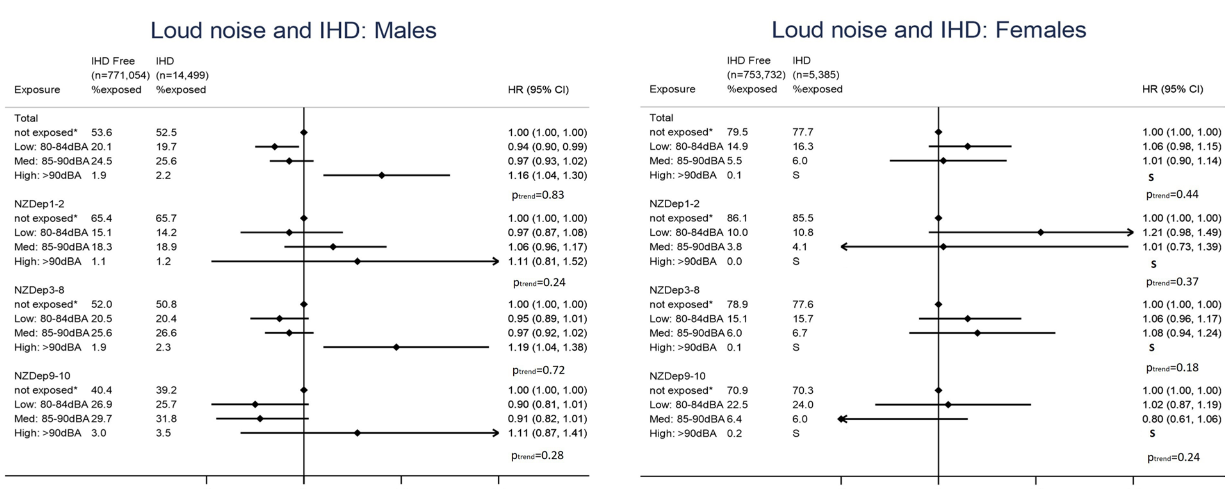

Figure 4 In compliance with the confidentiality requirements for reporting of results from Stats NZ's IDI, all frequencies were rounded to the nearest multiple of 3, and percentages were calculated from the rounded counts. S=suppressed (counts under six and associated statistics are suppressed according to IDI protocol). All total numbers exclude individuals with missing information on ethnicity, smoking and deprivation. Model adjusted for age groups, NZDEP, smoking status, ethnicity and exposures (dichotomous for sedentary and night shift). *Working in an occupation in which <50% of workers are exposed to noise >80 dBA. IDI, Integrated Data Infrastructure; IHD, ischaemic heart disease; NZ, New Zealand.

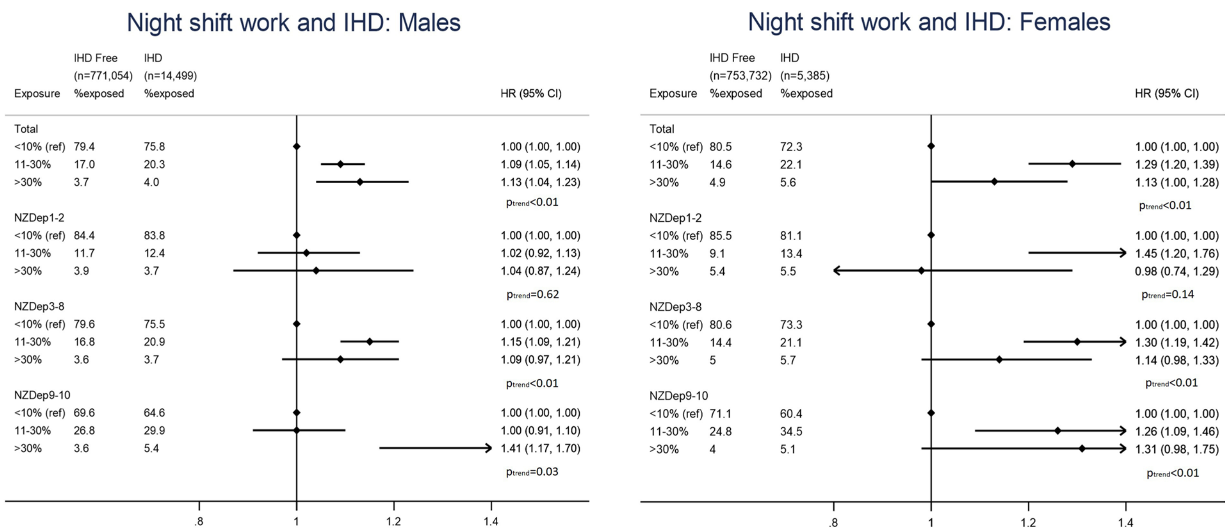

Figure 5 In compliance with the confidentiality requirements for reporting of results from Stats NZ's IDI, all frequencies were rounded to the nearest multiple of 3, and percentages were calculated from the rounded counts. All total numbers exclude individuals with missing information on ethnicity, smoking and deprivation. Model adjusted for age groups, NZDEP, smoking status, ethnicity and exposures (dichotomous for noise and sedentary). IDI, Integrated Data Infrastructure; IHD, ischaemic heart disease; NZ, New Zealand.

the highest exposure category to calculate an HR, and the low/medium categories were not associated with IHD.

Approximately one-fifth of men and women worked in jobs with >10% night shifts. For males, risk was higher with higher proportion exposed (HR-11%–30%: 1.09; 95% CI 1.05 to 1.14; HR->30%: 1.13; 95% CI 1.04 to 1.23) (figure 5). For males, heterogeneity between deprivation groups was observed, with the highest risks observed for the most deprived males (HR->30%: 1.41; 95% CI 1.17 to 1.70) (NZDep1-2 vs NZDep9-10 $p_{(interaction)}=0.02$), while among the least deprived males, risks were not elevated. For females, risks were elevated for the low (HR 1.29; 95% CI 1.20 to 1.39) and the high (HR 1.13; 95% CI 1.00 to 1.28) category of night shift (figure 5). For females, night shifts were associated with a higher IHD risk for all deprivation groups.

DISCUSSION

In this study, night shifts and occupational noise were associated with elevated IHD risks. The use of administrative data has limitations. In particular, we were not able to adjust for general health status at baseline and other potential confounders such as diet, body mass index, physical activity, stress and alcohol. We also did not control for diabetes, hypertension and high cholesterol, as these may be mediators on the causal pathway. In addition, census information on smoking was limited to whether an individual smoked ≥1 cigarette/day. Private hospital information was not available, but public hospital records capture >95% of CVD hospitalisations in NZ.[13] We also had no access to primary healthcare data; however, community dispensings of antiangina medication likely capture at least some IHD cases seen by primary care only. Also, the validity of the IHD definition has not been assessed; the inclusion of drug dispensing may therefore have resulted in measurement error.[15] However, only 15% of male and 24% of female cases were identified from pharmaceutical data only. We had information on occupation at the 2013 census only and whether risks increased with longer exposure duration could therefore not be assessed. Three exposures were assessed using JEMs, which assume everyone in the same occupation to be equally exposed, despite exposure variance within occupations. This cohort is also relatively young with the oldest participants aged 69 years at the end of follow-up, contributing to a relatively low IHD incidence affecting study power, particularly for females. The analysis involved stratification by sex and deprivation, which resulted in many comparisons; however, the difference in expected (based on chance alone) and observed significant findings were considerably greater, with all the multiple testing results for the number of tests significant at $p<0.05$ and $p<0.01$ themselves highly significant (maximum $p<10^{-7}$ for each of the tables/figures presented).

The study has major strengths. It included the entire NZ working population of over 1.5 million people, increasing study power, eliminating participation bias and enabling stratification of results by sex/SES. IHD ascertainment was based on administrative health data rather than self-report, limiting misclassification. Exposure was based on census information collected prior to diagnosis, avoiding differential exposure misclassification and recall bias.

The association with night shifts is consistent with a meta-analysis that reported increases in IHD risk of 10%–30% for shift work and 40% for night shift work.[3] More recent reviews have reported duration–response associations,[4] with some suggestion of non-linear associations after ≥5 years of exposure.[2] Our study found significant associations for males and females, with higher HRs observed in females and across all deprivation groups. The few studies that reported results for both sexes also found a slightly higher risk for females for either night shifts[16] or shift work in general.[17] The US Nurses' Health Study found that coronary heart disease (CHD) risk increased with longer duration of rotating shift work.[18] Studies adjusting for lifestyle factors such as physical activity, diet and alcohol reported attenuated but still elevated HRs, suggesting that associations are not explained by these factors alone.[18] Night shifts disrupt the circadian rhythm leading to dysregulation of sleep–wake cycles, body temperature, energy metabolism, cell cycle and hormone production,[19] which could impact on IHD risk. Night shift work may also have an indirect effect through stress-related factors such as adverse psychosocial working conditions, disruption to work–life balance, insufficient time for recovery outside of work and promotion of unhealthy lifestyles.

Our study did not observe associations between long working hours and IHD. The definition of long hours has varied between studies, and the evidence for an association is inconsistent. A meta-analysis of prospective cohorts reported a smaller RR of 1.13 (95% CI 1.02 to 1.26) for incident CHD.[20] A recent systematic review, including two additional studies, concluded there was 'moderate quality' evidence for the association between working ≥55 hours and IHD with the increased risk limited to those with lower SES.[5] In contrast, we also observed higher risks for males with higher SES, while for the lowest SES males, a higher risk was observed for short working hours (<35 hours), which may indicate that for low SES groups, part-time work is associated with ill-health. The global PAF for IHD deaths for working ≥55 hours has been estimated at 3.7% (5.3% males; 1.9% females).[21] Several cohort studies found an increased risk only for having worked long hours for ≥10 years[22] highlighting the absence of exposure duration as a limitation in our study.

No association between sedentary work and IHD was found, apart from a slightly higher risk for the most deprived males. A systematic review of self-reported occupational sitting and CVD concluded that the evidence was inconclusive.[23] A pooled analysis of British cohorts reported that sitting occupations were not associated with CVD mortality,[24] supported by recent large prospective studies.[7,25] However, prolonged sitting has been associated with cardiometabolic risk factors, and workplace interventions targeting sedentary behaviour have shown improvements in cardiovascular risk factors.[26] Our results suggest workplace interventions may need to target the most deprived groups.

This study found a 19% higher risk for the highest noise exposure (>90 dBA) in males. Loud noise has been consistently linked to high blood pressure,[27] but evidence for a link with CVD is equivocal. A recent meta-analysis reported an RR of 1.29 (95% CI 1.15 to 1.43) for incident IHD but concluded that the evidence is limited.[1] An earlier meta-analysis reported an RR for CVD of 1.34 (95% CI 1.15 to 1.56).[28] Most studies have been conducted in males, but a recent cohort of female paper mill workers found an increased myocardial infarction standardised mortality ratio for noise exposure >90 dBA.[29] This suggests that noise is a risk factor for both males and females, although in our study, the number of women exposed to >90 dBA was too small to calculate an HR. Loud noise may act as a stressor on the autonomic and endocrine systems, potentially resulting in increased heart rate and blood pressure and the secretion of stress hormones including cortisol, adrenalin and noradrenalin.[27]

In conclusion, this study showed an association between night shift work, high levels of noise and higher IHD risk. The impact of night shift work on IHD in NZ may be significant, as suggested by the PAFs of 1.8% for males and 4.6% for females. The study does not support a role for sedentary work or long working hours, although results need to be interpreted with caution due to exposure assessment limitations, in particular the absence of information on exposure duration.

IDI requirements for reporting of results

In compliance with the confidentiality requirements for reporting of results from Stats NZ's IDI, all frequencies were rounded to the nearest multiple of 3, and percentages were calculated from the rounded counts. All statistical tests were performed on the unrounded counts. All counts under six and the HRs derived from these are suppressed according to the confidentiality requirements (marked as 'S' in the tables/figures).

Correction notice This article has been corrected since Online First publication to correct the spelling of author name Hayley J Denison.

Acknowledgements The authors wish to thank members of the Virtual Health Information Network for their advice throughout this project.

Contributors AE (the guarantor) and JD devised the study idea and design. AE conducted the statistical analyses and wrote the manuscript with input from HJD, MC, JD, AtM, and LB. The job exposure matrices were developed with expertise from DM, IL, HJD, AtM and AE. RJ provided advice on the definition of IHD. All authors critically reviewed the manuscript.

Funding The study was funded by the Health Research Council (HRC 16/351).

Disclaimer These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) which is carefully managed by Stats NZ. For more information about the IDI please visit https://www.stats.govt.nz/integrated-data/Access to the data used in this study was provided by Stats NZ under conditions designed to give effect to the security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the author, not Stats NZ or individual data suppliers.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical approval was granted by the NZ Health and Disability Ethics Committees (reference: 16/NTB/173).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. No other data are available due to the confidentiality requirements of the Integrated Data Infrastructure.

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