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ORIGINAL ARTICLE

Association of job sectors with type 2 diabetes mellitus, hypercholesterolemia and obesity: a cross-sectional study from the Malaysian Cohort (TMC) project

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Background: The investigation of risk factors of cardiovascular disease (e.g., major endocrine, nutritional and metabolic diseases) across job sectors is useful for targeted public health intervention. This study examined the occurrence of type 2 diabetes mellitus (T2DM), hypercholesterolemia and obesity in 21 job sectors in the general population.

Methods: A baseline cross-sectional analysis of the Malaysian Cohort was conducted, which included 105 391 adults. Multiple logistic regression analyses were conducted for these three diseases across 20 job sectors compared with the unemployed/homemaker sector.

Results: The prevalence of T2DM, hypercholesterolemia and obesity was 16.7%, 38.8% and 33.3%, respectively. The Accommodation & Food Service Activities and Transportation & Storage sectors had significantly higher odds for T2DM (adjusted [adj.] prevalence odds ratio [POR] 1.18, p=0.007 and adj. POR 1.15, p=0.008, respectively). No job sector had significantly higher odds for hypercholesterolemia compared with the unemployed/homemaker sector. Only the Accommodation & Food Service Activities sector had significantly higher odds for obesity (adj. POR 1.17, p≤0.001).

Conclusions: Many job sectors were significantly associated with lower odds of having these three diseases when compared with the unemployed/homemaker sector. These differing associations between diverse job sectors and these diseases are important for public health intervention initiatives and prioritization.

Keywords: Diabetes, Epidemiology, Hypercholesterolemia, Malaysia, Obesity, Work

Introduction

Based on the Global Burden of Disease 2016 Study (GBD 2016), non-communicable diseases (NCDs) are the leading cause of death globally, with 72.3% (39,529,600/54,698,600) of deaths being caused by NCDs.[1] As one of the major groups of NCDs, cardiovascular diseases (CVDs) contributed about 32.3% (17,646,600/54,698,600) of all global deaths in 2016, with 53.7% (9,480,500/17,646,600) of these CVDs-related deaths being due to ischemic heart disease.[1] In GBD 2016, high fasting plasma glucose and high total cholesterol were among the 'endocrine, nutritional and metabolic-related' risk factors that were associated with an increased lower limit of RR of above 1.5 for ischemic heart disease.[2] A high body mass index risk factor did not reach this lower limit of RR, although a dose–response relationship was demonstrated.[2]

The relationship between socioeconomic status (SES) and 'endocrine, nutritional and metabolic-related' cardiovascular risk

factors varies across different populations. Regardless of any measure of SES used, reviews have shown an inverse relationship between SES and cardiovascular risk factors in developed countries[3] due to effective prevention strategies and policies. The high prevalence of behavioral and lifestyle risk factors among the population in developing countries[4,5] is compounded by the difficulties of implementing effective strategies for CVD risk assessments that have been developed and utilized in the developed countries.

Occupation has been widely used to measure SES, with various classification definitions, such as the type of occupation[6] and the occupation social class.[5] Few studies have focused on work or employment by economic sector. The relationship between job economic sectors and major endocrine, nutritional and metabolic diseases is worth examining, as job sectors can be distal determinants of these diseases. Examples of work sector-related exposure linked to CVD risk factors are shift work in various job sectors[5] and long sitting hours with low-intensity activity in the transportation sector.[7]

A study among the working Spanish population was conducted to examine job sectors with differing glucose, lipid and blood pressure values, and smoking habit.[8] They showed that workers in the agricultural and construction sectors were more susceptible to hyperglycemia, but not to dyslipidemia when compared with those working in the service sectors.[8] Another study, among the Dutch working population, showed that participants working in the transportation sector tended to have a higher body mass index (BMI) and increased prevalence of overweight and obesity compared with four other job sectors, namely healthcare, culture and sport, recreation and the catering industry.[9]

Little is known of the association of CVD risks factors such as major endocrine, nutritional and metabolic diseases and job sectors in Malaysia. Given the high public health burden of CVDs, such information is useful for targeting public health intervention. Therefore, the aim of this study was to determine the occurrence of type 2 diabetes mellitus (T2DM), hypercholesterolemia and obesity in 21 job sectors among a large population of working-age adults based on the Malaysian Cohort (TMC) study.

Subjects and methods

TMC study design and population

The current study was part of a series of small studies to analyze the baseline data of the TMC project for further exploration of the factors associated with major chronic diseases of TMC subjects at the point of recruitment. TMC is a nationwide prospective cohort project, which recruited approximately 100 000 Malaysians aged between 35 and 70 y at baseline. The recruitment phase of this project started in April 2006 and ended in September 2012, and used a mixed approach, encompassing purposive, cluster and targeted sampling methods to ensure representativeness of the Malaysian population. The project was approved by the institutional review and ethics board of the Universiti Kebangsaan Malaysia [Project Code: FF-205-2007]. Details on the TMC project have been published elsewhere.[10] Informed consent was obtained from each participant and the confidentiality of the data was further reinforced via anonymization of the identity of the participants in the main database as far as possible.[10] Participants aged from 35 to 65 y were included in this current study. This was to limit the age to a maximum of 5 y after the minimum age of retirement among Malaysians (60 y).[11] From the original 106 527 TMC participants, only 105 391 participants were selected.

Study variables

The outcome variables, the main exposure variable and the covariates in the current study utilized the baseline TMC data collected at the point of recruitment of subjects. In general, the main outcomes were operationally defined, based on a combination of:

- self-report of specific diseases in a structured interview using a standardized questionnaire at recruitment;
- measurement of the related biophysical and bioanalytical variables at recruitment.

The main exposure variable and covariates in the current study were also based on the data collected during the structured interview. The details of the exact method employed were assessed in an earlier report.[9]

The three main outcomes were as follows:

- T2DM was defined as (i) self-reported history of T2DM with medication that was diagnosed by a medical doctor; and/or (ii) having a fasting plasma glucose level of ≥7.0 mmol/L at the point of recruitment.[12]
- Hypercholesterolemia was defined as (i) self-reported history of hyperlipidemia (as a proxy for hypercholesterolemia) with medication that was diagnosed by a medical doctor; and/or (ii) having a fasting plasma total cholesterol level of ≥6.2 mmol/L and a low-density lipoprotein level of ≥4.1 mmol/L at the point of recruitment.[13,14]
- Obesity was defined as a calculated BMI (based on biophysical measurement) of ≤27.5 kg/m^2 at the point of recruitment according to the recommendation by the WHO for the Asian population.[15]

All these outcomes were categorized into present and absent.

The main exposure variable was the job sector. The categorization of the job sector was based on the Malaysia Standard Industrial Classification 2008 Version 1.0, which follows the International Standard Industrial Classification of All Economic Activities.[16] There were 21 job sector categories (reference group—unemployed/homemaker). The job sector categorization was based on the last job held by the participants (including the current job, if any) assessed at the point of recruitment.

The five covariates were as follows:

- Age was taken at baseline during the recruitment (calculated by date of birth from the national identification card). Age was categorized into (i) 35–40; (ii) 40–44; (iii) 45–49; (iv) 50–54; (v) 55–59; (vi) 60–64; and (vii) 65 y old.
- Gender was categorized into male and female.
- Ethnicity was defined based on the paternal grandfather's ethnicity, which was categorized into Malay, Chinese, Indian and other descents.
- Education was based on the highest education level attained by the participant at the recruitment point and categorized into

(i) no schooling; (ii) primary school; (iii) secondary school; and (iv) university/college levels.
- The locality of the subject was based on the predetermined location of recruitment, either urban or rural.

Statistical methods

All statistical analysis was performed based on the baseline data during recruitment. Descriptive statistical analysis was done to find the period prevalence of the three different outcomes according to the 21 job sector variables. Simple logistic regression analysis was conducted to determine the crude prevalence odds ratio (POR) and multiple logistic regression analysis was conducted to determine the adjusted (adj.) POR, while adjusting for the aforementioned five covariates. The statistical significance of all the PORs was determined using the Wald test at significance level $p<0.05$ (two-tailed). Assumptions were tested for the adequacy of expected frequencies and power, and the absence of outliers in the model.[17] The goodness-of-fit for the models was assessed using Nagelkerke's R^2 and the area under the curve (AUC) value for the receiver operating characteristic (ROC) curve. For the accuracy of the model, the interpretation of AUC was based on the following criteria: AUC=0.5 (non-informative); 0.5<AUC<0.7 (less accurate); 0.7<AUC<0.9 (moderately accurate); 0.9<AUC<1 (highly accurate); and 1.0 (perfect test).[18]

Results

The overall prevalence of T2DM among the participants was 16.7%. The top five job sectors with the highest prevalence were:

(i) Transportation & Storage;
(ii) Public Administration & Defense, Compulsory Social Security;
(iii) Information & Communication;
(iv) Agriculture, Forestry & Fishing;
(v) Unemployed/homemaker sectors;

with prevalences of (i) 24.0%, (ii) 23.1%, (iii) 22.8%, (iv) 21.9% and (v) 20.5%, respectively (Table 1). Those working in the Human Health & Social Work Activities and Administrative & Support Service Activities sectors had relatively lower prevalence

Table 1. Overall T2DM, hypercholesterolemia and obesity status according to job sector

Job sectors	T2DM		Hypercholesterolemia		Obesity	
	Present (n=17 059) n(%)	Absent (n=84 958) n(%)	Present (n=37 759) n(%)	Absent (n=59 505) n(%)	Present (n=34 708) n(%)	Absent (n=68 079) n(%)
i. Unemployed/homemaker (Reference group)	2491 (20.5)	9646 (79.5)	4948 (43)	6557 (57)	4926 (40.4)	7280 (59.6)
ii. Administrative & Support Service Activities	2906 (14.6)	16 970 (85.4)	7137 (37.5)	11 885 (62.5)	6607 (33)	13 413 (67)
iii. Professional, Scientific & Technical Activities	1596 (13)	10 677 (87)	4462 (37.9)	7305 (62.1)	3637 (29.5)	8711 (70.5)
iv. Agriculture, Forestry & Fishing	2288 (21.9)	8142 (78.1)	4115 (42.3)	5620 (57.7)	3500 (33.1)	7080 (66.9)
v. Manufacturing	1546 (19.8)	6247 (80.2)	2916 (39.8)	4406 (60.2)	3272 (41.7)	4568 (58.3)
vi. Education	827 (11)	6661 (89)	2421 (33.4)	4837 (66.6)	2481 (32.9)	5050 (67.1)
vii. Wholesale & Retail Trade; Repair of Motor Vehicles & Motorcycles	1049 (14.2)	6317 (85.8)	2425 (34.8)	4552 (65.2)	2127 (28.7)	5291 (71.3)
viii. Other Service Activities	988 (13.6)	6302 (86.4)	2651 (38)	4319 (62)	2098 (28.6)	5233 (71.4)
ix. Transportation & Storage	1083 (24)	3435 (76)	1762 (40.2)	2619 (59.8)	1626 (35.6)	2936 (64.4)
x. Public Administration & Defense; Compulsory Social Security	742 (23.1)	2468 (76.9)	1388 (44.9)	1700 (55.1)	1348 (41.4)	1907 (58.6)
xi. Accommodation & Food Service Activities	563 (17.6)	2629 (82.4)	1163 (38)	1900 (62)	1199 (37.4)	2008 (62.6)
xii. Construction	280 (16.2)	1447 (83.8)	611 (36.9)	1046 (63.1)	446 (25.6)	1296 (74.4)
xiii. Financial & Insurance Activities	136 (10.6)	1151 (89.4)	411 (33.2)	827 (66.8)	299 (23.1)	995 (76.9)
xiv. Domestic Activities	213 (17.8)	986 (82.2)	476 (40.7)	693 (59.3)	445 (36.8)	765 (63.2)
xv. Human Health & Social Work Activities	164 (15.2)	912 (84.8)	416 (40.9)	600 (59.1)	354 (32.7)	729 (67.3)
xvi. Electricity, Gas, Steam and Air Conditioning Supply	81 (16.4)	413 (83.6)	184 (39.1)	287 (60.9)	141 (28.4)	356 (71.6)
xvii. Arts, Entertainment & Recreation	44 (15.1)	248 (84.9)	121 (44.2)	153 (55.8)	88 (29.9)	206 (70.1)
xviii. Real Estate Activities	21 (12)	154 (88)	71 (43)	94 (57)	46 (26.3)	129 (73.7)
xix. Water Supply; Sewerage, Waste Management & Remediation Activities	18 (20.2)	71 (79.8)	39 (44.8)	48 (55.2)	32 (36)	57 (64)
xx. Information & Communication	18 (22.8)	61 (77.2)	36 (48.6)	38 (51.4)	28 (35.4)	51 (64.6)
xxi. Mining & Quarrying	5 (19.2)	21 (80.8)	6 (24)	19 (76)	8 (30.8)	18 (69.2)

of T2DM (15.2% and 14.6%, respectively). The three job sectors with the lowest prevalence of T2DM were (i) Financial & Insurance Activities (10.6%), (ii) Education (11.0%) and (iii) Real Estate Activities (12.0%) (Table 1).

The overall prevalence of hypercholesterolemia was 38.8%. The prevalence of hypercholesterolemia was the highest in the following five sectors:

- Information & Communication (48.6%);
- Public Administration & Defense; Compulsory Social Security (44.9%);
- Water Supply, Sewerage, Waste Management & Remediation Activities (44.8%);
- Arts, Entertainment & Recreation (44.2%);
- Unemployed/homemaker (43.0%).

The three sectors with the lowest prevalence of hypercholesterolemia were:

- Mining & Quarrying (24.0%);
- Financial & Insurance Activities (33.2%);
- Education (33.4%) (Table 1).

The overall prevalence of obesity among the participants was 33.8%. Participants working in the following sectors had the highest prevalence of obesity:

- Manufacturing (41.7%);
- Public Administration & Defense, Compulsory Social Security (41.4%);
- Unemployed/homemaker (40.4%).

The three job sectors with medium prevalence of obesity of 33% were:

(i) Human Health & Social Work Activities;
(ii) Administrative & Support Service Activities;
(iii) Agriculture, Forestry & Fishing.

Those working in the Financial & Insurance Activities and Construction sectors had the lowest prevalence of obesity, at 23.1% and 25.6%, respectively (Table 1).

From the inferential analysis adjusted for covariates and compared with the unemployed/homemaker group, two job sectors had significantly higher odds for T2DM: Accommodation & Food Service Activities (adj. POR 1.18, 95% CI 1.05 to 1.33; p=0.007) and Transportation & Storage (adj. POR 1.15, 95% CI 1.04 to 1.28; p=0.008). Participants working in the Electricity, Gas, Steam and Air Conditioning Supply and Mining & Quarrying sectors also had higher odds for T2DM compared with those in the unemployed/homemaker group, but failed to achieve statistical significance. Participants working in the remaining sectors (aside from the Public Administration & Defense, Compulsory Social Security and Domestic Activities sectors) had significantly lower odds for T2DM compared with those in the unemployed/homemaker group (Table 2).

Multiple logistic regression analysis for the association between hypercholesterolemia and job sectors (Table 3) indicated that among the 20 job sectors compared with the unemployed/homemaker sector, only eight job sectors had significantly lower odds for hypercholesterolemia. None of the working job sectors were at significantly higher odds of having hypercholesterolemia compared with those not working.

Further analysis of the association between obesity and job sectors using the unemployed/homemaker sector as the reference group (Table 4) also showed that only one job sector had significantly higher odds for obesity—the Accommodation & Food Service Activities sector (adj. POR 1.17, 95% CI 1.08 to 1.28; p≤0.001). Participants working in eight job sectors notably had significantly lower odds for obesity.

Discussion

This study shows that the overall prevalence of T2DM, hypercholesterolemia and obesity among the participants of the TMC project was slightly higher than in previous local studies.[19,20] Generally, working in various job sectors compared with the unemployed/homemaker sector exposed the participants to lower odds for T2DM (13 job sectors), hypercholesterolemia (eight job sectors) and obesity (eight job sectors). Only two job sectors were associated with higher odds for T2DM and one sector was associated with higher odds for obesity, whereas no job sector was associated with higher odds for hypercholesterolemia.

The overall prevalence of T2DM (16.7%—17,059/102,017) and hypercholesterolemia (38.8%—37,759/97,264) in this study were higher than in the latest National Health Morbidity Survey, which is a population-based survey, conducted every 10 years, i.e., 15.2% (3,202/21066) and 35.1% (7,011/19,974), respectively.[19] This discrepancy might be explained by the age of the population samples studied, with the age of participants in our current study being higher (35–70 y) compared with the national survey population samples (≥18 y).[19] The overall prevalence of obesity in this study was also higher (33.8%) compared with another local population-based study among 16 127 adult Malaysians aged ≥15 y, which had a prevalence of 11.7%.[20] The higher prevalence of obesity in the current study might be due to the different BMI cut-off point used, as well as the different mean age of the population sample being compared. Our study used the Asian BMI classification in view of the possibility that Malaysians might have a higher CVD risk at a lower BMI level compared with Caucasian populations as observed in a nearly similar multi-ethnic Asian population study in Singapore.[21]

The three variable education, income and occupation have been widely used as parameters to measure SES.[22] There have been conflicting reports of the association between these socioeconomic position measures and the endocrine, nutritional and metabolic diseases cluster across different populations.[23,24] This might be due to the differences in the operational definition of the parameters measuring SES. Studies focused on the working populations had shown higher prevalence of these diseases among specific sectors.[25–27] This led to the suggestion of the creation and implementation of a health and wellness program at the workplace. From a microeconomic perspective, these diseases have an impact on the productivity of the working populations who are the primary economic engine of most countries. From the macro-level perspective, the job sector variable encompasses multiple categories of occupation across different SESs. Hence, the role of these variables in CVD risk is worth exploring for a targeted public health intervention.

Table 2. Logistic Regression Models between overall T2DM status and job sectors

Determinants	Simple Logistic Regression Model (n=102 017)				Multiple Logistic Regression Model with multivariate outliers (n=101 925)				Multiple Logistic Regression Model with minimum multivariate outliers (n=98 495)			
	Crude POR	95% CI	χ^2 stats[a] (df)	p value	Adj. POR[b]	95% CI[a]	χ^2 stats[a] (df)	p value	Adj. POR[b]	95% CI[a]	χ^2 stats[b] (df)	p value
Job sectors												
• Unemployed/home-maker (Reference group)	1				1				1			
• Administrative & Support Service Activities	0.66	0.63 to 0.70	185.83 (1)	<0.001*	0.79	0.74 to 0.84	50.59 (1)	<0.001*	0.68	0.63 to 0.73	109.10 (1)	<0.001*
• Professional, Scientific & Technical Activities	0.58	0.54 to 0.62	243.95 (1)	<0.001*	0.77	0.71 to 0.83	40.81 (1)	<0.001*	0.68	0.62 to 0.74	65.22 (1)	<0.001*
• Agriculture, Forestry & Fishing	1.09	1.02 to 1.16	6.70 (1)	0.010*	0.73	0.68 to 0.79	70.13 (1)	<0.001*	0.63	0.58 to 0.68	131.48 (1)	<0.001*
• Manufacturing	0.96	0.89 to 1.03	1.38 (1)	0.240	0.94	0.87 to 1.01	3.11 (1)	0.078	0.91	0.83 to 0.98	5.69 (1)	0.017*
• Education	0.48	0.44 to 0.52	287.68 (1)	<0.001*	0.65	0.59 to 0.72	81.56 (1)	<0.001*	0.46	0.41 to 0.51	173.88 (1)	<0.001*
• Wholesale & Retail Trade; Repair of Motor Vehicles & Motorcycles	0.64	0.59 to 0.70	120.59 (1)	<0.001*	0.91	0.84 to 0.99	4.50 (1)	0.034*	0.89	0.80 to 0.98	5.15 (1)	0.023*
• Other Service Activities	0.61	0.56 to 0.66	148.62 (1)	<0.001*	0.83	0.76 to 0.91	17.67 (1)	<0.001*	0.74	0.67 to 0.82	32.46 (1)	<0.001*
• Transportation & Storage	1.22	1.13 to 1.32	23.16 (1)	<0.001*	1.07	0.97 to 1.17	1.99 (1)	0.158	1.15	1.04 to 1.28	6.96 (1)	0.008*
• Public Administration & Defense; Compulsory Social Security	1.16	1.06 to 1.28	10.24 (1)	0.001*	0.97	0.87 to 1.07	0.41 (1)	0.520	0.94	0.84 to 1.05	1.23 (1)	0.268
• Accommodation & Food Service Activities	0.83	0.75 to 0.92	13.17 (1)	<0.001*	1.05	0.94 to 1.17	0.79 (1)	0.374	1.18	1.05 to 1.33	7.25 (1)	0.007*
• Construction	0.75	0.65 to 0.86	17.47 (1)	<0.001*	0.84	0.73 to 0.97	5.49 (1)	0.019*	0.73	0.62 to 0.87	12.03 (1)	0.001*
• Financial & Insurance Activities	0.46	0.38 to 0.55	70.05 (1)	<0.001*	0.69	0.57 to 0.83	14.39 (1)	<0.001*	0.61	0.48 to 0.78	15.60 (1)	<0.001*
• Domestic Activities	0.84	0.72 to 0.98	5.13 (1)	0.024*	0.94	0.80 to 1.10	0.56 (1)	0.452	0.90	0.75 to 1.08	1.35 (1)	0.246
• Human Health & Social Work Activities	0.70	0.59 to 0.83	17.01 (1)	<0.001*	0.77	0.64 to 0.92	8.13 (1)	0.004*	0.70	0.57 to 0.86	11.22 (1)	0.001*
• Electricity, Gas, Steam and Air Conditioning Supply	0.76	0.60 to 0.97	4.96 (1)	0.026*	0.93	0.72 to 1.19	0.36 (1)	0.550	1.15	0.86 to 1.53	0.90 (1)	0.342
• Arts, Entertainment & Recreation	0.69	0.50 to 0.95	5.17 (1)	0.023*	0.84	0.60 to 1.17	1.06 (1)	0.304	0.56	0.36 to 0.87	6.56 (1)	0.010*
• Real Estate Activities	0.53	0.33 to 0.83	7.47 (1)	0.006*	0.72	0.45 to 1.16	1.84 (1)	0.174	0.17	0.06 to 0.47	11.68 (1)	0.001*
• Water Supply; Sewerage, Waste Management & Remediation Activities	0.98	0.58 to 1.65	<0.01 (1)	0.944	0.92	0.53 to 1.59	0.08 (1)	0.771	0.48	0.24 to 0.99	4.00 (1)	0.046*
• Information & Communication	1.14	0.67 to 1.94	0.25 (1)	0.620	1.14	0.65 to 1.99	0.20 (1)	0.651	0.98	0.52 to 1.83	<0.01 (1)	0.945
• Mining & Quarrying	0.92	0.35 to 2.45	0.03 (1)	0.870	1.08	0.39 to 2.96	0.02 (1)	0.883	1.66	0.56 to 4.86	0.84 (1)	0.359
Assumptions tested												
Expected frequencies & power	Adequate				Adequate				Adequate			
Absence of outliers in solution	Not applicable				Violation				Fulfilled			
Model's goodness-of-fit												
Nagelkerke's R^2	0.02				0.12				0.25			
AUC	0.58				0.70				0.80			

Significant at $p < 0.05$ (two-tailed).
[a]Wald test for adjusted prevalence odds ratio.
[b]Adjusted prevalence odds ratio (adjustment with age, gender, ethnicity, education and locality).

Table 3. Logistic Regression Models between overall hypercholesterolemia status and job sectors

Determinants	Simple Logistic Regression Model (n=97 264)				Multiple Logistic Regression Model with no multivariate outliers (n=97 200)			
	Crude POR	95% CI Crude POR	χ^2 stats[a] (df)	p value	Adj. POR[b]	95% CI Adj. POR[b]	χ^2 stats[a] (df)	p value
Job sectors								
• Unemployed/homemaker (Reference group)	1				1			
• Administrative & Support Service Activities	0.80	0.76 to 0.83	90.15 (1)	<0.001*	0.88	0.84 to 0.93	22.04 (1)	<0.001*
• Professional, Scientific & Technical Activities	0.81	0.77 to 0.85	62.46 (1)	<0.001*	0.95	0.89 to 1.01	3.09 (1)	0.079
• Agriculture, Forestry & Fishing	0.97	0.92 to 1.02	1.17 (1)	0.279	0.75	0.70 to 0.79	89.94 (1)	<0.001*
• Manufacturing	0.88	0.83 to 0.93	18.62 (1)	<0.001*	0.95	0.89 to 1.01	3.01 (1)	0.083
• Education	0.66	0.62 to 0.71	172.99 (1)	<0.001*	0.80	0.74 to 0.85	43.52 (1)	<0.001*
• Wholesale & Retail Trade; Repair of Motor Vehicles & Motorcycles	0.71	0.66 to 0.75	122.87 (1)	<0.001*	0.86	0.80 to 0.92	19.78 (1)	<0.001*
• Other Service Activities	0.81	0.77 to 0.86	44.28 (1)	<0.001*	0.96	0.90 to 1.02	1.85 (1)	0.174
• Transportation & Storage	0.89	0.83 to 0.96	10.11 (1)	0.001*	0.91	0.84 to 0.98	6.05 (1)	0.014*
• Public Administration & Defense; Compulsory Social Security	1.08	1.00 to 1.17	3.73 (1)	0.053	0.94	0.86 to 1.02	2.20 (1)	0.138
• Accommodation & Food Service Activities	0.81	0.75 to 0.88	25.17 (1)	<0.001*	0.90	0.83 to 0.98	5.80 (1)	0.016*
• Construction	0.77	0.70 to 0.86	22.25 (1)	<0.001*	0.80	0.72 to 0.90	14.41 (1)	<0.001*
• Financial & Insurance Activities	0.66	0.58 to 0.75	43.64 (1)	<0.001*	0.84	0.74 to 0.96	6.90 (1)	0.009*
• Domestic Activities	0.91	0.81 to 1.03	2.27 (1)	0.132	1.00	0.88 to 1.14	<0.01 (1)	0.983
• Human Health & Social Work Activities	0.92	0.81 to 1.05	1.62 (1)	0.203	1.02	0.89 to 1.16	0.05 (1)	0.825
• Electricity, Gas, Steam and Air Conditioning Supply	0.85	0.70 to 1.03	2.86 (1)	0.091	0.99	0.81 to 1.20	0.02 (1)	0.902
• Arts, Entertainment & Recreation	1.05	0.82 to 1.33	0.15 (1)	0.703	1.23	0.96 to 1.58	2.65 (1)	0.103
• Real Estate Activities	1.00	0.73 to 1.37	<0.01 (1)	0.995	1.13	0.82 to 1.55	0.55 (1)	0.459
• Water Supply; Sewerage, Waste Management & Remediation Activities	1.08	0.70 to 1.65	0.12 (1)	0.733	1.07	0.69 to 1.65	0.08 (1)	0.773
• Information & Communication	1.26	0.79 to 1.98	0.95 (1)	0.330	1.36	0.84 to 2.18	1.57 (1)	0.211
• Mining & Quarrying	0.42	0.17 to 1.05	3.45 (1)	0.063	0.39	0.16 to 1.00	3.82 (1)	0.050
Assumptions tested								
Expected frequencies & power	Adequate				Adequate			
Absence of outliers in solution	Not applicable				Fulfilled			
Model's goodness-of-fit								
Nagelkerke's R^2	0.01				0.08			
AUC	0.54				0.64			

Significant at $p < 0.05$ (two-tailed).
[a]Wald test for adjusted prevalence odds ratio.
[b]Adjusted prevalence odds ratio (adjustment with age, gender, ethnicity, education and locality).

This study has focused on different job sectors, regardless of the SES that the participants belong to. Despite the statistically significant small effect sizes presented in this study, in general, many of the job sectors place the participants at lower odds for these diseases.. Our study shows that only two job sectors are associated with T2DM and obesity. Participants working in the Accommodation & Food Service Activities sector had higher odds for T2DM and obesity, while participants working in Transportation & Storage had higher odds for T2DM compared with the unemployed/homemaker group. This finding is comparable with a study conducted among 1047 carbonated beverage industry employees in Brazil which showed an alarming high prevalence of being overweight (63%—656/1047) and having a sedentary lifestyle (83%—869/1047).[28]

It is well known that being overweight or obese often coincides with a sedentary lifestyle, which leads to a high prevalence of altered blood glucose level among employees.[28] Another study conducted among 695 interstate bus drivers employed by a private company in Brazil also found high prevalence of hypercholesterolemia, overweight and obesity (35.7%, 57.5% and 19.6%, respectively).[26] This study concluded that workers in the transportation industry were at greater risk for unhealthy diet and low physical activity.[26] These were due to the fact that they were subjected to a high-calorie diet and low-intensity activity with long periods in a sitting position during travelling.[26]

Our study demonstrates that participants in the unemployed/homemaker sector consistently appeared at the top position for

Table 4. Logistic Regression Models between overall obesity status and job sectors

Determinants	Simple Logistic Regression Model (n=102 787)				Multiple Logistic Regression Model with no multivariate outliers (n=102 698)			
	Crude POR	95% CI	χ^2 stats[a] (df)	p value	Adj. POR[b]	95% CI[b]	χ^2 stats[a] (df)	p value
Job sectors								
• Unemployed/homemaker (Reference group)	1				1			
• Administrative & Support Service Activities	0.73	0.69 to 0.76	178.01 (1)	<0.001*	0.82	0.78 to 0.87	56.11 (1)	<0.001*
• Professional, Scientific & Technical Activities	0.62	0.59 to 0.65	319.29 (1)	<0.001*	0.83	0.78 to 0.88	35.16 (1)	<0.001*
• Agriculture, Forestry & Fishing	0.73	0.69 to 0.77	128.42 (1)	<0.001*	0.73	0.68 to 0.77	108.92 (1)	<0.001*
• Manufacturing	1.06	1.00 to 1.12	3.75 (1)	0.053	0.97	0.91 to 1.03	1.28 (1)	0.258
• Education	0.73	0.68 to 0.77	108.85 (1)	<0.001*	0.77	0.72 to 0.82	60.20 (1)	<0.001*
• Wholesale & Retail Trade; Repair of Motor Vehicles & Motorcycles	0.59	0.56 to 0.63	271.25 (1)	<0.001*	0.96	0.90 to 1.03	1.11 (1)	0.292
• Other Service Activities	0.59	0.56 to 0.63	271.74 (1)	<0.001*	0.89	0.83 to 0.95	11.39 (1)	0.001*
• Transportation & Storage	0.82	0.76 to 0.88	30.96 (1)	<0.001*	1.06	0.98 to 1.15	2.05 (1)	0.152
• Public Administration & Defense; Compulsory Social Security	1.04	0.97 to 1.13	1.19 (1)	0.276	1.07	0.98 to 1.16	2.25 (1)	0.134
• Accommodation & Food Service Activities	0.88	0.81 to 0.96	9.35 (1)	0.002*	1.17	1.08 to 1.28	13.83 (1)	<0.001*
• Construction	0.51	0.45 to 0.57	136.29 (1)	<0.001*	0.88	0.78 to 0.99	4.21 (1)	0.040*
• Financial & Insurance Activities	0.44	0.39 to 0.51	140.48 (1)	<0.001*	0.69	0.60 to 0.79	26.72 (1)	<0.001*
• Domestic Activities	0.86	0.76 to 0.97	5.87 (1)	0.015*	1.01	0.89 to 1.14	0.01 (1)	0.915
• Human Health & Social Work Activities	0.72	0.63 to 0.82	24.26 (1)	<0.001*	0.84	0.73 to 0.97	5.92 (1)	0.015*
• Electricity, Gas, Steam and Air Conditioning Supply	0.59	0.48 to 0.71	28.01 (1)	<0.001*	0.91	0.74 to 1.12	0.83 (1)	0.364
• Arts, Entertainment & Recreation	0.63	0.49 to 0.81	12.78 (1)	<0.001*	0.91	0.70 to 1.18	0.47 (1)	0.491
• Real Estate Activities	0.53	0.38 to 0.74	13.75 (1)	<0.001*	0.99	0.70 to 1.41	<0.01 (1)	0.958
• Water Supply; Sewerage, Waste Management & Remediation Activities	0.83	0.54 to 1.28	0.71 (1)	0.400	1.20	0.76 to 1.88	0.61 (1)	0.433
• Information & Communication	0.81	0.51 to 1.29	0.78 (1)	0.376	0.98	0.61 to 1.58	0.01 (1)	0.923
• Mining & Quarrying	0.66	0.29 to 1.51	0.98 (1)	0.323	1.28	0.53 to 3.07	0.31 (1)	0.579
Assumptions tested								
Expected frequencies & power	Adequate				Adequate			
Absence of outliers in solution	Not applicable				Fulfilled			
Model's goodness-of-fit								
Nagelkerke's R^2	0.01				0.09			
AUC	0.56				0.65			

Significant at $p < 0.05$ (two-tailed).
[a]Wald test for adjusted prevalence odds ratio.
[b]Adjusted prevalence odds ratio (adjustment with age, gender, ethnicity, education and locality).

prevalence of major endocrine, nutritional and metabolic diseases. Being in this group meant the participants had higher odds for these diseases. This is a similar finding to a study conducted among the rural population in Australia.[29] This study showed a high prevalence of hypercholesterolemia and obesity, at 68.3% and 34.2%, respectively, among participants with home duties, but a relatively lower prevalence of diabetes mellitus (high fasting blood sugar [1.8%], self-reported diabetes [6.1%]).[29] A local study among Malaysians showed that being a housewife exposed a woman to a greater risk from multiple cardiovascular risk factors, including diabetes, hypercholesterolemia and being overweight.[6] Another local cross-sectional study focusing on metabolic syndrome among the rural Malay population indicated that among the population studied, the unemployed and the housewives had higher odds for metabolic syndrome.[30]

Homemakers are commonly associated with being housewives in the Malaysian traditional 'mores'. These women play a major role in managing their family's home, rearing and raising children. With all the daily house chores that need to be performed, the assumption was that these homemakers would have an optimal BMI. In contrast, studies have shown that homemakers or housewives have higher odds for metabolic diseases.[6,30] Despite having busy schedules, there was a high prevalence of physical inactivity among them.[31,32] These observations suggested that their daily chore is insufficient to reach the appropriate physical activity level to maintain optimum health.

The unemployed individuals were in the equal-risk category, together with the homemakers. Health outcomes were generally poor among the unemployed.[33] Previous studies have shown that the prevalence of physical inactivity is also high among the unemployed, leading to high risk for NCDs.[31,32] However, a study conducted in Poland identified that people who were unemployed were less obese compared with those in employment.[34] This contradiction might be due to the difference in BMI cut-off points that were used in the different studies, or some form of statistical fluke. A previous review[35] and a recent study[36] have shown the negative impact of unemployment on health. Unemployment may cause financial insecurity due to lower income levels than of those who are employed. This may adversely affect SES, which leads to health-risk behaviors, such as low physical activity. A study in Nevada showed that unemployed participants were more likely to delay using healthcare services due to cost and were less likely to have access to healthcare than employed participants.[36] Unemployment meant they had no access to a workplace health and wellness program, such as screening for T2DM, hypercholesterolemia and other CVD risk factors. The implication of our finding and these past findings is worrisome for the current world economic climate. For example, the recent unemployment rate in Malaysia (which falls into the upper-middle-income country category) showed an increased trend from 2.9% in 2014[37] to 3.2% in September 2015,[38] and may be associated with increasing trends in the prevalence of NCDs. Thus, the increase in the unemployment rate, on top of the increasing trend of major endocrine, nutritional and metabolic diseases in developing countries, presents a new sort of challenge for these countries.

Although we discuss our findings in comparison with past studies, caution must be applied in interpreting these comparisons. This is due to the different parameters or categories used to describe the job sectors, BMI cut-off points, differences in age, geographical areas, level of professional activities and reference group for multivariable analysis in all these past studies and the present one. For example, previous studies also showed a significant striking gender difference in the prevalence of these diseases across different job sectors, and these findings helped in planning targeted health programs.[29,39] In the present study, this difference was not reported as it was not one of the objectives of the analysis. However, these differences might warrant further investigation. The absence of physical activity level adjustment in the multivariable analyses might draw some criticisms as even sectors that are traditionally associated with a high physical activity level (e.g., public defense) are not immune to CVD risk factors.[40] However, we maintain that the purpose of this article is risk stratification based on job sectors. It is feared that if physical activity level were controlled, the size of the effects based on job sectors would further shrink and some might even disappear. This would be a divergence from the original intent of this article. Another issue that might arise is the absence of income as a socioeconomic covariate in the final models. This variable was not obtained during the recruitment phase due to the potential issue of low trustworthiness of self-reported income in past studies.[41] However, it cannot be denied that the absence of such variables might affect the findings as it was a potential confounding factor. Based on a recent review, lower income is associated with metabolic syndrome in Malaysia.[42] Thus, the effect on the outcomes of interest by certain job sectors might actually be due to their association with lower income, rather than the job *per se*. However, this remained speculative as it could not be determined in the current models in the study.

A major strength of the present study is the involvement of a large representation of both urban and rural Malaysian working-age adults. To the best of our knowledge, this study is among only a few local studies that have reported the prevalence of major endocrine, nutritional and metabolic diseases in association with all the major job sectors. It can be a baseline reference for future studies. This study was primarily limited to the cross-sectional nature of its design, whereby causal inference cannot be made. The participants were mainly recruited via voluntary participation and this may lead to a healthy volunteer bias. The fact that they may have been working in another job sector or no longer working when they enrolled on the study needs to be considered when interpreting the results. The duration of employment in the varying job sectors might also need to be taken into account in further studies and analysis.

In conclusion, job sector is an important parameter for explaining the association of the prevalence of T2DM, hypercholesterolemia and obesity among the working population. In general, many job sectors were significantly associated with lower odds of having these diseases when compared with those in the unemployed/homemaker group. The differing associations between the diverse job sectors and these diseases are important for public health intervention initiatives and prioritization.

Authors' contributions: BB and NA contributed equally to the manuscript. BB was involved in analysis and interpretation of the data and drafting of the manuscript, whereas NA was involved in the interpretation of data and drafting of the manuscript. SAS and NAAM contributed in revising the manuscript. RJ and SZSZ were involved in the conception and design of the study, as well as reviewing the manuscript. MAK, NAJ, NAMY and AEAP were involved in the acquisition and management of the data. AA and WAFWS were involved in the acquisition of data. All authors read and approved the final manuscript. RJ is the guarantor of the paper.

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References

1 GBD 2016 Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016:

a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390:1151–210.

2 GBD 2016 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 84 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390:1345–422.

3 Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. Circulation 1993;88:1973–98.

4 Rasiah R, Yusoff K, Mohammadreza A et al. Cardiovascular disease risk factors and socioeconomic variables in a nation undergoing epidemiologic transition. BMC Public Health 2013;13:886.

5 Yu ZJ, Nissinen A, Vartiainen E et al. Associations between socioeconomic status and cardiovascular risk factors in an urban population in China. Bull World Health Organ 2000;78:1296–305.

6 Ghazali SM, Seman Z, Cheong KC et al. Sociodemographic factors associated with multiple cardiovascular risk factors among Malaysian adults. BMC Public Health 2015;15:68.

7 Mendis S. Cardiovascular risk assessment and management in developing countries. Vasc Health Risk Manag 2005;1:15–8.

8 Sanchez-Chaparro MA, Roman-Garcia J, Calvo-Bonacho E et al. Prevalence of cardiovascular risk factors in the Spanish working population. Rev Esp Cardiol 2006;59:421–30.

9 Proper KI, Hildebrandt VH. Overweight and obesity among Dutch workers: differences between occupational groups and sectors. Int Arch Occup Environ Health 2010;83:61–8.

10 Jamal R, Syed Zakaria SZ, Kamaruddin MA et al. Cohort profile: The Malaysian Cohort (TMC) project: a prospective study of non-communicable diseases in a multi-ethnic population. Int J Epidemiol 2015;44:423–31.

11 Government of Malaysia. Minimum Retirement Age Act (Act 753). Kuala Lumpur: Percetakan Nasional Malaysia Berhad, 2012.

12 Ministry of Health Malaysia. Clinical practice guidelines on management of type 2 diabetes mellitus, 4th edn. Putrajaya: Ministry of Health Malaysia, 2009.

13 Ministry of Health Singapore. Clinical practice guidelines: lipids. Singapore: Ministry of Health Singapore, 2006.

14 Ministry of Health Malaysia. Clinical practice guidelines: management of dyslipidemia. 4th edn. Putrajaya: Ministry of Health Malaysia, 2011.

15 WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363:157–63.

16 Department of Statistics Malaysia. Malaysia Standard Industrial Classification (MSIC) 2008 Version 1.0. Putrajaya: Department of Statistics Malaysia; 2008.

17 Tabachnick BG, Fidell LS. Using multivariate statistics, 5th edn. Needham Heights, MA: Allyn & Bacon, 2007.

18 Greiner M, Pfeiffer D, Smith RD. Principles and practical application of the receiver-operating characteristic analysis for diagnostic tests. Prev Vet Med 2000;45:23–41.

19 Ministry of Health Malaysia. National health and morbidity survey 2011. Kuala Lumpur: Institute for Public Health, 2011.

20 Rampal L, Rampal S, Khor GL et al. A national study on the prevalence of obesity among 16,127 Malaysians. Asia Pac J Clin Nutr 2007;16:561–6.

21 Deurenberg-Yap M, Chew SK, Lin VF et al. Relationships between indices of obesity and its co-morbidities in multi-ethnic Singapore. Int J Obes Relat Metab Disord 2001;25:1554–62.

22 Galobardes B, Shaw M, Lawlor DA et al. Indicators of socioeconomic position (part 1). J Epidemiol Community Health 2006;60: 7–12.

23 Kim SJ, Jee SH, Nam JM et al. Do early onset and pack-years of smoking increase risk of type II diabetes? BMC Public Health 2014;14:178.

24 Lee TC, Glynn RJ, Pena JM et al. Socioeconomic status and incident type 2 diabetes mellitus: data from the Women's Health Study. PLoS One 2011;6:e27670.

25 Mannocci A, Pignalosa S, Saulle R et al. Prevalence of major cardiovascular risk factors among oil and gas and energy company workers. Ann 1st Super Sanita 2015;51:148–53.

26 Hirata RP, Sampaio LM, Leitao Filho FS et al. General characteristics and risk factors of cardiovascular disease among interstate bus drivers. Scientific World Journal 2012;2012:216702.

27 Nazri SM, Tengku MA, Winn T. The association of shift work and hypertension among male factory workers in Kota Bharu, Kelantan, Malaysia. Southeast Asian J Trop Med Public Health 2008;39:176–83.

28 Cassani RS, Nobre F, Pazin Filho A et al. Prevalence of cardiovascular risk factors in a population of Brazilian industry workers. Arq Bras Cardiol 2009;92:16–22.

29 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.

30 Jan Mohamed HJ, Mitra AK, Zainuddin LR et al. Women are at a higher risk of metabolic syndrome in rural Malaysia. Women Health 2013;53:335–48.

31 Ying C, Kuay LK, Huey TC et al. Prevalence and factors associated with physical inactivity among Malaysian adults. Southeast Asian J Trop Med Public Health 2014;45:467–80.

32 Vaidya A, Krettek A. Physical activity level and its sociodemographic correlates in a peri-urban Nepalese population: a cross-sectional study from the Jhaukhel-Duwakot health demographic surveillance site. Int J Behav Nutr Phys Act 2014;11:39.

33 Andrade FC, Wu F, An R et al. Employment status and health outcomes among Brazilian adults. Int Health 2016;8:413–22.

34 Zagozdzon P, Parszuto J, Wrotkowska M et al. Effect of unemployment on cardiovascular risk factors and mental health. Occup Med (Lond) 2014;64:436–41.

35 Jin RL, Shah CP, Svoboda TJ. The impact of unemployment on health: a review of the evidence. Can Med Assoc J 1995;153:529–40.

36 Pharr JR, Moonie S, Bungum TJ. The impact of unemployment on mental and physical health, access to health care and health risk behaviors. ISRN Public Health 2012;2012:483432.

37 Department of Statistics Malaysia. Labour force survey report. Putrajaya: Department of Statistics Malaysia, 2014.

38 Department of Statistics Malaysia. Monthly principle statistics of labour force, September 2015. Putrajaya: Department of Statistics Malaysia, 2015.

39 Lewin A, Thomas F, Pannier B et al. Work economic sectors and cardiovascular risk factors: cross-sectional analysis based on the RECORD Study. BMC Public Health 2014;14:750.

40 Sakuta H, Suzuki T. Physical activity and selected cardiovascular risk factors in middle-aged male personnel of self-defense forces. Ind Health 2006;44:184–9.

41 Kim CH, Tamborini CR. Response error in earnings: an analysis of the survey of income and program participation matched with administrative data. Sociol Methods Res 2014;43:39–72.

42 Lim KG, Cheah WK. A review of metabolic syndrome research in Malaysia. Med J Malaysia 2016;71:20–8.