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Non-skilled occupation as a risk factor of diabetes among working population: A population-based study of community-dwelling adults in Hong Kong

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Abstract

Diabetes among working population brings to society concerns on productivity and social welfare cost, in addition to healthcare burden. While lower socio-economic status has been recognised as a risk factor of diabetes; occupation, compared with other socio-economic status indicators (e.g., education and income), has received less attention. There is some evidence from studies conducted in Europe that occupation is associated with diabetes risk, but less is known in Asia, which has different organisational cultures and management styles from the West. This study examines the association between occupation and diabetes risk in a developed Asian setting, which is experiencing an increasing number of young onset of diabetes and aging working population at the same time. This is a cross-sectional study of working population aged up to 65 with data from a population-based survey collecting demographic, socio-economic, behavioural and metabolic data from Hong Kong residents, through both self-administered questionnaires and clinical health examinations (1,429 participants). Non-skilled occupation was found to be an independent risk factor for diabetes, with an odds ratio (OR) of 3.38 ($p < 0.001$) and adjusted OR of 2.59 ($p = 0.022$) after adjusting for demographic, behavioural and metabolic risk factors. Older age (adjusted OR = 1.08, $p < 0.001$), higher body mass index (adjusted OR = 1.23, $p < 0.001$) and having hypertriglyceridemia (adjusted OR = 1.93, $p = 0.033$) were also independently associated with diabetes. Non-skilled workers were disproportionately affected by diabetes with the highest age-standardized prevalence (6.3%) among all occupation groups (4.9%–5.0%). This study provides evidence that non-skilled occupation is an independent diabetes risk factor in a developed Asian setting. Health education on improving lifestyle practices and diabetes screening should prioritise non-skilled workers, in particular through company-based and sector-based diabetes screening programmes. Diabetes health service should respond to the special needs of non-skilled workers, including service at non-office hour and practical health advice in light of their work setting.

KEYWORDS
Asia, chronic disease, diabetes mellitus, Hong Kong, occupational groups, risk factors, work

1 | BACKGROUND

Diabetes mellitus (DM) is one of the main causes of deaths related to chronic diseases worldwide. DM global prevalence is estimated to be 9.3% in 2019, affecting 463 million adults, with type 2 diabetes being the most common type, accounting for about 90% of all diabetes cases (International Diabetes Federation, 2019). DM prevalence in Hong Kong, a highly developed Asian city, stands at around 10%, with a rising prevalence across age groups in the last 10 years (Quan et al., 2017). While old age is strongly associated with DM risk, the number of people with DM between the age of 20 and 64 has been estimated to increase from 351 million in 2019 to 486 million in 2045 worldwide (International Diabetes Federation, 2019); and the largest number of people with DM globally were in the 40- to 59-year age group, with such situation expected to continue in the next 20 years (Guariguata et al., 2014). A recent study in Hong Kong pointed out that there had been a significant increase in DM incidence among the 40- to 59-year olds (Quan et al., 2017). A related development is the phenomenon of young onset of type 2 DM (YOD), defined as onset of YOD at the age of up to 40. YOD patients have shown faster loss of glycaemic control (Lascar et al., 2018) and had complications developed at an earlier stage in the natural history of the disease (Al-Saeed et al., 2016; Chan et al., 2014). YOD is particularly important in the Asian context as Southeast Asia and Western Pacific were among the regions that had experienced the biggest increase in YOD (Lascar et al., 2018), and Asia had the highest number of DM patients aged between 20 and 39 years in the world (Chan et al., 2009).

When a person at working age is affected by DM, the economic burden of DM comprises of the productivity lost due to the disease and its complications, in addition to healthcare cost. The first Asian estimation on productivity loss from DM was done in Singapore, with the total economic costs per working age patient estimated to be US$5,646, with a split of roughly 40% and 60% attributable to excess direct medical costs and productivity-related costs respectively -(Png et al., 2016). In terms of DM risk factors, lower socio-economic status (SES; Agardh et al., 2011; Stringhini et al., 2012) has been recognised as one, in particular in high-income settings, together with non-modifiable risk factors including old age (Kirkman et al., 2012), genetics (Lyssenko & Laakso, 2013), ethnicity (Golden et al., 2012); modifiable risk factors including physical inactivity (Jeon et al., 2007), unhealthy diet (Sami et al., 2017); and metabolic risk factors including overweight/obesity (Eckel et al., 2011). SES is most often measured in terms of education in existing DM epidemiological studies, and occupation has received relatively less attention, in particular in Asia (Agardh et al., 2011). Existing studies looking at association between occupation and DM risk were conducted predominantly in Europe, including some recent studies in England (Kumari et al., 2004; Stringhini et al., 2012), Denmark (Cleal et al., 2014) and Sweden (Hedén Stahl et al., 2014), with lower occupation status related to higher DM risks in general (Agardh et al., 2011). There are also studies looking at association between DM risk and certain working conditions, e.g., long working hours (Kivimäki et al., 2015), shift work (Gan et al., 2015; Knutsson & Kempe, 2014) and work stress (Cosgrove et al., 2012; Nyberg et al., 2014), with mixed results; but again they were done in mainly non-Asian setting.

What is known about this topic

- Incidence of diabetes among people of working age has been rising globally and in Asia, causing concern over the economic and social cost of the disease.
- There is consistent evidence from Europe that occupation is associated with diabetes risk.
- There is little understanding on the association between occupation and diabetes risk in Asian context, with mixed findings in previous studies.

What this paper adds

- Non-skilled occupation was found to be an independent risk factor for diabetes in a developed Asian setting.
- Non-skilled workers were disproportionately affected by diabetes.
- Occupation-based screening and health education on prevention of diabetes should be considered; and health services related to diabetes should respond to the needs of non-skilled workers.

As workplace could be a natural cluster for health intervention, an understanding on occupation as a DM risk factor would provide some indication on the potential of such strategy. While there is some evidence from several European studies that lower occupation status is related to higher DM risks, studies focusing on occupation are scare in Asia with no consistent findings (Wu et al., 2017). Asian and Western settings are known to have different organisational cultures and management styles (Chikudate, 2004; Hofstede, 2007), but whether such differences may alter the association between occupation and diabetes risk is relatively unknown. For the development of more effective preventive and contextualised strategy for potential healthcare needs among DM patients in the working population, it is vital to examine the role of occupation as a risk factor among the working population in the Asian setting. Hong Kong, being a highly developed urban population in Asia with an aging workforce (Hong Kong Census & Statistics Department, 2017), could shed some light for other cities in the region undergoing rapid economic development. This study aimed to examine whether occupation is an independent DM risk factor for the working population in a developed Asian setting.

2 | METHODS

2.1 | Data source and subjects

A Population Health Survey (PHS) was conducted between 2014 and 2016 by the Department of Health of the Hong Kong Special Administrative Region Government on various aspects of the population in Hong Kong, in order to support evidence-based decision making in health policy, resource allocation, provision of health and public health services by the Government. PHS was a population-based study covering the land-based non-institutional population aged 15 or above in Hong Kong (excluding foreign domestic helpers and visitors of Hong Kong) and adopted the Frame of Quarters maintained by the Census and Statistics Department as the sampling frame. Systematic replicated sampling was adopted for selecting samples of living quarters, and each replicate of living quarters is a representative sample of domestic households in Hong Kong; 12,022 individuals from 5,435 domestic households were successfully enumerated, representing a household response rate of 75.4%. All participants responded to a structured questionnaire administered by trained interviewers; and those who consented were randomly selected to undergo health examination supervised by medical practitioners. Among the 12,022 participants in the PHS, 1,429 were included in the current study, i.e., all those who were 'working' (reported to have a full-time or part-time job seven days preceding the completion of the questionnaire), up to the age of 65, and provided clinical data through health examinations. The publicly available PHS Report give detailed descriptions of the sampling and data collection procedures (Department of Health, 2017).

The data used in the study was from the PHS which was conducted by the Department of Health of the Hong Kong Special Administrative Government, and the PHS had been approved by the Ethics Committee of the Department of Health. Participants were invited to sign a consent form. The data used in this study were obtained from PHS and that the interpretations, conclusions and recommendations were from the authors and did not represent the opinions of the Department of Health.

2.2 | Occupational groups

The occupations of the subjects were classified into three groups according to their skill levels: highly skilled, medium skilled and non-skilled. The classifications were made with reference to the International Standard Classification of Occupation (ISCO-08) published by the International Labour Organization (Resolution Concerning Updating the International Standard Classification of Occupations, 2007) and adapted by the Hong Kong Census and Statistics Department. Occupation group has long been considered as a comprehensive indicator of socio-economic position in previous social epidemiological studies related to DM (Elovainio et al., 2011; Marmot et al., 1991; Stringhini et al., 2012).

2.3 | Behavioural risk factors

For diet, subjects were asked in the structured questionnaire about their fruit and vegetable intake (fruits: categorised into <1 serving, 1 to <2 servings and ≥2 servings per day; vegetables: categorised into <2 servings and ≥2 servings per day). Smoking status was classified into 'current smoker', 'previous smoker' and 'non-smoker'. In terms of alcohol consumption, subjects were classified as 'non-drinker', 'rare/occasional drinker' (if not more than 3 days a month) and as 'regular drinker' (at least once a week). Amount of physical activities performed was measured by the Global Physical Activity Questionnaire developed by the WHO, expressed in metabolic equivalent (MET)-minutes per week; and <600 MET-minutes per week was considered inactive (Surveillance & Population-based Prevention of Noncommunicable Diseases Department, 2002).

2.4 | Metabolic risk factors

The health examinations included physical measurements of height, weight, blood pressure and blood tests for glycated haemoglobin (HbA1c), fasting plasma glucose (FPG) and lipid profile. Procedures of physical measurements and blood tests followed the WHO STEPS Surveillance Manual. All laboratory reports were reviewed first by registered medical laboratory technologists, then further reviewed by medical staff of the Department of Health. Laboratory results were then disseminated to all respondents concerned, and health advice was further provided to those with results outside reference range. Body mass index (BMI) was calculated from height and weight; and obesity was defined by Asian BMI cut-off values of ≥25 kg/m^2 (WHO Expert Consultation, 2004). Hypertension was defined as either systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, reduced high-density lipoprotein (HDL) cholesterol as <1 mmol/L, and hypertriglyceridemia as ≥1.7 mmol/L (Expert Panel on Detection & Evaluation, 2001; Grundy et al., 2004).

For a subject to be classified as having DM, s/he would have responded in the questionnaire that s/he had been diagnosed with DM by a doctor or if s/he had 'previously undiagnosed DM', i.e., reported not having been diagnosed with DM in the questionnaire but her/his blood sample indicated either FPG ≥ 7.0 mmol/L or HbA1c ≥ 6.5%. For those with self-reported DM diagnosis, over 70% of the response was confirmed by laboratory testing, and 20% was verified by self-reported use of diabetic medication. While the questionnaire and laboratory testing did not directly distinguish between type 1 and type 2 diabetes, it was reasonable to assume that those included in the analysis were highly likely to be type 2 cases, as none of those with self-reported DM was on insulin (which was an essential therapy for individuals with type 1 diabetes; American Diabetes Association, 2020); and none of those with previously undiagnosed DM were diagnosed before the age of 25. A previous study looking at diabetes prevalence and incidence in Hong Kong has used diagnosis age of 20 as the cut-off for distinguishing type 1 and type 2 diabetes (Quan et al., 2017). It is also worth noting that less than

4% of the patients in the Hong Kong Diabetes Registry had type 1 diabetes (Chan et al., 2011), largely in line with a study among US adults with diabetes, which found that type 1 accounted for only 5.6% (Xu et al., 2018). As such, the effect of including type 1 cases in our analysis, if any, would be minimal.

2.5 | Statistical analysis

Demographics, lifestyle practices, physical measurements and blood test results of subjects were summarised in descriptive statistics. Occupational differences were subject to linear-by-linear association test or ANOVA test. Age-standardized DM prevalence among the three occupation groups was calculated to facilitate comparison, with the age distribution of the working population of Hong Kong in 2016 as reference population (Hong Kong Census & Statistics Department, 2016). Risk factors were categorised into the domains of demographic, behavioural and metabolic, with bivariate binary logistic regression analyses performed on all individual risk factors. Four regression models were then developed to examine if occupation group was an independent DM risk factor for the working population. Model 1 was adjusted for demographics including age, gender and place of birth. Model 2 was further adjusted for behavioural risk factors. Model 3 covered Model 1 plus further adjustment of metabolic factors. Model 4 had all three groups of risk factors entered simultaneously, i.e., demographic, lifestyle and metabolic risk factors. All significance tests were two tailed, and a $p < 0.05$ was considered statistically significant. All regression analyses were conducted by the IBM Statistics SPSS Version 22.

3 | RESULTS

Table 1 showed the general characteristics of the subjects included in this analysis (n = 1,429). The overall population distribution and sex ratio among the three occupational groups was generally in line with the results of the 2016 Population By-census of Hong Kong, with the medium-skilled occupation slightly overrepresented by about 12%, and the non-skilled occupation underrepresented by about 8% (Census & Statistics Department Hong Kong Special Administrative Region Government, 2017). Except for smoking status, highly skilled workers seemed to have a less healthy lifestyle compared with the non-skilled workers, as they had a higher percentage of regular drinkers ($p < 0.001$), were less physically active ($p <.001$) and had a lower level of fruits consumption ($p = 0.015$). No occupational gradient was found among the metabolic risk factors except for BMI, the mean of which was slightly higher for the non-skilled workers ($p = 0.014$). Figure 1 showed that the crude DM prevalence among the working population was 4.8% and that for the non-skilled occupation was 12.5%, for medium-skilled occupation 4.0% and for highly skilled occupation 4.1%. This indicated a major DM burden and stronger healthcare needs among the non-skilled workers. Moreover, non-skilled workers were disproportionately affected by DM as the age-standardized prevalence among this occupation group (6.3%) was still higher than the other two groups (4.9%–5.0%), though at a smaller extent.

Table 2 showed the association between various risk factors and DM under bivariate analysis. When unadjusted, increased age, male sex, non-skilled occupation, ex-smoker and all metabolic risk factors, i.e. BMI, hypertension, hypertriglyceridemia and reduced HDL cholesterol, were associated with an increased risk of DM.

Table 3 showed the association between risk factors and DM in the multivariate analysis under four different models. Non-skilled occupation was an independent risk factor of DM under all four models: Model 1 with adjusted OR = 2.10 ($p = 0.050$), Model 2 with adjusted OR = 2.16 ($p = 0.050$), Model 3 with adjusted OR = 2.33 ($p = 0.022$) and Model 4 with adjusted OR = 2.59 ($p = 0.022$). Not surprisingly, older age (adjusted OR = 1.08, $p < 0.001$), higher BMI (adjusted OR = 1.23, $p < 0.001$) and having hypertriglyceridemia (adjusted OR = 1.93, $p = 0.033$) were also associated with DM under in the final model. It was worth noting that behavioural risk factors were non-significant under the various models.

4 | DISCUSSION

This is the first study to examine the DM risk factors among working population in Hong Kong, utilising population-based data. We found that non-skilled occupation was an independent risk factor of DM, representing over twofold increase in risk. The non-skilled occupation was disproportionately affected by DM as compared with other occupation groups, with a crude prevalence over 12% and an age-standardized prevalence above 6%.

Our study provided evidence that low occupation status was an independent DM risk factor in a developed Asian setting, with the non-skilled occupation most at risk. When unadjusted, non-skilled workers had an odds ratio of 3.38, and it reduced to 2.59 after adjustment of demographic, behavioural and metabolic factors. This finding echoes with the social gradient found in previous studies but with a slightly stronger association (Agardh et al., 2011; Cleal et al., 2014; Hedén Stahl et al., 2014; Kumari et al., 2004; Stringhini et al., 2012). This could be due to the different work culture in Asia from the West (Hofstede, 2007), but further research to confirm this possible explanation is warranted. The importance of occupation as a DM risk factor cannot be overemphasised, and this lends support to occupation-based health interventions. In terms of primary prevention of DM, education on improving lifestyle practices should prioritise workers with non-skilled occupation. For secondary prevention, there is a critical need of DM screening for non-skilled workers. Early screening would increase the chance of better disease control which could mean continued capacity to work. While occupation had been studied in understanding the social gradient of DM risk factors in previous research (Cleal et al., 2014; Hedén Stahl et al., 2014; Yang et al., 2017), the results will have practical value only if they are interpreted in a workplace setting which is a natural cluster for interventions (Siu et al., 2012), e.g., company-based and sector-based DM

TABLE 1 General characteristics of the subjects

	Highly skilled		Medium skilled		Non-skilled		Total		*p* trend[b]
No. of subjects	545	(38.1)	748	(52.3)	136	(9.5)	1,429		
Age (years)[a]	39.6	(11.0)	38.7	(12.5)	50.5	(10.9)	40.2	(12.3)	<0.001
Male	342	(62.8)	367	(49.1)	58	(42.6)	767	(53.7)	<0.001
Born in Hong Kong	442	(81.1)	541	(72.3)	60	(44.1)	1,043	(73.0)	<0.001
Smoking status									
Non-smoker	423	(77.6)	529	(70.7)	91	(66.9)	1,043	(73.0)	<0.001
Ex-smoker	73	(13.4)	90	(12.0)	23	(16.9)	186	(13.0)	
Current smoker	49	(9.0)	129	(17.2)	22	(16.2)	200	(14.0)	
Alcohol consumption									
Non-drinker	101	(18.5)	202	(27.0)	47	(34.6)	350	(24.5)	<0.001
Rare/occasional drinker	360	(66.1)	469	(62.7)	78	(57.4)	907	(63.5)	
Regular drinker	84	(15.4)	77	(10.3)	11	(8.1)	172	(12.0)	
Physical activities (MET-min/week)[a]	2,614.5	(3,135.7)	4,040.9	(5,391.9)	4,924.3	(5,854.4)	3,581.0	(4,778.4)	<0.001
Inactive	84	(15.4)	91	(12.2)	12	(8.8)	187	(13.1)	0.021
Fruits serving/day									
<1	42	(7.7)	59	(7.9)	2	(1.5)	103	(7.2)	0.015
1 to <2	444	(81.5)	613	(82.0)	107	(78.7)	1,164	(81.5)	
≥2	59	(10.8)	76	(10.2)	27	(19.9)	162	(11.3)	
Vegetables serving/day									
<2	366	(67.2)	537	(71.8)	87	(64.0)	990	(69.3)	0.691
2 and above	179	(32.8)	211	(28.2)	49	(36.0)	439	(30.7)	
Hypertension[c]	82	(15.0)	113	(15.1)	33	(24.3)	228	(16.0)	0.062
BMI[a,c]	23.6	(3.9)	23.1	(3.8)	23.8	(3.5)	23.3	(3.8)	0.014
Obesity[c]	180	(33.0)	197	(26.3)	44	(32.4)	421	(29.5)	0.152
Hypertriglyceridemia[c]	82	(15.0)	123	(16.4)	22	(16.2)	227	(15.9)	0.564
Low HDL-C[c]	60	(11.0)	71	(9.5)	20	(14.7)	151	(10.6)	0.659

Note: Data are *N* (%).

Abbreviations: BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; MET, metabolic equivalent of task.

[a]Mean (*SD*).

[b]Occupational differences assessed by linear-by-linear association test or ANOVA test.

[c]Based on clinical measurements.

screening programmes. The DM prevalence among the non-skilled workers found in this study also has implications on tertiary DM prevention. To better support DM management by working patients, in particular the non-skilled workers, health service planning must respond to their special needs, and one of them is to have complication screenings or routine check-up held at non-office hour (Paterson et al., 2010). Such accommodation is important in facilitating better disease control as default from scheduled medical appointment was associated with higher mean HbA1c (Karter et al., 2004) and greater risk for hospitalisation among DM patients (Nuti et al., 2012). In addition, healthcare professionals should consider providing more practical advice to patients from non-skilled occupation in light of their work setting, e.g., dietary recommendations for workers involving heavy manual work.

Contrary to previous research (Agardh et al., 2011; Stringhini et al., 2012), behavioural/lifestyle factors were not significant DM risk factors in our multivariate analysis, and the effect of non-skilled occupation was not attenuated by such factors. In fact, we found that non-skilled workers did not necessarily have less healthy life style as compared with highly skilled workers, in particular in terms of physical activities, drinking habit and diet. On the other hand, recall bias arising from the reliance on self-reported data (Althubaiti, 2016) might have affected the reliability of measurement of behavioural factors, and it might be more critical in survey questions employing concepts that the participants are not familiar with, e.g., number of servings in vegetable and fruit consumption.

A major strength of this study is that it utilises population-based data which minimise selection bias to a large extent. The

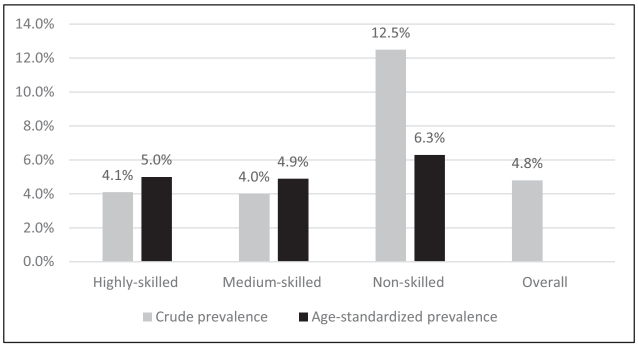

FIGURE 1 Crude and age-standardized diabetes mellitus prevalence by occupation groups. Prevalence calculated by the number of subjects with diabetes diagnosed before the survey or with blood sample indicating either FPG ≥ 7.0 mmol/L or HbA1c ≥ 6.5%

comprehensiveness of the PHS allows a wide range of relevant variables to be taken into account in the risk factors analysis, hence the adjustment of possible confounders. As we are able to identify DM patients who are actually employed, our analysis on DM prevalence and risk factors is more accurate than estimation based on age groups alone, as such estimation would not have been able to account for patients who quit their jobs during working age. One limitation of our study is that only HbA1c and FPG were adopted as DM diagnostic criteria, and no data on oral glucose tolerance test (OGTT) were available. Moreover, as a cross-sectional study, no causal relationship could be established between the risk factors and DM. Longitudinal study is recommended for further analysis of the changes over time.

Policymakers must bear in mind the potential economic cost as workers with DM could mean reduced productivity in the short run or even premature exit from the labour force (Kouwenhoven-Pasmooij et al., 2016). Lowered capacity of a DM patient to work might lead to disruption in livelihood at individual and family levels, which could lead to reliance on unemployment benefits or other forms of social welfare. Better management and control of conditions by DM patients among the working population therefore could minimise the impact of DM on productivity and social welfare needs and human resource policies and labour laws that facilitate self-management have a role to play. Issues that could hinder the self-management by DM patients at work are often related to human resource and labour policies and laws, e.g., stigmatisation and discrimination at work place (Ruston et al., 2013), support from employers (Weijman et al., 2005) and sick leave arrangements and the situation of DM patients among the working population clearly brings out this crossover of public health and labour policies. It is worth noting that the self-management of chronic disease patients among the working population has already reached policy level discussion in the European Union, and challenges faced by chronic disease patients, including those with DM, in self-managing their conditions at work and the corresponding measures have been mapped out (Leonardi & Scaratti, 2018).

TABLE 2 Association between DM and risk factors by bivariate analysis

	Crude OR (95% CI)	*p* value
Demographic risk factors		
Age	1.09 (1.07–1.12)	<0.001
Male	2.37 (1.38–4.06)	0.002
Place of birth		
Born in Hong Kong	1.00	
Born outside Hong Kong	1.19 (0.70–2.02)	0.517
Occupation		
Highly skilled	1.00	
Medium skilled	0.99 (0.56–1.74)	0.971
Non-skilled	3.38 (1.74–6.60)	<0.001
Behavioural risk factors		
Smoking status		
Non-smoker	1.00	
Ex-smoker	2.92 (1.65–5.18)	<0.001
Current smoker	1.50 (0.75–2.97)	0.251
Alcohol consumption		
Non-drinker	1.00	
Rare/occasional drinker	0.87 (0.50–1.51)	0.620
Regular drinker	0.74 (0.31–1.79)	0.504
Physically inactive (<600 MET-min/week)	0.62 (0.27–1.45)	0.270
Fruits serving/day		
<1	0.70 (0.24–2.08)	0.521
1 to <2	0.66 (0.34–1.28)	0.218
≥2	1.00	
Vegetables serving/day		
<2	0.94 (0.56–1.59)	0.826
2 and above	1.00	
Metabolic risk factors		
Hypertension[a]	2.26 (1.31–3.88)	0.003
BMI[a]	1.24 (1.17–1.31)	<0.001
Hypertriglyceridemia[a]	3.56 (2.14–5.94)	<0.001
Low HDL-C[a]	2.76 (1.53–4.96)	0.001

Abbreviations: BMI, body mass index; HDL-C, high-density lipoprotein cholesterol; MET, metabolic equivalent of task.
[a]Based on clinical measurements.

This study highlighted the urgent need for a better understanding of the DM situation among the working population for health education, health service planning and more accurate assessment on the economic and social cost of DM. In order to build up evidence for possible change in public health and labour policies to facilitate better prevention and disease control by DM patients at work, cohort study should be conducted to examine the risk factors; and studies looking at the self-management behaviours of non-skilled DM patients are also recommended.

TABLE 3 Association between DM and risk factors by multivariate analysis

Risk factors	Model 1 AOR (95% CI)	Model 1 *p* value	Model 2 AOR (95% CI)	Model 2 *p* value	Model 3 AOR (95% CI)	Model 3 *p* value	Model 4 AOR (95% CI)	Model 4 *p* value
Non-skilled occupation	2.10 (1.00–4.40)	0.050	2.16 (1.00–4.67)	0.050	2.33 (1.07–5.06)	0.033	2.59 (1.15–5.83)	0.022
Age	1.09 (1.06–1.11)	<0.001	1.08 (1.06–1.11)	<0.001	1.09 (1.05–1.12)	<0.001	1.08 (1.05–1.11)	<0.001
Male	2.19 (1.24–3.87)	0.007	2.15 (1.14–4.05)	0.018	1.76 (0.96–3.24)	0.070	1.84 (0.94–3.62)	0.077
BMI	–	–	–	–	1.23 (1.15–1.31)	<0.001	1.23 (1.15–1.31)	<0.001
Hypertriglyceridemia	–	–	–	–	1.88 (1.05–3.37)	0.034	1.93 (1.06–3.51)	0.033

Note: Model 1: adjusted by demographics (age, sex and place of birth); Model 2: adjusted by demographics and behavioural factors (smoking status, alcohol consumption, physical activities and diet); Model 3: adjusted by demographics and metabolic factors (BMI, hypertension, hypertriglyceridemia and low high-density lipoprotein cholesterol); Model 4: adjusted by demographics, behavioural factors and metabolic factors.

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index.

5 | CONCLUSIONS

This study found that non-skilled occupation was an independent risk factors of DM in a developed Asian setting, with an association slightly stronger than similar studies conducted in Europe, and that non-skilled workers were disproportionately affected. These findings provided evidence that DM prevention at primary, secondary and tertiary levels in Asia should prioritise and address the special needs of non-skilled workers.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTIONS

HHYE and EYYC designed the study. HHYH analysed and interpreted the data and was the major contributor in writing the manuscript. EYKC provided clinical advice regarding diabetes. GKKC, FTTL and EKY critically reviewed study design, statistical analysis and writing.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study were made available by the Department of Health (DH) of the Hong Kong Special Administrative Region Government upon application. Data accessibility was subject to approval by DH.

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