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Prevalence of undiagnosed diabetes mellitus and cardiovascular risk factors in Hong Kong professional drivers

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ABSTRACT

Aims: To investigate the prevalence of undiagnosed diabetes mellitus (DM) and cardiovascular risk factors among professional drivers in Hong Kong.
Methods: Chinese professional drivers with no history of DM were invited to complete a questionnaire on their health status, followed by taking their body measurements, fasting blood glucose (FG) and lipids. 75 g OGTT were performed when FG $\geq$ 5.6 to <7.0 mmol/L.
Results: Of these 3376 drivers (male 92.6%, mean age 50.9 $\pm$ 7.6 years), the prevalence of undiagnosed DM, prediabetes, and metabolic syndrome was 8.1% (272/3376, 95% CI 7.1–9.0%), 10.0% (337/3376, 95% CI 9.0–11.0%) and 26.8% (904/3376, 95% CI 25.3–28.3%) respectively, while the corresponding WHO Standard Population age-standardized prevalence was 7.8%, 9.0% and 24.7% respectively. Many of them were obese (51.2%), had hypertension (57.0%) and high cholesterol (58.7%), and a third had hypertriglyceridaemia (34.9%) and low HDL-cholesterol (29.3%). Their median working hours were 60.0 (IQR 14) h. Majority had exercise <1 h/week (56.0%) and ate out $\geq$6 times/week (54.9%).
Conclusions: Hong Kong professional drivers have higher prevalence of undiagnosed DM, cardiovascular risk factors and metabolic syndrome than the general population. Therefore, health care measures targeting against them should be taken to prevent and detect DM and cardiovascular diseases.

1. Introduction

Diabetes mellitus (DM) is common in Hong Kong [1]. With the spread of western lifestyle, the prevalence of diabetes mellitus is predicted to increase in the coming decades [2]. The care of this large group of people with diabetes mellitus is imposing a heavy burden to the local community. Fortunately, lifestyle modification has been shown to be effective in preventing diabetes mellitus [3], reducing the cardiovascular diseases risk factors [4] and be associated with a lower mortality among men [5]. Lifestyle modification is also cost effective [6].

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Abbreviations: BMI, body mass index; BP, blood pressure; DM, diabetes mellitus; FG, fasting glucose; HDL-C, high density lipoprotein cholesterol; HT, hypertension; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; LDL-C, low density lipoprotein cholesterol; OGTT, oral glucose tolerance test; TC, total cholesterol; TG, triglycerides; WC, waist circumference.

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Professional drivers have been reported by overseas studies to have adverse working condition and unfavourable lifestyle [7,8], which are associated with higher risk of hypertension, myocardial infarction and glucose intolerance [9,7,10], higher hospital admissions [11] and higher mortality [12]. Furthermore, most professional drivers are not aware of the association of diabetes mellitus with their obesity [13]. Of concern to public safety, professional drivers and particularly those with diabetes mellitus or cardiovascular diseases have been found to encounter more traffic accidents [14].

In Hong Kong, there is a large population of 400,000 professional drivers [15]. Yet, there is little data on their health status to guide the planning of preventive and medical health care for them. In this study, we aimed to find out the prevalence of undiagnosed diabetes mellitus and cardiovascular risk factors among professional drivers in Hong Kong to inform the public, health professionals and service planners.

2. Subjects and methods

2.1. Subjects

The study was part of the Hong Kong professional driver community project to raise their awareness of diabetes mellitus. Chinese professional drivers of both sexes, aged 18–70 years, were invited through the media and drivers' groups to join the study by attending two local diabetic clinics. They were excluded if they had history of known DM either on diet or any drug treatment. Drivers who had driving duration less than 6 months, working hours less than 10 h per week or had retired from driving for 3 months or more were excluded from study. Informed consent was obtained from all drivers and the study was approved by the Ethics Committee of the Hong Kong East Cluster Hospitals of the Hospital Authority.

2.2. Measurements

All drivers were requested to complete a questionnaire on their lifestyle habits and medical history with the help of a research assistant. The mean of two anthropometric measurements was recorded. Body weight and height were taken while on light clothing with no shoes. Waist circumference (WC) was measured in a horizontal plan around the abdomen at the top of the right iliac crest at the end of normal expiration [16]. Blood pressure (BP) was measured after sitting for 15 min by BP monitor (Colin BP 8800-C). Blood samples were taken for glucose and lipid profile after fasting for 12 h. Plasma glucose, triglycerides (TG), total cholesterol (TC) and high density lipoprotein cholesterol (HDL-C) were measured using the Abbott Architect c16000 chemistry analyzer. Low density lipoprotein cholesterol (LDL-C) was derived from the Friedewald formula [17].

2.3. Definition of DM, prediabetes and metabolic syndrome

Drivers with fasting glucose (FG) $\geq$ 7.0 mmol/L were classified to have diabetes mellitus [18]; those with fasting glucose $\geq$ 5.6 mmol/L and <7.0 mmol/L were further assessed by 75 g oral glucose tolerance test (OGTT) to establish the diagnosis of DM or impaired glucose tolerance (IGT). DM was defined by FG $\geq$ 7.0 mmol/L or 2 h plasma glucose $\geq$ 11.1 mmol/L whereas IGT was defined by FG <7.0 mmol/L and 2 h plasma glucose $\geq$ 7.8–11.0 mmol/L [19]. Impaired fasting glucose (IFG) was defined as FG $\geq$ 5.6 to <7.0 mmol/L [20]. Drivers were classified to have prediabetes if they had either IFG or IGT [21]. Asian modified cut-off values of body mass index (BMI) $\geq$ 25 kg/m^2 and WC ($\geq$90 cm for male and $\geq$80 cm for female) were used to define obesity and central obesity [22]. Hypertension (HT) (systolic BP $\geq$ 130 mmHg or diastolic BP $\geq$ 85 mmHg, or history of HT on treatment), hypertriglyceridaemia (TG $\geq$ 1.7 mmol/L) and reduced HDL-cholesterol (male < 1.03 mmol/L, female < 1.29 mmol/L) were defined using the International Diabetes Federation (IDF) definition [23]. Drivers were considered to have metabolic syndrome (IDF definition) when they had central obesity plus two of the following four criteria, namely HT, FG $\geq$ 5.6 mmol/L, hypertriglyceridaemia and reduced HDL-cholesterol [23].

2.4. Outcome measures and statistical analysis

The primary outcome was prevalence of undiagnosed diabetes mellitus. The rates of prediabetes, cardiovascular risk factors and metabolic syndrome were secondary outcomes.

Socio-demographics, medical history and lifestyle characteristics of professional drivers were summarized by descriptive statistics. The age-standardized prevalence rates of undiagnosed DM, pre-diabetes, metabolic syndrome and cardiovascular risk factors were calculated with reference to the World Health Organization (WHO) World Standard Average Population 2000–2025 [24]. Their differences between genders were assessed by Chi-square test or Independent t-test. Univariate logistic regression models, followed by a forward stepwise logistic regression, were used to determine factors associated with the presence of undiagnosed DM and prediabetes. Factors considered were socio-demographics, medical history, lifestyle characteristics and cardiovascular risk factors. Goodness-of-fit of logistic regression model was assessed by the Hosmer–Lemeshow test. All significance tests were two-tailed and used 5% as the nominal level of significance. All statistical analyses were conducted by the SPSS 18.0 for Windows (SPSS, IBM Inc., Chicago, IL, USA).

3. Results

3.1. Characteristics of study subjects

Among the 3482 Chinese professional drivers who responded to the invitation and attended the clinics from May 2007 to May 2010, 81 did not meet the study admission criteria, and another 25 were excluded either because of incomplete questionnaire or refusal of blood taking. A total of 3376 professional drivers, predominantly male (92.6%), completed the baseline study. Equal proportions of them came from the three different regions of Hong Kong, namely Hong Kong Island, Kowloon and the New Territories. Their basal characteristics were shown in Table 1. Female drivers were younger, had lower BMI and blood pressure than male drivers.

Table 1 – Basal medical and lifestyle characteristics of professional drivers.

	Male	Female	Total	[b]p-Value
No. of drivers	3127 (92.6)	249 (7.4)	3376	
Age (years)[a]	51.1 (7.7)	49.0 (6.9)	50.9 (7.6)	<0.001
Physical[a]				
Weight (kg)	70.4 (10.6)	58.6(9.6)	69.5(11.0)	<0.001
BMI (kg/m^2)	25.5(3.4)	24.2(3.6)	25.4(3.4)	<0.001
Waist (cm)	89.5(8.1)	84.3 (8.4)	89.1(8.2)	<0.001
Systolic BP (mmHg)	132.8 (15.8)	126.7 (16.3)	132.4 (15.9)	<0.001
Diastolic BP (mmHg)	80.8(10.5)	73.5 (11.2)	80.3(10.7)	<0.001
Biochemistry[a]				
TC (mmol/L)	5.4 (1.0)	5.3 (1.0)	5.4 (1.0)	0.136
TG (mmol/L)	1.7 (1.3)	1.1 (0.5)	1.7 (1.3)	<0.001
HDL-C(mmol/L)	1.2 (0.3)	1.5 (0.3)	1.2 (0.3)	<0.001
LDL-C (mmol/L)	3.5 (0.9)	3.3 (0.9)	3.5 (0.9)	0.010
FG (mmol/L)	5.3 (1.4)	5.1 (1.0)	5.4 (1.4)	0.001
Medical history				
Family history of DM	963 (30.8)	93 (37.3)	1056 (31.3)	0.032
Family history of CHD	389 (12.4)	48 (19.3)	437 (12.9)	0.002
HT	402 (12.9)	30 (12.0)	432 (12.8)	0.714
CHD	36 (1.2)	4 (1.6)	40 (1.2)	0.523
CVA	26 (0.8)	2 (0.8)	28 (0.8)	0.962
Work				
Taxi	1336 (42.8)	58 (23.3)	1394 (41.3)	<0.001
Bus and minibus	1021 (32.7)	178 (71.5)	1199 (35.5)	
Lorry	348 (11.2)	2 (0.8)	350 (10.4)	
Sedan	406 (13.0)	8 (3.2)	414 (12.3)	
Working hours per week	60 (IQR 15)	48 (IQR 22)	60 (IQR 14)	<0.001
Work experience (year)	20 (IQR 15)	8 (IQR 12)	18 (IQR 15)	<0.001
Social				
Current smoker	646 (20.7)	9 (3.6)	655 (19.4)	<0.001
Ex-smoker	773 (24.7)	8 (3.2)	781 (23.1)	
Current drinker (≥1 unit/day)	1591 (50.9)	70 (28.1)	1661 (49.2)	<0.001
Ex-drinker	254 (8.1)	7 (2.7)	261 (7.7)	
Regular exercise (≥1 h/week)	1383 (44.2)	102 (41.0)	1485 (44.0)	0.316
Exercise duration (h/week)	1.5 (IQR 2.0)	1.5 (IQR 2.0)	1.5 (IQR 2.0)	0.324
Dietary				
No of fruit/day				
<1	1238 (39.6)	71 (28.5)	1309 (38.8)	0.002
1	1339 (42.8)	121 (48.6)	1460 (43.2)	
≥2	550 (17.6)	57 (22.9)	607 (18.0)	
Vegetable bowls/day				
<1	1239 (39.6)	67 (26.9)	1306 (38.7)	<0.001
1	1536 (49.1)	130 (52.2)	1666 (49.3)	
≥2	352 (11.3)	52 (20.9)	404 (12.0)	
Eating out/week				
<6	1355 (43.3)	168 (67.5)	1523 (45.1)	<0.001
6–10	1104 (35.3)	47 (18.9)	1151 (34.1)	
>10	668 (21.4)	34 (13.7)	702 (20.8)	

Note: Data are *N* (%). BMI, body mass index; BP, blood pressure; TC, total cholesterol; TG, triglycerides; FG, fasting glucose; HT, hypertension; CHD, coronary heart disease; CVA, cerebral vascular disease; IQR, interquartile range.
[a] Mean (SD).
[b] Assessing gender differences by Chi-square test or Independent *t*-test.

They also had lower LDL-cholesterol, higher HDL-C and lower TG levels. On the other hand, many more male drivers smoked and drank alcohol. Besides, male drivers worked for longer hours and had longer years of working experience than female.

3.2. *DM, prediabetes and metabolic syndrome*

Of these 3,376 professional drivers, 197 (5.8%) had FG ≥ 7.0 mmol/L and 2661 (78.8%) had FG < 5.6 mmol/L on initial FG screening, and they were categorized as undiagnosed DM and normal glucose tolerance, respectively. Of the remaining 518 drivers who had FG ≥ 5.6 to <7.0 mmol/L, 400 agreed to undertake OGTT. As a result, an additional 75 drivers were classified as undiagnosed DM, 98 drivers as IGT and 121 drivers as IFG. For the 118 drivers who refused OGTT, they were classified as IFG. The resulting crude prevalence rates of undiagnosed DM, prediabetes and metabolic syndrome in professional drivers were 8.1% (272/3376, 95% confidence interval (CI) 7.1–9.0%), 10.0% (337/3376, 95% CI 9.0–11.0%) and 26.8% (904/3376, 95% CI 25.3–28.3%) respectively; while the corresponding age-standardized prevalence rates based on the

Table 2 – Prevalence of undiagnosed DM, prediabetes, metabolic syndrome and cardiovascular risk factors in professional drivers.

	Male (N = 3127)		Female (N = 249)		Total (N = 3376)		[b]p-Value
	N (%)	[a]Adjusted %	N (%)	[a]Adjusted %	N (%)	[a]Adjusted %	
Undiagnosed DM	261 (8.3)	8.0%	11 (4.4)	5.9%	272 (8.1)	7.8%	0.029
Prediabetes	320 (10.2)	9.2%	17 (6.8)	7.1%	337 (10.0)	9.0%	0.099
Metabolic syndrome	846 (27.1)	25.2%	58 (23.3)	26.1%	904 (26.8)	24.7%	0.207
Central obesity	1451 (46.4)	45.1%	177 (71.1)	63.1%	1628 (48.2)	46.8%	<0.001
Obesity	1651 (52.8)	52.7%	80 (32.1)	34.0%	1731 (51.3)	58.4%	<0.001
Severe obesity (BMI $\geq$ 30 kg/m^2)	290 (9.3)	13.7%	22 (8.8)	15.2%	312 (9.2)	13.8%	0.910
Low HDL-cholesterol	920 (29.4)	31.7%	68 (27.3)	37.0%	988 (29.3)	31.0%	0.520
High TG	1145 (36.6)	34.6%	32 (12.9)	13.6%	1177 (34.9)	33.0%	<0.001
HT	1816 (58.1)	53.5%	108 (43.4)	47.6%	1924 (57.0)	52.2%	<0.001
Total cholesterol $\geq$ 5.2 mmol/L	1854 (62.5)	54.3%	129 (51.8)	55.8%	1983 (58.7)	52.7%	0.020

Note: DM, diabetes mellitus; BMI, body mass index; BP, blood pressure; TG, triglycerides; HT, hypertension.
[a] Age-standardized prevalence rates were calculated based on the WHO World Standard Population.
[b] Assessing gender differences by Chi-square test.

WHO World Standard Population were 7.8%, 9.0% and 24.7% respectively (Table 2).

Female drivers had lower prevalence of the above three categories when compared with male drivers (Table 2). Both the prevalence of undiagnosed DM and prediabetes increased with age, from 4.0% to 9.7% ($p < 0.001$) and from 2.7% to 12.5% ($p < 0.001$) respectively for aged 40 years or below to aged 61–70 years (Fig. 1). When stratified by sex, the trend remained the same, but the results were not statistically significant for female drivers (Fig. 1). Similarly, rate of undiagnosed DM rose from 5.9% for driving duration of five years or less to 9.5% with driving duration of more than 20 years ($p = 0.08$). We also found that male taxi drivers when compared with male drivers of other car types, had a higher undiagnosed DM rate (10.9% vs 6.4%, $p < 0.001$) and prediabetes rate (12.0% vs 8.9%, $p = 0.005$).

3.3. *Cardiovascular risk factors*

The cardiovascular risk factors of the 3376 professional drivers are shown in Table 2. Majority of them had hypertension (57.0%) and high cholesterol (58.7%). More than half (51.3%) were obese. About one third of them had hypertriglyceridaemia (34.9%) and low HDL-cholesterol (29.3%). With the exception of central obesity, male drivers had more cardiovascular risk factors than female drivers. When drivers with undiagnosed DM or prediabetes were compared with those with normal glucose tolerance, they had more cardiovascular risk factors, longer working experience and less intake of fruits and vegetables.

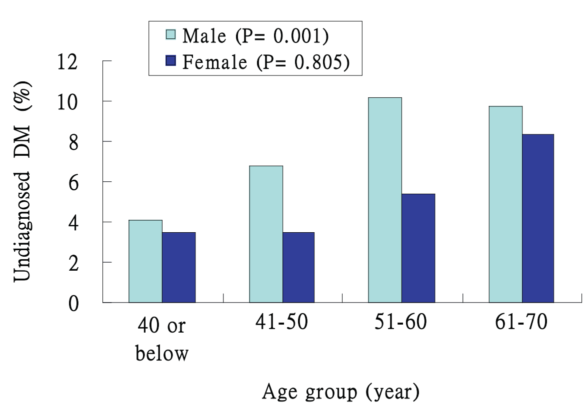

Fig. 1 – Prevalence of undiagnosed DM by age and sex.

3.4. *Factors associated with undiagnosed DM and prediabetes*

Using univariate analysis, presence of hypertension, family history of DM, obesity, central obesity, hypertriglyceridaemia, low HDL-cholesterol and eating out frequently were associated with an increased risk of undiagnosed DM, as did male gender, higher total cholesterol, increasing working experience, increasing age and being a taxi driver. On the other hand, regular exercise and eating more vegetable, but not fruit, reduced the risk of undiagnosed DM (Table 3).

Forward stepwise logistic regression was used to examine the association of all the variables in univariate analysis with undiagnosed DM and prediabetes. For undiagnosed DM, family history of DM, age, systolic BP and TG levels was significant factor associated with increased risk, whereas exercise duration was a significant factor in reducing the risk (Table 4). Regarding prediabetes, having ever been married, history of HT, intake of more than 1 fruit per day, LDL-cholesterol, waist and systolic BP were factors statistically significantly associated with increased risk of prediabetes (Table 4).

4. Discussion

This was the first study to examine the glucose tolerance status, cardiovascular risk factors and lifestyle in Hong Kong professional drivers.

We found a high prevalence of undiagnosed DM in Hong Kong Chinese professional drivers. Both the male and female prevalence of undiagnosed DM were higher than the total DM prevalence reported by a study of the local general population of similar ages in 2002 (8.3% vs 5.9% and 4.4% vs 4.1% respectively) [25]. Another earlier local study in 1997 reported an undiagnosed DM rate of only 3.9% in the community [26].

Table 3 – Risk factors associated with undiagnosed DM.

	Undiagnosed DM (%)	Odds ratio	95% C.I.	*p*-Value
Hypertension				
No	5.0%	1.00		
Yes	10.4%	2.22	1.68–2.94	<0.001
Obesity				
No	5.8%	1.00		
Yes	10.2%	1.87	1.44–2.42	<0.001
Central obesity				
No	6.2%	1.00		
Yes	10.0%	1.67	1.30–2.15	<0.001
High TG				
No	6.5%	1.00		
Yes	11.0%	1.77	1.38–2.27	<0.001
Low HDL-C				
No	7.4%	1.00		
Yes	9.7%	1.35	1.04–1.76	0.0230
Family history of DM				
No	6.2%	1.00		
Yes	12.1%	2.08	1.62–2.68	<0.001
Family history of CHD				
No	7.8%	1.00		
Yes	9.8%	1.29	0.92–1.82	0.143
History of CHD				
No	8.1%	1.00		
Yes	7.5%	0.92	0.28–3.02	0.896
History of CVA				
No	8.1%	1.00		
Yes	3.6%	0.42	0.06–3.11	0.396
Marital status				
Single	7.5%	1.00		
Married	8.1%	1.08	0.69–1.71	0.732
Divorced	8.9%	1.21	0.62–2.37	0.580
Widowed	5.0%	0.65	0.08–5.07	0.680
Smoking habit				
Never	7.9%	1.00		
Ex-smoker	7.9%	1.00	0.74–1.36	1.000
Active smoker	8.5%	1.08	0.79–1.49	0.620
Drinking habit				
Never	8.5%	1.00		
Ex-drinker	5.7%	0.66	0.38–1.15	0.660
Active drinker	8.1%	0.95	0.74–1.23	0.950
Regular exercise				
No	9.5%	1.00		
Yes	6.3%	0.64	0.49–0.83	<0.001
No of fruit/day				
<1	8.0%	1.00		
1	8.6%	1.07	0.82–1.41	0.607
≥2	6.9%	0.85	0.59–1.24	0.399
Vegetable bowls/day				
<1	9.5%	1.00		
1	7.6%	0.78	0.60–1.01	0.060
≥2	5.4%	0.55	0.34–0.88	0.012
Eating out/week				
0–5 times	6.8%	1.00		
6–10 times	7.9%	1.18	0.88–1.59	0.260
Above 10 times	11.1%	1.72	1.27–2.35	<0.001
Type of vehicle				
Bus/minibus	6.0%	1.00		
Sedan	6.3%	1.05	0.66–1.67	0.840
Lorry	7.1%	1.20	0.75–1.93	0.440
Taxi	10.6%	1.86	1.39–2.50	<0.001
Work experience (years)	NA	1.02	1.01–1.03	0.002
Working hours/week	NA	1.01	1.00–1.02	0.051
TC (mmol/L)	NA	1.19	1.05–1.34	0.005
LDL-C (mmol/L)	NA	1.10	0.95–1.27	0.205
Age (years)	NA	1.04	1.03–1.06	<0.001

Note: TC, total cholesterol; TG, triglycerides; CHD, coronary heart disease; CVA, cerebral vascular disease; NA, not applicable.

Table 4 – Factors associated with undiagnosed DM and prediabetes by multivariate logistic regression.

Independent variables	Odds ratio	95% CI	*p*-Value
Undiagnosed DM[a]			
Family history of DM	2.12	1.36–3.30	<0.001
Triglycerides level (mmol/L)	1.75	1.33–2.29	<0.001
Age (years)	1.07	1.03–1.10	<0.001
Systolic BP (mmHg)	1.02	1.01–1.04	0.003
Exercise duration (h)	0.85	0.69–0.97	0.020
Prediabetes[b]			
Marital status			
Single[c]	1.00		
Married	3.22	1.15–9.02	0.026
Divorced	3.78	1.07–13.42	0.039
Widowed	9.20	1.70–49.91	0.010
History of HT	1.84	1.16–2.90	0.009
No of fruit/day			
<1[c]	1.00		
1	1.35	0.83–2.18	0.224
≥2	2.12	1.27–3.55	0.004
LDL-C (mmol/L)	1.31	1.08–1.60	0.007
Waist (cm)	1.04	1.01–1.06	0.003
Systolic BP (mmHg)	1.01	1.00–1.03	0.037

[a] *p*-Value of Hosmer–Lemeshow goodness-of-fit test was 0.303.
[b] *p*-Value of Hosmer–Lemeshow goodness-of-fit test was 0.707.
[c] It was the reference level of categorical variable.

Nevertheless, it may not be totally appropriate to compare our results directly with them as there were differences in study methodology and time frame.

It has been shown that the American Diabetic Association 1997 DM definition (FG ≥ 7.0 mmol/L) [18], as compared with OGTT WHO 1998 definition [19], may under-report DM prevalence in Hong Kong Chinese by 37% [27]. It is therefore possible that the true prevalence of undiagnosed DM in drivers could be higher than what was found in our study since only 11.8% of them had had OGTT done. The finding that taxi drivers had higher prevalence of undiagnosed DM and prediabetes deserves further study. One possible explanation is that bus drivers are required to have pre-employment health checks and have company subsidized medical care, but taxi drivers do not.

On the other hand, using similar corresponding IFG definitions of the two other local studies, our study revealed that the IFG rate of our drivers was lower than that reported in 1997 (FG ≥ 6.1 to <7.0 mmol/L; 5.7% vs 8.9%) and 2002 (FG ≥ 5.6 to <7.0 mmol/L; 15.3% vs 18.2%) respectively [26,25]. It may be possible that the professional drivers, under adverse working condition and having poor lifestyle, progressed rapidly to DM, leaving fewer drivers in the prediabetes stage.

Our study also showed a high prevalence of cardiovascular risk factors and metabolic syndrome in Hong Kong Chinese professional drivers. Nearly all cardiovascular risk factors like central obesity (48.2% vs 30.0%), HT (57.0% vs 47.0%) and hypertriglyceridaemia (34.9% vs 20.0%) occurred more frequently than that found in the community population [25]. Similarly, the rate of metabolic syndrome was also markedly higher (26.8% vs 17.6%) [25]. As we had revealed that drivers with DM possessed more cardiovascular risk factors, the true prevalence of cardiovascular risk factors in all professional drivers might be even higher if the study had included drivers with known DM. In view of these results, Hong Kong Chinese professional drivers would have a higher risk of developing cardiovascular and renal diseases than the general population, which are potentially modifiable.

Overall, the working condition and lifestyle of drivers were unsatisfactory. Apart from their long working hours (median 60 h/week), majority of them (56%) had no habits of regular exercise. Furthermore, many did not consume enough vegetable (38.7% took <1 bowl/day) or fruit (38.8% took <1 fruit/day). Worse still, most of them ate out in fast food stores or restaurants frequently (54.9% eating out ≥6 times/week), which were well known to serve food high in calories and salt. All these factors, together with the possible poor access by drivers to quality medical services, may explain the high prevalence of cardiovascular risk factors and undiagnosed DM in drivers. Fortunately, contrary to findings of overseas studies [7] that reported a higher smoking rates in drivers compared with others (50% vs 30%), our drivers had a low frequency of smoking (19.4%), comparable with that of our local general population [1,25,28]. This may have been attributed to the success of anti-smoking campaigns in Hong Kong.

In this study, we found by logistic regression that TG and systolic BP were associated with increased risk of undiagnosed DM, whereas exercise was associated with reduced risk. Similarly in prediabetes, LDL-cholesterol, waist and systolic BP were associated with increased risk. The results support the strategies of prevention of DM and prediabetes by controlling these modifiable risk factors through lifestyle intervention and health care measures. Unlike studies which reported beneficial effects of fruit intake on glucose metabolism [29], we failed to find such association after adjustment for known risk factors. Rather, taking more fruit was related with increased risk of prediabetes, providing further evidence that dietary fructose may increase obesity and impaired glucose tolerance [30]. That having ever been married was associated with increased risk of prediabetes was a new finding that requires further investigations.

Interestingly, female drivers seemed to be healthier compared with their male counterpart, with a lower prevalence of undiagnosed DM (8.3% vs 4.4%, $p = 0.029$) despite a higher frequency of family history of DM and central obesity. The also had fewer cardiovascular risk factors (except central obesity) and lower rate of metabolic syndrome. These were likely due to the fact that female drivers in our study were younger and practiced healthier lifestyle. They smoked much less, ate more vegetable and fruit, and visited restaurant less frequently. Furthermore, their working hours were shorter and they had worked as driver for a shorter period.

Nevertheless, our study has several limitations. The study subjects were recruited on a voluntary non-random basis that might not be representative of the driver population. Drivers with higher risk of DM and cardiovascular diseases might have been attracted to the study causing bias in the results. Another concern is the small proportion of female drivers (7.4%), although it may probably reflect the gender distribution of the driver population.

In conclusion, Hong Kong Chinese professional drivers appear to have a high prevalence of undiagnosed DM. Their rates of cardiovascular risk factors and metabolic syndrome were also high. These can partially be explained by their poor lifestyle of working long hours, few exercise and unhealthy eating habits. Taken together, professional drivers constitute a large group of high risk people prone to develop cardiovascular and renal diseases that can cause a great burden to the health care system. Furthermore, their poor health status may have an adverse impact on public safety. Therefore, more proactive lifestyle modification and health care measures targeting to professional drivers should be taken to prevent them from developing DM and cardiovascular diseases, as well as to detect and treat those with these diseases earlier. Further studies should evaluate the long-term benefit and cost effectiveness of health promotion interventions and regular health screening of professional drivers.

Conflicts of Interests

The authors declare that they have no conflict of interest.

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