

# Exploratory study on multiple health-risk behaviours among Chinese adults in Hong Kong

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## Research Article

**Keywords:** Drinking alcohol, multiple health-risk behaviours, non-communicable diseases, smoking, physical inactivity, unhealthy diet,

**Posted Date:** April 7th, 2022

**DOI:** <https://doi.org/10.21203/rs.3.rs-1348422/v1>

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# Abstract

**Background:** The World Health Organization has identified four major behavioural risk factors—tobacco use, excessive alcohol consumption, an unhealthy diet and physical inactivity—that substantially contribute to non-communicable diseases and can increase the risk of death. A literature review revealed that clustering patterns of multiple health-risk behaviours among the Chinese population have been underexplored. This study investigated the prevalence and clustering patterns of multiple health-risk behaviours and their associations with non-communicable diseases among Chinese adults in Hong Kong.

**Methods:** A large sample survey was conducted in all 18 districts of Hong Kong between 21 June and 31 August 2021. A behavioural health-risk factor survey was used to collect demographic data and information regarding smoking, alcohol consumption, physical inactivity and an unhealthy diet.

**Results:** A total of 5,737 adults completed the survey. Overall, 4,605 (80.3%) had at least one health-risk behaviour, and 2,696 (47.0%) had two or more health-risk behaviours. Multiple health-risk behaviours were more prevalent among men. The prevalence of smoking and alcohol consumption among Hong Kong Chinese women was considerably lower than in most Western countries. In contrast to previous findings, this study revealed that a high proportion of adults with high educational attainment or household income had multiple health-risk behaviours. In addition, this study revealed that the health-risk behaviours in Chinese adults co-occurred in clusters, with smoking and alcohol consumption co-occurring with other health-risk behaviours. Those who smoked or consumed alcohol had the highest proportion of multiple health-risk behaviours and the highest proportion of non-communicable diseases.

**Conclusion:** This study addressed the gaps in the literature by examining the clustering patterns of multiple health-risk behaviours among Hong Kong Chinese adults. The findings add further evidence that health-risk behaviours co-occur in clusters and can contribute to non-communicable diseases.

**Trial registration:** Registered at [clinicaltrials.org](https://clinicaltrials.org) (NCT04961073) on 14/07/2021.

## Background

Non-communicable diseases (NCDs), including cardiovascular diseases, cancer, diabetes and chronic respiratory diseases, are the most common and preventable causes of morbidity and mortality worldwide [1, 2]. According to the World Health Organization (WHO), 41 million (71%) of the 57.7 million global deaths each year are attributed to NCDs [3]. The total number of annual deaths related to NCDs is expected to further increase to 55 million by 2030 unless urgent preventive measures are taken [1].

Hong Kong is facing an increasing burden of NCDs, which is compounded by population ageing [4]. In 2016, 25,771 registered deaths (approximately 55% of all deaths) were attributed to NCDs [5]. In addition, NCDs caused 104,600 potential years of life lost before the age of 70 [4].

The WHO has identified four major behavioural risk factors that substantially contribute to NCDs and can increase the risk of death; these are tobacco use, excessive alcohol use, an unhealthy diet and physical inactivity [1]. The WHO has also designated four metabolic risk factors: high blood pressure, overweight/obesity, hyperglycaemia and hyperlipidaemia [3]. Most premature deaths from NCDs could have been prevented through lifestyle modifications [6]. Therefore, assisting people to engage in healthy lifestyle practices, such as quitting smoking, avoiding excessive alcohol use, maintaining a balanced diet and engaging in regular physical activity, can help prevent NCDs and improve the overall health of the population. However, despite their awareness of the associated health hazards, many people lack motivation or find it difficult to modify their health-risk behaviours, especially when there is little advice and support from healthcare professionals [7–10]. In addition, health-risk behaviours co-occur in clusters, such that many people engage in multiple behaviours [11–13]. A sample of 16,818 adults from the 1998 US National Health Interview Survey revealed that 52% had two or more health-risk factors, including physical inactivity, overweight, cigarette smoking and excessive alcohol consumption. [12]. Our previous study on youth smokers in Hong Kong found associations between smoking and physical inactivity, and between an unhealthy diet and alcohol consumption [14]. Research findings indicate that people with multiple health-risk behaviours have higher morbidity and mortality rates than those with a single health-risk behaviour [11–15]. However, previous studies have shown that people with multiple health-risk behaviours face more challenges in the adoption of a healthy lifestyle than those with a single health-risk behaviour [11, 12, 16]. Moreover, a review of the literature showed that many intervention studies of health-risk behaviours have targeted only a single behaviour, while few have addressed multiple behaviours [12]. It is therefore crucial to develop and evaluate appropriate interventions that target people with multiple risk behaviours to help them refrain from health-risk behaviours and adopt a healthy lifestyle, either sequentially or concurrently. First, however, a thorough understanding of the clustering of multiple health-risk behaviours and the factors associated with such behaviours is crucial before appropriate interventions can be developed and evaluated. A review of the literature revealed that clustering patterns of multiple health-risk behaviours among the Chinese population are underexplored. Thus, this study aimed to investigate the prevalence and clustering patterns of multiple health-risk behaviours among Chinese adults in Hong Kong and their association with NCDs.

## Methods

### Design and sample

We surveyed a large sample to develop a robust understanding of multiple health-risk behaviours among Hong Kong Chinese adults. A convenience sample of Chinese adults aged 30 years or older who were able to speak Cantonese and read Chinese were recruited at select locations in all 18 districts of Hong Kong. To obtain a representative sample, the research team recruited at least 300 adults from each district for a total sample size of approximately 5,400. After receiving an explanation of the study's purpose, informed written consent was obtained from each eligible participant. Data collection was conducted between 21 June and 31 August 2021, and 70 sessions of recruitment and survey activities were organized. The survey was conducted via face-to-face interviews by trained research assistants.

The reason for including people aged 30 years or older was that NCDs are increasingly seen in the younger population, although the majority of NCD onset occurs in those aged 40–50 years.

## Assessment

A behavioural health-risk factor survey was used to collect demographic data and information regarding health-risk behaviours. The survey was a modified version of a Hong Kong Department of Health survey. The demographic data included age, gender, socioeconomic status and presence of NCDs. Body mass index (BMI) and information on four major health-risk behaviours—(1) smoking, (2) alcohol consumption, (3) physical inactivity and (4) unhealthy diet—were collected.

To assess smoking, participants were asked about their smoking history (currently, formerly or never). Current smokers were asked how many cigarettes they smoked on average per day and whether they had smoked at least one cigarette per day over the past 30 days. Alcohol consumption was assessed based on the frequency and amount of consumption and on the number of binge drinking episodes (the consumption of five or more standard drinks on one occasion) in the past year. To assess physical activity levels, participants were provided with examples of moderate and vigorous physical activities. They were then asked whether they had performed any moderate-intensity or vigorous-intensity aerobic physical activity in the previous 7 days and the duration of the activity. To assess diet, participants were asked on how many days of the previous 7 did they consume fruit and vegetables and the amount consumed. The criteria for determining whether the person engaged in each health-risk behaviour are listed in Table 1.

Table 1  
Criteria for determining engagement in health-risk behaviours

<b>Health-risk behaviour</b>	<b>Criteria for engaging in the health-risk behaviour</b>
Tobacco use	Smoked at least one cigarette per day for the past 30 days
Alcohol consumption	Consumed alcohol regularly (i.e. at least 1 day per week) in the 12 months preceding the survey
Unhealthy diet	Consumed less than five servings of fruit and vegetables per day or had a daily intake of less than 400 grams of fruit and vegetables
Physical inactivity	(1) Performed less than 150 minutes of moderate-intensity aerobic physical activity throughout the week, or (2) performed less than 75 minutes of vigorous-intensity aerobic physical activity throughout the week

This survey study was approved by the institutional review board of the University of Hong Kong and the Hospital Authority of Hong Kong, West Cluster (Reference number: UW 21–440). This study was conformed to the principles embodied in the Declaration of Helsinki. Participants were given an information sheet that fully described the study’s purpose and nature. The participants were told that all questions being asked were related to their health and that the information provided by them would be

kept strictly confidential and for collective analysis only. The participants could terminate the interview at any time without negative consequences. The survey took approximately 20 minutes to complete.

## Analysis

SPSS for Windows (SPSS version 26.0; IBM Corp., Armonk, NY, USA) was used for the data analysis. Descriptive statistics were used to calculate the mean, standard deviation, and frequency of the demographic and health-risk behaviour data. Demographic characteristics of participants with different health-risk behaviours were compared using the chi-square test ( $\chi^2$ ).

## Patient and public involvement statement

Patients were not involved in this study.

## Results

We approached 8,687 Chinese adults and identified 7,898 eligible participants during the data collection period. Overall, 2,161 people refused to participate in the study because they were unable to stay for the 20 minutes required to complete the survey, while 5,737 people participated in the study and completed the survey, giving a response rate of 72.6%. Table 2 presents the demographic data of the participants. There were similar numbers of men and women, with a mean participant age of  $49.4 \pm 13.1$  years. The majority of participants (77%) were between 30 and 60 years old. Most participants were married (69.8%) and employed (67.1%); approximately half (44.4%) had completed upper secondary school education, and 54% had a household income above the median. According to the locally adapted classification of BMI for Chinese adults in Hong Kong, 54.6% of the respondents were classified as normal (BMI 18.5 – 23.0), 17.1% as overweight (BMI 23.0 – 25.0), 17.1% as obese (BMI > 25.0) and 11.2% as underweight (BMI < 18.5).

Table 2  
Demographic Characteristics of the Participants (N= 5737)

	Frequency (No./Total No.) <sup>a</sup>	%
<b>Age (Years)</b>		
30 to 40	1930/5737	33.6%
41 to 50	1480/5737	25.9%
61–70	794/5737	13.8%
71–80	384/5737	6.7%
<b>Sex</b>		
<b>Male</b>	2867/5737	49.9%
<b>Female</b>	2870/5737	50.1%
<b>Marital status</b>		
Single	1359/5346	25.4%
Married or cohabiting	3731/5346	69.8%
Divorced, separated, or widowed	256/5346	4.8%
<b>Educational Attainment</b>		
Primary school or below	602/5364	11.2%
Lower secondary school	785/5364	14.7%
Upper secondary school	2383/5364	44.4%
Tertiary education	1594/5364	29.7%
<b>Household income</b>		
HK\$<20000	727/5737	12.7%
HK\$20000 – 39999	1913/5737	33.3%
HK\$40000 – 59999	1260/5737	22.0%
HK\$60000 or above	1837/5737	32.0%
<b>Employment status</b>		
Unemployed or retired	1878/5706	32.9%
Employed	3828/5706	67.1%

<sup>a</sup> Sample sizes varied because of missing data on some variables

	Frequency (No./Total No.) <sup>a</sup>	%
Body mass index classification		
Underweight (< 18.5)	626/5580	11.2%
Normal (18.5 to 23.0)	3048/5580	54.6%
Overweight (23.0 to 25.0)	954/5580	17.1%
Obese (> 25)	952/5580	17.1%
Non-Communicable Diseases		
	3786/5728	66.1%
Diabetes	607/5728	10.6%
Chronic respiratory diseases,	173/5728	3.0%
Cardiovascular diseases	1095/5728	19.1%
Tobacco use		
Smokers	704/5737	12.3%
Non-smokers	5033/5737	87.7%
Alcohol use		
Drinkers	734/5737	12.8%
Non-drinkers	5005/5737	87.2%
Diet intake		
Unhealthy diet intake	2353/5737	41.0%
Healthy diet intake	3384/5737	59.0%
Physical activity		
No regular physical activity	4330/5737	75.5%
Have regular physical activity	1407/5737	24.5%
<sup>a</sup> Sample sizes varied because of missing data on some variables		

## Health-risk behaviours

Of the 5,737 participants, 1,909 (33.3%) had one health-risk behaviour; 1,987 (34.6%) had two health-risk behaviours; 598 (10.4%) had three health-risk behaviours and 111 (1.9%) had four health-risk behaviours.

## Smoking

Overall, 12.3% (704 of 5,735) of the respondents were current smokers at the time of the survey. Among the current smokers, the vast majority (93.5%; 658 of 704) were daily smokers, and 39.1% (275 of 704) reported smoking at least 11 cigarettes per day.

### Alcohol consumption

During the year prior to the survey, 12.8% (734 of 5,737) of the participants consumed alcoholic beverages at least 1 day per week. Among this group, 38.4% (282 of 734) consumed alcohol at least three times per week, and 39.1% (287 of 734) reported that they had engaged in binge drinking (drinking five or more glasses/cans of alcohol on one occasion) during the past month.

### Physical activity

During the 7 days prior to the survey, 75.5% (4,330 of 5,737) of the participants had not engaged in the WHO physical activity recommendation of at least 75 minutes of vigorous-intensity or 150 minutes moderate-intensity aerobic physical activity throughout the week.<sup>17</sup>

### Fruit and vegetable consumption

During the 7 days prior to the survey, 2,353 (41.0%) of the participants had consumed less than the WHO recommendation of five servings of fruit and vegetables per day or had a daily intake of less than 400 grams of fruit and vegetables.<sup>18</sup>

### Non-communicable diseases

A total of 33.9% (1,942 of 5,728) of participants reported that they had a NCD; 10.6% (607) had diabetes, 3.0% (173) had a chronic respiratory disease, 1.2% (67) had cancer and 19.1% (1,095) had cardiovascular disease.

Table 3 compares the demographic characteristics of the participants among the four health-risk behaviours. There were significant differences regarding gender. Compared with women, more men (53.9%; 2,484 of 4,605) had at least one health-risk behaviour. In particular, 77.7% (547 of 704) and 78.7% (578 of 734), respectively, of those who regularly smoked or consumed alcohol were men. With the exception of smoking, compared with participants with lower educational attainment, a higher proportion of those with tertiary education regularly consumed alcohol (45.7%, 331 of 725); had an unhealthy diet (40.6%, 947 of 2,330); and were physically inactive (41.8%, 1,792 of 4,289). Additionally, compared with those with lower household income, a higher proportion of participants with higher household income (HK \$60,000 or above) were smokers (42.3%, 298 of 704); regularly consumed alcohol (35.7%, 262 of 734); had an unhealthy diet (37.3%, 879 of 2,330); and were physically inactive (31.5%, 1,362 of 4,289). Moreover, compared with participants with other health-risk behaviours, a higher proportion of smokers (50.9%, 358 of 703) and regular alcohol consumers (49.2%, 360 of 733) had NCDs. There were significant differences in NCDs among the four health-risk behaviours, with more smokers having chronic respiratory

diseases (8.2%, 58 of 703) and cardiovascular diseases (26.9%, 189 of 703) and more alcohol consumers having diabetes (24.3%, 178 of 733).

Table 3  
Demographic Characteristics of the Participants among the four health-risk behaviours (N = 4605)

	<b>Total</b>	<b>Smoking</b>	<b>Alcohol consumption</b>	<b>Unhealthy Diet</b>	<b>Physical Inactivity</b>	<b>Physical Inactivity</b>
	Frequency No (%)					
<b>Age (Years)</b>	(N = 4605)	(N = 704)	(N = 734) <sup>a</sup>	(N = 2353)	(N = 4330) <sup>a</sup>	(N = 4330)
30 to 40	1693 (36.8)	180 (25.6)	257 (35.0)	923 (39.2)	1586 (36.5)	1586 (36.5)
41 to 50	1181 (25.6)	210 (29.7)	190 (25.9)	602 (25.6)	1114 (25.7)	1114 (25.7)
51 to 60	768 (16.7)	148 (21.0)	143 (19.5)	374 (15.9)	721 (16.7)	721 (16.7)
61–70	586 (12.7)	113 (16.1)	88 (12.0)	269 (11.4)	548 (12.7)	548 (12.7)
71–80	275 (6.0)	47 (6.7)	48 (6.5)	133 (5.7)	263 (6.1)	263 (6.1)
81–90	102 (2.2)	6 (0.9)	8 (1.1)	52 (2.2)	98 (2.3)	98 (2.3)
<b>Sex</b>	(N = 4605)	(N = 704)	(N = 734)	(N = 2353)	(N = 4330) <sup>a</sup>	(N = 4330) <sup>a</sup>
<b>Male</b>	2484 (53.9)	547 (77.7)	578 (78.7)	1389 (59.0)	2293 (53.0)	2293 (53.0)
<b>Female</b>	2121 (46.1)	157 (22.3)	156 (21.3)	964 (41.0)	2037 (47.0)	2037 (47.0)
<b>Marital status</b>	(N = 4226) <sup>a</sup>	(N = 698)	(N = 729)	(N = 2335)	(N = 4302) <sup>a</sup>	(N = 4302) <sup>a</sup>
Single	1176 (27.6)	154 (22.1)	179 (24.6)	653 (28.0)	1084 (25.2)	1084 (25.2)
Married or cohabiting	2885 (67.6)	456 (65.3)	457 (62.6)	1405 (60.1)	2726 (63.4)	2726 (63.4)
Divorced, separated, or widowed	205 (4.8)	88 (12.6)	93 (12.8)	277 (11.9)	492 (11.4)	492 (11.4)

<sup>a</sup> Sample sizes varied because of missing data on some variables

	<b>Total</b>	<b>Smoking</b>	<b>Alcohol consumption</b>	<b>Unhealthy Diet</b>	<b>Physical Inactivity</b>	<b>Physical Inactivity</b>
Educational Attainment	(N = 4280) a	(N = 697)	(N = 725)	(N = 2330)	(N = 4289) a	(N = 4289)
Primary school or below	456 (10.7)	63 (9.0)	54 (7.4)	237 (10.2)	601 (14.0)	601 (14.0)
Lower secondary school	604 (14.1)	197 (28.3)	151 (20.8)	450 (19.3)	659 (15.4)	659 (15.4)
Upper secondary school	1921 (44.9)	283 (40.6)	189 (26.1)	696 (29.9)	1237 (28.8)	1237 (28.8)
Tertiary education	1299 (30.3)	154 (22.1)	331 (45.7)	947 (40.6)	1792 (41.8)	1792 (41.8)
Household Income	(N = 4605)	(N = 704)	(N = 734)	(N = 2353)	(N = 4302) a	(N = 4330)
HK\$<20000	577 (12.5)	14 (2.0)	23 (3.1)	86 (3.7)		516 (11.9)
HK\$20000 – 39999	1407 (30.6)	185 (26.3)	187 (25.5)	719 (30.6)		1343 (31.0)
HK\$40000 – 59999	1197 (26.0)	207 (29.4)	262 (35.7)	669 (28.4)		1109 (25.6)
HK\$60000 or above	1424 (30.9)	298 (42.3)	262 (35.7)	879 (37.3)		1362 (31.5)
Employment status	(N = 4578) a	(N = 699)	(N = 730)	(N = 2337)	(N = 4306) a	(N = 4306)
Unemployed or retired	1353 (29.6)	206 (29.5)	170 (23.3)	675 (28.9)	1280 (29.7)	1280 (29.7)
Employed	3225 (70.4)	493 (70.5)	560 (76.7)	1662 (71.1)	3026 (70.3)	3026 (70.3)
BMI	(N = 4456) a	(N = 679)	(N = 722)	(N = 2275)	(N = 4182) a	(N = 4182)
Underweight (< 18.5)	506 (11.4)	49 (7.2)	44 (6.1)	259 (11.4)	486 (11.6)	486 (11.6)
Normal (18.5 to 23.0)	2429 (54.5)	350 (51.5)	349 (48.3)	1199 (52.7)	2296 (54.9)	2296 (54.9)

<sup>a</sup> Sample sizes varied because of missing data on some variables

	Total	Smoking	Alcohol consumption	Unhealthy Diet	Physical Inactivity	Physical Inactivity
Overweight (23.0 to 25.0)	725 (16.3)	131 (19.4)	138 (19.1)	365 (16.0)	680 (16.3)	680 (16.3)
Obese (> 25)	796 (17.8)	149 (21.9)	191 (26.5)	452 (19.9)	720 (17.2)	720 (17.2)
Non-Communicable Diseases	(N = 4596) a	(N = 703)	(N = 733)	(N = 2347)	(N = 4322) a	(N = 4322)
No	3063 (66.6)	345 (49.1)	373 (50.8)	1514 (64.5)	2848 (65.9)	2848 (65.9)
Diabetes	495 (10.8)	105 (14.9)	178 (24.3)	280 (11.9)	468 (10.8)	468 (10.8)
Chronic respiratory diseases	146 (3.2)	58 (8.2)	24 (3.3)	88 (3.7)	142 (3.3)	142 (3.3)
Cancer	43 (0.9)	6 (0.9)	7 (1.0)	19 (0.8)	40 (0.9)	40 (0.9)
Cardiovascular diseases	849 (18.5)	189 (26.9)	151 (20.6)	446 (19.1)	824 (19.1)	824 (19.1)
a Sample sizes varied because of missing data on some variables						

Table 4 compares the demographic characteristics of participants with different numbers of health-risk behaviours. There were significant differences regarding gender, with more women having only one health-risk behaviour (56.1%, 1,070 of 1,909) and more men having two or more health-risk behaviours. In particular, of the participants with three or four health-risk behaviours, 78.9% (472 of 598) and 92.8% (103 of 111) were men, respectively. Moreover, of those with three or four health-risk behaviours, a larger proportion were people with higher educational attainment or household income compared with those with lower educational attainment or household income. Additionally, a higher proportion of participants with four health-risk behaviours had NCDs (57.7%, 64 of 111) compared with those with only one health-risk behaviour (28.2%, 537 of 1,907).

Table 4  
Demographic Characteristics of the Participants with different numbers of health-risk behaviours (N = 4605)

	<b>Total</b>	<b>One risk</b>	<b>Two risks</b>	<b>Three risks</b>	<b>Four risks</b>
	Frequency No (%)				
<b>Age (Years)</b>	(N = 4605)	(N = 1909)	(N = 1987)	(N = 598)	(N = 111)
30 to 40	1693 (36.8)	688 (36.0)	787 (39.6)	188 (31.5)	30 (27.0)
41 to 50	1181 (25.6)	478 (25.0)	499 (25.1)	176 (29.4)	28 (25.3)
51 to 60	768 (16.7)	313 (16.5)	321 (16.2)	105 (17.6)	29 (26.1)
61–70	586 (12.7)	269 (14.1)	219 (11.0)	81 (13.5)	17 (15.3)
71–80	275 (6.0)	115 (6.0)	111 (5.6)	42 (7.0)	7 (6.3)
81–90	102 (2.2)	46 (2.4)	50 (2.5)	6 (1.0)	0 (0.0)
<b>Sex</b>	(N = 4605)	(N = 1909)	(N = 1987)	(N = 598)	(N = 111)
<b>Male</b>	2484 (53.9)	839 (43.9)	1070 (53.9)	472 (78.9)	103 (92.8)
<b>Female</b>	2121 (46.1)	1070 (56.1)	917 (46.1)	126 (21.1)	8 (7.2)
<b>Marital status</b>	(N = 4226) a	(N = 1771)	(N = 1846)	(N = 547)	(N = 102)
Single	1176 (27.6)	478 (27.0)	527 (28.5)	146 (26.7)	25 (24.5)
Married or cohabiting	2885 (67.6)	1231 (69.5)	1217 (65.9)	369 (67.5)	68 (66.7)
Divorced, separated, or widowed	205 (4.8)	62 (3.5)	102 (5.6)	32 (5.8)	9 (8.8)
<b>Educational Attainment</b>	(N = 4280) a	(N = 1786)	(N = 1838)	(N = 548)	(N = 108)
Primary school or below	456 (10.7)	203 (11.4)	187 (10.2)	53 (9.7)	13 (12.0)
Lower secondary school	604 (14.1)	231 (12.9)	234 (12.7)	114 (20.8)	25 (23.1)
Upper secondary school	1921 (44.9)	879 (49.2)	830 (45.2)	183 (33.4)	29 (26.9)
Tertiary education	1299 (30.3)	473 (26.5)	587 (31.9)	198 (36.1)	41 (38.0)
<b>Household Income</b>	(N = 4605)	(N = 1909)	(N = 1987)	(N = 598)	(N = 111)
HK\$<20000	577 (12.5)	520 (27.2)	52 (2.6)	5 (0.8)	0 (0.0)

	<b>Total</b>	<b>One risk</b>	<b>Two risks</b>	<b>Three risks</b>	<b>Four risks</b>
HK\$20000 – 39999	1407 (30.6)	551 (28.9)	707 (35.6)	127 (21.2)	22 (19.8)
HK\$40000 – 59999	1197 (26.0)	450 (23.6)	478 (24.1)	235 (39.3)	34 (30.7)
HK\$60000 or above	1424 (30.9)	388 (20.3)	750 (37.7)	231 (38.7)	55 (49.5)
Employment status	(N = 4578) a	(N = 1901)	(N = 1971)	(N = 595)	(N = 111)
Unemployed or retired	1353 (29.6)	588 (30.9)	583 (29.6)	151 (25.4)	31 (27.9)
Employed	3225 (70.4)	1313 (69.1)	1388 (70.4)	444 (74.6)	80 (72.1)
BMI	(N = 4456) a	(N = 1852)	(N = 1914)	(N = 582)	(N = 108)
Underweight (< 18.5)	506 (11.4)	235 (12.7)	218 (11.4)	45 (7.7)	8 (11.6)
Normal (18.5 to 23.0)	2429 (54.5)	1036 (55.9)	1067 (55.7)	280 (48.1)	46 (54.9)
Overweight (23.0 to 25.0)	725 (16.3)	293 (15.8)	299 (15.7)	109 (18.8)	24 (16.3)
Obese (> 25)	796 (17.8%)	288 (15.6)	330 (17.2)	148 (25.4)	30 (17.2)
Non-Communicable Diseases	(N = 4596) a	(N = 1907)	(N = 1980)	(N = 598)	(N = 111)
No	3063 (66.6)	1370 (71.8)	1316 (66.5)	330 (55.2)	47 (42.3)
Diabetes	495 (10.8)	176 (9.2)	217 (11.0)	87 (14.5)	15 (13.6)
Chronic respiratory diseases	146 (3.2)	37 (1.9)	62 (3.1)	37 (6.2)	10 (9.0)
Cancer	43 (0.9)	21 (1.1)	16 (0.8)	5 (0.9)	1 (0.9)
Cardiovascular diseases	849 (18.5)	303 (16.0)	369 (18.6)	139 (23.2)	38 (34.2)
a Sample sizes varied because of missing data on some variables					

Table 5 shows the clustering of four health-risk behaviours. Among all health-risk behaviours, smokers had the highest proportion of those with multiple health-risk behaviours (97.6%, 687 of 704). Those who regularly consumed alcohol had the second-highest proportion of having multiple health-risk behaviours, with 94.7% (695 of 734) having more than one health-risk behaviour.

Table 5  
The clustering of four health-risk behaviours (N = 4605)

	<b>One risk behaviour</b>	<b>Two risk behaviours</b>	<b>Three risk behaviours</b>	<b>Four risk behaviours</b>
	Frequency [No./Total No. (%)]			
Smoking	17/704 (2.4)	197/704 (28.0)	379/704 (53.8%)	111/704 (15.8)
Alcohol consumption	39/734 (5.3)	258/734 (35.1)	326/734 (44.4)	111/734 (15.1)
Unhealthy diet	141/2353 (6.0)	1584/2353 (67.3)	517/2353 (22.0)	111/2353 (4.7)
Physical inactivity	1712/4330 (39.5)	1935/4330 (44.7)	572/4330 (13.2)	111/4330 (2.6)
Total	1909/4605 (41.5)	1987/4605 (43.1)	598/4605 (13.0%)	111/4605 (2.4)

The results also revealed clustering patterns of multiple health-risk behaviours. Of the 704 smokers, 231 (32.8%) regularly consumed alcohol. In addition, of the 4,330 respondents who were physically inactive, 2,147 (49.6%) had an unhealthy diet.

## Discussion

To the best of our knowledge, this is the first large survey study conducted to examine the number, types and clustering of health-risk behaviours among Hong Kong Chinese adults. A strength of this study is that the data collection was conducted through face-to-face interviews. Compared with large survey studies conducted via phone interviews, face-to-face interviews might enhance the response rate and the reliability of the findings [19]. Another strength is that this study was conducted in all 18 districts of Hong Kong and included a wide age spectrum of the population, thereby increasing the sample representativeness. Thus, the findings are more generalizable to the entire population.

Consistent with the National Health Interview Survey conducted in the United States [12], this study showed that over 80% of participants (4,605 of 5,737) had at least one health-risk behaviour, and 47.0% (2,696 of 5,737) had two or more health-risk behaviours. Physical inactivity was the most commonly reported health-risk behaviour (75.5%). Physical inactivity has been identified as one of the behavioural risk factors that contribute to NCDs and is the major cause of premature death worldwide [20]. Although the Hong Kong government has made efforts to promote regular physical activity in the past few decades through health education in schools and social media campaigns, these findings indicate that the government should make greater efforts and incorporate new strategies to advocate the public to be physically active.

Similar to the findings of previous studies [21, 22], this study found that multiple health-risk behaviours were more prevalent among men. The study found that the proportions of Hong Kong Chinese women who regularly smoke or consume alcohol were considerably lower than in most Western countries [23, 24]. Unlike in Western culture, in Chinese culture, it is less acceptable for women to smoke and consume alcohol [23, 24]. In Hong Kong, some people still believe that only sex workers or 'bad' women smoke and consume alcohol; thus, there is a stigma against women who smoke or consume alcohol, which can be perceived as 'bad' or 'evil'.

Previous studies conducted in Western countries have found that multiple health-risk factors are more prevalent among those of lower social class, the economically inactive and those with less education [12, 21, 22]. In contrast to previous findings, this study revealed that a high proportion of adults with higher educational attainment or household income had multiple health-risk behaviours. One possible reason for this is that most middle-class people in Hong Kong are highly educated, white-collar professionals, but they are often referred to as the 'sandwich class' because of insufficient government support and inadequate social welfare, particularly a lack of government-subsidized public housing, which has placed increasing pressure on this population [25, 26]. Moreover, many highly educated middle-class people work long hours, and their time is occupied by work and further education.<sup>27</sup> Consequently, they might encounter more difficulties, negative emotions and stress when trying to balance their busy family and working lives and in paying for the soaring cost of private housing.<sup>26</sup> These difficulties might explain why they have a higher proportion of physical inactivity compared with other population groups. In addition, owing to constant stressful life situations, they tend to engage in health-risk behaviours to relax, such as smoking and consuming alcohol.<sup>28</sup> Therefore, more attention should be given to this population. Specifically, healthcare professionals must focus on helping people understand the negative health consequences of health-risk behaviours and counsel them about alternative strategies for coping with negative emotions and stress.

This study examined the clustering patterns of multiple health-risk behaviours among Hong Kong Chinese adults. In line with previous studies conducted in the West [11–13], health-risk behaviours in Chinese adults co-occurred in clusters. Of the 4,605 participants identified to have at least one health-risk behaviour (Table 4), more than half (58.5%, 2,696 of 4,605) had two or more health-risk behaviours. Similar to previous findings [11, 29], this study identified clustering between smoking and alcohol consumption, and between an unhealthy diet and physical inactivity. The study revealed that people who smoked or consumed alcohol were more likely to have other health-risk behaviours, and this group had the highest proportion of having multiple health-risk behaviours and NCDs. Given that cigarette smoking and alcohol consumption can result in negative and serious health consequences [15, 30], more resources and effort should be allocated to help this vulnerable group to lead a healthier life.

The findings add further evidence to the literature that people with multiple health-risk behaviours have a higher likelihood of having NCDs. Therefore, more attention should be given to those with multiple health-risk behaviours by developing and evaluating effective interventions to help them adopt a healthy lifestyle.

## Limitations

This survey study relied on self-reported data. Hence, there might be response bias due to respondents under-reporting behaviours that are socially undesirable or over-reporting behaviours that are considered desirable. Additionally, there was a lack of objective assessments for NCDs. For example, some participants might not have been aware of having high blood pressure, glucose or cholesterol levels because the signs and symptoms for these metabolic risk factors are not obvious in the early stage. Consequently, self-reported NCDs might have been underestimated. To better quantify the impacts of health-risk behaviours on health outcomes, future studies should consider including biometric screening for NCDs, such as checking the participants' blood pressure, performing a lung function test, and hyperglycaemia and hyperlipidaemia blood testing. Finally, qualitative information, which might enable us to better understand participants' perceptions, behaviours and attitudes related to their health-risk behaviours, was lacking.

## Practice Implications

The results of this study indicated that multiple health-risk behaviours might contribute to the high morbidity and mortality rates associated with NCDs, which have a large impact not only on the health of individuals but also on families, the healthcare system, society and the economy [31]. Therefore, there is a need to adopt innovative approaches to motivate people to modify their health-risk behaviours and lead healthier lives. The implementation of targeted NCD interventions through the primary healthcare system is expected to improve the early screening, detection and timely treatment of NCDs. The early provision of interventions would help reduce the need for subsequent expensive treatments, thereby reducing healthcare expenditures and decreasing the economic burden on society. The successful prevention and control of NCDs rely on a collaborative effort by various stakeholders, including government bureaus and departments, academic and non-governmental organizations, the private sector and individuals. Healthcare professionals should work together to develop policies, systems, programmes and actions to mitigate NCDs by strengthening health advocacy efforts, fostering partnerships to create supportive environments, and enhancing NCD surveillance and progress monitoring. By conducting these activities, it is anticipated that in the long term there will be a meaningful and significant reduction in people's risk of developing NCDs and in the morbidity and mortality rates associated with NCDs.

## Conclusions

This study filled a knowledge gap by examining the clustering patterns of multiple health-risk behaviours and their associations with NCDs among Hong Kong Chinese adults. Health-risk behaviours, especially the presence of multiple health-risk behaviours, contribute to the development of NCDs and can increase the risk of death. Thus, the results of this study support the use of interventions to reduce these behaviours in the population.

# Abbreviations

BMI: Body mass index; NCD: Non-communicable disease; WHO: World Health Organization

# Declarations

## Acknowledgements

We thank Katherine Thieltges from Edanz (<https://www.edanz.com/ac>) for editing a draft of this manuscript.

## Authorship contribution statement

WHCL, LLKH, JOKC, WX contributed the study conceptualization and methodology design. ATC, LLKH conducted the interview. WX, PS conducted the data analysis. WHCL conduct the project administration, review & editing. WHCL, WX, LLKH, PS drafted the manuscript. All authors reviewed, and approved the final version.

## Funding

This study was funded by internal funding from University of Hong Kong

## Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author, subject to approval from the ethics committee that approved the original study.

## Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Review Board of the University of Hong Kong / Hospital Authority Hong Kong West Cluster (W 21-440). This study is registered at [clinicaltrials.org](http://clinicaltrials.org) (NCT04961073). All participants provided informed written consent. They received an explanation of the purpose of the study and were reassured about the study confidentiality and anonymous participation. They were told that they were free to withdraw from the study at any time without penalty. The researchers strictly adhered to the Declaration of Helsinki and the ethical principles in designing and conducting clinical research.

## Consent for publication

Not applicable.

## Competing interests

All authors declare no competing interests.

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