Dietary habits and physical activity during the third wave of the COVID-19 pandemic: associated factors, composite outcomes in a cross-sectional telephone survey of a Chinese population, and trend analysis

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ABSTRACT

Introduction: The coronavirus disease 2019 (COVID-19) pandemic created many challenges for Hong Kong residents attempting to maintain healthy lifestyle habits. This study aimed to measure the prevalences of unhealthy dietary habits and physical inactivity levels in Hong Kong Chinese, identify associated factors, and conduct a time trend analysis during the third wave of the COVID-19 pandemic.

Methods: A cross-sectional telephone survey was conducted in Hong Kong by simple random sampling. The survey comprised socio-demographic characteristics, clinical information, the Hong Kong Diet Score (HKDS), smoking and alcohol consumption, and a Chinese version of the International Physical Activity Questionnaire Short Form. The composite outcome was low HKDS, physical inactivity, smoking, and alcohol consumption. We used 14 Health Behaviour Survey reports from 2003 to 2019 to establish a trend analysis regarding fruit and vegetable consumption, physical activity level, smoking, and alcohol consumption.

Results: We performed 1500 complete telephone surveys with a response rate of 58.8%. Most participants were older adults (≥65 years, 66.7%), women (65.6%), and married (77.9%). The HKDS was significantly lower in men, single individuals, low-income participants, alcohol drinkers, and patients with diabetes mellitus or renal disease. Participants who were single, undergoing long-term management of medical diseases, or had diabetes or renal diseases exhibited greater likelihood of physical inactivity.

Conclusion: Prevalences of unhealthy lifestyle habits were high among men, single individuals, and chronic disease patients during the third wave of the COVID-19 pandemic in Hong Kong. The adoption of physical activity habits tended to decrease in the past two decades.

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New knowledge added by this study

- This population-based survey indicated that a larger proportion of Hong Kong residents, compared with pre-pandemic years, had a non-healthy lifestyle during the third wave of the coronavirus disease 2019 pandemic.
- Majority of participants had a low Hong Kond Diet Score, suggesting minimal adherence to the traditional Chinese eating pattern; these participants were mainly younger individuals and men.

Implications for clinical practice or policy

- There is an urgent need to formulate and implement effective public health strategies at both individual and organisational levels. The encouragement of healthy lifestyles through evidence-based health promotion programmes is essential, which could be conveyed to communities through organised and concerted efforts by the government and relevant stakeholders.
- Future studies should evaluate the effectiveness of various interventions and approaches to achieve these important goals.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has affected >770 million people worldwide, causing >7 million deaths as of 31 December 2023.[1] The period between July and September 2020 constituted the third wave of the pandemic in Hong Kong,

第三波新冠疫情的飲食習慣及體能活動：相關因素、華裔人口橫斷面電話調查的綜合結果及趨勢分析

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引言：新冠疫情為香港市民保持健康生活習慣帶來挑戰。本研究旨在找出華裔港人在第三波新冠疫情期間的不健康飲食習慣及體能活動不足程度與相關因素，並進行時間趨勢分析。

方法：我們以簡單隨機抽樣法在香港進行橫斷面電話調查，內容包括社會人口特徵、臨床資料、香港飲食評分、吸煙及喝酒情況，以及國際體力活動問卷調查簡短中文版。綜合結果為香港飲食評分低、體能活動不足、吸煙及喝酒。我們使用2003年至2019年間共14份健康行為調查報告進行有關食用水果及蔬菜、體能活動水平、吸煙及喝酒的時間趨勢分析。

結果：我們完成了1500個電話調查，回應率為58.8%。大部分受訪者是長者（≥65歲，66.7%）、女性（65.6%）及已婚（77.9%）。男性、單身人士、低收入人士、喝酒者及糖尿或腎病患者的香港飲食評分顯著較低。單身人士、需長期管理疾病者或糖尿或腎病患者較大機會體能活動不足。

結論：本港第三波新冠疫情期間，男性、單身人士及慢性病患者的生活習慣普遍較不健康。過去20年間市民養成體能活動習慣呈下降趨勢。

resulted in >1.2 million reported cases between 23 January 2020 and 29 January 2023.[2] The containment strategies implemented during the third wave included mandatory mask wear in public places, even when exercising in public outdoor areas; suspensions of public leisure facilities and private gyms; and the initiation of work-from-home arrangements.[3] These strategies led to reductions in physical activity and daily movement, with the goal of viral containment. Furthermore, compulsory social distancing and suspension of dine-in services were included among the policies that could affect various dietary and lifestyle habits, although these methods were less stringent than approaches in cities under lockdown. Overall, the unprecedented public health crisis created many challenges for Hong Kong residents attempting to maintain healthy lifestyle habits. Nevertheless, few studies have examined dietary and physical activity habits in the general population during the COVID-19 pandemic.[4-6]

Considering that individuals with chronic diseases are more likely to develop severe cases of COVID-19, this study aimed to measure the prevalences of unhealthy dietary habits and physical inactivity levels in an adult Chinese population, to identify factors associated with their adoption of these dietary and physical activity habits, and to perform a time trend analysis comparing the proportions of the population that adopted healthy dietary habits, physical activity levels, and avoidance of smoking and alcohol consumption during the third wave of the COVID-19 pandemic.

Methods

Sampling

We utilised a methodology similar to a previous population-based, random telephone survey conducted in Hong Kong.[7] Two-stage sampling was performed, in which participants were recruited by trained interviewers through a telephone interview system based on telephone calls to landlines identified by random digit dialling. The sample population was randomly selected by the Centre for Health Behaviours Research at The Chinese University of Hong Kong. Calls were made during typical office hours, 9 am to 5 pm, Monday through Saturday between 7 and 31 October 2020. Three attempts were made if the call initially was not answered. Territory-wide, any Chinese adults aged ≥18 years who could communicate in Chinese via telephone were eligible to participate. Assuming an outcome variable rate of 35%, at least 1456 participants were required to achieve a precision level of 2.5% from the following formula:

$$\text{Precision} = 1.96 \times \sqrt{(p) \times (1-p)/N}$$

where 'p' stands for proportion and 'N' stands for sample size.

The interviews were performed using a fieldwork manual highlighting standard operating procedures by a team of trained interviewers and supervised by an experienced project coordinator throughout the study. The characteristics of survey participants are shown in Table 1.

Survey instrument

The survey consisted of five sections: (1) socio-demographic details (age, sex, marital status, education level, job status, household income, and receipt of comprehensive social security assistance); (2) clinical information (eg, presence of chronic diseases); (3) smoking (current daily amount/ex-/non-smoker) and alcohol consumption habits (daily amount in the preceding 7 days); (4) dietary screening via the Hong Kong Diet Score (HKDS), using a validated scale that contained nine items assessing the participant's daily consumption of nine food groups in the preceding 7 days; and (5) level of physical activity in the preceding 7 days, as determined by a Chinese version of the 7-item International Physical Activity Questionnaire Short Form (IPAQ-C).

Scoring of the Hong Kong Diet Score, International Physical Activity Questionnaire, and unhealthy lifestyle score

The traditional Mediterranean diet is well-defined and has been positively associated with favourable

health outcomes.[8-10] The Mediterranean diet score is used to measure compliance with a traditional Mediterranean diet. This scoring system has been widely utilised in studies that measure Mediterranean diet adherence or adaptation as an indicator of healthy dietary choices. In this study, we developed the HKDS, a dietary screener that contained nine items assessing dietary intake of nine food groups (alcohol, legumes, grains, fruits, vegetables, meats, dairy, red/orange vegetables, and fatty fish) in the preceding 7 days. The screener incorporated key traditional Greek diet characteristics, known as the Mediterranean diet score of de Groot et al,[8] which were also used in a study of Hong Kong Chinese by Woo et al (Table 2).[11] The original 8-item survey was modified by removing the ratio of monounsaturated fatty acids to saturated fatty acids and replacing ethanol with alcohol. Dietary fatty acids and ethanol are widely distributed among various food groups; they are typically assessed through weighted foods, which are unlikely to be accurately determined using a single question in a telephone interview. Two additional items were included regarding carotenoid-rich and omega-3–rich food intake based on the Hong Kong Centre for Food Safety Recommended Nutrient Intake for vitamin A[12] and the World Health Organization recommendation for omega-3. Both nutrients are inversely associated with incidence of non-communicable diseases (NCDs). For each item, consumption at or above the recommended amount was scored as 1 point and 0 points otherwise; however, for ethanol, consumption below the specified amount was scored as 1 point and 0 points otherwise. Each participant received a total score of 0 to 9; a score of ≥5 was considered high. A pilot survey was conducted with a convenience sample of 23 participants. Intraclass correlation coefficient estimates and 95% confidence intervals (CIs) were determined using a two-way mixed-effects model to assess internal consistency regarding the number of serves (ie, serving sizes of the food group consumed) reported. The intraclass correlation coefficient was 0.87, indicating good reliability. Cohen's κ was calculated to evaluate agreement between test and retest scores. Agreement between the two tests was fair (κ=0.24, 95% CI=-0.15 to 0.63; P=0.239).

The IPAQ-C score was regarded as a categorical variable indicating exercise level based on the frequency and intensity of physical activity: (1) low (total activity <600 metabolic equivalent of task [MET]–minutes/week), (2) moderate (total activity ≥600 MET-minutes/week), or (3) high (total activity >3000 MET-minutes/week).

Finally, an unhealthy lifestyle score (0 to 4) was assigned to each participant based on a composite outcome involving low HKDS, physical inactivity, current smoking habit, and alcohol consumption; each unhealthy habit contributed 1 point to the score.

Data analysis

We used SPSS software (Windows version 26.0; IBM Corp, Armonk [NY], United States) for data analysis. Descriptive analyses were performed regarding the participants' socio-demographic details, clinical information (eg, presence of chronic diseases), and the HKDS. The primary outcome variables included: (1) unhealthy dietary habits (low HKDS score); (2) suboptimal physical activity (low IPAQ-C score, indicating low exercise level); and (3) unhealthy lifestyle score (≥2). Univariable logistic regression was performed to examine associations between socio-demographic variables and each of the first two outcome variables. Multivariable logistic regression was modelled by controlling for covariates with P values <0.20 in univariable regression analysis, a cut-off level commonly used in public health research. For example, Torenfält and Dimberg[13] utilised this approach when evaluating stroke and death in middle-aged Swedish men. The approach was also used in a French study[14] concerning medical features of patients with COVID-19 and influenza. Additionally, linear regression analysis was conducted in the present study to examine associations between socio-demographic variables and the unhealthy lifestyle score. Time trends for various food intake, physical inactivity, current smoking, and alcohol consumption statuses were evaluated; the prevalences of these lifestyle habits were compared with population-wide figures from governmental reports over the past two decades using the Chi squared test for heterogeneity. P values <0.05 were considered statistically significant.

Data sources for time trend comparisons

The Centre for Health Protection has been conducting health surveys periodically since 2003 to collect information about health and lifestyle-related behaviours, as well as practices related to the prevention of NCDs among residents aged ≥15 years.[15] The resulting reports have presented key findings concerning physical activity, dietary habits, alcohol consumption, and smoking habits, as well as other self-care practices. We gathered relevant findings from 14 governmental reports covering the period from 2003-2004 to 2018-2019 (calendar years with the most updated figures)[15] to perform trend analysis of fruit and vegetable consumption, physical activity level, smoking, and alcohol consumption status among Hong Kong residents. These results were compared with the findings of the present study; adjustments were solely performed for sex because the age distribution was limited in all but the most recent reports.

Results

In total, 2551 individuals were contacted for

TABLE 1. Participant characteristics (n=1500)

	No. (%)
Age, y	
18-44	183 (12.2%)
45-64	317 (21.1%)
65-74	550 (36.7%)
≥75	450 (30.0%)
Sex	
Male	516 (34.4%)
Female	984 (65.6%)
Marital status	
Married	1168 (77.9%)
Single/divorced/widowed	319 (21.3%)
Refused to answer	13 (0.9%)
Working status	
Full-time or part-time	325 (21.7%)
Housewife or retired	1129 (75.3%)
Refused to answer	46 (3.1%)
Job type	
Professional and office work	601 (40.1%)
Manual work	552 (36.8%)
Housewife/student	309 (20.6%)
Refused to answer	38 (2.5%)
Education level	
Primary or below	728 (48.5%)
Secondary	514 (34.3%)
Tertiary or above	244 (16.3%)
Refused to answer	14 (0.9%)
Household monthly income, HK$	
<10 000	616 (41.1%)
10 000-29 999	355 (23.7%)
≥30 000	239 (15.9%)
Refused to answer	290 (19.3%)
Self-reported health status	
Very good or good	774 (51.6%)
Average	638 (42.5%)
Very poor or poor	88 (5.9%)
Long-term medical management of chronic diseases	
No	682 (45.5%)
Yes	818 (54.5%)
Diabetes mellitus	315 (21.0%)
Cardiovascular disease	111 (7.4%)
Chronic obstructive pulmonary disease	0
Liver disease	2 (0.1%)
Renal disease	18 (1.2%)
Hypertension	640 (42.7%)
Cancer, all sites	24 (1.6%)

Abbreviations: HK$ = Hong Kong dollars; HKDS = Hong Kong Diet Score

TABLE 1. (cont'd)

	No. (%)
Smoking status	
Smoker	42 (2.8%)
Ex-smoker/non-smoker	1458 (97.2%)
Alcohol consumption in the preceding 1 week	
Drinker	127 (8.5%)
Non-drinker	1371 (91.4%)
Refused to answer	2 (0.1%)
HKDS	
5-9 (high score)	733 (48.9%)
0-4 (low score)	766 (51.1%)
Refused to answer	1 (0.1%)
Dietary habits (based on the HKDS food groups)	
Alcohol	1495 (99.7%)
Legumes	22 (1.5%)
Grains	754 (50.3%)
Fruits	356 (23.7%)
Vegetables	1001 (66.7%)
Meats	1086 (72.4%)
Dairy	1479 (98.6%)
Red/orange vegetables	198 (13.2%)
Fatty fish	326 (21.7%)
Physical activity level	
Low	532 (35.5%)
Moderate	810 (54.0%)
High	158 (10.5%)

a telephone interview and 1500 participated; the response rate was 58.8%. Most interviewed individuals were older adults (≥65 years, 66.7%), women (65.6%), and married (77.9%). Of the participants, 40.1% were engaged in professional and office work; only 16.3% had attained a tertiary education or higher. About 16% of participants reported a household income ≥HK$30 000, whereas 41.1% reported a household income <HK$10 000. Health status was predominately self-reported as average (42.5%) or above average (51.6%). More than half of the participants (54.5%) were undergoing long-term medical management or were taking medications for chronic diseases; the most common chronic conditions were diabetes mellitus (21.0%) and hypertension (42.7%) [Table 1].

Prevalence of low dietary score among Hong Kong Chinese

Dietary habits, as measured by the HKDS (score

TABLE 2. Prevalence of low dietary scores according to participant characteristics[*]

	HKDS (current study)[†]	MDS (2001)[11 ‡ §]
Age, y		
≤34[¶]	66%	49%
35-54[¶]	65%	38%
≥55[¶]	47%	36%
Sex		
Male[¶]	58%	50%
Female[¶]	47%	29%
Household monthly income, HK$		
<10 000	54%	
10 000-29 999	53%	
>30 000	43%	
Chronic diseases		
Diabetes mellitus	60%	
Cardiovascular disease	47%	
Renal disease	78%	
Hypertension	48%	
Cancer, all sites	50%	
Smoking		
Smoker	69%	
Non-smoker	51%	
Alcohol consumption		
Drinker	67%	
Non-drinker	50%	
Physical activity level		
Low	62%	
Moderate	45%	
High	43%	

Abbreviations: HK$ = Hong Kong dollars; HKDS = Hong Kong Diet Score; MDS = Mediterranean Diet Score

* Data are shown as %, calculated as No. of participants scoring low HKDS divided by the total participants in the category
† High score=5-9; low score=0-4
‡ High score=4-7; low score=0-3
§ Comparison with low MDS is based on modified dietary recommendations
¶ Chi squared differences between HKDS and MDS, P<0.005

range, 2-9), were classified as high scoring (5-9) or low scoring (0-4). Approximately 51% of participants had a low score (Table 1), suggesting minimal adherence to the traditional Chinese eating pattern; these participants were mainly younger individuals (aged ≤34 years, 66%) and men (58%) [Table 2]. Greater proportions of participants with lower income, current smokers, and current drinkers had low scores according to the HKDS (54%, 69%, and 67%, respectively) [Table 2]. Participants with chronic diseases had various HKDS results; <50% of patients with renal diseases and diabetes had a high score, and this result indicated that they had a poor dietary habits.

Dietary habits and physical activity

A greater risk of practising unhealthy dietary habits (low HKDS) was associated with male sex (adjusted odds ratio [aOR]=1.31, 95% CI=1.03-1.67), non-married status (ie, single/divorced/widowed) [aOR=1.56, 95% CI=1.20-2.03], a diagnosis of diabetes (aOR=1.53, 95% CI=1.15-2.03), and alcohol consumption (aOR=1.76, 95% CI=1.17-2.64) [Table 3].

Among all participants, 35.5%, 54.0% and 10.5% had low, moderate, and high levels of physical activity, respectively (Table 1). Participants who were non-married (aOR=1.66, 95% CI=1.23-2.22), undergoing long-term management of medical diseases (aOR=1.65, 95% CI=1.08-2.54), had diabetes (aOR=1.39, 95% CI=1.02 to 1.89), and had renal diseases (aOR=9.32, 95% CI=2.06-42.25) exhibited greater likelihood of physical inactivity (Table 4).

Other lifestyle habits: smoking and alcohol

Few participants were current daily smokers (2.8%) and alcohol drinkers (8.5%) [Table 1].

Factors associated with higher risk of an unhealthy lifestyle score

Factors associated with an unhealthy lifestyle score are presented in Table 5. Male sex (beta coefficient [β]=0.25, 95% CI=0.16-0.34), non-married status (β=0.19, 95% CI=0.08-0.29), manual work (β=0.17, 95% CI=0.07-0.27), self-reported poor or very poor health status (β=0.26, 95% CI=0.07-0.45), a diagnosis of diabetes (β=0.31, 95% CI=0.20-0.41), and a diagnosis of renal disease (β=0.92, 95% CI=0.53-1.31) increased the likelihood of poor lifestyle habits. Housewife or retired status (β=-0.15, 95% CI=-0.25 to -0.04) and a higher household income (≥HK$30 000; β=-0.20, 95% CI=-0.33 to -0.08) decreased the likelihood of poor lifestyle habits.

Time trend analysis of fruit and vegetable consumption, physical activity, smoking, and alcohol consumption

The Health Behaviour Survey, with a response rate of 70.8% in the 2018/2019 report, is a population-based fieldwork study conducted by the Centre for Health Protection of the Department of Health.[16] In that survey, female participants comprised 52.7% of the sample, compared with 65.6% in the present telephone survey. The age-group with the largest proportion of participants in the Survey was 65 to 74 years (36.7% vs 11.0%), which might have influenced the sex ratio.

TABLE 3. Factors associated with unhealthy dietary habits (HKDS <5) among telephone-surveyed participants (n=766)

	No. (%)	cOR	95% CI	P value*	aOR	95% CI	P value
Age, y				0.728			
18-44	88 (11.5%)		Reference				
45-64	164 (21.4%)	1.17	0.81-1.68	0.412			
65-74	277 (36.2%)	1.10	0.78-1.53	0.594			
≥75	237 (30.9%)	1.20	0.85-1.69	0.296			
Sex							
Female	466 (60.8%)		Reference			Reference	
Male	300 (39.2%)	1.54	1.24-1.91	<0.001	1.31	1.03-1.67	0.029
Marital status				0.004			0.004
Married	570 (74.4%)		Reference			Reference	
Single/divorced/widowed	187 (24.4%)	1.48	1.16-1.91	0.002	1.56	1.20-2.03	0.001
Working status				0.446			
Full-time or part-time	176 (23.0%)		Reference				
Housewife or retired	566 (73.9%)	0.85	0.67-1.09	0.207			
Job type				0.008			0.214
Professional and office work	303 (39.6%)		Reference			Reference	
Manual work	306 (39.9%)	1.23	0.97-1.55	0.082	1.02	0.76-1.37	0.893
Housewife/student	135 (17.6%)	0.76	0.58-1.01	0.055	0.75	0.55-1.03	0.079
Education level				0.096			0.116
Primary or below	379 (49.5%)		Reference			Reference	
Secondary	252 (32.9%)	0.89	0.71-1.12	0.308	0.816	0.61-1.09	0.174
Tertiary or above	123 (16.1%)	0.94	0.70-1.25	0.655	0.882	0.59-1.31	0.535
Household monthly income, HK$		0.020			0.034		
<10 000	333 (43.5%)		Reference			Reference	
10 000-29 999	188 (24.5%)	0.96	0.74-1.25	0.775	1.02	0.77-1.36	0.892
≥30 000	102 (13.3%)	0.63	0.47-0.86	0.003	0.62	0.43-0.88	0.008
Self-reported health status				0.414			
Very good or good	391 (51.0%)		Reference				
Average	324 (42.3%)	1.01	0.82-1.25	0.897			
Very poor or poor	51 (6.7%)	1.35	0.86-2.11	0.187			
Long-term medical management of chronic diseases							
No	351 (45.8%)		Reference				
Yes	415 (54.2%)	0.97	0.79-1.19	0.755			
Diabetes mellitus							
No	574 (74.9%)		Reference			Reference	
Yes	189 (24.7%)	1.58	1.23-2.04	<0.001	1.53	1.15-2.03	0.003
Cardiovascular disease							
No	711 (92.8%)		Reference				
Yes	52 (6.8%)	0.83	0.57-1.23	0.359			
Renal disease							
No	749 (97.8%)		Reference			Reference	
Yes	14 (1.8%)	3.40	1.12-10.38	0.032	2.28	0.72-7.21	0.162
Hypertension							
No	453 (59.1%)		Reference			Reference	
Yes	310 (40.5%)	0.83	0.68-1.02	0.082	0.69	0.54-0.88	0.002
Cancer, all sites							
No	751 (98.0%)		Reference				
Yes	12 (1.6%)	0.96	0.43-2.15	0.918			
Smoking							
Non-smoker/ex-smoker	737 (96.2%)		Reference			Reference	
Smoker	29 (3.8%)	2.18	1.12-4.23	0.021	1.79	0.87-3.67	0.112
Alcohol consumption							
Non-drinker	679 (88.6%)		Reference			Reference	
Drinker	87 (11.4%)	2.11	1.44-3.09	<0.001	1.76	1.17-2.64	0.007

Abbreviations: 95% CI = 95% confidence interval; aOR = adjusted odds ratio; cOR = crude odds ratio; HK$ = Hong Kong dollars; HKDS = Hong Kong Dietary Score

* Variables with cOR P value <0.1 were included in the final model

TABLE 4. Factors associated with physical inactivity among telephone-surveyed participants (n=532)*

	No. (%)	cOR†	95% CI	P value†	aOR	95% CI	P value
Age, y				<0.001			0.107
18-44	52 (9.8%)		Reference			Reference	
45-64	90 (16.9%)	1.00	0.67-1.50	0.995	1.07	0.66-1.75	0.783
65-74	181 (34.0%)	1.24	0.86-1.78	0.259	0.97	0.54-1.72	0.904
≥75	209 (39.3%)	2.19	1.51-3.17	<0.001	1.38	0.74-2.57	0.304
Sex							
Female	365 (68.6%)		Reference			Reference	
Male	167 (31.4%)	0.81	0.65-1.02	0.069	0.70	0.54-0.91	0.009
Marital status							
Married	381 (71.6%)		Reference			Reference	
Single/divorced/widowed	146 (27.4%)	1.74	1.36-2.24	<0.001	1.66	1.23-2.22	0.001
Working status							
Full-time or part-time	100 (18.8%)		Reference			Reference	
Housewife or retired	418 (78.6%)	1.323	1.02-1.72	0.038	0.73	0.49-1.09	0.124
Job type				<0.001			0.104
Professional and office work	182 (34.2%)		Reference			Reference	
Manual work	235 (44.2%)	1.71	1.34-2.18	<0.001	1.10	0.80-1.51	0.579
Housewife/student	103 (19.4%)	1.15	0.86-1.54	0.348	0.73	0.50-1.07	0.107
Education level				<0.001			0.002
Primary or below	313 (58.8%)		Reference			Reference	
Secondary	144 (27.1%)	0.52	0.41-0.66	<0.001	0.71	0.50-0.99	0.042
Tertiary or above	64 (12.0%)	0.47	0.34-0.65	<0.001	0.66	0.41-1.06	0.082
Household monthly income, HK$				<0.001			0.512
<10 000	259 (48.7%)		Reference			Reference	
10 000-29 999	115 (21.6%)	0.66	0.50-0.87	0.003	0.93	0.67-1.28	0.650
≥30 000	61 (11.5%)	0.47	0.34-0.66	<0.001	0.73	0.48-1.10	0.133
Self-reported health status							
<0.001		0.104					
Very good or good	239 (44.9%)		Reference			Reference	
Average	240 (45.1%)	1.35	1.08-1.68	0.008	0.84	0.64-1.10	0.207
Very poor or poor	53 (10.0%)	3.39	2.15-5.33	<0.001	1.37	0.81-2.32	0.237
Long-term medical management of chronic diseases							
No	179 (33.6%)		Reference			Reference	
Yes	353 (66.4%)	2.13	1.71-2.66	<0.001	1.65	1.08-2.54	0.022
Diabetes mellitus							
No	372 (69.9%)		Reference			Reference	
Yes	158 (29.7%)	2.19	1.70-2.82	<0.001	1.39	1.02-1.89	0.036
Cardiovascular disease							
No	296 (55.6%)		Reference			Reference	
Yes	55 (10.3%)	1.88	1.28-2.77	0.001	1.13	0.73-1.73	0.587
Renal disease							
No	335 (63.0%)		Reference			Reference	
Yes	16 (3.0%)	15.00	3.44-65.51	<0.001	9.32	2.06-42.25	0.004
Hypertension							
No	81 (15.2%)		Reference			Reference	
Yes	270 (50.8%)	1.67	1.35-2.07	<0.001	0.89	0.61-1.28	0.505
Cancer, all sites							
No	331 (62.2%)		Reference				
Yes	9 (1.7%)	1.10	0.48-2.52	0.831			
Smoking							
Non-smoker/ex-smoker	516 (97.0%)		Reference				
Smoker	16 (3.0%)	1.12	0.60-2.11	0.718			
Alcohol consumption							
Non-drinker	492 (92.5%)		Reference				
Drinker	40 (7.5%)	0.80	0.54-1.19	0.269			

Abbreviations: 95% CI = 95% confidence interval; aOR = adjusted odds ratio; cOR = crude odds ratio; HK$ = Hong Kong dollars
* Low exercise level (total activity <600 metabolic equivalent of task–minutes/week) based on the frequency and intensity of physical activity
† Variables with P value of cOR <0.1 were included in the final model

TABLE 5. Factors associated with higher risk of unhealthy lifestyle score

	Beta coefficient	95% confidence interval	P value
Age, y			
18-44	Reference		
45-64	0.04	-0.12 to 0.19	0.642
65-74	-0.02	-0.16 to 0.12	0.763
≥75	0.10	-0.05 to 0.24	0.185
Sex			
Female	Reference		
Male	0.25	0.16-0.34	<0.001
Marital status			
Married	Reference		
Single/divorced/widowed	0.19	0.08-0.29	<0.001
Working status			
Full-time or part-time	Reference		
Housewife or retired	-0.15	-0.25 to -0.04	0.007
Job type			
Professional and office work	Reference		
Manual work	0.17	0.07-0.27	0.001
Housewife/student	-0.15	-0.26 to -0.03	0.011
Education level			
Primary or below	Reference		
Secondary	-0.09	-0.19 to 0.00	0.060
Tertiary or above	-0.09	-0.21 to 0.03	0.154
Household monthly income, HK$			
<10 000	Reference		
10 000-29 999	-0.07	-0.18 to 0.04	0.224
≥30 000	-0.20	-0.33 to -0.08	0.002
Self-reported health status			
Very good or good	Reference		
Average	0.00	-0.09 to 0.08	0.928
Very poor or poor	0.26	0.07-0.45	0.006
Long-term medical management of chronic diseases			
No	Reference		
Yes	0.08	0.00-0.17	0.062
Diabetes mellitus	0.31	0.20-0.41	<0.001
Cardiovascular disease	0.04	-0.12 to 0.21	0.603
Chronic obstructive pulmonary disease	N/A		
Liver disease	0.02	-1.15 to 1.20	0.971
Renal disease	0.92	0.53-1.31	<0.001
Hypertension	-0.01	-0.10 to 0.08	0.811
Cancer, all sites	-0.14	-0.48 to 0.19	0.400

Abbreviations: HK$ = Hong Kong dollars; N/A = not applicable

Time trend analysis showed that the proportion of surveyed Hong Kong residents eating five daily servings of fruits and vegetables declined for both sexes in general (Fig a). Similarly, a significantly smaller proportion of participants reported walking >10 minutes for ≥5 days per week, and this proportion has continued to decline since 2016 (Fig b). There was a gradual decrease in the number of participants with a moderate or high level of physical activity. Despite a notable peak in 2019, there was a decline in 2020 with <60% of participants reportedly engaging in these physical activities. Finally, significantly smaller proportion of the study participants reported not currently smoking or consuming alcohol, compared with the proportions in previous population-based surveys (2010-2019) [Fig c and d].

Discussion

In this population-based study of 1500 Hong Kong residents during the third wave of the COVID-19 pandemic, we found that the proportion of people with healthy food intake (ie, daily consumption of five servings of fruits and vegetables) has decreased since 2003; although a slight increased was observed in 2020, it was still below the overall average. Additionally, we found that the prevalence of low physical activity has gradually increased. In contrast, the rates of smoking and alcohol consumption were below the rates observed in pre-pandemic population-based surveys. Men and women in various age-groups had dietary habits less adherent to the traditional Chinese eating pattern, as measured by the HKDS, than 20 years prior. Adherence to the traditional eating pattern was significantly lower among male participants, single individuals, low-income participants, alcohol drinkers, individuals with low physical activity, and patients with diabetes mellitus or renal disease. We also found that men, individuals with non-married status, manual workers, individuals with self-perceived poor or very poor health status, and patients with diabetes and renal disease had a greater likelihood of poor lifestyle habits.

Worldwide, insufficient intake of fruits and vegetables and inadequate physical activity have been attributed to 34% and ≥20% of NCDs, respectively.[17,18] The incidence of chronic diseases (eg, cancers, diabetes, and cardiovascular disease) in Hong Kong has increased by 60% in the past two decades.[19] Although processed food intake was not assessed in this study, the HKDS results indicated very low intakes of legumes and red/orange vegetables among Hong Kong residents; a previous study showed that fruit intake in Hong Kong is among the lowest levels worldwide.[20] The report of Health Behaviour Survey 2018/2019 revealed that

95.6% of surveyed participants had inadequate daily fruit and vegetable intake, based on World Health Organization recommendations.[16] The present study showed further reduction, such that the proportion of Hong Kong residents consuming the recommended (≥5) daily servings of fruits and vegetables declined by 3.9% in the past two decades. Additionally, 10% of the population reported consuming more than one daily serving of processed meat, and the frequency of processed meat consumption increased by 3.1%.[16] Another known risk factor for NCDs, overweight or obesity, affected approximately half of the Hong Kong population aged 15 to 84 years in 2015; this value was slightly (2%) below the global average.[21]

Disruptions to usual routines can lead to new dietary behaviours. For example, dine-in restrictions at restaurants and bars during the pandemic led to greater use of food delivery services, and take-away food is often less healthy.[22] However, we observed increased fruit and vegetable consumption after the third wave of the COVID-19 outbreak. This finding is supported by the work of Wang et al,[23] which showed that fruit and vegetable consumption increased. Collectively, the disease prevention and control policies that prohibited group gatherings and shortened the operating hours of bars and clubs (if such facilities were not entirely closed) could have significantly reduced smoking and alcohol consumption in Hong Kong during the pandemic. Additionally, the lower level of physical activity could be related to the closure of public sports avenues and restricted access to sports facilities.

The dietary habits of Hong Kong residents have changed from the traditional Chinese diet to a fast-paced dining experience involving convenient, processed foods with limited diversity. Hong Kong has a population of >7.5 million people, and 90% of its food supply is imported from other countries.[24] Woo et al[11] concluded that, despite geographical and cultural differences, traditional Chinese dietary habits were conceptually similar to the health-promoting Mediterranean diet. In 2001, high overall adherence to the Mediterranean diet was observed across all age-groups in Hong Kong, except for younger populations and men.[11] In contrast, the present study showed that a smaller proportion of participants in all age and sex groups had high overall adherence to the Mediterranean diet. In this study, intriguingly, women consistently exhibited higher Mediterranean diet score (71%) and HKDS (53%; P<0.005) results, compared with their male counterparts. Moreover, the present study revealed lower prevalences of some chronic diseases among women: diabetes, cardiovascular disease, liver disease, and renal disease. The contemporary diets in modern Hong Kong and many developed regions have low fibre content and high processed food content; they also include food additives, refined
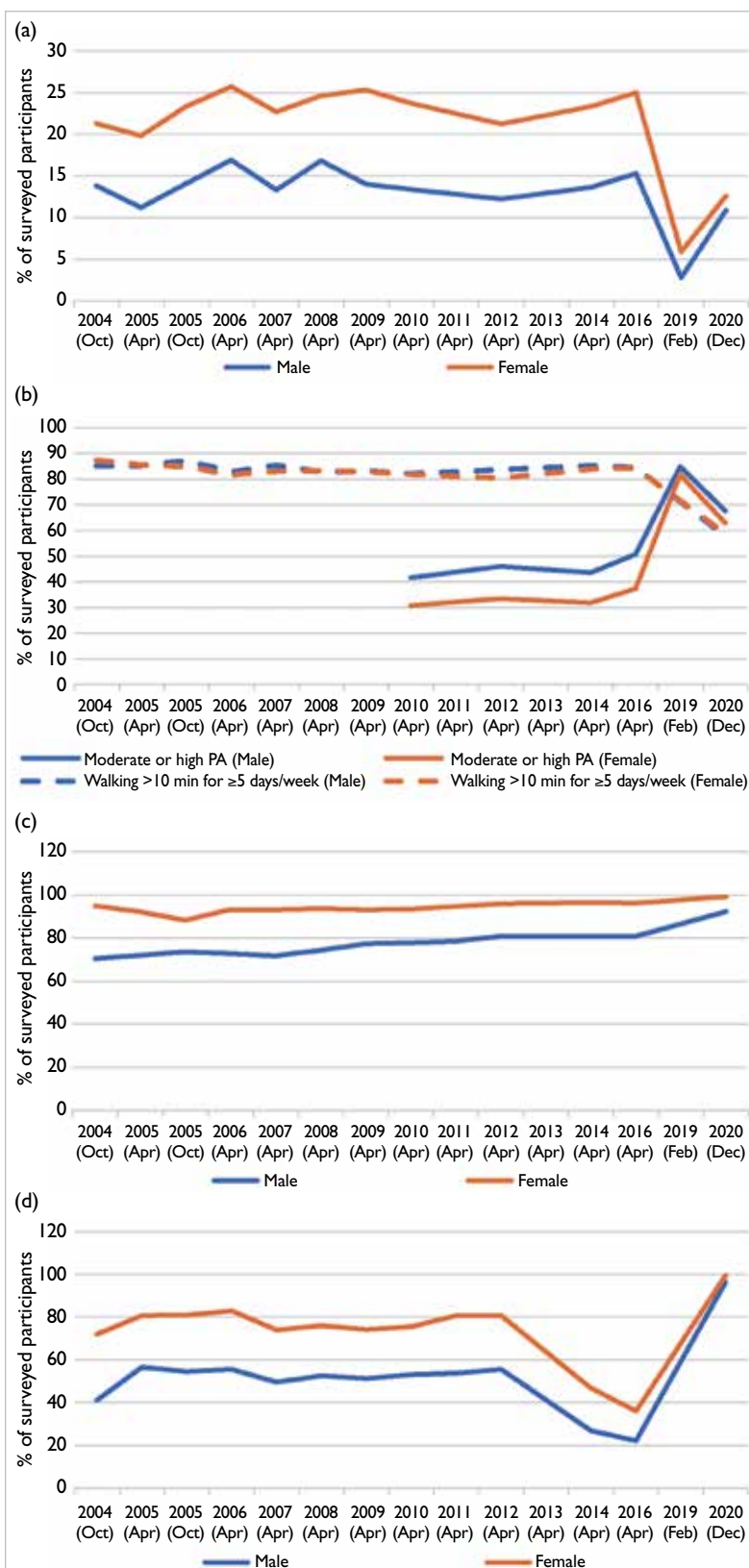

FIG. (a) Fruit and vegetable consumption, (b) physical activity, (c) smoking status, and (d) alcohol consumption status of surveyed Hong Kong residents from 2004 to 2020. The proportions of participants surveyed by the Department of Health since 2004 who reportedly engaged in healthy dietary habits (ie, consumed recommended amounts of fruits and vegetables, grains, and dairy), had a moderate to high level of physical activity, did not smoke, and did not drink, were compared with surveyed participants in 2020

Abbreviation: PA = physical activity

sugar, and hydrogenated fats.[25] The subtle but consistent westernisation of dietary habits appears to be detrimental for residents who consistently consume these food items.

A lack of colourful vegetables and fruits may reduce the diversity of beneficial gut microbiota,[26] although leafy greens such as pak choy (Chinese cabbage), choy sum (Chinese flowering cabbage), and Chinese kale are staple foods in the Hong Kong diet throughout the year. Moreover, in a review of literature concerning exercise and gut microbial composition, Mitchell et al[27] found that exercise alters gut microbiota; however, the direction of apparent change has varied among studies. Increases in butyrate-producing bacteria and faecal butyrate concentrations, with protective anti-inflammatory effects and the potential to enhance anti-infection immunity, have been observed among physically active adults.[28] The mechanisms are unclear but the benefits of adopting a lifestyle with a diverse diet and physical activity consistently create an optimal environment for gut microbiota.

Limitations

The large sample size and random sampling design of this territory-wide survey were strengths that enhanced the validity of the findings. However, this study had several limitations that should be addressed. First, cause-and-effect relationships between the COVID-19 pandemic and changes in lifestyle habits could not be established because of the cross-sectional approach. Individuals in home quarantine during the third wave of the pandemic might have experienced temporary changes in lifestyle habits; a prospective observational study and longer trend analysis are needed to facilitate long-term comparisons. Factors other than the pandemic (eg, mental wellness) could also have affected lifestyles among the study population. Although the present study utilised a random sampling strategy, non-response and selection biases were possible because younger segments of the Hong Kong population did not use landlines during the study period. Furthermore, response and social desirability biases may have been present in this telephone survey. Nevertheless, the high response rate and anonymous nature of this survey may have minimised these potential biases. Additionally, generalisation of the study findings should be performed with caution because the survey only included a single Chinese population. Considering that the participants' characteristics differed from the general population, the findings might not be directly applicable to the general public. Moreover, the survey was conducted in 2020, and lifestyle habits in the general population might have changed throughout the pandemic. Finally, the low case numbers of some self-reported diseases, such as renal disease and cancer, may have resulted in type II error.

Conclusion

This representative population-based survey revealed that larger proportions of the general population had unhealthy lifestyles, including dietary habits and physical inactivity, during the COVID-19 pandemic than during pre-pandemic years. There is an urgent need to formulate and implement effective public health strategies at both individual and organisational levels. The encouragement of healthy lifestyles through evidence-based health promotion programmes is essential. This encouragement could be conveyed to communities through organised and concerted efforts by the government and relevant stakeholders. Future studies should evaluate the effectiveness of various interventions and approaches to achieve these important goals.

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