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Original Research

Time-trend analysis of fruit and vegetable intake in Hong Kong, 2004–2016

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ABSTRACT

Objectives: In 2005, the Hong Kong government launched a series of large-scale dietary promotion campaigns aiming to increase fruit and vegetable intake. This study aimed to investigate changes in mean fruit and vegetable intake in the population between 2004 and 2016.

Study design: Time-trend analysis.

Methods: Fruit and vegetable intake data from adults aged 18–64 years between 2004 and 2016 were extracted from government online databases. Descriptive analyses were conducted. One-way analysis of variance was employed to compare population-weighted age-specific and sex-specific mean fruit and vegetable intake at 95% confidence levels in SPSS. **Results:** Between 2004 and 2016, mean fruit intake (males: 0.70–1.22 servings/day; females: 0.95–1.59 servings/day) and mean vegetable intake (males: 1.80–2.51 servings/day; females: 2.10–2.83 servings/day) among Hong Kong adults across all age groups were lower than recommended. Adults aged 45–54 years and over ate more fruit than younger adults. However, decreasing fruit intake trends were observed among both females and males across all ages. The decreased mean fruit intake among males aged 35–54 years and females aged 35–44 years and below has become statistically significant in more recent years, which may indicate a slow transitioning toward significantly lower mean fruit intake across these age groups. Although statistically non-significant, increasing vegetable intake trends were observed among adults aged 35–44 years and below, which may indicate a slow transitioning process toward significantly higher mean vegetable intake among these age groups. However, there is concern about the downward vegetable intake trends among adults aged 45–64 years.

Conclusions: More research is needed to investigate the effectiveness of dietary promotion campaigns, especially in terms of promotion coverage and population age ranges. More effective strategies are needed to increase fruit and vegetable intake in the population.

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Introduction

Non-communicable diseases, especially cancers, cardiovascular diseases, and diabetes, are the leading causes of death globally. Fruit and vegetables are rich sources of vitamins (especially vitamins C and A), minerals (especially electrolytes), and phytochemicals, which function as antioxidants, phytoestrogens, and antiinflammatory agents.¹ Fruit and vegetables are high in dietary fiber, which is important for normal function of the digestive system. In recent years, eating at least two servings of fruit and three servings of vegetables daily has been recognized as one of the most important strategies to prevent non-communicable diseases and is recommended in dietary guidelines worldwide.^{2–9} Epidemiological studies and systematic reviews have shown that increased fruit and vegetable intake could potentially reduce the burden of diseases, including cancers, cardiovascular diseases, diabetes, metabolic syndrome, chronic respiratory diseases, bowel diseases, fractures, and cognitive disorder.¹⁰ Cancers, cardiovascular diseases, and diabetes are the leading causes of deaths in Hong Kong. In 2017, malignant neoplasms (international classification of diseases [ICD]10: C00–C97) accounted for 14,310 deaths (31% of total deaths), heart (ICD10: I00–I09, I11, I13, I20–I51) and cerebrovascular diseases (ICD10: I60–I69) accounted for a total of 9240 deaths (20% of total deaths), chronic lower respiratory diseases (ICD10: J40–J47) accounted for 1651 deaths (4% of total deaths), and diabetes accounted for 396 deaths (about 1% of total deaths).¹¹ Since 2005, the Hong Kong Department of Health (HKDH) has launched a series of large-scale dietary/health promotion campaigns.

The Hong Kong government seeks to promote the potential benefits of healthy eating to reduce the risk of diet-related diseases and improve community health and well-being. The HKDH has developed and disseminated guidelines describing healthy food choices that aim to reduce the burden of dietary-related diseases.¹² The guidelines encourage the principles of the Healthy Eating Food Pyramid, which involves including a variety of foods that provide appropriate calories and nutrients and reducing fat, salt, and sugar intake.

In 2005, a territory-wide ‘2 plus 3 A Day’ healthy diet campaign was launched.^{13,14} The campaign aimed to raise public awareness of the importance of a balanced diet and encouraged those aged 18–64 years to eat at least two servings of fruit and three servings of vegetables daily.

The following year, the ‘EatSmart@school.hk’ campaign was launched,¹⁵ which was aimed at motivating and assisting families, schools, and communities to work together to build up a favorable environment to formulate and implement healthy eating school policies to help students cultivate and strengthen good eating habits. Nutrition guidelines for lunch were provided,¹⁶ which suggested eating at least one serving of fruit daily for both primary and secondary students, and one serving of vegetables for primary students and one and a half servings for secondary students. By 12 June 2018, 264 schools were enrolled,¹⁷ and 101 events had been recorded on the website,¹⁵ which included 42 ceremonies, forums, and summits; 49 training workshops for chefs, food suppliers, and

school staff (although only one workshop involved parents); two public lectures for parents; and another seven events which might have directly involved the target consumers/children participants.

In response to a survey that found 40% of the Hong Kong population eat out for lunch at least 5 days a week,¹⁸ the ‘EatSmart@restaurant.hk’ campaign was launched in 2007. Participating restaurants offer either:

1. ‘Choice of vegetable (蔬菜之選)’—fruit or vegetables are the only ingredients of the dish, or they make up at least twice as much as the quantity of meat (or its alternatives) present in the dish or
2. ‘Choice of 3 less (三少之選)’—the dish has less fat or oil, salt, and sugar, meeting the ‘3 Less’ requirement.

By 30 June 2018, a total of 693 participating food premises across 18 different districts in Hong Kong were recorded on the website. The website also recorded 177 promotion events which included 75 online newsletters, magazines, or other online announcements; 69 briefings; 16 forums, expos, ceremonies, or other public announcements; 12 cooking demonstrations; and five coupon or discount promotions, which might have directly involved restaurant consumers.

In 2011, believing that ‘multisectoral and integrated efforts are required to combat the growing threat of childhood obesity’,¹⁸ the HKDH launched the ‘StartSmart@school.hk’ pilot project. The campaign aimed to promote healthy eating and physical activities in children aged 2–6 years to help them cultivate a sustainable healthy lifestyle.¹⁹ A total of 645 pre-school institutes were registered by 2017/2018 school year.²⁰ In addition to online education materials, there were workshops for teachers and people who prepare food, but no specific activities that directly involved the target children participants were recorded on the website.¹⁹ All these campaigns aimed to (i) raise public awareness of the importance of a balanced diet and (ii) promote eating at least two servings of fruit and three servings of vegetables daily. This study aimed to investigate the changes in mean fruit and vegetable intake in the population between 2004 and 2016.

Methods

The Hong Kong Behavioral Risk Factor Surveys collected information on health-related behaviors and other relevant issues from the general adult population. The surveys draw a random sample of telephone numbers from a sampling frame generated from the 2007 Hong Kong residential telephone directory. Information was collected through Computer Assisted Telephone Interview (CATI) from Cantonese-speaking, Putonghua-speaking, or English-speaking residents aged 18–64 years (excluding foreign domestic helpers) in Hong Kong.^{21–26} Fruit and vegetable intake data were extracted from the Behavioral Risk Factor Surveys database: 2004 ($n = 2088$), 2005 ($n = 2102$), 2006 ($n = 2047$), 2007 ($n = 2074$), 2008 ($n = 2099$), 2009 ($n = 2185$), 2010 ($n = 2013$), 2012 ($n = 2041$), 2014 ($n = 4134$), and 2016 ($n = 4071$). Correlation analyses were

conducted between fruit and vegetable intake, age, sex, education level, household income, and fruit and vegetable price index (baseline = 2004). Population-weighted age-specific and sex-specific descriptive analyses, as well as one-way analysis of variance to compare changes in population mean fruit and vegetable intake against different age-specific and sex-specific groups and years at 95% confidence levels were conducted using IBM SPSS Statistics, version 24. The term ‘mean’ in the following sections is defined as population-weighted 7-day mean intake per day. Given that intake information in 2011, 2013, and 2015 were not collected, the estimated mean values of these years were calculated as the average of the sum of the mean intake of the year before and the year after.

Results

Mean fruit and vegetable intake trends and correlation analyses

Between 2004 and 2016, mean fruit intake (males: 0.70–1.22 servings/day; females: 0.95–1.59 servings/day) and mean vegetable intake (males: 1.80–2.51 servings/day; females: 2.10–2.83 servings/day) among Hong Kong adults across all age groups were lower than recommended (see Fig. 1, and Appendix A1 and A2 in the supplementary material). When looking at the distribution of fruit and vegetable intake in the investigated years, there was a normal distribution, skewness was 0.06–0.08 for males and 0.05–0.07 for females. Males ate significantly less fruit and vegetables than females (Spearman's rho, fruit: $r = -0.16$, $P < 0.001$; vegetables: $r = -0.16$, $P < 0.001$). Fruit intake was significant negatively associated with vegetable intake (Pearson Correlation, males: $r = -0.23$, $P < 0.001$; females: $r = -0.24$, $P < 0.001$). The correlations of fruit and vegetable intake with calendar year,

fruit and vegetable price index, participants' education level, and household income were significant, although very weak (see Appendix A3 in the supplementary material). However, fruit and vegetable price increased by 23%,²⁷ while the median monthly household income increased by 93%.²⁸ Mean fruit intake among both males and females has been decreasing over the study period. In addition, mean vegetable intake among both males and females aged 45–54 and 55–64 years has also been decreasing, which is in contrast to other age groups, where an increase in vegetable intake is seen (see Fig. 1 and Appendix A4 in the supplementary material).

Comparison of fruit and vegetable intake with government recommendations

The percentages of adults meeting the government recommendations for fruit and vegetable intake were low (fruit intake = males: 6.2–30.6%, females: 11.0–46.4%; vegetable intake = males: 11.7–31.4%, females: 28.2–45.6%; both fruit and vegetable intake = males: 0.6–14.1%, females: 3.9–25.3%) [Fig. 2]. The percentages of adults meeting the fruit intake recommendations were decreasing among both males and females. On the other hand, the percentages of adults meeting the vegetable intake recommendations were increasing, except for males aged 45–54 years and above, which were decreasing, and for females aged 45–54 years and above, which remained relatively stable. For females aged 45–54 years and above, this might be a result of internal adjustments, from higher vegetable intake toward the recommended intake level. As a result, the percentage of adults meeting both the fruit and vegetable intake recommendations was decreasing, except among adults aged 25–34 years, where an increase was seen, and among females aged 18–25 years, which remained relatively stable.

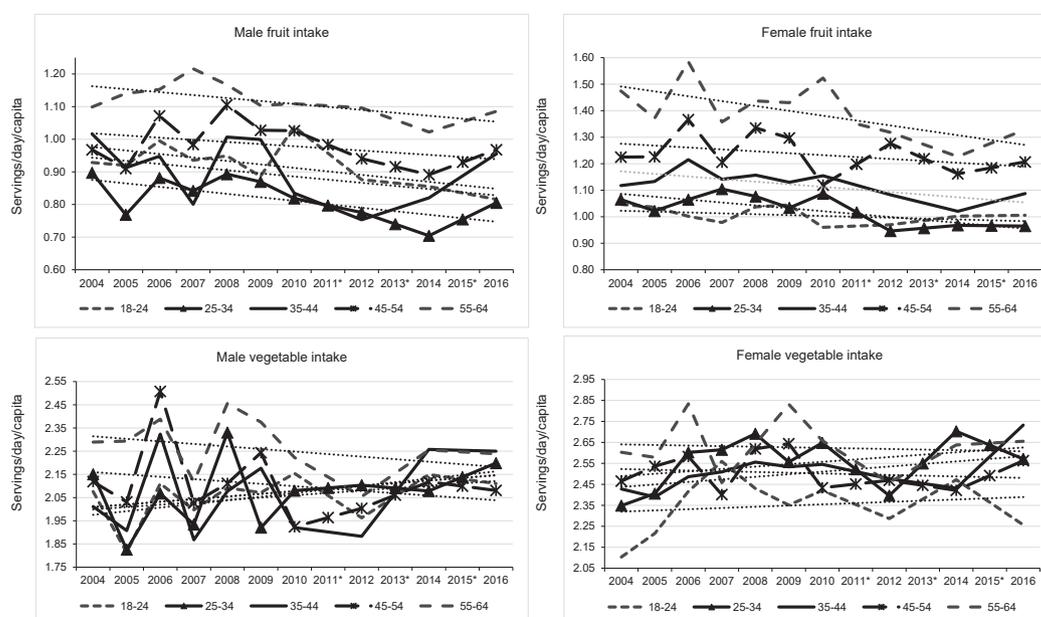


Fig. 1 – Hong Kong adult population-weighted mean^a fruit and vegetable intake by age, sex, and year (servings/day/capita).
^aMean = population-weighted 7-day average/day.

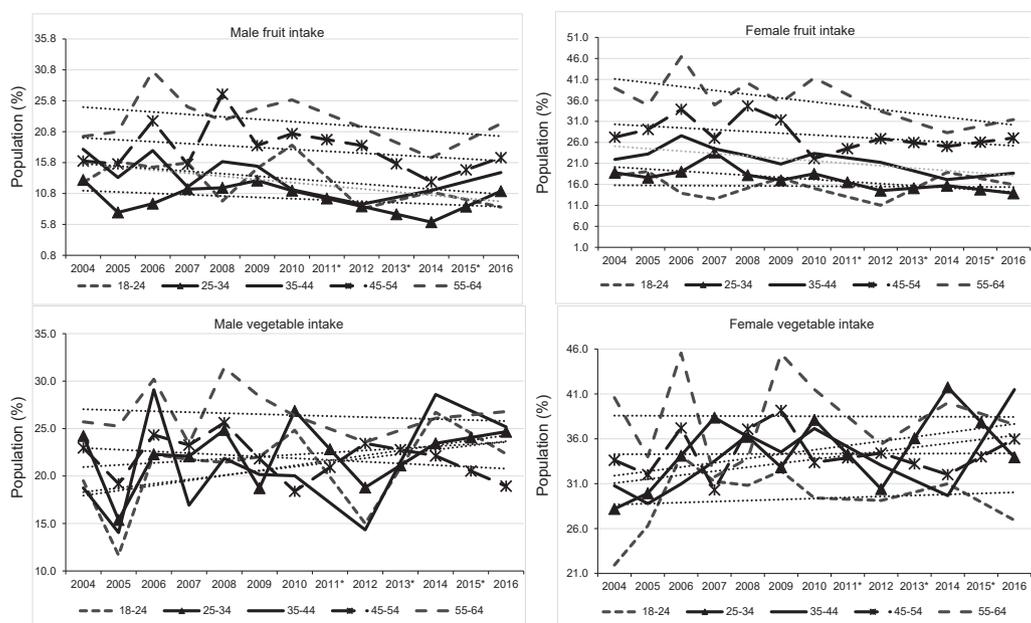


Fig. 2 – Percentage of the Hong Kong population meeting the fruit and vegetable intake recommendations by age, sex, and year.

Multiple comparison of mean fruit intake

Mean fruit intake was significantly different between the age groups for both males and females (Table 1). Mean fruit intake among females aged 54–64 years was higher than in females aged 35–44 years and below. Similar patterns were observed among males, but to a lesser degree. Mean fruit intake among females aged 45–54 years was also higher than for those aged 24–35 years and below. The changes of mean fruit intake across the investigated years (2004–2016) were non-significant among males aged 18–24, 25–34, and 55–64 years, and among females aged 18–24 and 25–34 years (Table 2). Significant changes in mean fruit intake were observed among males aged 35–44 and 45–54 years. The decrease in mean fruit intake among males aged 35–44 years became significant in 2012 when compared with fruit intake in 2004 and 2008; a significant decrease in fruit intake was also seen among males aged 45–54 years in 2014 when compared with fruit intake in 2008. The decrease in mean fruit intake among females aged 45–54 years became significant in 2010 when compared with fruit intake in 2006 and 2008; a significant decrease in fruit intake was also seen among females aged 55–64 years in 2014 when compared with fruit intake in 2006 and 2010.

Multiple comparison of mean vegetable intake

Differences in mean vegetable intake among males and females across different age groups were mostly non-significant, except in 2004, 2005, 2014, and 2016 (Table 3). In 2005, mean vegetable intake among males aged 55–64 years was significantly higher than in males aged 35–44 years and below; this gap in mean vegetable intake narrowed thereafter. In 2004, mean vegetable intake among females aged 55–64

years was also significantly higher than in females aged 18–24 years; this intake gap also narrowed thereafter. In 2014, the mean vegetable intake among females aged 25–34 years was significantly higher than in females aged 45–54 years. However, with the increase in vegetable intake among females aged 45–54 years and the decrease in intake among those aged 25–34 years, the gap also narrowed in 2016. No significant changes in mean vegetable intake across the investigated years were observed among males aged 18–24 and 55–64 years and among females across all age groups, except among females aged 35–44 years (see Table 4). The increase in mean vegetable intake among males aged 25–34 years became significant in 2008 when compared with mean vegetable intake in 2005 but was then offset in 2009. Among males aged 35–44 years, the increase in mean vegetable intake was significant in 2006 when compared with the mean vegetable intake in 2005 but was then offset by the significantly decreased mean intake the following year (2007); mean vegetable intake in 2014 also significantly increased by 0.18, 0.19, 0.17, and 0.19 servings when compared with mean vegetable intake in 2005, 2007, 2010, and 2012, respectively. However, with the decrease in mean vegetable intake in 2016, the differences became non-significant, except when compared with the intake in 2007. The increased mean vegetable intake among females aged 35–44 years also became significant in 2016, when compared with the intake in 2005.

Discussion

Summary of main results

Despite a series of large-scale government dietary promotion campaigns over a period of 12 years since 2005, more than 92%

Table 1 – Multiple comparison of mean fruit intake by sex, age, and year (servings/day/capita).

Year	Male								Female					
	Age (years)		Mean ^a difference (I-J)	Sig.	95% CI		Age (years)		Mean ^a difference (I-J)	Sig.	95% CI			
	(I)	(J)			Lower	Upper	(I)	(J)			Lower	Upper		
2004	t1		Non-significant				t1	55–64	18–24	0.43*	0.000	0.17	0.68	
									25–34	0.41*	0.000	0.18	0.63	
									35–44	0.36*	0.000	0.14	0.57	
									45–54	0.25*	0.022	0.02	0.48	
2005	t1	55–64	18–24	0.22	0.118	–0.03	0.47	t1	55–64	18–24	0.34*	0.005	0.07	0.60
			25–34	0.37*	0.000	0.14	0.60			25–34	0.35*	0.000	0.12	0.58
			35–44	0.23*	0.039	0.01	0.45			35–44	0.24*	0.033	0.01	0.46
			45–54	0.23*	0.039	0.01	0.45			45–54	0.15	0.438	–0.09	0.38
2006	t2	55–64	18–24	0.16	0.496	–0.11	0.43	t2	55–64	18–24	0.58*	0.000	0.29	0.87
			25–34	0.27*	0.039	0.01	0.53			25–34	0.52*	0.000	0.25	0.79
			35–44	0.20	0.140	–0.04	0.45			35–44	0.37*	0.001	0.11	0.63
			45–54	0.08	0.898	–0.17	0.33			45–54	0.22	0.202	–0.06	0.50
2007	t1	55–64	18–24	0.28*	0.015	0.04	0.52	t1	55–64	18–24	0.38*	0.000	0.13	0.63
			25–34	0.37*	0.000	0.15	0.60			25–34	0.25*	0.013	0.04	0.47
			35–44	0.42*	0.000	0.20	0.63			35–44	0.22*	0.043	0.00	0.43
			45–54	0.23*	0.023	0.02	0.44			45–54	0.15	0.308	–0.06	0.37
2008	t2	55–64	18–24	0.22	0.057	0.00	0.44	t2	55–64	18–24	0.40*	0.000	0.14	0.66
			25–34	0.27*	0.016	0.03	0.51			25–34	0.36*	0.001	0.11	0.61
			35–44	0.16	0.230	–0.05	0.37			35–44	0.28*	0.013	0.04	0.52
			45–54	0.06	0.938	–0.16	0.28			45–54	0.10	0.787	–0.14	0.35
2009	t1	55–64	18–24	0.22	0.110	–0.03	0.46	t1	55–64	18–24	0.39*	0.001	0.12	0.65
			25–34	0.23*	0.033	0.01	0.46			25–34	0.40*	0.000	0.17	0.63
			35–44	0.10	0.681	–0.11	0.32			35–44	0.30*	0.003	0.07	0.53
			45–54	0.08	0.857	–0.13	0.28			45–54	0.13	0.495	–0.09	0.36
2010	t1	55–64	18–24	0.07	0.934	–0.17	0.32	t2	55–64	18–24	0.56*	0.000	0.32	0.81
			25–34	0.29*	0.003	0.07	0.51			25–34	0.44*	0.000	0.19	0.68
			35–44	0.27*	0.005	0.06	0.49			35–44	0.37*	0.000	0.13	0.61
			45–54	0.08	0.810	–0.12	0.29			45–54	0.40*	0.000	0.17	0.63
2012	t1	55–64	18–24	0.22	0.236	–0.07	0.51	t2	55–64	18–24	0.35*	0.001	0.10	0.59
			25–34	0.32*	0.007	0.06	0.58			25–34	0.37*	0.000	0.16	0.58
			35–44	0.34*	0.003	0.08	0.60			35–44	0.24*	0.025	0.02	0.45
			45–54	0.16	0.407	–0.09	0.40			45–54	0.04	0.987	–0.19	0.27
2014	t2	55–64	18–24	0.17	0.062	0.00	0.34	t2	55–64	18–24	0.22*	0.003	0.06	0.39
			25–34	0.32*	0.000	0.19	0.45			25–34	0.26*	0.000	0.13	0.39
			35–44	0.20*	0.002	0.05	0.35			35–44	0.21*	0.000	0.07	0.34
			45–54	0.13*	0.049	0.00	0.26			45–54	0.06	0.696	–0.07	0.20
2016	t1	55–64	18–24	0.27*	0.001	0.08	0.46	t2	55–64	18–24	0.32*	0.000	0.13	0.52
			25–34	0.28*	0.000	0.12	0.44			25–34	0.36*	0.000	0.22	0.51
			35–44	0.13	0.185	–0.03	0.29			35–44	0.24*	0.000	0.09	0.39
			45–54	0.12	0.240	–0.04	0.27			45–54	0.12	0.117	–0.02	0.26
2005								t1	45–54	18–24	0.19	0.149	–0.04	0.42
										25–34	0.20*	0.028	0.01	0.40
										35–44	0.09	0.625	–0.09	0.27
										55–64	–0.15	0.438	–0.38	0.09
2006								t2	45–54	18–24	0.36*	0.000	0.13	0.60
										25–34	0.30*	0.001	0.09	0.51
										35–44	0.15	0.259	–0.05	0.36
										55–64	–0.22	0.202	–0.50	0.06
2007								t1	45–54	18–24	0.23*	0.036	0.01	0.44
										25–34	0.10	0.565	–0.08	0.29
										35–44	0.06	0.859	–0.11	0.24
										55–64	–0.15	0.308	–0.37	0.06
2008								t2	45–54	18–24	0.30*	0.001	0.09	0.50
										25–34	0.26*	0.003	0.06	0.45
										35–44	0.18*	0.044	0.00	0.35
										55–64	–0.10	0.787	–0.35	0.14
2009								t1	45–54	18–24	0.25*	0.033	0.01	0.49
										25–34	0.26*	0.003	0.07	0.46
										35–44	0.17	0.130	–0.03	0.36
										55–64	–0.13	0.495	–0.36	0.09

Table 1 – (continued)

Year	Male								Female							
	Age (years)		Mean ^a difference (I-J)	Sig.	95% CI		Age (years)		Mean ^a difference (I-J)	Sig.	95% CI					
	(I)	(J)			Lower	Upper	(I)	(J)			Lower	Upper				
2010	t1	45–54	18–24	–0.01	1.000	–0.24	0.22									
			25–34	0.21*	0.040	0.01	0.41									
			35–44	0.19	0.062	–0.01	0.39									
			55–64	–0.08	0.810	–0.29	0.12									
2012	t1							t2	45–54	18–24	0.31*	0.005	0.07	0.55		
										25–34	0.33*	0.000	0.12	0.54		
											35–44	0.19	0.088	–0.02	0.40	
											55–64	–0.04	0.987	–0.27	0.19	
2014	t2	25–34	18–24	0.04	0.971	–0.12	0.19	t2	45–54	18–24	0.16	0.060	0.00	0.32		
				0.19*	0.000	0.07	0.30			25–34	0.19*	0.000	0.07	0.32		
				0.07	0.567	–0.06	0.20			35–44	0.14*	0.026	0.01	0.27		
				–0.13*	0.049	–0.26	0.00			55–64	–0.06	0.696	–0.20	0.07		
2016								t2	45–54	18–24	0.20*	0.031	0.01	0.39		
										25–34	0.24*	0.000	0.11	0.38		
										35–44	0.12	0.147	–0.02	0.26		
										55–64	–0.12	0.117	–0.26	0.02		

CI, confidence interval; Sig., significance; t1: Tukey HSD; t2: Games-Howell.

*The mean difference is significant at the 0.05 level.

^a Population-weighted, 7-day average/day.

Table 2 – Multiple comparison of change in mean fruit intake between 2004 and 2016 by sex and age (servings/day/capita).

Age (years)	Male								Female							
	Year		Mean ^a difference (I-J)	Sig.	95% CI		Year		Mean ^a difference (I-J)	Sig.	95% CI					
	(I)	(J)			Lower	Upper	(I)	(J)			Lower	Upper				
18–24			Non-significant						Non-significant							
25–34			Non-significant						Non-significant							
35–44	t1	2012	2004	–0.26*	0.020	–0.50	–0.02	t2	2014	2004	–0.10	0.715	–0.27	0.07		
			2005	–0.16	0.541	–0.40	0.08	2005		–0.11	0.543	–0.28	0.06			
		2006	–0.19	0.275	–0.44	0.05	2006	–0.19*		0.029	–0.38	–0.01				
		2007	–0.05	1.000	–0.30	0.20	2007	–0.12		0.441	–0.29	0.05				
		2008	–0.25*	0.045	–0.50	0.00	2008	–0.14		0.259	–0.31	0.04				
		2009	–0.25	0.059	–0.50	0.00	2009	–0.11		0.755	–0.31	0.09				
		2010	–0.08	0.992	–0.34	0.18	2010	–0.13		0.437	–0.33	0.06				
		2014	–0.07	0.995	–0.29	0.16	2012	–0.06		0.991	–0.26	0.13				
		2016	–0.20	0.124	–0.43	0.02	2016	–0.07		0.954	–0.23	0.10				
		45–54	t2	2014	2004	–0.08	0.923	–0.25		0.10	t2	2010	2004	–0.11	0.844	–0.31
2005	–0.02				1.000	–0.20	0.16	2005	–0.11	0.840	–0.32		0.10			
2006	–0.18			0.090	–0.37	0.01	2006	–0.25*	0.027	–0.48	–0.01					
2007	–0.09			0.847	–0.28	0.09	2007	–0.09	0.949	–0.29	0.12					
2008	–0.21*			0.014	–0.40	–0.02	2008	–0.22*	0.034	–0.42	–0.01					
2009	–0.14			0.390	–0.32	0.05	2009	–0.18	0.188	–0.39	0.03					
2010	–0.13			0.364	–0.32	0.05	2012	–0.16	0.491	–0.39	0.07					
2012	–0.05			0.998	–0.24	0.14	2014	–0.04	0.999	–0.22	0.13					
55–64		2016	2004	–0.08	0.820	–0.22	0.07	t2	2014	2004	–0.25	0.068	–0.50	0.01		
			2005					2005		–0.14	0.759	–0.41	0.12			
								2006		–0.36*	0.005	–0.65	–0.07			
								2007		–0.13	0.763	–0.37	0.11			
								2008		–0.21	0.284	–0.48	0.06			
								2009		–0.20	0.198	–0.45	0.04			
								2010		–0.30*	0.010	–0.55	–0.04			
								2012		–0.09	0.956	–0.32	0.13			
						2016	–0.10	0.645	–0.27	0.07						

CI, confidence interval; Sig., significance; t1: Tukey HSD; t2: Games-Howell.

*The mean difference is significant at the 0.05 level.

^a Population-weighted, 7-day average/day.

Table 3 – Multiple comparison of mean vegetable intake by sex, age, and year (servings/day/capita).

Year	Male				Female							
	Age (years)		Mean ^a difference (I-J)	Sig.	95% CI		Age (years)		Mean ^a difference (I-J)	Sig.	95% CI	
	(I)	(J)			Lower	Upper	(I)	(J)			Lower	Upper
2004			Non-significant				t1 55–64 18–24	0.50*	0.046	0.00	0.99	
							25–34	0.25	0.505	-0.18	0.69	
							35–44	0.18	0.790	-0.25	0.60	
							45–54	0.14	0.913	-0.30	0.58	
2005	t1 55–64	18–24	0.48*	0.013	0.07	0.89		Non-significant				
		25–34	0.47*	0.006	0.09	0.84						
		35–44	0.39*	0.030	0.02	0.75						
		45–54	0.26	0.287	-0.10	0.63						
2006			Non-significant					Non-significant				
2007			Non-significant					Non-significant				
2008			Non-significant					Non-significant				
2009			Non-significant				t1 55–64 18–24	0.48*	0.038	0.02	0.94	
							25–34	0.28	0.330	-0.13	0.68	
							35–44	0.30	0.233	-0.10	0.69	
							45–54	0.19	0.690	-0.21	0.58	
2010			Non-significant					Non-significant				
2012			Non-significant					Non-significant				
2014			Non-significant				t2 45–54 18–24	-0.05	0.994	-0.39	0.29	
							25–34	-0.28*	0.040	-0.56	-0.01	
							35–44	-0.01	1.000	-0.24	0.22	
							55–64	-0.22	0.117	-0.46	0.03	
2016			Non-significant				t2 18–24 25–34	-0.31	0.103	-0.67	0.04	
							35–44	-0.48*	0.001	-0.80	-0.16	
							45–54	-0.31*	0.048	-0.61	0.00	
							55–64	-0.40*	0.007	-0.72	-0.08	

CI, confidence interval; Sig., significance; t1: Tukey HSD; t2: Games-Howell.

*The mean difference is significant at the 0.05 level.

^a Population-weighted, 7-day average/day.

of male and 86% of female adults did not meet the recommendations for fruit or vegetable intake. In general, adults aged 45–54 years and above ate more fruit than younger adults. Adults aged 35–45 years seem to be in the transitioning age range toward higher fruit and vegetable intake. This could be a result of the increased risk of chronic diseases from the age of late 30s onwards; consequently, participants in this age range may start paying more attention to a healthy diet, and fruit requires less preparation than vegetables, so is an easier choice. A survey conducted in Hong Kong in late 2016²⁹ indicated that suffering from or concerns about chronic diseases was one of the main reasons that participants aged in their late 30s started shifting their meat intake toward a fruit and vegetable intake. Downward mean fruit intake trends were observed among both females and males across all ages, and the decreases in mean fruit intake among males aged 35–44 and 45–54 years and females aged 35–44 years and over became significant in more recent years. This could be an indication of a slow transitioning process toward significantly lower mean fruit intake across all age groups. Although statistically non-significant, the observed upward trends in terms of mean vegetable intake among both males and females aged 35–44 years and below and in terms of percentage of adults meeting the vegetable intake recommendations could be an indication of a slow transitioning process toward a significant increase in mean vegetable intake. However,

concerns exist over the observed downward trends in terms of mean vegetable intake and percentage of adults meeting the vegetable intake recommendations among those aged 45–54 and 55–64 years.

Limitations

Residents with new residential telephone numbers from 2008 onwards might not be included in the evaluation. Population fruit and vegetable intake data were based on a 7-day record; however, participants might not accurately remember exactly what they had eaten. If participants perceived eating fruit and vegetables as healthy, they might tend to overreport their fruit and vegetable intake, especially in retrospective cases.³⁰ Mean values of fruit and vegetable juice intake in 2005 and 2006 were used to estimate juice intake in other investigated years; thus, actual juice intake in the other investigated years might be different. However, the overall impact to each fruit and vegetable intake was small because less than 30% of the population were involved, and the mean values were less than 0.07 servings. These analyses were based on the assumption of independence between age groups. Although the probability is very small because of the large population size, there were chances a participant might be involved in different age groups in different years. Therefore, year specific between age groups analyses were conducted. Fruit and vegetable intake

Table 4 – Multiple comparison of change in mean vegetable intake between 2004 and 2016 by sex and age (servings/day/capita).

Age (years)	Male							Female							
	Year		Mean ^a difference (I-J)	Sig.	95% CI		Year	Mean ^a difference (I-J)	Sig.	95% CI					
	(I)	(J)			Lower	Upper				(I)	(J)	Lower	Upper		
18–24	Non-significant							Non-significant							
25–34	t1	2008	2004	0.18	0.966	-0.28	0.64	Non-significant							
			2005	0.50*	0.019	0.04	0.97	Non-significant							
			2006	0.26	0.752	-0.21	0.73								
			2007	0.40	0.175	-0.07	0.86								
			2009	0.41	0.137	-0.05	0.87								
			2010	0.25	0.813	-0.22	0.73								
			2012	0.23	0.888	-0.25	0.70								
			2014	0.25	0.622	-0.15	0.66								
35–44	t2	2006	2004	0.31	0.321	-0.10	0.72	t1	2016	2004	0.30	0.123	-0.03	0.64	
			2005	0.42*	0.038	0.01	0.82				2005	0.34*	0.050	0.00	0.69
			2007	0.46*	0.021	0.04	0.88				2006	0.25	0.428	-0.10	0.59
			2008	0.25	0.622	-0.15	0.64				2007	0.22	0.578	-0.13	0.57
			2009	0.15	0.995	-0.35	0.65				2008	0.18	0.851	-0.17	0.53
			2010	0.40	0.052	0.00	0.81				2009	0.20	0.736	-0.15	0.55
			2012	0.44*	0.032	0.02	0.86				2010	0.19	0.826	-0.17	0.55
			2014	0.07	1.000	-0.32	0.45				2012	0.26	0.428	-0.11	0.62
			2016	0.07	1.000	-0.33	0.47				2014	0.30	0.055	0.00	0.60
			2014	2004	0.25	0.396	-0.10				0.59				
	2005	0.35*	0.031	0.02	0.68										
	2006	-0.07	1.000	-0.45	0.32										
	2007	0.39*	0.017	0.04	0.74										
	2008	0.18	0.758	-0.14	0.51										
	2009	0.08	1.000	-0.37	0.53										
	2010	0.34*	0.045	0.00	0.67										
	2012	0.37*	0.028	0.02	0.73										
	2016	0.01	1.000	-0.32	0.34										
	2016	2004	0.24	0.517	-0.12	0.60									
	2005	0.34	0.062	-0.01	0.69										
2006	-0.07	1.000	-0.47	0.33											
2007	0.38*	0.034	0.01	0.75											
2008	0.17	0.847	-0.17	0.52											
2009	0.07	1.000	-0.39	0.53											
2010	0.33	0.086	-0.02	0.68											
2012	0.37	0.054	0.00	0.74											
2014	-0.01	1.000	-0.34	0.32											
45–54	t2	2010	2004	-0.19	0.738	-0.54	0.15	Non-significant							
			2005	-0.11	0.995	-0.47	0.26								
			2006	-0.58*	0.048	-1.16	0.00								
			2007	-0.10	0.992	-0.43	0.22								
			2008	-0.19	0.770	-0.53	0.15								
			2009	-0.32	0.214	-0.71	0.07								
			2012	-0.08	0.999	-0.42	0.26								
			2014	-0.19	0.569	-0.50	0.11								
2016	-0.16	0.868	-0.48	0.16											
55–64	Non-significant							Non-significant							

CI, confidence interval; Sig., significance; t1: Tukey HSD; t2: Games-Howell.

*The mean difference is significant at the 0.05 level.

^a Population-weighted, 7-day average/day.

among children aged below 18 years, and causal relationships between dietary promotion activities with fruit and vegetable intake among adults were not investigated because of lack of data. However, if there were any promotion impacts, the impact sizes were not sufficient to make a persistent significant increase in mean population fruit and/or vegetable intake. However, it remains a consideration that mean fruit

and vegetable intake may have been even less without these dietary promotion campaigns.

Implications for practice

A review of the large-scale government dietary campaigns over the past 12 years shows promotion activities mainly

focused on instant knowledge education and support associated with food supply participants. Little effort has been put on the actual food consumers (i.e. the demand side). Research studies have shown that improving perceptions, awareness, and the way of thinking about health and nutrition improved healthy food intake.^{31–33} Multi-component interventions, such as including education, changes to the environment, supporting policies, parental/family supports, and focusing on specific healthy foods, are likely to be effective.^{34–36} Although Nutrition Guidelines^{16,37} provide recommendations for both primary and secondary schools, secondary school students seem to be left out from the promotion campaigns. This may significantly hinder knowledge acquisition and retention, and achieving the promotion objectives of helping the public develop healthy dietary habits and cultures. A baseline survey conducted in 2007 for the ‘EatSmart@restaurant.hk’ campaign³⁸ found that participants had little knowledge of serving sizes and the health benefits of fruit and vegetable intake. More than a decade later, a qualitative survey conducted in 2016²⁹ also showed similar findings. Future promotion efforts should pay more attention to consumers’ knowledge awareness and retention, as well as stimulating customer demand for a healthy diet. More promotions targeting secondary school students are needed, especially among upper-level secondary students who are becoming adults. Their knowledge, attitudes, and behaviors are not only going to affect their adult lives but may also affect their future partners and the next generation.

Implications for research

Despite many dietary promotion activities that have been conducted, no postactivity process or outcome evaluation data or report could be found. Evaluations are needed to investigate current promotion coverages and their extent in terms of increasing fruit and vegetable intake (e.g. promotion in restaurants might mostly focus on increasing vegetable intake, whereas increasing fruit intake could probably be left out), as well as population age-specific and sex-specific segments. More research is needed to investigate the specific impacts of the promotion process, and the effectiveness of different promotion activities in changing fruit and vegetable intake among the exposed population. Identifying the current promotion barriers, gaps, as well as future promotion leverages, are also very important for future promotion plans. Pinpointing potential factors that may contribute to decreasing fruit and vegetable intake could be crucial to future promotion success.

Conclusions

Only a small proportion of the Hong Kong adult population met both the fruit and vegetable intake recommendations. More research is needed to investigate the effectiveness of existing dietary promotion campaigns, and more effective strategies are needed to further increase the fruit and vegetable intake of the population.

Author statements

Ethical approval

This study used de-identified secondary data extracted from a public online database provided by the Department of Health of the Hong Kong Special Administrative Region (SAR) Government. Therefore, ethical approval was not required. Published informed consent can be found at: <https://www.chp.gov.hk/en/resources/29/327.html>.

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Competing interests

None declared.

Author contributions

Cynthia Sau Chun Yip made substantial contributions to all of the following: (1) the conception and design of the study and acquisition of data, an analysis, and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the version to be submitted.

Yuk Cheung Yip made substantial contributions to all of the following: (1) the conception and design of the study; (2) revising it critically for important intellectual content; and (3) final approval of the version to be submitted.

Wendy Chan made substantial contributions to all of the following: (1) the conception and design of the study; (2) revising it critically for important intellectual content; and (3) final approval of the version to be submitted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2019.08.012>.