Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at *Int. J. Environ. Res. Public Health* **2018**, *15*, 1251; doi:10.3390/ijerph15061251

Article

Cardiovascular Health of Construction Workers in Hong Kong: A Cross-Sectional Study

Joanne Wai-Yee Chung, PhD [1,*], Bonny Yee-Man Wong, PhD[2], Vincent Chun-Man Yan, MPH[3], Louisa Ming-Yan Chung, PhD[4], Henry Chi-Fuk So, PhD[5] and Albert Chan, PhD[6]

[1] Department of Health and Physical Education, The Education University of Hong Kong, 10 Lo Ping Road, Tai Po, New Territories, Hon Kong SAR, China; joannechung@eduhk.hk
[2] Department of Health and Physical Education, The Education University of Hong Kong, 10 Lo Ping Road, Tai Po, New Territories, Hon Kong SAR, China; bymwong@eduhk.hk
[3] Department of Health and Physical Education, The Education University of Hong Kong, 10 Lo Ping Road, Tai Po, New Territories, Hon Kong SAR, China; cmyan@eduhk.hk
[4] Department of Health and Physical Education, The Education University of Hong Kong, 10 Lo Ping Road, Tai Po, New Territories, Hon Kong SAR, China; chungmy@eduhk.hk
[5] Department of Mathematics and Information Technology, The Education University of Hong Kong, 10 Lo Ping Road, Tai Po, New Territories, Hong Kong SAR, China; hcfso@eduhk.hk
[6] Department of Building and Real Estate, Polytechnic University, 11 Yuk Choi Rd, Hung Hom, Hong Kong SAR, China; albert.chan@polyu.edu.hk

* Correspondence: joannechung@eduhk.hk; Tel.: +852-2948-6436

Abstract: Objectives: 1) To describe the cardiovascular health of the construction workers in Hong Kong, 2) to examine the demographic differences in cardiovascular health, and 3) to examine the association between modifiable lifestyle behaviors and cardiovascular conditions.

Methods: 626 registered construction workers were included in the analysis. Blood chemistry, blood pressure, weight and height were measured. Face-to-face questionnaire interview was conducted. T-tests and One-way ANOVAs were used to compare the cardiovascular health score, cardiovascular outcomes, and lifestyle behaviors by demographic characteristics. Logistic regressions were performed to assess the cardiovascular outcomes by lifestyle behaviors.

Results: Two-thirds of the construction workers failed to achieve three out of the seven "ideal" cardiovascular health indicators. The younger, more educated, and female subjects had better cardiovascular health scores than their counterparts. The ideal fish and seafood consumption was associated with 1) ideal weight status and 2) ideal cholesterol level, whereas less soft drink consumption was associated with ideal cholesterol level.

Conclusions: The findings highlighted the importance of promoting cardiovascular health in the construction industry. This study provided insights for future interventions, which should include increasing fish and seafood intake, decreasing soft drink consumption, and enhancing the health literacy amongst older, less educated, and male construction workers.

Keywords: construction industry; heart health; lifestyle behaviors; healthy eating; physical activity

© 2018 by the author(s). Distributed under a Creative Commons CC BY license.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

1. Introduction

The World Health Organization (WHO) has been advocating healthy workplaces to prevent non-communicable diseases [1]. Cardiovascular diseases which were categorized under non-communicable diseases were more prevalent among construction workers than workers in other occupations [2, 3], and the workers in the construction industry have been reported as high cardiovascular risk individuals [4, 5].

Construction work was highly demanding because workers were incessantly exposed to harsh environments filled with fume, dust, heat, and moist [6]. Cardiovascular diseases, following musculoskeletal diseases, are one of the major causes for early retirement of these workers (known as healthy worker effect) [2, 7, 8]. Similar to Western countries, Hong Kong's construction industry suffers from a shortage of construction workers and a depleting aging workforce. It is, therefore, all the more important to develop strategies to avoid early retirement caused by cardiovascular diseases and maximize the productivity of its existing workforce.

The American Heart Association has established the "ideal cardiovascular health" metrics to monitor the Americans' cardiovascular health and track their progress towards the national goals set under the Healthy People 2020 by the US government [9]. Construction site workers' health, however, was overlooked because they were considered as healthy despite their cardiovascular risks [10]. So far only two studies have reported on the cardiovascular risks of construction workers, one with a focus on musculoskeletal pain [11] and the other on comparing the cardiopulmonary risk in different occupations [12]. The cardiovascular health of construction workers has not been systematically assessed; it is essential to have this systematic assessment done in order to monitor the secular trends, to make studies comparable, and hence, to develop long-term strategies to promote cardiovascular health to reduce premature retirement in the construction industry. At present, the characteristics of construction workers facing higher risk of cardiovascular diseases have not been assessed, and hence it is almost impossible to prioritize effectively for whom future interventions should be targeted

Modifiable lifestyle behaviors, e.g., eating, smoking, and physical activity (PA), have been consistently found to be associated with cardiovascular diseases [9, 13, 14]. Adopting healthy lifestyle behaviors can be a strategy to reduce the risk of cardiovascular diseases. However, the association between lifestyle behaviors and cardiovascular diseases remained unknown among the construction workers in Hong Kong; no previous studies have examined such an association. This information could provide insight into future strategies to prevent non-communicable diseases (i.e., cardiovascular diseases), reduce premature retirement and maximize the productivity of the existing workforce. Therefore, the objectives of this paper were 1) to describe the cardiovascular health of the construction workers in Hong Kong, 2) to examine the demographic differences in cardiovascular health, and 3) to examine the association between modifiable lifestyle behaviors and cardiovascular conditions.

2. Materials and Methods

2.1 Subjects and procedures

From July 2014 to August 2016, the research team recruited subjects by convenience sampling and collected the health data of 1,361 registered construction workers in 66 construction sites. The research team visited each construction site during lunch breaks and met each worker for about 15 minutes. The inclusion criteria was the construction workers registered to the Construction Worker Registration System in Hong Kong. Written consent was obtained from each participant before the research team measured his/her weight and height, and carried out the face-to-face questionnaire interview. Blood sample and blood pressure were taken by the staffs' from a professional clinic. Ethical approval was obtained from the Human

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Subjects Ethics Application Review System (HSEARS) of the Hong Kong Polytechnic University, Hong Kong (Reference number: HSEARS20131218001).

Only 626 subjects provided full data and hence, were included in the analysis. Those excluded were the 304 subjects who did not fast on the day of data collection and had only received random blood glucose tests, and the 461 subjects who did not take the PA questions, which were only added to the questionnaire at a later stage of the survey. However, there was little difference between the demographic background of the included and the excluded subjects (effect sizes<0.2, which is considered as small [15]]).

In Hong Kong, there were approximately 413,613 registered construction workers [16]. With the confidence level of 0.05 and 95% margin of error assumed, the estimated sample size was 384 [17]. Based on the cardiovascular outcomes, the design effects [18] were calculated ranging from 1.08 to 1.63. With the largest design effect, the effective sample size was 383.

2.2Independent variables: anthropometric measures and blood tests (clinical examination)

The workers' weight and height were measured on-site by the research assistant. The Body Mass Index (BMI) for each worker was then computed and categorized into 3 groups: underweight (BMI <18), normal weight (BMI=18-22.9), and overweight (BMI ≥23). His/her blood sample and pressure were taken and the measurements were sorted into 3 categories: normal (<120 mm Hg/<80 mm Hg) , pre-hypertension (Systolic blood pressure (SBP) 120-139 mm Hg or Diastolic blood pressure (DBP) 80-89 mm Hg), and hypertension (SBP≥140 mm Hg or DBP≥90 mm Hg). The clinic also performed the blood sample test to examine the blood glucose (fasting or random) and total cholesterol level. Only the workers who had the fasting blood glucose measured were included in the analysis. The fasting blood glucose was classified as normal (5.6 mmol/L converted as <100 mg/dL), glucose impaired tolerance (>5.6-6.9 mmol/L converted as 100-125 mg/dL), and diabetes (≥7.0 mmol/L converted as ≥126 mg/dL). Similarly, the total cholesterol level was categorized as normal (<200 mg/dL), borderline high (200-239 mg/dL), and high (≥240 mg/dL).

For data analysis, the cardiovascular outcomes were classified according to the American Heart Association into "ideal" vs. "undesired" which represent normal and higher than normal ranges respectively [9]. For example, "ideal" vs. "undesired" outcomes for the weight status is BMI≥23 vs. BMI<23, blood pressure is ≥120 mm Hg/ ≥80 mm Hg vs. <120 mm Hg/ <80 mm Hg, fasting blood glucose is ≥5.6 mmol/L converted as <100 mg/dL vs. <5.6 mmol/L converted as <100 mg/dL, and total cholesterol is ≥200 mg/dL vs. <200 mg/dL. The total number of ideal cardiovascular outcomes was then calculated (range: 0-4).

2.3Dependent variables: lifestyle behaviors (questionnaire)

The questionnaire comprised of questions regarding lifestyle behaviors of the subjects, e.g., leisure-time PA, smoking status, and diet pattern.

The responses to each of the questions on leisure-time PA and smoking status were coded as "ideal" or "undesired". Leisure-time PA was considered as ideal if the subject had 150 minutes or more (≥150 minutes) of moderate PA per week, and as undesired if he/she did less than 150 minutes (<150 minutes) per week. Smoking status was classified as ideal if the subject is a non-smoker, i.e., no cigarettes smoked, and as undesired if he/she is a smoker smoking one or more cigarettes (≥1 cigarette) in the last 30 days.

Diet pattern of consumption included 1) fruits and vegetables, 2) fish and seafood, and 3) soft drinks. Fruit and vegetable consumption was defined as ideal if the diet included 4.5 cups or more (≥4.5 cups) of fruits and vegetables per day, and as undesired if less than 4.5 cups (<4.5 cups) per day. According to the American Heart Association, fish consumption should be at

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

least 2 servings per week [9]. As the study was designed to develop a health profile for the Hong Kong construction workers, the consumption of fish was expanded to include seafood. That said, the majority of seafood consumption in Hong Kong was fish [19], and hence such a measure reasonably assessed the fish consumption. The fish and seafood consumption was separated into 2 groups: the ideal with two or more servings (≥2 servings) per week, and the undesired with less than 2 servings (<2 servings) per week. The study included only soft drink consumption rather than all sugar-sweetened beverages as suggested by the American Heart Association [9]. Soft drink consumption was classified as ideal if the subject took less than 36 oz (<36 oz) of soft drink per week, and as undesired if he/she consumed more than 36 oz (≥36 oz) per week. From the responses of each subject, the subjects' dietary behaviors were considered as "ideal" if they had ideal responses to the 3 aforementioned items, or else their behaviors would be considered as "undesired". The total number of "ideal" lifestyle behaviors (e.g., physical activity, smoking and dietary behaviors) (range: 0-3) was then counted.

2.3.1Cardiovascular health score

Cardiovascular health score was based on the American Heart Association's cardiovascular metrics that measured seven items, i.e., weight status, blood pressure, blood glucose level, cholesterol level, PA, dietary behaviors, and smoking [9]. The score, ranging from 0 to 7, is the sum of the total number of "ideal" conditions for the seven metrics to indicate the cardiovascular health of a participant.

2.4Covariates: demographic characteristics (questionnaire)

The questionnaire also comprised of questions regarding demographic characteristics of the subjects. The covariates were gender (males and females), age (20-29, 30-39, 40-49, 50-59), education (no formal education/ primary education, junior secondary education, senior secondary education, and post-secondary education), and ethnicity (Chinese: born in Hong Kong or have lived in Hong Kong for more than 7 years, Chinese: from Mainland, Minority).

2.5Statistical methods

For the objective 1, descriptive statistics were used to summarize the construction workers' cardiovascular outcomes (e.g., blood pressure, glucose level, cholesterol level, and weight status), lifestyle behaviors (e.g., smoking, dietary behaviors, and leisure-time PA), and cardiovascular health score. For objective 2, Krustal-Wallis test and Mann-Whitney test were performed to compare the individual cardiovascular outcomes and lifestyle behaviors by demographic characteristics (age, gender, education, and race). T-tests and One-way ANOVAs were used to compare the cardiovascular health score, and overall cardiovascular outcomes and lifestyle behaviors. For objective 3, multilevel logistic regressions were performed to regress the cardiovascular outcomes with lifestyle behaviors adjusting for age, gender, ethnicity, and education and the cluster effect of construction sites. All statistical analyses were performed using STATA 13.

3. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

3.1 Demographic Characteristics of the Sample

Out of the 626 subjects, 90% of them were male with 67% aged 40 or above (Table 1). In terms of ethnicity, about 84% were born in Hong Kong and 12% were from Mainland China, whilst the remaining subjects (4%) were from Nepal, Pakistan, or other countries. About 20% of the subjects had no formal education or only primary education. The percentages of subjects who had junior secondary (Form 3), senior secondary (Form 7 in the old education system or Form 6 in the new system), and post-secondary education (e.g., diploma, associate, or degree) were 40%, 27%, and 11% respectively.

3.2 Cardiovascular Health

As shown in Table 1, 38% of the subjects had ideal weight status; 68% had ideal total blood cholesterol level; 19% had ideal blood pressure; and 92% had ideal fasting blood glucose level.

Regarding lifestyle behaviors, 60% of the subjects were non-smokers and 28% engaged in an ideal amount of PA. In terms of the consumption of fruits and vegetables, soft drinks, and fish and seafood, 8%, 73% and 59% of them respectively were considered to be in an ideal state.

The average cardiovascular health score (range: 0-7) was 3.07 (SD=1.14) with 0 being the lowest score and 7 the highest. The distribution of the health scores among the subjects from score 0 to score 7 was 0.5%, 6.7% , 25.1%, 32.7%, 24.4%, 9.3%, 1.1%, and 0.2% respectively. The mean number of ideal lifestyle behaviours (range: 0-3) was 0.91 (SD=0.70) and the distribution of scores from 0 to 3 was 28.4%, 52.6%, 18.2%, and 0.8% respectively. The mean number of cardiovascular health outcomes (range: 0-4) was 2.16 (SD=0.91) with distribution of scores from 0 to 4 was 2.4%, 20.9%, 42.3%, 27.3 %, and 7.0% respectively.

3.3 Demographic differences in cardiovascular health

As shown in Table 2, there were no significant differences in the weight status, total cholesterol, blood pressure and fasting blood glucose across the gender, educational and ethnic groups. Nonetheless, there were significant differences in the mentioned items across specific age groups. More subjects aged 20-29 had ideal weight status and cholesterol level compared to those in other age groups ($p=0.01$ and <0.001, respectively), whereas more subjects in the age groups of 20-29 and 30-39 had ideal fasting blood glucose compared to those in the rest of the age groups ($p<0.001$).

There were no significant differences in the fruit and vegetable consumption among the gender, age, ethic, and education groups (Table 3). However, significant differences were found in other lifestyle behaviors across the gender, age, ethic, and education groups. More male subjects were smokers ($p<0.001$) and engaged in more PA than the females ($p=0.007$). In general, the percentage of subjects achieving ideal amount of PA decreased with age ($p<0.001$), whereas the percentage of the ideal amount of fish and seafood consumed by the subjects increased with age ($p<0.001$). The Chinese who were born in Hong Kong or lived in Hong Kong for more than 7 years were more physically active compared with the Chinese from the Mainland ($p=0.028$). Besides, the Chinese subjects consumed more seafood and fish than the subjects of other ethnic origins ($p=0.002$). As regards the subjects' educational levels, they were positively correlated with the percentage of the ideal amount of PA ($p<0.001$), but negatively to the percentage of the ideal amount of fish and seafood consumed ($p=0.002$).

In terms of the overall cardiovascular health as shown in Table 4, the younger, more educated, and female subjects had higher cardiovascular health scores than the older, less educated, and male subjects ($p=0.003$, <0.001, <0.001 respectively). Similarly, the younger, more educated, and female subjects had more ideal lifestyle behaviors than their older, less educated, and male counterparts ($p<0.001$, $=0.016$, <0.001 respectively). In terms of the cardiovascular health outcomes, significant differences occurred across different age groups ($p<0.001$); the subjects aged 20-29 had more ideal cardiovascular health outcomes than those aged 50-59.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

3.4 Associations between clinical test results and lifestyle behaviors

Only a few lifestyle behaviors were related to the cardiovascular health outcomes (Table 5). The non-smokers were more likely to have ideal weight status compared with the smokers (adjusted OR: 1.36, 95% CI: 1.02-1.81, p=0.03). The consumption of fish and seafood was associated with ideal weight status and total cholesterol level (adjusted ORweight: 1.34, 95%: CI: 1.02-1.76, p=0.04; adjusted ORchol: 1.35, 95% CI: 1.002-1.82, p=0.048). The subjects who drank less soft drinks were more likely to have ideal total cholesterol compared with those who drank excessively (adjusted OR: 1.48, 95%: 1.06-2.07, p=0.02).

3.5. Tables

Table 1. Sample descriptive

	N	%
Gender		
Male	564	90.2
Female	61	9.8
Ethnicity		
Chinese—born in HK or have lived more than 7 years in Hong Kong	526	84.0
Chinese—born in Mainland China	77	12.3
Minority	23	3.7
Education		
No Formal Education / Primary Education	135	21.7
Junior Secondary Education	249	40.0
Senior Secondary Education	170	27.3
Post-secondary Education (Diploma / Associate Degree / Degree etc.)	69	11.1
Age		
20-29	94	15.0
30-39	112	17.9
40-49	158	25.2
50-59	170	27.2
60 or older	92	14.7
Weight status		
Intermediate/ Poor (BMI=>23)	386	61.9
Ideal (BMI<23)	238	38.1
Blood cholesterol		
Intermediate/ Poor (=>5.2 mmol/L or 200 mg/dL)	202	32.3
Ideal (<5.2 mmol/L or 200 mg/dL)	424	67.7
Blood pressure		
Intermediate/ Poor (=>120 mm Hg/ =>80 mm Hg)	484	81.3
Ideal (<120 mm Hg/ <80 mm Hg)	111	18.7
Blood glucose		
Intermediate/ Poor (=>5.6 mmol/L or 100 mg/dL)	49	7.8
Ideal (<5.6 mmol/L or 100 mg/dL)	577	92.2

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Smoking		
Not desired (Smokers)	251	40.1
Ideal (Non-smoker)	375	59.9
Physical activity		
Not desired (<150 mins moderate/ wk)	452	72.2
Ideal (>=150 mins moderate/ wk)	174	27.8
Fruit and vegetable		
Not desired (<4.5 cups/ day)	579	92.5
Ideal (=>4.5 cups/ day)	47	7.5
Seafood or fish		
Not desired (<2 servings/ wk)	257	41.1
Ideal (=>2 servings/ wk)	369	58.9
Sweetened-beverage		
Not desired (=>36 oz/ wk)	169	27.0
Ideal (<36 oz/ wk)	457	73.0
	Mean	SD
Cardiovascular health score (0-7)	3.07	1.14
Number of ideal cardiovascular outcomes (0-4)	2.16	0.91
Number of ideal lifestyle indicators (0-3)	0.91	0.70

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Table 2: Cardiovascular health outcomes

	Weight status					Blood cholesterol					Blood pressure					Blood glucose				
	Intermediate/ Poor (BMI=>23)		Ideal (BMI<23)			Intermediate/ Poor (=>5.2 mmol/L or 200 mg/dL)		Ideal (<5.2 mmol/L or 200 mg/dL)			Intermediate/ Poor (=>120 mm Hg/ =>80 mm Hg)		Ideal (<120 mm Hg/ <80 mm Hg)			Intermediate/ Poor (=>5.6 mmol/L or 100 mg/dL)		Ideal (<5.6 mmol/L or 100 mg/dL)		
	N	%	N	%	p	N	%	N	%	p	N	%	N	%	p	N	%	N	%	p
Gender																				
Male	350	62.2	213	37.8	0.63	184	32.6	380	67.4	0.62	440	82.1	96	17.9	0.14	45	8.0	519	92.0	0.70
Female	36	59.0	25	41.0		18	29.5	43	70.5		43	74.1	15	25.9		4	6.6	57	93.4	
Age																				
20-29	44	46.8	50	53.2	0.01*	12	12.8	82	87.2	<0.001*	71	77.2	21	22.8	0.43	1	1.1	93	98.9	<0.001**
30-39	68	61.3	43	38.7		37	33.0	75	67.0		83	81.4	19	18.6		1	0.9	111	99.1	
40-49	110	69.6	48	30.4		52	32.9	106	67.1		118	79.2	31	20.8		14	8.9	144	91.1	
50-59	105	62.1	64	37.9		70	41.2	100	58.8		141	86.0	23	14.0		21	12.4	149	87.6	
60 or older	59	64.1	33	35.9		31	33.7	61	66.3		71	80.7	17	19.3		12	13.0	80	87.0	
Ethnicity																				
Chinese-Born in HK or have lived in HK for more than 7 years	325	61.9	200	38.1	0.23	179	34.0	347	66.0	0.10	417	81.8	93	18.2	0.44	45	8.6	481	91.4	0.22
Chinese-From Mainland	44	57.1	33	42.9		18	23.4	59	76.6		52	76.5	16	23.5		4	5.2	73	94.8	
Minority	17	77.3	5	22.7		5	21.7	18	78.3		15	88.2	2	11.8		0	0.0	23	100.0	
Education																				

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at *Int. J. Environ. Res. Public Health* **2018**, *15*, 1251; doi:10.3390/ijerph15061251

No Formal Education / Primary Education	90	67.2	44	32.8	0.34	43	31.9	92	68.1	0.18	110	84.0	21	16.0	0.63	14	10.4	121	89.6	0.50
Junior Secondary Education	156	62.7	93	37.3		79	31.7	170	68.3		194	81.5	44	18.5		19	7.6	230	92.4	
Senior Secondary Education	98	57.6	72	42.4		64	37.6	106	62.4		129	80.6	31	19.4		13	7.6	157	92.4	
Post-secondary Education	40	58.0	29	42.0		16	23.2	53	76.8		48	76.2	15	23.8		3	4.3	66	95.7	

*significant differences between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between 20-29 and 40-49; sig dif between 20-29 and 30-39

**significant difference between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between 20-29 and 40-49; sig dif between 30-39 and 60 or older; sig dif between 30-39 and 50-59; sig dif between 30-39 and 40-49

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Table 3: Lifestyle behaviors

	Smoking				Physical activity				Fruit and vegetable				Seafood or fish				Soft drink			
	Not desired (Smokers)		Ideal (Non-smoker)		Not desired (<150 mins moderate/ wk)		Ideal (>=150 mins moderate/ wk)		Not desired (<4.5 cups/ day)		Ideal (=>4.5 cups/ day)		Not desired (<2 servings/ wk)		Ideal (=>2 servings/ wk)		Not desired (<2 servings/ wk)		Ideal (=>2 servings/ wk)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Gender																				
Male	249	44.1	315	55.9[c]	398	70.6	166	29.4[b]	524	92.9	40	7.1	238	42.2	326	57.8	163	28.9	401	71.1[b]
Female	2	3.3	59	96.7	53	86.9	8	13.1	54	88.5	7	11.5	18	29.5	43	70.5	5	8.2	56	91.8
Age																				
20-29	35	37.2	59	62.8	50	53.2	44	46.8[c*]	88	93.6	6	6.4	56	59.6	38	40.4[c**]	42	44.7	52	55.3[c***]
30-39	47	42.0	65	58.0	73	65.2	39	34.8	103	92.0	9	8.0	55	49.1	57	50.9	56	43.4	73	56.6
40-49	67	42.4	91	57.6	112	70.9	46	29.1	150	94.9	8	5.1	60	38.0	98	62.0	50	31.6	108	68.4
50-59	72	42.4	98	57.6	142	83.5	28	16.5	153	90.0	17	10.0	61	35.9	109	64.1	29	17.1	141	82.9
60 or older	30	32.6	62	67.4	75	81.5	17	18.5	85	92.4	7	7.6	25	27.2	67	72.8	9	9.8	83	90.2
Ethnicity																				
Chinese-Born in HK or have lived in HK for more than 7 years	218	41.4	308	58.6	369	70.2	157	29.8[a#]	481	91.4	45	8.6	204	38.8	322	61.2[b##]	148	28.1	378	71.9
Chinese-From Mainland	27	35.1	50	64.9	63	81.8	14	18.2	75	97.4	2	2.6	36	46.8	41	53.2	13	16.9	64	83.1
Minority	6	26.1	17	73.9	20	87.0	3	13.0	23	100.0	0	0.0	17	73.9	6	26.1	8	34.8	15	65.2

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Education																				
No Formal Education / Primary Education	48	35.6	87	64.4	113	83.7	22	16.3[c^]	123	91.1	12	8.9	40	29.6	95	70.4[b^]	27	20.0	108	80.0[a^^]
Junior Secondary Education	121	48.6	128	51.4	182	73.1	67	26.9	231	92.8	18	7.2	106	42.6	143	57.4	62	24.9	187	75.1
Senior Secondary Education	63	37.1	107	62.9	118	69.4	52	30.6	158	92.9	12	7.1	71	41.8	99	58.2	54	31.8	116	68.2
Post-secondary Education	18	26.1	51	73.9	36	52.2	33	47.8	64	92.8	5	7.2	39	56.5	30	43.5	25	36.2	44	63.8

a p<0.05, b p<0.01, c p<0.001

*significant difference between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between 20-29 and 40-49; sig dif between 30-39 and 60 or older; sig dif between 30-39 and 50-59; sig dif between 40-49-50-59

**significant difference between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between 20-29 and 40-49; sig dif between 30-39 and 60 or older; sig dif between 30-39 and 50-59

***significant difference between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between 20-29 and 40-49; sig dif between 30-39 and 60 or older; sig dif between 30-39 and 50-59; sig dif between 40-49-50-59; sig dif between 40-49 and 60 or older

#sig dif between Chinese who were born in HK or lived in HK for more than 7 years and Chinese who came from the Mainland

sig dif between minority and Chinese who were born in HK or lived in HK for more than 7 years; sig dif between minority and Chinese who came from the Mainland

^sig dif between post-secondary education (post-sec) and no formal/primary education (pri); sig dif between post-sec and junior secondary education (jun sec); sig dif between post-sec and senior secondary education (sen sec); sig dif between pri and jun sec; sig dif between pri and sen sec

^^sig dif between pri and sec sec; sig dif between pri and post-sec

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

1 **Table 4: Overall cardiovascular health**

	Cardiovascular health score			Ideal lifestyles			Ideal cardiovascular outcomes		
	Mean	SD	p	Mean	SD	p	Mean	SD	p
Gender									
Male	3.03	1.15	0.003	0.88	0.72	<0.001	2.14	0.92	0.21
Female	3.48	1.03		1.18	0.43		2.30	0.88	
Age									
20-29	3.73	1.13	<0.001*	1.12	0.76	0.016**	2.62	0.86	<0.001*
30-39	3.16	1.11		0.95	0.71		2.21	0.87	
40-49	2.96	1.11		0.88	0.68		2.08	0.92	
50-59	2.79	1.09		0.81	0.69		1.98	0.92	
60 or older	2.99	1.06		0.91	0.66		2.08	0.85	
Ethnicity									
Chinese-Born in HK or have lived in HK for more than 7 years	3.06	1.15	0.55	0.93	0.71	0.61	2.13	0.92	0.14
Chinese-From Mainland	3.19	1.12		0.84	0.63		2.35	0.93	
Minority	2.96	0.88		0.87	0.63		2.09	0.67	
Education									
No Formal Education / Primary Education	2.92	1.14	<0.001^	0.86	0.69	<0.001^	2.06	0.84	0.17
Junior Secondary Education	2.97	1.01		0.82	0.67		2.16	0.87	
Senior Secondary Education	3.12	1.18		0.97	0.69		2.15	1.01	
Post-secondary Education	3.61	1.34		1.25	0.76		2.36	0.94	

2 *significant difference between 20-29 and 60 or older; sig dif between 20-29 and 50-59; sig dif between
3 20-29 and 40-49; sig dif between 20-29 and 30-39
4 ** sig dif between 20-29 and 60 or older
5 ^sig dif between post-sec and pri; sig dif between post-sec and jun sec; sig dif between post-sec and
6 sen sec

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

Table 5: Associations between lifestyle behaviors and cardiovascular health outcomes

	Weight status#								Total cholesterol#							
	Crude OR*	95% CI		p	Adj. OR**	95% CI		p	Crude OR*	95% CI		p	Adj. OR**	95% CI		p
Smoking^	1.52	(1.20,	1.92)	<0.001	1.36	(1.02,	0.81)	0.034	1.20	(0.93,	1.54)	0.15	1.28	(0.94,	1.75)	0.11
PA^	0.97	(0.71,	1.32)	0.83	0.97	(0.70,	0.33)	0.83	1.20	(0.86,	1.69)	0.28	1.24	(0.88,	1.74)	0.22
Fruit and vegetable^	1.09	(0.71,	1.69)	0.69	0.98	(0.59,	0.63)	0.94	1.09	(0.71,	1.69)	0.69	0.82	(0.48,	1.42)	0.48
Fish and seafood^	1.39	(1.11,	1.74)	<0.001	1.34	(1.02,	0.76)	0.038	1.20	(0.94,	1.54)	0.14	1.35	(1.00,	1.82)	0.048
Softdrink^	1.12	(0.88,	1.44)	0.35	1.16	(0.85,	0.58)	0.36	1.30	(1.00,	1.69)	0.049	1.48	(1.06,	2.07)	0.020
	Blood pressure#								Blood glucose#							
	Crude OR*	95% CI		p	Adj. OR**	95% CI		p	Crude OR*	95% CI		p	Adj. OR**	95% CI		p
Smoking^	0.97	(0.70,	1.36)	0.87	1.05	(0.70,	1.58)	0.83	1.13	(0.66,	1.91)	0.66	0.86	(0.46,	1.59)	0.62
PA^	0.81	(0.53,	1.25)	0.35	0.80	(0.52,	1.23)	0.31	1.41	(0.72,	2.77)	0.32	1.43	(0.72,	2.81)	0.30
Fruit and vegetable^	0.77	(0.44,	1.35)	0.36	0.64	(0.34,	1.21)	0.17	0.79	(0.27,	2.27)	0.66	1.10	(0.37,	3.29)	0.86
Fish and seafood^	1.00	(0.73,	1.38)	0.98	0.95	(0.64,	1.40)	0.79	0.99	(0.58,	1.67)	0.96	1.06	(0.56,	2.01)	0.85
Softdrink^	0.91	(0.65,	1.29)	0.60	0.84	(0.55,	1.30)	0.43	0.89	(0.48,	1.64)	0.70	1.07	(0.50,	2.30)	0.86

^Smoking: non-smokers vs. smokers (ref); Fruit and vegetable: =>4.5 cups/ day vs. <4.5 cups/ day (ref); Fish and seafood: =>2 servings/ wk vs. <2 servings/ wk (ref); Soft drink: =>2 servings/ wk vs. <2 servings/ wk (ref);

#Weight status: BMI<23 vs. BMI=>23 (ref); Blood cholesterol: <5.2 mmol/L or 200 mg/dL vs. =>5.2 mmol/L or 200 mg/dL (ref); Blood pressure: <120 mm Hg/ <80 mm Hg vs. =>120 mm Hg/ =>80 mm Hg (ref); Blood glucose: <5.6 mmol/L or 100 mg/dL vs. =>5.6 mmol/L or 100 mg/dL (ref)

*crude OR was adjusted for age, gender, ethnicity, and education.

**adjusted OR was adjusted for age, gender, ethnicity, and education and other lifestyle behaviors.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

4. Discussion

Cardiovascular risks are prevalent among the construction workers in Hong Kong. As shown in this study (objective 1), about two-thirds of the subjects failed to achieve three out of the seven "ideal" cardiovascular health indicators. Consistent with previous studies [2, 4, 7, 20], the prevalence of pre-hypertension/hypertension, borderline high blood cholesterol/hypercholesterolemia, and overweight/obesity was high in the construction workers in Hong Kong. Many studies have already demonstrated that the "healthy worker effect" is paradoxical; cardiovascular diseases such as ischaemic heart disease, heart failure, and hypertension are permanent disabilities that forced workers to retire early [7, 8, 21, 22] or caused them to die prematurely [21, 23]. Moreover, cardiovascular disease was the second leading cause of permanent disability and the leading cause of premature death among construction workers [8, 23]. Hence, promoting cardiovascular health in the construction industry will enhance the sustainability of the existing workforce.

For the objective 2, younger, higher educated, and female workers were found to have better cardiovascular health. They had been reported to have higher health literacy, and hence might have greater awareness of health problems and more healthy lifestyles [24], which might lead to better cardiovascular health in the subgroups. In view of this, future interventions should enhance the health literacy of construction workers, particularly the older, less educated, and male workers.

In terms of objective 3, this study found that the subjects who consumed fish and seafood were more likely to have healthier weight status than those who did not. This is consistent with the literature suggesting that fish and seafood consumption improved weight status possibly through reduction in body fat mass, and satiety regulation and lipid oxidation stimulated by n-3 polyunsaturated fatty acid (PUFA) [25, 26]. Moreover, the construction workers who consumed more fish and seafood were more likely to have lower serum cholesterol level. Some previous studies suggested that phospholipids and fish protein consumption could lower serum cholesterol level possibly by reducing serum ad liver cholesterol levels, improving lipid metabolism, inhibiting cholesterol and bile acid absorption, and enhancing cholesterol catabolism in the liver [25, 27-29]. This was probably the reason why the United States' recent dietary recommendation suggested two servings (eight ounces) of seafood per week [30]. Given that 41% of the subjects did not consume enough fish and seafood, promoting fish and seafood intake in the construction industry may be one of the effective strategies to enhance cardiovascular health among construction workers.

The subjects who consumed less soft drinks were found to have lower serum cholesterol level compared with those with excessive consumption. An intervention study showed that reduction in soft drink consumed lowered the total serum cholesterol level in school-aged children [31]. Similarly, another study demonstrated that drinking colas increased total serum cholesterol [32]. Besides, some other studies also identified related associations: drinking soft drinks was related to lower high-density-lipoprotein (HDL) cholesterol (good cholesterol) and higher triglycerides, and low-density-lipoprotein (LDL) and very-low-density-lipoprotein (VLDL) cholesterol, a precursor of low-density-lipoprotein [33-35]. Such change in serum lipid profiles may be resulted from the alteration of lipid metabolism and profiles in liver and serum by the added sugar (e.g., fructose) and acid in soft drinks [35-37]. Therefore, the American Heart Association recommended that sugar-sweetened beverage should be reduced to less than 36 oz per week [9]. Future intervention should consider promoting such dietary recommendation in order to improve cardiovascular health in construction workers.

This study had several limitations. Firstly, the cross-sectional design examined associations but failed to establish causal relationships. Secondly, due to incomplete information, only half of the subjects were included in the analysis. As the data collection was conducted from 10 a.m. to 1 p.m., a high percentage of the subjects had random rather than

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

fasting blood glucose test, and hence were excluded in the final analysis. Another hiccup was that the research team decided to add PA measurement into the questionnaire after the data collection had begun, and hence many subjects were not asked about their PA and were excluded from this analysis as a result. Thirdly, some dietary items used in this study were different from the existing recommendations of the American Heart Association [9] which may be due to the cultural differences in dietary habits, for example, whole grain intake.

5. Conclusions

About two-thirds of the construction workers failed to achieve three out of the seven "ideal" cardiovascular health indicators. The ideal fish and seafood consumption was associated with 1) ideal weight status and 2) ideal cholesterol level, whereas less soft drink consumption was associated with ideal total cholesterol level. The findings highlighted the importance of promoting cardiovascular health in the construction industry and provided some insights for future interventions, which should include increasing fish and seafood intake, decreasing soft drink consumption, and enhancing the health literacy amongst older and less educated construction worker.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

6.

Acknowledgments: The "Pilot medical examination scheme for construction workers" project presented in this paper was fully supported by a grant from the Construction Industry Council of Hong Kong (Ref. No. K-ZJJP). The participation of the frontline workers is this study is gratefully acknowledged.

Author contribution: Conceptualization, Joanne Wai-Yee Chung, Louisa Ming-Yan Chung, Henry Chi-Fuk So and Albert Chan; Data curation, Bonny Yee-Man Wong and Vincent Chun-Man Yan; Formal analysis, Bonny Yee-Man Wong; Funding acquisition, Joanne Wai-Yee Chung, Louisa Ming-Yan Chung, Henry Chi-Fuk So and Albert Chan; Investigation, Joanne Wai-Yee Chung, Bonny Yee-Man Wong, Vincent Chun-Man Yan and Albert Chan; Methodology, Joanne Wai-Yee Chung, Louisa Ming-Yan Chung, Henry Chi-Fuk So and Albert Chan; Project administration, Bonny Yee-Man Wong and Vincent Chun-Man Yan; Supervision, Joanne Wai-Yee Chung and Albert Chan; Writing – original draft, Bonny Yee-Man Wong; Writing – review & editing, Joanne Wai-Yee Chung, Bonny Yee-Man Wong, Vincent Chun-Man Yan, Louisa Ming-Yan Chung, Henry Chi-Fuk So and Albert Chan.

Conflicts of Interest: The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. **Healthy workplaces: a WHO global model for action** [http://www.who.int/occupational_health/healthy_workplaces/en/]. Accessed August 29, 2017.
2. Dong X, Men Y, Fujimoto A: **Health risk factors and chronic illnessess among construction workers**. In: *The Construction Chart Book: The US Construction Industry and its Workers*. 4 edn. USA: The Center for Construction Research and Training; 2008.
3. Sánchez-Chaparro MA, Román-García J, Calvo-Bonacho E, Gómez-Larios T, Fernández-Meseguer A, Sáinz-Gutiérrez JC *et al*: **Prevalence of Cardiovascular Risk Factors in the Spanish Working Population**. *Rev Esp Cardiol (Engl Ed)* 2006, **59**(05):421-430.
4. Thabit H, Burns N, Shah S, Brema I, Crowley V, Finnegan F *et al*: **Prevalence and predictors of diabetes and cardiometabolic risk among construction workers in Ireland: The Construction Workers Health Trust screening study**. *Diab Vasc Dis Res* 2013, **10**(4):337-345.
5. Hwang WJ, Hong O: **Work-related cardiovascular disease risk factors using a socioecological approach: implications for practice and research**. *Eur J Cardiovasc Nurs* 2012, **11**(1):114-126.
6. Safe Work Australia: **Work Health & Safety Perceptions: Construction Industry**. In. Canberra, Australia: Safe Work Australia; 2015.
7. Arndt V, Rothenbacher D, Daniel U, Zschenderlein B, Schuberth S, Brenner H: **Construction work and risk of occupational disability: a ten year follow up of 14 474 male workers**. *Occup Environ Med* 2005, **62**(8):559.
8. Brenner H, Ahern W: **Sickness absence and early retirement on health grounds in the construction industry in Ireland**. *Occup Environ Med* 2000, **57**:615-620.
9. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L *et al*: **Defining and setting national goals for cardiovascular health promotion and disease reduction**. *Circulation* 2010, **121**(4):586-613.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

10. Groeneveld IF, Proper KI, van der Beek AJ, Hildebrandt VH, van Mechelen W: **Factors associated with non-participation and drop-out in a lifestyle intervention for workers with an elevated risk of cardiovascular disease**. *Int J Behav Nutr Phys Act* 2009, **6**(1):80.
11. Yi W, Chan A: **Health Profile of Construction Workers in Hong Kong**. *Int J Environ Res Public Health* 2016, **13**(12):1232.
12. Tin SPP, Lam WWT, Yoon S, Zhang N, Xia N, Zhang W *et al*: **Workplace Health Promotion: Assessing the Cardiopulmonary Risks of the Construction Workforce in Hong Kong**. *PLOS ONE* 2016, **11**(1):e0146286.
13. Carlsson AC, Wandell PE, Gigante B, Leander K, Hellenius ML, de Faire U: **Seven modifiable lifestyle factors predict reduced risk for ischemic cardiovascular disease and all-cause mortality regardless of body mass index: a cohort study**. *Int J Cardiol* 2013, **168**(2):946-952.
14. Perk J, De Backer G, Gohlke H, Graham I, Reiner Z, Verschuren M *et al*: **European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts)**. *Eur Heart J* 2012, **33**(13):1635-1701.
15. Cohen J: **Statistical Power Analysis for the Behavioral Sciences**: Routledge; 1988.
16. **Total number of valid registered workers in designated trades** [http://cwr.hkcic.org/information/total.asp]. Accessed September 15, 2016.
17. **Sample Size Calculator** [http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator]. Accessed Februrary 28, 2018.
18. Ahmed S: **Methods in Sample Surveys: Cluster Sampling**. In. Johns Hopkins University; 2009.
19. **Meat consumption trends in Asia Pacific, and what they mean for food service strategy** [http://blog.euromonitor.com/2015/08/meat-consumption-trends-in-asia-pacific-and-what-they-mean-for-foodservice-strategy.html]. Accessed August 29, 2017.
20. Arndt V, Rothenbacher D, Brenner H, Fraisse E, Zschenderlein B, Daniel U *et al*: **Older workers in the construction industry: results of a routine health examination and a five year follow up**. *Occup Environ Med* 1996, **53**(10):686-691.
21. Siebert U, Rothenbacher D, Daniel U, Brenner H: **Demonstration of the healthy worker survivor effect in a cohort of workers in the construction industry**. *Occup Environ Med* 2001, **58**(12):774-779.
22. Karpansalo M, Manninen P, Lakka TA, Kauhanen J, Rauramaa R, Salonen JT: **Physical Workload and Risk of Early Retirement: Prospective Population-Based Study Among Middle-Aged Men**. *Int J Occup Environ Med* 2002, **44**(10):930-939.
23. **Patterns of ill-health amongst Irish construction workers** [http://www.cwht.ie/_webedit/uploaded-files/All%20Files/Documents/Pdf%20-Patterns%20of%20ill-health%20amonsgt%20Irish%20Construction%20Workers%20.pdf]. Accessed August 12, 2017.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 20 April 2018 doi:10.20944/preprints201804.0272.v1

Peer-reviewed version available at Int. J. Environ. Res. Public Health 2018, 15, 1251; doi:10.3390/ijerph15061251

24. Sørensen K, Pelikan JM, Röthlin F, Ganahl K, Slonska Z, Doyle G *et al*: **Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU)**. *Eur J Pub Health* 2015, **25**(6):1053-1058.
25. Hosomi R, Yoshida M, Fukunaga K: **Seafood Consumption and Components for Health**. *Glob J Health Sci* 2012, **4**(3):72-86.
26. Thorsdottir I, Tomasson H, Gunnarsdottir I, Gisladottir E, Kiely M, Parra MD *et al*: **Randomized trial of weight-loss-diets for young adults varying in fish and fish oil content**. *Int J Obes* 2007, **31**(10):1560-1566.
27. Aadland EK, Lavigne C, Graff IE, Eng O, Paquette M, Holthe A *et al*: **Lean-seafood intake reduces cardiovascular lipid risk factors in healthy subjects: results from a randomized controlled trial with a crossover design**. *Am J Clin Nutr* 2015, **102**(3):582-592.
28. Mozaffarian D, Wu JHY: **Omega-3 Fatty Acids and Cardiovascular Disease**. *J Am Coll Cardiol* 2011, **58**(20):2047-2067.
29. Cardoso C, Afonso C, Bandarra NM: **Seafood lipids and cardiovascular health**. *Nutrire* 2016, **41**(1):7.
30. US Department of Health and Human Services, US Department of Agriculture: **2015-2020 Dietary Guidelines for Americans**. In. Washington, DC: Department of Health and Human Services,; 2015.
31. de Moraes MM, Mediano MFF, de Souza RAG, Moura AS, da Veiga GV, Sichieri R: **Discouraging soft drink consumption reduces blood glucose and cholesterol of Brazilian elementary students: Secondary analysis of a randomized controlled trial**. *Prev Med* 2017, **100**:223-228.
32. Maersk M, Belza A, Stodkilde-Jorgensen H, Ringgaard S, Chabanova E, Thomsen H *et al*: **Sucrose-sweetened beverages increase fat storage in the liver, muscle, and visceral fat depot: a 6-mo randomized intervention study**. *Am J Clin Nutr* 2012, **95**(2):283-289.
33. Hostmark AT: **The Oslo health study: soft drink intake is associated with the metabolic syndrome**. *Appl Physiol Nutr Metab* 2010, **35**(5):635-642.
34. Dhingra R, Sullivan L, Jacques PF, Wang TJ, Fox CS, Meigs JB *et al*: **Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community**. *Circulation* 2007, **116**(5):480-488.
35. Lebda MA, Tohamy HG, El-Sayed YS: **Long-term soft drink and aspartame intake induces hepatic damage via dysregulation of adipocytokines and alteration of the lipid profile and antioxidant status**. *Nutr Res* 2017, **41**:47-55.
36. Høstmark AT, Lunde MSH, Haug A: **Increased serum triglycerides and reduced HDL cholesterol in male rats after intake of ammonium chloride for 3 weeks**. *Lipids Health Dis* 2013, **12**(1):92.
37. Stanhope KL, Schwarz J-M, Havel PJ: **Adverse metabolic effects of dietary fructose: Results from recent epidemiological, clinical, and mechanistic studies**. *Curr Opin Lipido* 2013, **24**(3):198-206.