

Risk Factors Related to Weight Gain for Chines During Home Confinement in COVID-19 Pandemic: An Observational Retrospective Study

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Research

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Abstract

Objective: The observational study was intended to explore the weight changes and risk factors of weight gain during the self-quarantine and find available methods to lose weight.

Method: This was an online retrospective observational study investigating the weight changes before and after home confinement. A total of 530 participants completed the online questionnaire. diet, sleep, self-reported depression, disease history and exercise information possibly relating to weight changes were incorporated into the questionnaire. The differences among four groups (underweight, normal weight, overweight and obesity) in BMI change and weight change were compared, and the risk factors of weight gain was also analyzed by multiple linear regression analysis.

Result: Participants were mostly between 21-50 years old, getting an average weight change of 0.82 ± 3.31 kg, and an average BMI change of 0.35 [-0.37, 1.00]. 43.77% of them gained weight by 2.99 ± 2.29 kg averagely. People with normal weight were easier to gain weight than obese group ($p=0.001$). There were differences in food intake ($p<0.001$), eating habits ($p<0.001$), taste preference ($p=0.047$), daily exercise step change ($p=0.007$), exercise ($p=0.02$) between non-weight gain group and weight gain group. The multiple linear regression revealed that weight gains were associated with sex ($p=0.002$), food intake ($p=0.004$), current daily exercise step ($p=0.009$) and self-reported depression ($p=0.002$) and weight loss was related to food intake ($p=0.004$) and pre-BMI ($p=0.001$).

Conclusion: Eating irregularly, increasing food intake, self-reported depression and decreased daily steps were risk factors of weight gain, yet weight loss was related to decreased food intake and pre-BMI.

Introduction

In response to public health incident of COVID-19, a lot of provinces in China announced the launch of a first-level response. A series of policies including traffic lockdown and home quarantine were formulated to lower the spread of the virus by keeping social distance and restricting needless egress. Home quarantine has indeed significantly reduced the spread of the virus, allowing the epidemic to be effectively controlled. Not only in China, many people all around the world were proposed to self-isolate at home to reduce social interaction during the COVID-19 pandemic (1).

However, emotional and lifestyle changes during self-quarantine might increase the risks of obesity during quarantine (2–4). Home confinement for several months could lead to weight gain, further increasing incidence of obesity (5). To many patients in Italy, weight gain was found related to increased self-reported anxiety or depression and not consuming healthy food in obese adults according to multiple regression analysis (6). In Poland, almost 30% of people gain weight of 3.0 ± 1.6 kg, and it seemed that overweight, obese and older individuals were more likely to gain weight (7). Because of school closures resulting from COVID-19, the risk of weight gain increased for children in USA (8, 9).

In China, the breakout of the epidemic coincided with the Spring Festival. Some studies show that, the mean weight increased approximately by 0.5 kg during the holiday period, compared with the weight before the holidays (10, 11), and that could be related to the increase in food intake (12, 13). It was not clear whether the isolation during the holiday led to weight gain and increased BMI in China. The online observational retrospective survey sought to probe the weight changes and factors resulting in weight gain during the home confinement.

Method

Participants and procedures

This was an observational study. We promulgated this questionnaire on the WeChat platform on May 23, 2020. Participants who completed the online questionnaire from May 23 to May 31 were going to be included in the retrospective observational survey. A total of 530 participants accomplished the questionnaire in the survey. All participants came from China, and approximately half of them were from Hubei Province.

Questionnaire

This was an anonymous questionnaire which was designed on the web (<https://www.wjx.cn/login.aspx>). Before filling out the questionnaire, protected individual privacy and the purpose of this survey were notified. The weight change, BMI change, exercise, diet, sleep time, self-reported depression, ideal weight and satisfaction of current weight during the pandemic period were assessed in this questionnaire.

The main content of the questionnaire is as follows:

1. Demographics. The descriptive information included gender, age, height, pre-weight before home confinement, weight after home confinement and existing physical illness. BMI was calculated based on weight and height ($BMI = \text{weight(kg)} / \text{height(m)}^2$), which categorized into categories of underweight ($BMI < 18.5$), normal weight ($18.5 \leq BMI < 25$), overweight ($25 \leq BMI < 30$), obesity ($BMI \geq 30$).
2. Diet information. People were asked to choose the change of food intake than that before the home confinement (including increase, fixedness and decrease), the diet habit (including eating multiple small meals, eating less, engorgement, eating three meals regularly and eating irregular meals), the preference of taste (including spicy, sweet, salty, tart and light). Only one option could be selected for these 3 aforementioned questions. The last question was about the type of diet. Participants could choose more than one type of diet which they preferred.
3. Exercise information. An inquiry into the exercise details during the lockdown was made as a part of the questionnaire. This part composed of the average exercise steps before the pandemic (including below 1000 steps, 1000–5000 steps, 5000–10000 steps, 10000–15000 steps and at least 15000 steps), the average exercise steps during lockdown (same as the previous question options), the frequency of exercise (including 1–3 times/week, 4–6 times/week and everyday), the average

exercise time every exercise (including below 0.5 h, 0.5-1 h, 1–2 h and at least 2 h). Single choice was set for the above four questions. Another question was about the methods of exercise that subjects selected or recommended. If participant didn't do exercise, they could skip this part. The daily exercise step was counted and supplied by We-chat app for everyone.

4. Others. Containing sleep time (including less 6 h, 6–8 h and over 8 h), self-reported depression (including no depression, mild depression, moderate depression and severe depression), satisfaction of current weight (yes/no), and ideal weight (losing 2.5 kg at most, losing 2.5-5 kg, losing 5 kg at least, maintaining the status quo, gaining 2.5 kg at most, gaining 2.5-5 kg and gain 5 kg at least). Only one answer could be chosen for the above four questions respectively.

Analytic strategy

All statistical analysis was performed using Rstudio software (Rstudio version 1.2.5042, 2009–2020 RStudio, Inc.). Normal distribution data were expressed as means \pm standard deviation, and skewed distribution data were expressed as median[q1,q3]. Descriptive statistics summarized the demographic features of participants, and the percentages of each option were accounted. About statistic differences between non-weight gain group and weight gain group during the home confinement, chi-sq.test was used for categorical variables, kruskal.test was used for continuous variable of skewed distribution, and t-test was employed for continuous variable of normal distribution. The same statistical methods were used for comparisons between participators with non-increased BMI and those with increased BMI during the home confinement. Comparing the difference between weights before and after home confinement was carried on by paired t-test, and the difference of BMI before and after home confinement was analyzed by Wilcox.test. The multiple linear regression models were applied to assess the contribution of other variables to weight gain and weight loss. Analyzing the difference of BMI change and weight change among four groups (underweight, normal weight, overweight and obesity) was performed by Kruskal-Wallis test and analysis of variance respectively.

Result

Descriptive data

A total of 530 participants (356 females and 174 males) accomplished the online questionnaire in the survey. Descriptive statistics are presented in Table 1. Participants ranged from 21 to 50 years old mostly, having an average weight change of 0.82 ± 3.31 kg, and an average BMI change of $0.35 [-0.37, 1.00]$. It was worth noting that 43.77% participants gained weight with an average change of 2.99 ± 2.29 kg. About 30% participants lost weight with an average decrease of 2.88 ± 1.99 kg. In item of diet, roughly 26% participants increased food intake during self-isolation, and approximately 27% individuals had irregular eating habits. About 40% people in the survey prefer to eat spicy food. In exercise, about 58% people didn't do exercise at home, and over half of participant had decreased daily exercise steps due to lockdown during the pandemic. More than half of individuals had sufficient sleep time, but roughly 40% people had varying degrees of self-reported depression. Over half participants were not pleased with their

current weight and longed for losing weight regardless of weight gain people or weight loss people (Fig. 1A and B).

Table 1
Basic characteristics of participants

	level	Overall		level	Overall
n		530			530
sex (%)	female	356 (67.2)	taste preference (%)	spicy	214 (40.4)
	male	174 (32.8)		sweet	38 (7.2)
age (%)	under 10y	2 (0.4)		salty	78 (14.7)
	11y-20y	40 (7.5)		tart	12 (2.3)
	21y-30y	204 (38.5)		light	188 (35.5)
	31y-40y	123 (23.2)	daily exercise step change (%)	decrease by 10000 steps at least	29 (5.5)
	41y-50y	64 (12.1)		decrease by 5000 to 10000 steps	133 (25.1)
	51y-60y	52 (9.8)		decrease by 1000 to 5000 steps	199 (37.5)
	61y-70y	35 (6.6)		almost unchanged	149 (28.1)
	over 70y	10 (1.9)		increase by 1000 to 5000 steps	19 (3.6)
height (m) (mean (SD))		1.64 (0.09)		increase by 5000 to 10000 steps	1 (0.2)
pre-weight(kg) (mean (SD))		61.17 (12.48)	exercise (%)	yes	218 (41.1)
current weight(kg) (mean (SD))		61.99 (12.70)		no	312 (58.9)
weight change(kg) (mean (SD))		0.82 (3.31)	sleep time (%)	less 6 h	64 (12.1)
pre-BMI (median [IQR])		21.97 [20.07, 24.38]		between 6 h and 8 h	315 (59.4)
current BMI (mean (SD))		22.29 [20.20, 24.89]		over 8 h	151 (28.5)

	level	Overall		level	Overall
BMI change (median [IQR])		0.35 [-0.37, 1.00]	self-reported depression (%)	no	313 (59.1)
existing physical illness (%)	yes	117 (22.1)		mild	131 (24.7)
	no	413 (77.9)		moderate	79 (14.9)
food intake (%)	increase	139 (26.2)		severe	7 (1.3)
	decrease	99 (18.7)	Pre-BMI	underweight	55(10.4)
	fixedness	292 (55.1)		Normal weight	366(69.1)
eating habits (%)	eat multiple small meals	43 (8.1)		overweight	90(17)
	eat less	29 (5.5)		obesity	19(3.5)
	engorgement	16 (3.0)			
	eat three meals regularly	297 (56.0)			
	eat irregular meals	145 (27.4)			

Characteristic differences between non-increased weight group and increased weight group

There were considerable differences in different items of food intake, eating habits ($p < 0.001$), taste preference ($p < 0.05$), daily exercise step change ($p = 0.007$) and exercise or not ($p = 0.02$) (Table 2) between non-increased weight group and increased weight group. Table S1 showed characteristic differences between non-increased BMI and increased BMI. Through assessing the weight and BMI changes before and after the home confinement, significant difference in weight change but not in BMI change was found (Table S2). So we further analyzed what caused weight gain and weight loss by multiple linear regression.

Table 2
Characteristic differences between non-weight gain group and weight gain group during the home confinement.

	level	Non-weight gain	weight gain	p
n		232	298	
sex (%)	female	160 (69.0)	196 (65.8)	0.494
	male	72 (31.0)	102 (34.2)	
age (%)	under 10y	1 (0.4)	1 (0.3)	0.889
	11y-20y	17 (7.3)	23 (7.7)	
	21y-30y	90 (38.8)	114 (38.3)	
	31y-40y	59 (25.4)	64 (21.5)	
	41y-50y	24 (10.3)	40 (13.4)	
	51y-60y	20 (8.6)	32 (10.7)	
	61y-70y	17 (7.3)	18 (6.0)	
	over 70y	4 (1.7)	6 (2.0)	
height (m) (mean (SD))		1.64 (0.08)	1.65 (0.09)	0.732
existing physical illness (%)	yes	49 (21.1)	68 (22.8)	0.717
	no	183 (78.9)	230 (77.2)	
food intake (%)	increase	26 (11.2)	113 (37.9)	< 0.001***
	decrease	75 (32.3)	24 (8.1)	
	fixedness	131 (56.5)	161 (54.0)	
eating habits (%)	eat multiple small meals	24 (10.3)	19 (6.4)	< 0.001***
	eat less	22 (9.5)	7 (2.3)	
	engorgement	3 (1.3)	13 (4.4)	
	eat three meals regularly	136 (58.6)	161 (54.0)	

	level	Non-weight gain	weight gain	p
	eat irregular meals	47 (20.3)	98 (32.9)	
taste preference (%)	spicy	93 (40.1)	121 (40.6)	0.047*
	sweet	10 (4.3)	28 (9.4)	
	salty	30 (12.9)	48 (16.1)	
	tart	4 (1.7)	8 (2.7)	
	light	95 (40.9)	93 (31.2)	
daily exercise step change (%)	decrease by 10000 steps at least	14 (6.0)	15 (5.0)	0.007**
	decrease by 5000 to 10000 steps	41 (17.7)	92 (30.9)	
	decrease by 1000 to 5000 steps	88 (37.9)	111 (37.2)	
	almost unchanged	77 (33.2)	72 (24.2)	
	increase by 1000 to 5000 steps	11 (4.7)	8 (2.7)	
	increase by 5000 to 10000 steps	1 (0.4)	0 (0.0)	
exercise (%)	yes	109 (47.0)	109 (36.6)	0.020*
	no	123 (53.0)	189 (63.4)	
sleep time (%)	less 6 h	26 (11.2)	38 (12.8)	0.261
	between 6 h and 8 h	147 (63.4)	168 (56.4)	
	over 8 h	59 (25.4)	92 (30.9)	
self-reported depression (%)	no	143 (61.6)	170 (57.0)	0.276
	mild	52 (22.4)	79 (26.5)	
	moderate	32 (13.8)	47 (15.8)	
	severe	5 (2.2)	2 (0.7)	

Factors affecting weight change

Multiple linear regression was adopted to investigate the factors for weight change, including weight gain and weight loss. Table S3 showed the result of multiple linear regression of weight change. We filtered out the following variables: gender, food intake, eating habits, daily exercise step after home confinement, pre-BMI and self-reported depression. Gender ($p < 0.001$), food intake ($p < 0.001$), eating habits ($p < 0.001$), daily exercise step after home confinement ($p < 0.001$), and pre-BMI ($p < 0.01$) were found related to weight. In the multiple linear regression of weight gain, the variables: sex, food intake, daily exercise step after home confinement and self-reported depression were chosen to make a statistical model (Table 3). There was statistical significance in sex (male) ($p < 0.01$), food intake ($p < 0.01$), daily exercise step after home confinement ($p < 0.01$) and self-reported depression ($p < 0.01$) for weight gain. It seemed that male objects were easier to gain weight compared with female (Table 4). In the multiple line regression of weight-loss, gender, age, height, food intake, eating habits and pre-BMI were selected to make multiple regression model, but there were statistic differences in food intake and pre-BMI.

Table 3
Multiple Linear regression of weight-gain

term	estimate	std.error	statistic	p.value
(Intercept)	5.17	0.72	7.18	< 0.001***
sex(male)	-0.87	0.27	-3.19	0.002**
food intake	-0.39	0.14	-2.88	0.004**
current daily exercise step	-0.42	0.16	-2.61	0.009**
self-reported depression	0.52	0.17	3.15	0.002**
F-statistic: 9.042 on 4 and 290 DF, p-value: < 0.001				
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Table 4
Multiple Line regression of weight-loss

term	estimate	std.error	statistic	p.value
(Intercept)	6.58	5.51	1.19	0.235
sex(male)	-0.68	0.49	-1.40	0.163
age	-0.15	0.10	-1.50	0.137
height (m)	-4.21	2.87	-1.47	0.144
food intake	0.62	0.21	2.95	0.004**
eating habits	0.20	0.11	1.82	0.071
pre-BMI	-0.13	0.04	-3.30	0.001**
F-statistic: 12.62 on 3 and 153 DF, p-value: <0.001				
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

It was interesting that pre-BMI associating with weight change, so we analyzed the difference among four groups, namely underweight, normal weight, overweight and obesity, in BMI change and weight change by Kruskal-Wallis test and analysis of variance respectively. The result showed that there was difference in BMI change ($p < 0.05$) and weight change ($p < 0.05$) among four groups during home confinement (Table S4). Significant difference was found between normal weight group and obesity group in BMI change and weight change (Table S5). Since the previous study had shown that obese individuals were more likely to gain weight during the epidemic(7), we further compared medium number and mean of normal weight and obesity group in BMI change and weight change respectively, and found that the medium number of normal weight group was greater than obesity group ($p = 0.0018$) (Fig. 1D), and the mean of normal weight group was larger than obesity group by using turkey multiple comparisons (Figure S1); in other words, participants with normal weight were easier to gain weight than obese participants. Small samples (19 obese objects) might be the main course.

In a word, the social behaviors such as eating habits, food intake and daily exercise step and self-reported depression were reverent to weight change, in addition to uncontrollable factors such as height, age, and gender. The results revealed that weight gain was associated with food intake, daily exercise step and self-reported depression, and weight loss was related to food intake and pre-BMI. Next, we discussed in detail the differences in diet and exercise between weight gain and weight loss participants.

The differences in diet and exercise between weight gain and weight loss participants

According to the result of multiple linear regression, the social behaviors: exercise and diet were closely associated with weight change. So we analyzed the differences in diet and exercise between weight gain

and weight loss participants, aiming to provide suggestions to people who wished to lose weight (Fig. 1A, 1B).

In exercise, most participants walked below 10000 steps every day before home confinement, and the daily exercise step was below 5000 steps for most people during the quarantine (Fig. 1C, Fig. 2A) regardless of weight change. Roughly half of the people didn't do exercise, especially in weight-gain group. Over 30% of weight-loss people had an average exercise time of 0.5-1 h (Fig. 2B). Exercise frequency of weight-loss group focused on 1–3 times/week and 4–6 times/week (Fig. 2C). By coincidence, aerobics and speed walking were become the most commonly adopted exercises for both weight-gain and non-weight gain group (Fig. 2D). The multiple linear regression referred that eating habits affected the weight change (Table S3), however, more people ate irregularly and ate three meals regularly in weight-gain group than the other group (Fig. 3A), and eating irregular meals became one possible reason of weight gain. The percentage of people who prefer to eat light and salty food in weight gain group was higher than weight loss group (Fig. 3B). Approximately 40% people in non-weight gain group decreased their food intake (Fig. 3C), and the multiple linear regression also showed that food intake was relevant to weight loss and weight gain (Tables 4 and 5), which was the main cause of weight loss and weight gain. There was no difference in type of diet between weight-gain group and weight-loss group (Fig. 3D). In short, decreased food intake could be the main reason of weight loss, nevertheless eating irregularly and increased food intake was associated with weight-gain. The decrease in daily exercise steps led to weight change overall.

Discussion

The survey including 530 participants was dedicated to investigating the relation between weight changes and lifestyles of Chinese people during the epidemic. The present survey indicates that 43.77% participants gained weight by 2.99 ± 2.29 kg averagely during a self-quarantine for several months. The imbalance between energy intake and energy expenditure is the essential cause of weight change. Excessive energy intake may result in increased fat storage capacity and weight gain, even obesity, insulin resistance and lipotoxicity in severe cases (14). The problematic eating behaviors such as frequent overeating, snacking after dinner, eating in response to stress are the risk factors for weight gain during the self-isolation in USA and Poland (15, 16). Even though the weight gain was slight relatively, this small change in weight for adults may contribute to substantial increases over decades (5).

Because of the impact of self-isolation and holidays, people have reduced physical activity especially in daily exercise step change. People were easier to gain weight in average of 0.5 kg during holiday than usual (12, 17). Unhealthy dietary habits, such as irregular eating and excessive food intake, are the essential factors resulting in weight gain. Nevertheless, sleep time was not related to weight change in our survey. However, it is worth paying attention to the generalized depressive symptoms and lower sleep quality during COVID-19 outbreak in China(2).

As we all know, excessive food intake and lack of exercise could lead to gain weight. Nevertheless, gender and depression were associated to weight gain in our statistical analysis. The multiple linear regression of weight gain confirmed that males were easier to gain weight than females. Through analyzing the difference of four groups (underweight, normal weight, overweight and obesity) in BMI change and weight change before and during the home confinement, we found unexpectedly that participants of normal weight gained more weight than obese objects, resulting from small samples in obese group (n = 19). Likewise, our survey indicated that self-reported depression was related to gain weight, which coincided with the previous study (6).

Most participants tended to lose weight and were not satisfied with current weight, and our study reveals that weight-loss people had a decreased food intake comparing weight-gain people. So if one want to lose weight during quarantine, these suggestions you can take: 1) don't take excessive food and minimize food intake based on maintaining daily energy requirements, 2) use the health management apps which is used to make a home exercise plan, boohee health app which can provide dietary guidance and record daily calorie intake, 3) take note of your weight every day by using weight scale to prevent from gaining weight, which is the effective way to manage weight (17, 18).

Although our survey provided an insight into variables affecting weight change during home confinement, there were some limitations: 1) due to the various educational backgrounds of the participants, the understanding of some items in the questionnaire was not clear, 2) since this questionnaire was published on the online platform, there was a lack of relevant professionals to guide participants to fill out the questionnaire, 3) in the option settings of some questions, objective standardization was not achieved, such as eating habits, and participants were more subjective.

The survey exposed that food intake was the key course of weight change, increasing food intake may resulting weight gain, and decreasing food intake may leading to weight loss, which coincided with the current clinical research on reducing food intake through alternate fasting to achieve weight loss(19, 20).

Abbreviations

BMI: Body mass index

COVID-19: Coronavirus disease 2019

SD: Standard deviation

IQR: Interquartile-range

CI: Confidence interval

TCM: Technology of Chinese medicine

Declarations

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Contribution

Dong H, Jing Gong and Lu FE designed the research. Gong MM, Zhao Y, Wang DK and Xu LJ collected the questionnaire. Xia QS and Wu F analyzed data. Xia QS and Gong J wrote the manuscript. Gong J and Lu FE supervised and approved the final version of the study.

Ethics declaration

Ethics approval and consent to participate

All participants voluntarily participated in this study and consented to use their information for scientific research.

Consent for publication

Not applicable.

Competing interests

There are no conflict of interest to declare.

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Figures

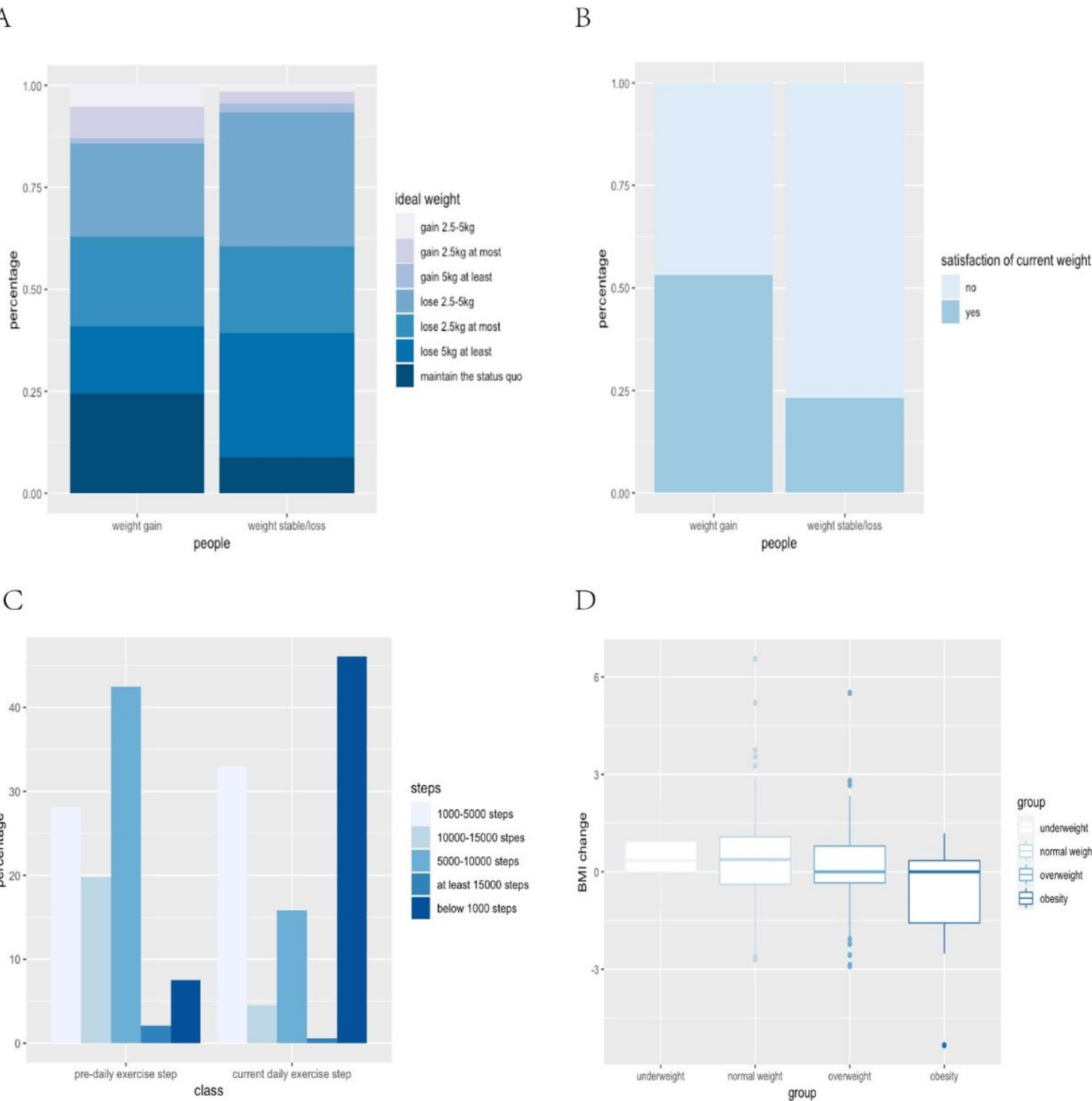


Figure 1

Ideal and satisfaction of weight, daily steps and BMI changes of participants. Almost participants weren't satisfied with their current weight and wanted to lose weight. (A) ideal weight change, (B) satisfaction of current weight, (C) daily steps (D) BMI change of participants.

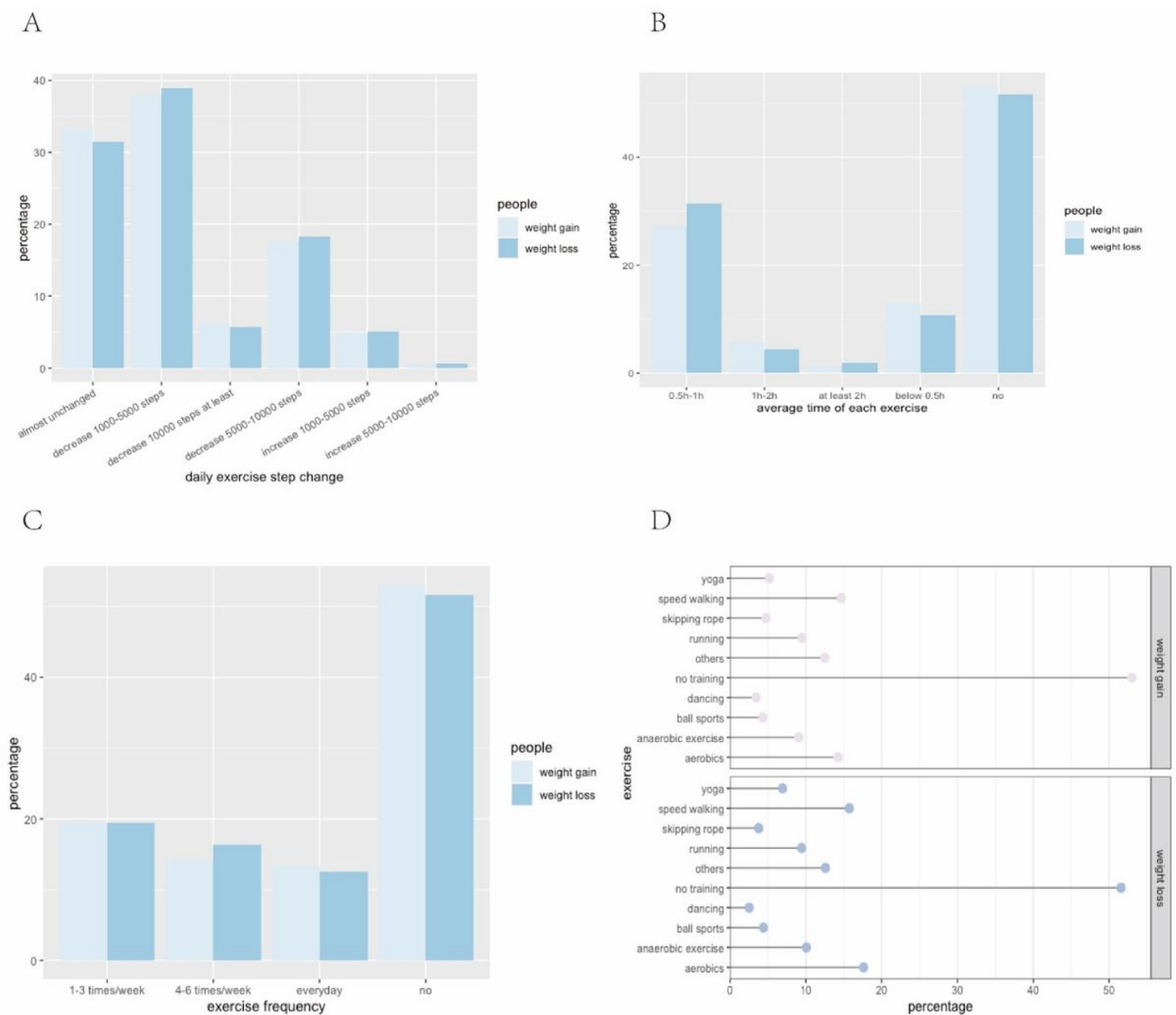


Figure 2

The differences of exercise between weight gain group and weight loss group during self-quarantine. (A) daily step change, (B) daily exercise time change, (C) exercise frequency, (D) exercise methods.

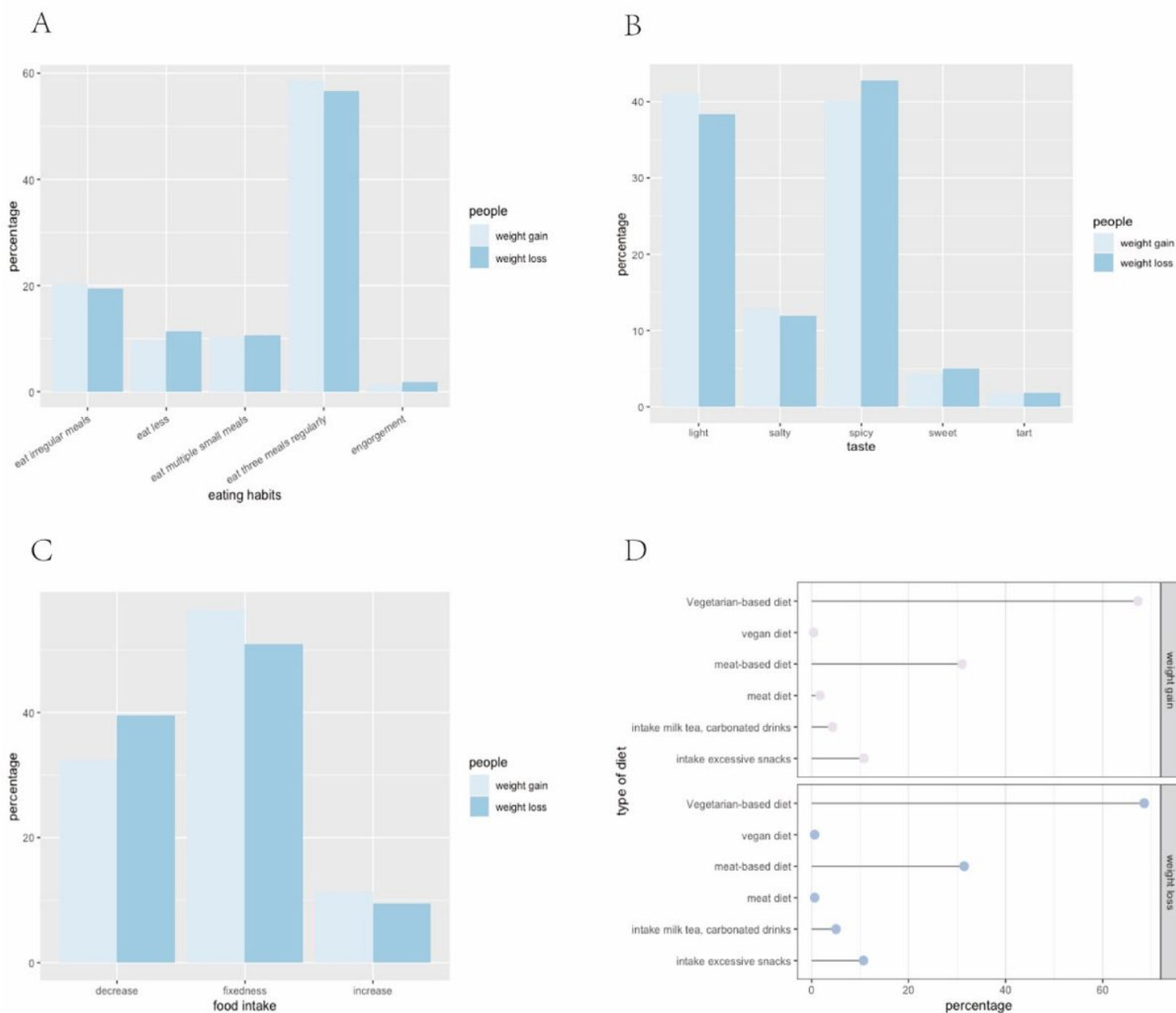


Figure 3

The differences of diet between weight gain group and weight loss group during self-quarantine. (A) eating habits, (B) tastes, (C) food intake, (D) type of diet.

Supplementary Files

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- [Supplementaryinformation.docx](#)