

Association Between Dietary Behaviors and Weight Gain During City-Wide Quarantine

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Background: The impact of quarantine-induced changes in dietary behavior on weight gain remained unclear. This study aimed to evaluate the association between changes in dietary behavior and body weight during quarantine and to identify the risk factors of weight gain.

Methods: This was a pilot observational cross-sectional study. All the potential participants were those who underwent body weight management program in one teaching hospital in China from 26th April 2021 to 31st March 2022. An online self-reported questionnaire was sent to collect information on sex, age, self-reported body weight before and after quarantine, dietary quality, meal time, food consumption, physical activities, and sleep quality. Weight gain was defined as an increase of 1 kilogram or more. The study has been performed in accordance with the Declaration of Helsinki and approved by the Ethics Committee (KY2020-204). The participants were informed about the objectives of the study and electronic informed consent was obtained from each participant.

Results: Finally, 79 participants (22.8% male and 77.2% female, aged 33.3 ± 7.1 years) was included in the analysis. During quarantine, the mean body weight gain was 0.8 (interquartile range: $-1.0 \sim 3.0$) kg. The proportion of weight gain among the participants was 45.6%. Increased cooked white rice (OR=16.93; 95% CI: 2.66–108.00), convenient food (OR=11.69; 95% CI: 2.00–68.26), and snack consumption (OR=5.56; 95% CI: 1.08–28.56), delayed dinner time (OR=6.64; 95% CI: 1.20–36.74) and house working time less than 30 minutes (OR=12.80; 95% CI: 2.01–81.44) were risk factors for body weight gain.

Conclusion: During the quarantine, weight gain was observed even in participants who were previously on body weight management. Increased consumption of cooked white rice, convenient food, and snack, as well as delayed dinner time and reduced house working time (less than 30 minutes), were found to be associated with body weight gain.

Keywords: body weight, physical activity, food consumption, quarantine

Introduction

One of the biggest challenges in the management of obesity is the prevention of weight regain after successful weight loss. In the Look Ahead study, which included participants with type 2 diabetes mellitus (T2DM) who were overweight, an intensive lifestyle intervention (ILI group), with regular group sessions, structured meal plans, and free provision of meal replacements during the first year, resulted in improved long-term weight loss compared with diabetes support and education alone (DSE group). At year 1, the ILI group lost about 8.5% of initial weight. However, the average weight regain in the ILI group was still 50% of the initial weight loss after 4 years, which was maintained until 8 years.¹ Even after bariatric surgery, weight regain is a common problem, which can even occur early after surgery, resulting in the return of obesity-associated comorbidities.^{2,3}

Quarantine is a common and valuable strategy to curb the pandemic of infectious disease. However, the lifestyles and dietary behaviors of residents commonly changed under the condition, which might significantly influence health, such as weight gain,⁴ increased risk of cardiovascular disease,⁵ and mental health.⁶ Some studies reported that the changes in

dietary habits among people with obesity were healthy^{7,8} and yet others found that it was unhealthy.^{9–11} A French survey revealed unfavorable nutritional behaviors, such as decreased consumption of fruits and vegetables and increased consumption of sweets, biscuits, cakes and snacking, decreased physical activity, increased sedentary time, contributed to weight gain.¹² Another Polish study found that increased body mass index (BMI) was associated with less frequent consumption of vegetables, fruit, and legumes.¹³ One systematic-reviewed study indicated that increased snack frequency (particularly after dinner), increased alcohol intake, and sedentary behaviors while decreased water intake, emotional eating, and sleep quality, were contributed to weight gain.¹⁴ Physical inactivity was another problem caused by city-wide quarantine. One Malaysia cross-sectional study indicated that maintaining daily physical activities for 30 minutes or more for at least 5 days per week was associated with 1.4 (95% CI: 1.05, 1.97) times higher odds of weight loss¹⁵ while shorter housework time was not associated with body weight in Chinese youths.¹⁶

Studies were limited to evaluate the changes in dietary behaviors during the quarantine and their association on body weight in Chinese population participants who previously underwent body weight management. Therefore, we conducted the current pilot observational cross-sectional study to evaluate the changes in dietary behaviors (changes in dietary/sleep quality, 11 food group consumption, meal time and physical activities) during the quarantine and to assess whether these dietary behaviors are associated with weight gain. The results might be helpful to formulate strategies to prevent weight regain after successful weight loss.

Materials and Methods

Study Design and Participants

This study was a pilot observational cross-sectional study. One online survey was conducted from 15th to 23rd of June 2022 via an online WeChat platform tool (Wen Juan Xing, Changsha Ranxing Information Technology Co., LTD). The questionnaire link was sent to 126 potential participants who underwent body weight management to loss body weight from 26th April 2021 to 31st March 2022. A total of 89 participants returned (70.6% response-rate) the questionnaire and 10 of them were excluded due to not complete body weight management program. Finally, 79 respondents (22.8% male and 77.2% female, aged 33.3 ± 7.1 years) were analyzed. The details of the body weight management program could be found in [Supplemental Material \(Supplemental File 1\)](#).

Online Questionnaire

The online self-reported questionnaire included 29 questions which could be divided into five sections: (1) personal data and basic characteristics: sex, age, height, quarantine location, length of quarantine and self-reported body weight before and after quarantine; (2) dietary quality: improved, unchanged, or decreased; changes in consumption of 11 food groups (eg, cooked white rice, convenient food, whole grain, soy and soy product, meat, vegetable, fruit, egg, milk and dairy product, alcohol/beverage, and snack): increased, decreased, or unchanged; (3) meal time: regular, earlier, or delayed; (4) physical activities: ①house working time/participating in physical exercises/sedentary time: <30 minutes, 30 minutes–3 hours, or >3 hours; ②leisure entertainment activities: <1 hour, 1–5 hours, or >5 hours. (5) sleep quality: improved, unchanged, or decreased. These 11 food groups were designed according to the Dietary guideline for Chinese Residents (2022).¹⁷ Details of the questionnaire were shown in [Supplemental Material \(Supplemental File 2\)](#).

Statistical Analysis

Values were presented as mean (Standard deviation, SD) for continuous variables and as proportion for categorical variables. In this study, weight gain was defined as an increase of 1 kilogram or more, which was used as the primary outcome measure. Furthermore, significant weight gain was characterized as an increase of 5% or more of the initial body weight (before quarantine). Risk factors were converted into dichotomous variables in the analysis. Reference points were established for each variable: improved/unchanged dietary and sleep quality; decreased/unchanged consumption of cooked white rice, convenient food, alcohol/beverage, and snack; increased/unchanged consumption of whole grain, soy and soy product, meat, vegetable and fruit, eggs, milk and dairy product; earlier/unchanged mealtime. Daily house working time ≥ 30 minutes, physical activities ≥ 30 minutes, sedentary time ≤ 3 hours, and leisure

entertainment activities ≤ 5 hours were treated as the reference points. Each of these variables was subjected to univariate regression analysis, and those with a P -value of less than 0.2 were included in the subsequent multivariable-adjusted stepwise logistic regression analysis. All tests were two-sided and a P -value < 0.05 was considered statistically significant. Analysis was conducted using Statistical Analysis System (SAS) version 9.4 (SAS Institute, Inc., Cary, NC).

Ethics

The study has been performed in accordance with the Declaration of Helsinki and approved by the Ethics Committee, Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine (KY2020-204). Electronic informed consent was obtained from all participants prior to participation. All the participants could decide whether or not to participate in the research. The data collected through the questionnaire were only used for research analysis to ensure the privacy and autonomy of the participants.

Results

Characteristics of Participants

A total number of 79 (22.8% male and 77.2% female, aged 33.3 ± 7.1 years) participants was finally analyzed. The mean length of quarantine was 61 ± 20 days. The proportion of weight gain among the participants was 45.6%. During quarantine, the mean body weight gain was 0.8 (interquartile range: $-1.0 \sim 3.0$) kg. The proportion who experienced weight gain was 45.6% and 20.3% of them reported a dramatic increase ($\geq 5\%$) in body weight (Table 1).

Changes in Dietary Behaviors, Physical Activities and Sleep Quality

Overall, forty-six (58.2%) participants reported a decreased dietary quality and 40.5% of them experienced weight gain. Participants who experienced weight gain reported an unregular mealtime (31.7% vs 15.2%), later dinner time (19.0% vs 10.1%), less house working time (30.4% vs 21.5%) and physical exercise (39.2% vs 34.2%) than those with stable body weight. Interestingly, participants with weight gain preferred to less sedentary time than their counterpart (27.9% vs 39.2%). The proportion who experienced weight gain showed higher consumption of cooked white rice, convenient food, alcohol/beverage and snack while lower consumption of whole grain, soy and soy product, meat, vegetable, egg, milk and milk product. The proportion of participants with weight gain who declared poor sleep quality was 20.3% compared to 12.7% of those with stable body weight (Supplementary Table 1).

Table 1 Baseline Characteristics of the Participants (n=79)

Characteristics	Mean or %	SD
Age, year	33.3	7.1
Sex		
Male	22.8%	
Female	77.2%	
Length of quarantine, days	61	20
Quarantine location		
Home	70.9%	
Others	29.1%	
Weight change during the quarantine, kg	0.8	3.2
Weight gain ^a	45.6%	
Weight loss/unchanged ^b	54.4%	
Significant weight gain ^c	20.3%	

Notes: ^aWeight gain was defined as an increase of 1 kilogram or more of the initial body weight. ^bWeight loss/unchanged was defined as weight loss or weight change less than 1 kilogram during the quarantine. ^cSignificant weight gain was characterized as an increase of 5% or more of the initial body weight (before quarantine).

Abbreviation: SD, Standard deviation.

The Association Between Weight Gain and Dietary Behaviors

The binary regression analysis showed that decreased dietary quality (OR=16.6, 95% CI: 4.90–56.10), delayed meal time (OR=5.87, 95% CI: 2.22–15.54), delayed dinner time (OR=3.13, 95% CI: 1.13–8.62) were associated with weight gain. For dietary behaviors, increased consumption of cooked white rice (OR=12.91, 95% CI: 4.29–38.84), convenient food (OR=20.67, 95% CI: 6.01–71.04), alcohol/beverage (OR=5.43, 95% CI: 1.73–17.04) and snack (OR=19.50, 95% CI: 5.64–67.42), and decreased consumption of vegetable (OR=2.90, 95% CI: 1.16–7.27), less house working time (OR=3.06, 95% CI: 1.21–7.71) and physical exercises (OR=3.67, 95% CI: 1.19–11.36) were also associated with weight gain ([Supplementary Table 1](#)).

Multivariable-adjusted stepwise logistic regression results showed that increased consumption of cooked white rice (OR=16.93, 95% CI: 2.66–108.00), and convenient food (OR=11.69, 95% CI: 2.00–68.26) and snack (OR=5.56, 95% CI: 1.08–28.56), delayed dinner time (OR=6.64, 95% CI: 1.20–36.74) and less house working time (OR=12.80, 95% CI: 2.01–81.44), were risk factors for body weight gain during a quarantine ([Table 2](#)).

Discussion

Our study found that nearly half of the participants (45.6%) experienced weight gain, and 20.3% reported a $\geq 5\%$ increase in body weight during quarantine. Various changes in behavior habits, including increased cooked white rice, convenient food consumption and increased snack consumption, delayed dinner time and less housing working time, were associated with the risk of weight gain.

As change in body weight was usually collected by online questionnaire or phone interview, some studies^{11,18,19} reported that about 30% of the participants reported weight gain during the quarantine. Study including Spanish adults reported that 44.5% of participants experienced weight gain.²⁰ Sidor et al¹³ reported the largest body weight gain (3.0 ± 1.5 kg) in Poland adults during quarantine. However, the proportion of participants who reported weight gain was lower than our study (30% vs 45.6% in our study). Another French study reported that body weight gain of 1.8 kg (SD: 1.3 kg),¹² then Kuwait study (body weight gain: 1.13 ± 5.39 kg).²¹ Italian study reported a similar proportion of weight gain with our study (43.3% vs 45.6%) during 2-month quarantine,²² and body weight gain was 0.4 kg (SD: 2.3 kg). Studies in Asian countries reported that body weight gain was 2.1kg (30.7%) in Malaysia,¹⁵ 3.8 ± 7.8 kg in the Kingdom of Saudi Arabia²³ and 0.5 ± 2.8 kg in China.²⁴ One cross-sectional, single-center, observational study performed in patients with diabetes founded that the mean body weight before and after Japanese declaration of a state of emergency

Table 2 Odds Ratios (OR) for the Weight Change During Quarantine by Changes in Dietary Behaviors and Physical Activities

Variables	Multivariate Analysis	
	OR [95% CI]	P-value
Meal time		
Dinner time delayed	6.64 [1.20–36.74]	0.03
Food consumption		
Cooked white rice increased	16.93 [2.66–108.00]	<0.01
Convenient food increased	11.69 [2.00–68.26]	<0.01
Snack increased	5.56 [1.08–28.56]	0.04
Physical activities		
House working time <30 minutes	12.80 [2.01–81.44]	<0.01

Notes: Multivariate stepwise logistic regression analyses were adjusted for sex, age, length of quarantine and quarantine location. Weight gain was defined as an increase of 1 kilogram or more and was used as the primary outcome measure. Improved/unchanged dietary and sleep quality, earlier/unchanged dinner time, decreased/unchanged consumption of cooked white rice, convenient food and snack and house working time ≥ 30 minutes were treated as the reference points.

Abbreviations: OR, odds ratios; CI, confidence interval.

on 7 April 2020 were 69.6 ± 15.2 kg and 69.5 ± 15.3 kg ($P < 0.01$).²⁵ The differences in criteria of body weight gain (as for our study, body weight gain was defined as an increase of 1.0 kg or more), sample size, and duration of quarantine could explain the discrepancies.

City-wide quarantine could have a significant effect on lifestyle and dietary behaviors. People are difficult to obtain healthy foods and fresh products.⁴ The diversity of foods was also limited during the quarantine.¹² Thus, people have to turn to convenient foods,²⁶ which are conveniently stored but with high energy density and unbalanced nutrition.²⁷ Our study found that 53.2%, 55.7%, and 35.5% of participants reported increased consumption of cooked white rice, convenient food, and snack. One cross-sectional study performed in United Arab Emirates indicated that participants who consumed more cereals during quarantine were significantly associated with increased weight gain (adjusted OR = 1.50, 95% CI: 1.10, 2.06).²⁸ A higher consumption of foods with a high glycemic index²⁹ (glycemic index of rice in China: 63–106)³⁰ could contribute to weight gain. One prospective study confirmed that increased intake from refined grains (0.8 kg more weight gain per 100 g/day increase) was positively associated with weight gain.³¹ A higher frequency of evening snacks during the quarantine (28.9% vs 25.4%),³² which might increase the risk of weight gain.³³ Participants following a delayed dinner time had 6.64 (95% CI: 1.20–36.74) times higher odds of weight gain. One possible explanation was that delayed dinner or eating later may decrease fat oxidation,³⁴ thus leading to high risk of obesity.^{35,36}

Polish studies confirmed that decreased consumption of vegetables, fruit, and legumes while increased consumption of meat, dairy, and fast foods during quarantine contribute to increased BMI.¹³ Increased consumption of junk food was associated with 3.12 times higher odds of weight gain in Italy.³⁷ In our study, 25.3% of participants reported an increased alcohol and beverage consumption though it was not significantly associated with body weight gain. Several prospective studies^{38–41} showed that light-to-moderate alcohol intake was not associated with adiposity gain but heavy drinking was associated with weight gain. Another Australian cohort study⁴² showed that there was no association between alcohol intake and body weight or waist circumference. The available evidences on alcohol and body weight gain were conflicting and some of the confounding factors should be further taken into consideration (sex, type of alcohol, frequency and amount of alcohol consumed, drinking pattern, and physical activity level etc.).⁴³

Another dramatic change was decreased physical activity. In our study, 51.9% of participants spent less than 30 minutes on house working, 73.4% of participants spent for less than 30 minutes on exercise, 67.1% of them reported sedentary time more than 3 hours, and 31.7% of them reported leisure entertainment for more than 5 hours per day. Another study also reported that 1.3 hours increase in non-workday sedentary behavior.⁴⁴ Decreased physical and outdoor activities was associated with several metabolic effects while regular physical activity reduces inflammation and oxidative stress, helps maintain normal weight, and reduces visceral fat accumulation.⁵

Strengths and Limitations

The strength of our study is that this was the first study which reported the association between dietary behaviors and weight gain in Chinese adults underwent body weight management. However, some limitations also needed to be addressed. Firstly, the changes in diet, physical activity, and body weight, were self-reported and the possibility of recall or social desirability biases could not be excluded. However, it is impossible to obtain this information by face-to-face interview. Secondly, the sample size was relatively small which might decrease statistical power to generate more robust results. The calculation of sample size was based on two published studies.^{45,46} The total number of participants ranging between 16 and 28 participants is enough to detect provided a power of 80% to detect statistically significant change in body weight at a two-tailed significance level of 0.05. However, for some subgroup analysis, the participants in different groups were abnormal distributed, thus resulting in a wider range of confidence interval. Thirdly, the control group was deficient. Thus, we did not know if the effects of quarantine differed between the general adult population and those who underwent body weight intervention. Finally, most of the participants were female, thus the generalizability was limited.^{47,48}

Conclusions

During the quarantine period, weight gain was observed among participants who previously underwent body weight management. Changes in dietary factors and physical activity were found to be associated with this weight gain.

Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Statement

The study has been performed in accordance with the Declaration of Helsinki and approved by the Ethics Committee, Ren Ji Hospital, Shanghai Jiao Tong University School of Medicine (KY2020-204). Electronic informed consent was obtained from all participants prior to participation. All the participants could decide whether or not to participate in the research. The data collected through the questionnaires were only used for research analysis to ensure the privacy and autonomy of the participants.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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