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SHORT COMMUNICATION

Changes in patterns of take-away food ordering among youths before and after COVID-19 lockdown in China: the COVID-19 Impact on Lifestyle Change Survey (COINLICS)

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Abstract

Background The lockdown due to COVID-19 may have led to changes in food ordering patterns among youths, which could affect their dietary patterns and the operation of the restaurant industry.

Objectives This study aimed to examine the impacts of COVID-19 lockdown on patterns of take-away food ordering among youth in China.

Methods The COVID-19 Impact on Lifestyle Change Survey (COINLICS) was conducted among youths at three educational levels (high or vocational school, college, and graduate school) in China in early May 2020. Information on patterns of take-away food ordering in the months immediately before and after the COVID-19 lockdown period (23 January to 8 April 2020) was collected through an online questionnaire survey.

Results A total of 10,082 participants were included in the analysis. Participants ordering food more than once per week dropped from 15.4 to 9.2%, while 81.1% of participants have never ordered food at both time points. Graduate students, although experiencing a decrease in food ordering for more than once per week (from 33.3 to 10.7%), were more likely to order food compared to undergraduate and high school students. A slight increase was observed for ordering fried food or hamburgers and for breakfast and midnight snacks.

Conclusions The youth have generally ordered take-away food less frequently after COVID-19 lockdown, and the times and types of ordering have both changed. These findings would contribute solid evidence to the current knowledge pool for reference of health promotion communities to keep youth's lifestyles healthy and of the restaurant industry to achieve more cost-effective operation in China during future health emergencies.

Keywords COVID-19 · Youth · Lockdown · Food ordering · Take-away food

Introduction

The online take-away food ordering industry has developed rapidly in recent years. According to the Big Data Insight of Online Takeout Consumption, the Chinese young people have become the main consumers of online platforms for take-away food ordering [1]. This situation may have changed due to the coronavirus disease 2019 (COVID-19) pandemic, which, as of 8 April 2021, has spread to almost every country on the planet and resulted in over 132.4 million confirmed cases and over 2.8 million deaths globally [2]. This widely spread disease and concomitant controlling measures/policies may lead to changes in food ordering patterns, which can affect youths' dietary patterns and the operation of the restaurant industry. Studies have reported that COVID-19 lockdown has changed dietary and lifestyle

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behaviors in various countries around the world [3–6]. For example, a recent study in Italy reported that around two-thirds of the study population declared changes in healthy food eating during the lockdown period [6].

In China, youths' food ordering patterns may also be influenced by the COVID-19 lockdown. This may be further affected as most schools and universities have closed and shifted on-site to remote teaching in the early half of 2020. In the meanwhile, most restaurants have not provided dine-in services and have only relied on food delivery services during the lockdown period. People started to eat out only after the lockdown period, which has differed slightly across provinces with the restrictions (e.g., stay-at-home, wearing masks) gradually loosed in March and generally lifted in April [7]. Given the substantial impact on various aspects of society, it is extremely important to understand how the COVID-19 lockdown may have influenced youths' food ordering patterns, which may help to promote a healthy lifestyle in youths and convey important suggestions on the operation of the restaurant industry during this difficult period. This study aimed to reveal the impact of COVID-19 lockdown on the changes in patterns of take-away food ordering among youths in China.

Methods

Study design, sample, and setting

Data used in this study were collected from the COVID-19 Impact on Lifestyle Change Survey (COINLICS), a national retrospective survey conducted among youth (generally aged 15–24, according to the United Nations) at three educational levels (high or vocational school, college, and graduate school) in China in early May 2020, when the daily number of new cases across the country has reduced to < 100, most imported from abroad, under some persisting restrictions (e.g., wearing masks, school closure, no public gathering). Information on sociodemographic characteristics and routine lifestyles (e.g., take-away food ordering patterns, dietary behaviors, physical activity, sedentary behaviors) in the month immediately before the COVID-19 lockdown (23 December 2019 to 23 January 2020, hereafter referred to as pre-lockdown) and in the month after the lockdown was lifted (8 April to 8 May 2020, hereafter referred to as post-lockdown) were reported through an online questionnaire, which, designed by an expert panel, takes about 20–30 min to complete. Only completed surveys could be submitted. Three easy questions (e.g., where the capital of China is) were inserted in the early, middle, and late phases of the questionnaire to confirm participant attentiveness of the questionnaire. Participants were recruited using a snowball sampling method. A web-based questionnaire was initially distributed among several social media groups, including WeChat and Tencent QQ, by educators at all three educational levels across all provinces in China. At least two educators in each province were ensured to share the questionnaire with their surrounding students via chat groups and WeChat and QQ moments, and the participating students were encouraged to further share the questionnaire with others in the same ways. All the participants gave informed assent before taking part; in addition, on the cover page of the online questionnaire, it has been stated that the youth aged under 18 could not proceed with the online survey without their parental consent. The study was approved by the Sichuan University Medical Ethical Review Board (KS2020414).

Measures of food ordering patterns

Measures of food ordering patterns included average weekly frequency of online food ordering, time of food ordering, and main types of food ordered frequently. The food ordering pattern was restricted to self-eating orders of take-away food, without considering orders for family members or others. Participants were first asked about their average weekly frequency of online food ordering, then the time of food ordering, and lastly the main types of food ordered frequently; in each aspect, a pair of questions for the two time points (before and after the lockdown period) were placed next to each other for participants to better recall and compare [8, 9]. The average weekly frequency of online food ordering was categorized into "daily", "4–6 days per week", "1–3 days per week", and "less than 1 day per week or none". To enable an intuitive comparison of food ordering patterns in two periods, the categories of frequency were converted into continuous variables, i.e., "daily" was denoted by 7 days/week, "4–6 days per week" by 5 days/week, "1–3 days per week" by 2 days/week, and "less than 1 day per week or none" by 0. Regarding the time of food ordering, participants could select one or more of the four mealtimes, i.e., breakfast, lunch, dinner, and night snack. Also, according to the classification of take-away food in the Chinese online ordering systems, participants could select one or more of 10 major food categories as the main types of food ordered frequently, including Chinese dish with rice, (spicy) hot pot, fried foods or hamburgers, cakes/pastries or drinks, simple western meal (e.g., pizza, pasta), barbecue/grill (e.g., Korean barbecue), flour-based food (e.g., noodles, wonton, dumplings, steamed stuffed buns), braised food, Japanese/Korean food, and others.

Statistical analyses

The *t* tests, ANOVA, and chi-square tests were used to compare food ordering patterns across educational levels

and sexes. The paired *t* tests and chi-square tests were used to compare differences before and after COVID-19 lockdown for continuous variables and categorical variables respectively. We also conducted the individual-level analysis by comparing the raw frequency of food ordering between the two time points. All statistical analysis was conducted using R (R Core Team, 2020), with $p < 0.05$ considered significant.

Results

This study included a total of 10,082 participants with a mean age of 20 years old, consisting of 2824 high school or vocational school students, 7024 undergraduate students, and 234 graduate students (Table 1).

The weekly frequency of food ordering was compared by educational level and sex (Table 2). Overall, the percentage of the participants who did not order food increased from 84.6% pre-lockdown to 90.8% post-lockdown. The participants ordering food 1–3 days per week dropped from 12.3 to 7.8%, and those ordering food more frequently, including 4–6 and 7 days per week, also decreased from 1.5–1.6% pre-lockdown to 0.5–0.9% post-lockdown. When stratified by educational level, we found that around 90% of the high school students and 80% of the undergraduate students, for both sexes, seldom ordered food at both time points, despite that the trends of change for ordering frequency at these two levels were consistent with the overall trend. Graduate students were more likely to order food compared to the participants at lower educational levels, although the percentage of those ordering food for more than once per week decreased from 33.3 to 10.7% during the study period. At the individual level, 4.0% of the participants started or increased food ordering, 10.5% stopped or decreased ordering, 4.7% did not change their ordering patterns, and 81.1% never ordered food online (Table 3).

Among those who ordered food, the most common ordering time was lunch, followed by dinner, although the percentage of the participants who ordered for lunch and dinner decreased from 68.4 to 62.6% and from 51.5 to 47%, respectively (Table 4). An increasing number of the participants ordered breakfast and midnight snacks, with the percentage increased from 8.6 to 10.5% and from 23.4 to 26.0%, respectively. Before lockdown, hotpot, Chinese dishes with rice, and fried food or hamburgers were the top three types of food ordered. After lockdown, participants ordering fried food or hamburgers increased from 45.0 to 51.4%, while those ordered hotpot and Chinese dish with rice decreased from 58.1 to 50.8% and from 46.3 to 35.8%, respectively.

Discussion

The rapid growth of the online food ordering industry has gradually changed people's lifestyles during the past few years, and youth aged 18–25 years old accounts for more than 40% of the total users [10]. In this study, the percentage of the participants ordering take-away food for more than once per week decreased from 15.4% pre-lockdown to 9.2% post-lockdown. The changes in take-away food ordering behaviors, although small, were significant in all subgroups. When stratified by educational level and gender, we found that graduate students ordered take-away food more often than undergraduate students and high school students, although the decreasing trend was consistent across three educational levels.

These decreases in food ordering may be related to school closure measures, which have not been fully lifted until September 2020. Although some high schools and universities in the provinces with less severe epidemics have gradually reopened since April 2020, most of them only allowed senior students going back to campus, while the remaining students continued to use remote learning till the end of the semester in July. As the majority of the students were living at home at the time of the survey, they may more often eat home-cooked meals together with their family, and perhaps dine in the restaurants/food outlets sometimes, alone or with family, instead of ordering food online. Safety concerns may also explain the decreases in food ordering, as people may worry about the spread of disease during food preparation and the contact with the deliverymen. Ensuring food hygiene and safety measures for all staff involved may help customers gain confidence in food ordering food.

The COVID-19 outbreak to some extent has changed the types of food that people ordered online and the ordering time. We found an increase in ordering for fried food, hamburgers, desserts, drinks, simple western meals, and barbecue grill, and a decrease in ordering for hotpot and Chinese dishes with rice. Also, an increased percentage of participants chose to order breakfast and midnight snacks. A possible reason for this trend may be that, due to not fully lifted school closure measures, students may go to sleep and wake up later post-lockdown than pre-lockdown, which could increase the demand for midnight snacks and brunch (students may mean brunch by choosing "breakfast"). This information may inform restaurants that the operation time and menu may need to be adjusted to survive during this difficult time. On the other hand, sufficient evidence supported that an excessive intake of fast food could increase calorie intake and increase risks for overweight and obesity [11], and studies have shown that having midnight snacks may increase breakfast-skipping

Table 1 Baseline characteristics of the participating youths

Variables	Percentage or mean ± standard deviation									
	High school students			Undergraduate students			Graduate students			All (n = 10,082)
	Male (n = 678)	Female (n = 2146)	Total (n = 2824)	Male (n = 2106)	Female (n = 4918)	Total (n = 7024)	Male (n = 68)	Female (n = 166)	Total (n = 234)	
Age (years)	17.5 ± 1.2	17.5 ± 1.2	17.5 ± 1.2	20.6 ± 2.0	20.6 ± 1.6	20.6 ± 1.8	24.3 ± 4.1	24.7 ± 3.2	24.6 ± 3.5	19.8 ± 2.3
Ethnic										
Han	96.9	96.7	96.7	94.2	95.1	94.8	92.6	92.2	92.3	95.3
Minority	3.1	3.3	3.3	5.8	4.9	5.2	7.4	7.8	7.7	4.7
Urbanicity										
Urban	**31.9**	**22.1**	24.4	40.2	41.3	41.0	57.4	63.3	61.5	36.8
Non-urban	**68.1**	**77.9**	75.6	59.8	58.7	59.0	42.6	36.7	38.5	63.2
Region										
Northeast	–	–	–	**0.3**	**0.2**	0.3	2.9	4.2	3.8	0.3
East	0.6	0.7	0.7	**10.1**	**12.2**	11.5	25.0	28.3	27.4	8.9
West	99.4	99.3	99.3	**85.5**	**84.1**	84.5	61.8	50.0	53.4	87.9
Central	–	–	–	**4.1**	**3.5**	3.7	10.3	17.5	15.4	2.9
Household income (CNY/year)										
< 12,000	**20.8**	**25.7**	24.5	21.7	18.5	19.4	13.2	4.2	6.8	20.6
12,000–19,999	**28.0**	**37.9**	35.6	23.2	28.2	26.7	4.4	11.4	9.4	28.8
20,000–59,999	**28.3**	**25.0**	25.8	26.4	28.1	27.6	14.7	24.7	21.8	27.0
60,000–99,999	**15.2**	**7.8**	9.6	14.8	13.4	13.8	22.1	22.9	22.6	12.8
100,000–199,999	**5.5**	**2.6**	3.3	9.4	8.6	8.9	27.9	24.7	25.6	7.7
≥ 200,000	**2.2**	**1.0**	1.3	4.6	3.2	3.6	17.6	12.0	13.7	3.2
Major										
Medical science	**59.0**	**98.4**	89.0	**12.4**	**16.0**	14.9	**41.2**	**52.4**	49.1	36.4
Science/engineering	**39.4**	**1.0**	10.2	**51.9**	**22.6**	31.4	**44.1**	**20.5**	27.4	25.4
Social science	**1.6**	**0.6**	0.8	**35.7**	**61.4**	53.7	**14.7**	**27.1**	23.5	38.2

All variables were significantly different ($P < 0.05$) across educational levels (high school students, undergraduate students, graduate students) within the overall population and within a given sex (male, female). Values under a given variable were shown in bold, if the difference between sexes within a given educational level was significant ($P < 0.05$)

Table 2 Food ordering patterns of participating youths before and after COVID-19 lockdown

Variables	Percentage or mean ± standard deviation									
	High school students			Undergraduate students			Graduate students			All ($n=10,082$)
	Male ($n=678$)	Female ($n=2146$)	Total ($n=2824$)	Male ($n=2106$)	Female ($n=4918$)	Total ($n=7024$)	Male ($n=68$)	Female ($n=166$)	Total ($n=234$)	
Weekly frequency of food ordering										
Pre-lockdown										
None	92.0***	93.5***	93.1***	83.8***	80.9***	81.7***	**77.9***	**62.0*****	66.7***	84.6***
1–3 days/week	6.5***	5.5***	5.8***	11.2***	16.0***	14.6***	**19.1***	**26.5*****	24.4***	12.3***
4–6 days/week	0.6***	0.5***	0.5***	2.6***	1.8***	2.0***	**2.9***	**4.3*****	3.8***	1.6***
7 days/week	0.9***	0.5***	0.6***	2.4***	1.3***	1.7***	**0.1***	**7.2*****	5.1***	1.5***
Post-lockdown										
None	95.3***	95.1***	95.1***	90.1***	88.6***	89.0***	92.6*	88.0***	89.3***	90.8***
1–3 days/week	3.8***	4.3***	4.2***	7.6***	9.8***	9.2***	5.9*	12.0***	10.3***	7.8***
4–6 days/week	0.5***	0.5***	0.5***	1.3***	1.0***	1.1***	0.0*	0.0***	0.0***	0.9***
7 days/week	0.4***	0.1***	0.2***	1.0***	0.6***	0.7***	1.5*	0.0***	0.4***	0.5***
Average weekly frequency of food ordering (days/week)										
Pre-lockdown	0.2 ± 0.9***	0.2 ± 0.7***	0.2 ± 0.8***	0.5 ± 1.4***	0.5 ± 1.2***	0.5 ± 1.3***	**0.5 ± 1.1***	**1.2 ± 2.0*****	1.0 ± 1.8***	0.4 ± 1.2***
Post-lockdown	0.1 ± 0.7***	0.1 ± 0.6***	0.1 ± 0.6***	0.3 ± 1.0***	0.3 ± 0.9***	0.3 ± 0.9***	**0.2 ± 1.0***	**0.2 ± 0.7*****	0.2 ± 0.8***	0.2 ± 0.9***

All variables were significantly different ($P<0.05$) across educational levels (high school students, undergraduate students, graduate students) within the overall population and within given sex (male, female). Values under a given variable were shown in bold, if the difference between sexes within a given educational level was significant ($P<0.05$); and marked by asterisks, if the difference before and after COVID-19 lockdown within a given educational level and sex was significant (*$P<0.05$,**$P<0.01$,***$P<0.001$)

Table 3 Changes in individuals' food ordering behaviors after COVID-19 lockdown

Variables	Percentage									
	High school students			Undergraduate students			Graduate students			All
	Male ($n=678$)	Female ($n=2146$)	Total ($n=2824$)	Male ($n=2106$)	Female ($n=4918$)	Total ($n=7024$)	Male ($n=68$)	Female ($n=166$)	Total ($n=234$)	($n=10,082$)
Changes in food ordering										
Started ordering	**1.5**	**2.1**	**2.0**	**3.2***	**4.5***	**4.1**	**1.5***	**4.8***	**3.8**	**3.5**
Stopped ordering	**4.7**	**3.7**	**4.0**	**9.4***	**12.3***	**11.4**	**16.2***	**30.7***	**26.5**	**9.7**
Increased	**0.0**	**0.3**	**0.1**	**0.4***	**0.7***	**0.6**	**1.5***	**0.1***	**0.4**	**0.5**
Decreased	**0.1**	**0.3**	**0.3**	**1.0***	**0.6***	**0.8**	**0.0***	**1.2***	**0.9**	**0.6**
Constant	**3.1**	**2.3**	**2.5**	**5.3***	**5.6***	**5.5**	**4.4***	**6.0***	**5.6**	**4.7**
Never	**90.6**	**91.3**	**91.1**	**80.7***	**76.3***	**77.6**	**76.4***	**57.2***	**62.8**	**81.1**
Changes in food ordering by ordering time										
Breakfast										
Started ordering	0.1	0.4	**0.3**	1.1*	0.7*	**0.8**	1.5	0.0	**0.4**	**0.6**
Stopped ordering	0.9	0.6	**0.6**	1.2*	1.1*	**1.2**	0.0	0.6	**0.4**	**1.0**
Constant	0.3	0.4	**0.4**	0.6*	0.2*	**0.3**	0.0	0.6	**0.5**	**0.4**
Never	98.7	98.6	**98.7**	97.1*	98.0*	**97.7**	98.5	98.8	**98.7**	**98.0**
Lunch										
Started ordering	**1.3**	**1.5**	**1.5**	**2.6***	**3.6***	**3.3**	**0.0***	**3.0***	**2.1**	**2.8**
Stopped ordering	**2.9**	**1.6**	**1.9**	**7.6***	**10.0***	**9.3**	**10.3***	**26.5***	**21.8**	**7.5**
Constant	**1.6**	**1.4**	**1.4**	**3.1***	**3.8***	**3.6**	**4.4***	**4.2***	**4.3**	**3.0**
Never	**94.2**	**95.5**	**95.2**	**86.7***	**82.6***	**83.8**	**85.3***	**66.3***	**71.8**	**86.7**
Dinner										
Started ordering	**0.9**	**1.2**	**1.1**	**2.5**	**2.7**	**2.6**	**2.9**	**3.6**	**3.4**	**2.2**
Stopped ordering	**1.0**	**1.7**	**1.5**	**6.5**	**7.4**	**7.1**	**10.3**	**22.3**	**18.8**	**5.8**
Constant	**1.2**	**1.0**	**1.1**	**2.3**	**2.7**	**2.6**	**3.0**	**1.2**	**1.7**	**2.2**
Never	**96.9**	**96.1**	**96.3**	**88.7**	**87.2**	**87.7**	**83.8**	**72.9**	**76.1**	**89.8**
Midnight snacks										
Started ordering	0.5	0.9	**0.8**	1.0	1.4	**1.3**	0.0	0.6	**0.4**	**1.1**
Stopped ordering	1.5	1.6	**1.6**	3.2	2.4	**2.7**	1.5	1.8	**1.7**	**2.3**
Constant	0.7	0.9	**0.9**	1.6	1.4	**1.4**	0.0	0.6	**0.5**	**1.3**
Never	97.3	96.6	**96.7**	94.2	94.8	**94.6**	98.5	97.0	**97.4**	**95.3**
Changes in food ordering by type of food										
Chinese dishes with rice										
Started ordering	**0.7**	**0.9**	**0.8**	**2.5**	**2.0**	**2.1**	**0.0**	**2.4**	**1.7**	**1.8**
Stopped ordering	**2.5**	**1.4**	**1.7**	**6.4**	**6.6**	**6.6**	**16.2**	**23.5**	**21.4**	**5.5**

Table 3 (continued)

Variables	Percentage									
	High school students			Undergraduate students			Graduate students			All
	Male ($n=678$)	Female ($n=2146$)	Total ($n=2824$)	Male ($n=2106$)	Female ($n=4918$)	Total ($n=7024$)	Male ($n=68$)	Female ($n=166$)	Total ($n=234$)	($n=10,082$)
Constant	**1.2**	**0.7**	**0.8**	**2.0**	**1.9**	**1.9**	**2.9**	**0.6**	**1.3**	**1.6**
Never	**95.6**	**97.0**	**96.7**	**89.1**	**89.5**	**89.4**	**80.9**	**73.5**	**75.6**	**91.1**
(Spicy) hot pot										
Started ordering	**1.0**	**1.2**	**1.2**	**2.2***	**2.7***	**2.5**	**2.9***	**3.0***	**3.0**	**2.2**
Stopped ordering	**1.3**	**2.3**	**2.1**	**4.9***	**9.0***	**7.8**	**5.9***	**21.7***	**17.1**	**6.4**
Constant	**1.1**	**1.4**	**1.3**	**2.4***	**3.3***	**3.0**	**2.9***	**3.0***	**3.0**	**2.5**
Never	**96.6**	**95.1**	**95.4**	**90.5***	**85.0***	**86.6**	**88.2***	**72.3***	**76.9**	**88.9**
Fried foods or hamburgers										
Started ordering	**1.6**	**1.4**	**1.5**	**2.1***	**3.1***	**2.8**	**0.0**	**2.4**	**1.7**	**2.4**
Stopped ordering	**1.9**	**2.2**	**2.2**	**4.5***	**5.7***	**5.4**	**5.9**	**9.6**	**8.5**	**4.5**
Constant	**0.8**	**1.2**	**1.1**	**2.7***	**3.1***	**2.9**	**0.0**	**1.9**	**1.3**	**2.4**
Never	**95.7**	**95.2**	**95.2**	**90.7***	**88.1***	**88.9**	**94.1**	**86.1**	**88.5**	**90.7**
Cakes/pastries or drinks										
Started ordering	**0.5**	**1.5**	**1.3**	**1.3***	**2.8***	**2.4**	**0.0***	**3.0***	**2.1**	**2.1**
Stopped ordering	**1.2**	**1.4**	**1.3**	**2.8***	**5.5***	**4.7**	**1.5***	**12.0***	**9.0**	**3.8**
Constant	**0.7**	**1.3**	**1.1**	**1.6***	**2.8***	**2.4**	**1.5***	**1.9***	**1.7**	**2.0**
Never	**97.6**	**95.8**	**96.3**	**94.3***	**88.9***	**90.5**	**97.0***	**83.1***	**87.2**	**92.1**
Simple western meals										
Started ordering	**0.3**	**0.7**	**0.6**	**1.1**	**1.1**	**1.1**	**0.0**	**2.4**	**1.7**	**1.0**
Stopped ordering	**0.3**	**0.6**	**0.5**	**1.7**	**1.8**	**1.8**	**1.5**	**4.8**	**3.8**	**1.4**
Constant	**0.4**	**0.3**	**0.3**	**0.8**	**1.1**	**1.0**	**0.0**	**1.8**	**1.3**	**0.8**
Never	**99.0**	**98.4**	**98.6**	**96.4**	**96.0**	**96.1**	**98.5**	**91.0**	**93.2**	**96.8**
Barbecue/grill										
Started ordering	0.4	**0.5**	**0.5**	0.9*	**1.9***	**1.6**	0.0	**3.0**	**2.1**	**1.3**
Stopped ordering	1.6	**0.7**	**0.9**	2.3*	**3.6***	**3.2**	2.9	**4.8**	**4.3**	**2.6**
Constant	0.4	**0.6**	**0.5**	1.2*	**1.7***	**1.5**	1.5	**0.0**	**0.4**	**1.2**
Never	97.6	**98.2**	**98.1**	95.6*	**92.8***	**93.7**	95.6	**92.2**	**93.2**	**94.9**
Flour-based foods										
Started ordering	**0.4**	**1.1**	**0.9**	**1.7***	**2.2***	**2.0**	**0.0***	**1.8***	**1.3**	**1.7**
Stopped ordering	**2.2**	**1.1**	**1.4**	**4.1***	**5.4***	**5.0**	**4.4***	**15.1***	**12.0**	**4.2**
Constant	**0.6**	**0.9**	**0.8**	**1.3***	**1.6***	**1.6**	**0.0***	**3.0***	**2.1**	**1.3**
Never	**96.8**	**96.9**	**96.9**	**92.9***	**90.8***	**91.4**	**95.6***	**80.1***	**84.6**	**92.8**

Table 3 (continued)

Variables	Percentage									
	High school students			Undergraduate students			Graduate students			All
	Male ($n=678$)	Female ($n=2146$)	Total ($n=2824$)	Male ($n=2106$)	Female ($n=4918$)	Total ($n=7024$)	Male ($n=68$)	Female ($n=166$)	Total ($n=234$)	($n=10,082$)
Braised foods										
Started ordering	**0.3**	**0.5**	**0.5**	**0.8**	**0.9**	**0.8**	**0.0**	**0.6**	**0.4**	**0.7**
Stopped ordering	**0.3**	**0.2**	**0.2**	**1.8**	**2.0**	**2.0**	**0.0**	**1.8**	**1.3**	**1.5**
Constant	**0.3**	**0.2**	**0.2**	**0.5**	**0.9**	**0.8**	**0.0**	**0.6**	**0.4**	**0.6**
Never	**99.1**	**99.1**	**99.1**	**96.8**	**96.2**	**96.4**	**100.0**	**97.0**	**97.9**	**97.2**
Japanese/Korean foods										
Started ordering	0.0	**0.3**	**0.2**	0.7	**0.7**	**0.7**	–	**0.0**	**0.0**	**0.5**
Stopped ordering	0.4	**0.3**	**0.3**	1.4	**1.7**	**1.6**	1.5	**7.2**	**5.6**	**1.3**
Constant	0.3	**0.0**	**0.1**	0.4	**0.8**	**0.7**	–	**0.0**	**0.0**	**0.6**
Never	99.3	**99.4**	**99.4**	97.5	**96.8**	**97.0**	98.5	**92.8**	**94.4**	**97.6**
Other foods										
Started ordering	0.2	**0.4**	**0.3**	0.5	**0.5**	**0.5**	0.0	**0.6**	**0.4**	**0.5**
Stopped ordering	0.4	**0.4**	**0.4**	1.2	**1.6**	**1.5**	1.5	**0.0**	**0.5**	**1.2**
Constant	0.3	**0.1**	**0.1**	0.5	**0.5**	**0.5**	0.0	**0.0**	**0.0**	**0.3**
Never	99.1	**99.1**	**99.2**	97.8	**97.4**	**97.5**	98.5	**99.4**	**99.1**	**98.0**

A participant may choose one or more categories of the ordering time and the types of food ordered. Values under a given variable were shown in bold, if the difference across educational levels (high school students, undergraduate students, graduate students) within the overall population or within given sex (male, female) was significant ($P<0.05$); shown in asterisks, if the difference between sexes within a given educational level was significant ($P<0.05$)

Table 4 Times and types of food ordering among participating youths who ordered food before and after COVID-19 lockdown

Variables	Percentage[a]									
	High school students			Undergraduate students			Graduate students			All ($n=1552$)
Pre-lockdown	Male ($n=54$)	Female ($n=140$)	Total ($n=194$)	Male ($n=339$)	Female ($n=941$)	Total ($n=1280$)	Male ($n=15$)	Female ($n=63$)	Total ($n=78$)	
Ordering time										
Breakfast	14.8	**14.3**	**14.4**	11.5$^{\#}$	**6.8**$^{\#}$	**8.0**	0.0	**3.2**	**2.6**	8.6*
Lunch	57.4	**45.7**	**49.0**	66.7	**72.3***	**70.8****	66.7	**81.0**	**78.2**	68.4*
Dinner	**27.8**	**40.7**	**37.1**	**54.3**	**52.7**	**53.1**	**60.0**	**61.9**	**61.5**	51.5
Midnight snacks	27.8	**38.6**	**35.6**	30.1$^{\#}$	**19.9**$^{\#}$*	**22.6****	6.7	**6.3**	**6.4**	23.4**
Type of food ordered										
Chinese dishes with rice	**46.3**	**32.1**	**36.1**	**52.5**$^{\#}$*	**44.3**$^{\#}$**	**46.5*****	**86.7**	**63.5****	**67.9****	46.3***
(Spicy) hot pot	29.6$^{\#}$	55.7$^{\#}$	**48.5**	45.7$^{\#}$	64.4$^{\#}$**	**59.5***	40.0	65.1	**60.3**	58.1*
Fried foods or hamburgers	33.3$^{\#}$	**52.1**$^{\#}$	**46.9**	44.5	**46.0****	**45.6****	26.7	**30.2**	**29.5**	45.0**
Cakes/pastries or drinks	24.1$^{\#}$	40.0$^{\#}$	35.6	27.1$^{\#}$	43.3$^{\#}$**	39.0**	13.3	36.5	32.1	38.2**
Simple western meals	9.3	12.9	11.9	15.3	15.3**	15.3***	6.7	17.5	15.4	14.9***
Barbecue/grill	25.9	**19.3**	**21.1**	21.8	**27.3***	**25.9***	20.0	**12.7**	**14.1**	24.7*
Flour-based foods	35.2	30.7	32.0	33.9	36.5	35.8	20.0	47.6	42.3	35.6
Braised foods	7.4	**6.4**	**6.7**	14.2	**15.4**	**15.1**	0.0	**6.3**	**5.1**	13.5
Japanese/Korean foods	9.3	**5.0**	**6.2**	11.2	**13.4**	**12.8**	6.7	**19.0**	**16.7**	12.2
Other foods	9.3	**7.1**	**7.7**	10.3	**10.6**	**10.5**	6.7	**0.0**	**1.3**	9.7
Variables	Percentage[a]									
	High school students			Undergraduate students			Graduate students			All ($n=930$)
Post-lockdown	Male ($n=32$)	Female ($n=106$)	Total ($n=138$)	Male ($n=209$)	Female ($n=558$)	Total ($n=767$)	Male ($n=5$)	Female ($n=20$)	Total ($n=25$)	
Ordering time										
Breakfast	9.4	**15.1**	13.8	16.7$^{\#}$	**7.5**$^{\#}$	10.0	20.0	**5.0**	8.0	10.5*
Lunch	59.4	58.5	58.7	57.9	65.4*	63.4**	60.0	60.0	60.0	62.6*
Dinner	43.8	44.3	44.2	47.8	47.3	47.5	80.0	40.0	48.0	47.0
Midnight snacks	25.0	**37.7**	**34.8**	26.3	**24.6***	**25.0****	0.0	**10.0**	**8.0**	26.0**
Type of food ordered										
Chinese dishes with rice	40.6	31.1	33.3	44.5$^{\#}$*	33.5$^{\#}$**	36.5***	40.0	25.0**	28.0**	35.8***
(Spicy) hot pot	43.8	51.9	50.0	46.4	52.3**	50.7*	80.0	50.0	56.0	50.8*

Table 4 (continued)

Variables	Percentage[a]									
	High school students			Undergraduate students			Graduate students			All ($n=930$)
Post-lockdown	Male ($n=32$)	Female ($n=106$)	Total ($n=138$)	Male ($n=209$)	Female ($n=558$)	Total ($n=767$)	Male ($n=5$)	Female ($n=20$)	Total ($n=25$)	
Fried foods or hamburgers	50.0	50.9	50.7	48.3	53.8**	52.3**	0.0	35.0	28.0	51.4**
Cakes/pastries or drinks	*25.0*	*56.6*	49.3	*29.2*$^{\#}$	*49.3***	43.8**	20.0	40.0	36.0	44.4**
Simple western meals	15.6	18.9	18.1	19.6	19.4**	19.4***	0.0	35.0	28.0	19.5***
Barbecue/grill	12.5	21.7	19.6	21.1$^{\#}$	31.0$^{\#}$*	28.3*	20.0	25.0	24.0	26.9*
Flour-based foods	21.9	37.7	34.1	30.1	33.2	32.3	0.0	40.0	32.0	32.6
Braised foods	12.5	14.2	13.8	12.4	15.8	14.9	0.0	10.0	8.0	14.5
Japanese/Korean foods	6.2	**6.6**	**6.5**	11.0	**12.9**	**12.4**	0.0	**0.0**	**0.0**	11.2
Other foods	9.4	9.4	9.4	9.1	7.9	8.2	0.0	0.0	0.0	8.2

A participant may choose one or more categories of the ordering time and the types of food ordered. Values under a given variable were shown in bold, if the difference across educational levels (high school students, undergraduate students, graduate students) within the overall population or within given sex (male, female) was significant ($P<0.05$); marked by hashes, if the difference between sexes within a given educational level was significant ($P<0.05$); and marked by asterisks, if the difference before and after COVID-19 lockdown within a given educational level and sex was significant using chi-square tests (*$P<0.05$, **$P<0.01$, ***$P<0.001$)

behavior and is also a risk factor for obesity [11]. The increasing trend of ordering fast food and for midnight snacks observed in this study also suggested the need to promote a healthy diet during the school closure period among youths.

This study has several limitations. First, food ordering patterns before COVID-19 were retrospectively collected from the online questionnaire, thus there may be recall biases and also underreporting issues possibly occurring in self-reported dietary data. Also, although placing a pair of questions for the two time points next to each other has been considered easier for participants to recall and differentiate [8, 9], some may argue that such arrangements might encourage participants to consider differences between the two time periods rather than reporting behaviour during the two time periods separately and in a random order, which is expected to be tested in more future efforts. In addition, this section of the questionnaire was self-devised for the first time (to the best knowledge of the authors) to capture food ordering information in a promptly accumulated sample in the context of public health emergencies, so could not have been validated. Second, although the questionnaire was initially ensured to be shared with potential participants via social media chat groups and moments, which were also encouraged to continue sharing the questionnaire in the same ways, some following participants in the middle and late stages of the survey may forward the questionnaire directly to their surrounding classmates and/or friends. In this case, selection bias may be introduced as those participants may tend to nominate people who might have similar lifestyle patterns as themselves. Also, the sample comprises of more females than males, and, in particular, the graduate students comprise of a low number of males. Moreover, we only recruited student participants, which may limit the generalizability of the findings to out-of-school youths. Only completed surveys were submitted with no records of all dropouts at any stage of the survey, which may also create a bias given the length of the survey (e.g., the included participants may have better health awareness than the dropouts).

Third, options for the frequency of food ordering in this study were designed as how many days per week instead of how many times per week/month one has ordered food; the latter may capture food ordering behaviors at multiple time scales more accurately, for example, among those who have ordered food only 2–3 times or less per month, and for differentiating those who have ordered food once and 2–3 times per day. Also, regarding the time of food ordering, only the four mealtimes were made available for participants to choose, which could not accurately capture food ordering at other times, such as brunch and afternoon tea. Fourth, the results of this study should be understood within the special situation that China has lived during the COVID-19 pandemic, which may provide limited implications to

the Western world. Also, we did not collect the information on the change in online food availability over time in this survey, which may partially account for the change in food ordering patterns. However, this may not significantly affect this study as most restaurants had returned to normal business in May 2020, so the influences on the availability of online food ordering at that time should have been much more trivial. Future research should also consider collecting other factors which may potentially explain the reasons underlying changes in youth's food ordering patterns (e.g., the main source of their meal, the extent to which parents determine their meal intake), so some negative changes observed could be intervened more effectively. Lastly, the study was conducted only 1 month after the lockdown was lifted, so future research is necessary to evaluate whether this change in food ordering patterns may persist for a longer period [12]. Also, in future research, it is worth further examining the variation in the patterns of take-away food ordering across other categories (e.g., subgroups with different weight statuses, dietary behaviors, etc.).

Conclusions

This is the first nationwide study that assessed the changes in patterns of take-away food ordering after the COVID-19 lockdown period in China. A unique strength of this study is to use the web-based online survey tool to accumulate a large sample size in the targeted population within a short period without physical contact, not allowed during the epidemic, from which we could draw quick and important conclusions for monitoring both individual- and population-level behaviors during this unusual period. Our findings would contribute to raising the attention to healthy dietary habit promotion among young students in China after the lockdown was lifted, and provide evidence for consideration of restaurant industry to achieve more cost-effective operation in China during future health emergencies.

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Declartions

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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