Heliyon 9 (2023) e17233

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Eating window and eating habits of adults in China: A cross-sectional study

Rongsong Tang [a,b,1], Jingpin Wang [a,b,1], Wenhui Zhang [b], Wei Fu [b], Lin Zhuo [c], Jin Yang [b], Qun Wang [b,**], Kun Yang [b,*]

[a] Nursing Department, Peking University Third Hospital, Huayuan North Road No. 49, Haidian District, Beijing, China
[b] Department of Endocrinology and Metabolism, Peking University Third Hospital, Huayuan North Road No. 49, Haidian District, Beijing, China
[c] Center for Clinical Epidemiology Research, Peking University Third Hospital, Huayuan North Road No. 49, Haidian District, Beijing, China

ARTICLE INFO

Keywords:
Eating window
Eating habits
Intermittent fasting
Mainland China
Questionnaire survey

ABSTRACT

Objective: Previous studies have demonstrated that eating time and habits play key roles in human health. However, there is a paucity of research on the epidemiology of eating window and eating habits in China. This study aimed to investigate the relationship between eating window and eating habits among adults in mainland China and explore the factors influencing these parameters.
Design: Cross-sectional study.
Setting: A questionnaire comprising demographic data, metabolic index, eating window and eating habits was administered via the Internet.
Participants: 1596 adults from mainland China.
Results: Eating window of all participants was 13.03 ± 2.02 h (mean ± standard deviation [SD]), which was longer than previously reported in smaller more controlled studies from China. Area of residence and occupation were significant factors influencing eating window after controlling for other factors (area of residence: β, −0.499; 95% confidence interval [CI], −0.897 to −0.101, p = 0.014; occupation: β, −0.309, 95% CI, −0.496 to −0.121, p = 0.001). Participants typically commenced eating at 08:00 h (interquartile range [IQR]: 8:00–9:00) and ceased eating at 20:00 h (IQR: 20:00–22:00). Regular meals which mean two or three meals per day regularly constituted the dominant eating pattern of participants (n = 1233, 77.3%) and 819 (51.1%) participants preferred cooking for themselves.
Conclusion: This study revealed that eating window of adults in China generally around 13 h. Area of residence and occupation were the main factors influencing eating window. Our data provide a foundation for future studies on eating window and eating habits in China.

1. Introduction

The relationship between diet and health is a topic of long-standing interest. Diet is closely correlated with physical health in

* Corresponding author.
** Corresponding author.
E-mail addresses: wq3025@sina.com (Q. Wang), yangkun@bjmu.edu.cn (Kun Yang).
[1] These authors contributed equally to this work and shared first authorship.

https://doi.org/10.1016/j.heliyon.2023.e17233
Received 21 September 2022; Received in revised form 5 June 2023; Accepted 12 June 2023
Available online 13 June 2023

humans; unhealthy eating habits such as consumption of diets high in calories, glucose, and/or trans fatty acids increase the incidence of obesity, diabetes [1,2], coronary heart disease [3,4], and various other metabolic diseases [5]. Simultaneously, the diet has been reported to impact mental health, which may influence affective behaviors and contribute to the development of depression [5–7].

Several eating models have been developed for losing weight and treating diseases. For example, medical nutrition therapies for diabetes, such as the Mediterranean diet, low-carbohydrate/high-protein diets, vegan diets, and vegetarian diets, are popular for diabetes management [8,9]. Although these diets, especially the Mediterranean diet, have been shown to prevent and delay the development of diseases [8,10,11], they are still not widely used in real-world settings because of their restrictive dietary requirements [12].

The temporal duration of food and beverage consumption, or the eating window, has recently gained attention as an important component of a healthy diet [13–16], which is defined as the time from the start to the cessation of food intake. A shorter eating time, particularly that shorter than 12 h, is associated with a longer lifespan, independent of the caloric intake [15]. Time-restricted Eating (TRE), an eating model that restricts the daily eating window to a target range or a fixed number of days throughout the week regardless of food categories and calories, has been associated with weight loss, improvements in glucose control and insulin sensitivity, lower blood pressure, and favorable alterations in plasma lipids [17–19]. This approach has become increasingly popular for disease management because of its convenience. However, there is a paucity of research on the epidemiology of eating window and eating habits in China.

This study aimed to investigate current trends in eating window and eating habits among adults in mainland China, and to identify factors that influence eating window and eating habits, provide suggestions for further interventions.

2. Materials and methods

2.1. Study design

In this cross-sectional study, voluntary unpaid participants were recruited through Moments and group chats in WeChat (the most popular mobile app for real-time communication with over 900 million users in China) in April 2021 (Appendix 1). Data were collected using questionnaire star, a professional questionnaire survey platform that enables data quality control by monitoring the response time and avoiding missed answers (https://www.wjx.cn/). The inclusion criteria were residence in Mainland China, age >18 years, and ability to complete the online questionnaire. Meanwhile, individuals with missing data or extreme outliers for key variables were excluded.

2.2. Ethical consideration

This study was approved by the Medical Research Ethics Committee of Peking University Third Hospital (IRB00006761-M2021024). Written informed consent was obtained from all subjects/patients.

2.3. Measures

Demographic data were collected through questionnaires, which were designed based on previous studies and clinical practice. Participants were characterized according to sex, age, nationality, area of residence, and occupation. Regions of residence were divided into first (top 10), middle (top 11–20), and last (top 21–31) segments based on Gross Domestic Product (GDP), which is the total value of goods and services produced in a country in a year. Regions of residence were also divided into Eastern (East 8th & 9th District), Central (East 7th District), and Western (East 5th & 6th District) districts of China, based on the geographic location. Participants were categorized based on their occupation into those with fixed-time jobs and those with flexible jobs. Participants in fixed-time jobs included those whose working and eating times were fixed, such as staff, teachers, and doctors. Participants in flexible jobs had the freedom to control their working and eating times, such as freelancers, retirees, and unemployed individuals.

Metabolic indicators were self-reported. Body weight and blood glucose were selected as proxies for the metabolic status. Body mass index (BMI), an indicator of body weight relative to height, was calculated using the following formula: (weight [kg]/height [m])^2. Based on the BMI range, participants were classified into malnutrition ($\leq$18.5 kg/m^2), normal (18.5 kg/m^2<BMI<24 kg/m^2) and overweight/obesity ($\geq$24 kg/m^2) groups [20]. Based on their self-reported glucose regulation status, they were categorized into abnormal (self-reported to have been diagnosed with diabetes or prediabetes) and normal glucose groups. And participants who have never been monitored can choose to be unclear and untested.

Eating was defined as having any food with calories, excluding water, black coffee, and any zero-calorie drinks. Participants could select a period during which they started and ended eating based on their usual eating habits. Eating window was calculated as the time of the last meal intake minus the time of the first meal intake. We checked for abnormal data, such as starting a meal in the afternoon or ending a meal after midnight, and processed them to maintain accuracy.

Eating habits include the frequency and method of eating. Eating frequency refers to the frequency of meals, where eating anything with calories is defined as one meal, and a 60-min time interval is a clear criterion for two meals [21]. Consumption of regular meals (two to three meals per day), consumption of multiple small meals with small amounts of food per meal (more than three meals per day), and consumption of irregular meals were options of eating frequency [22].Eating methods refers to the various sources of food. The most common sources for food were eating takeout meals, eating in restaurants, eating in cafeterias, and eating home-cooked meals [23]. Unlike a restaurant, the cafeteria is a place where the company provides food for internal employees and is not open to

the public. Participants could select an answer that best described their eating habits.

2.4. Sample size calculation

According to a previous study [24], the SD of eating window was 2.31; accordingly, the permissible error was 0.231 [24]. Assuming an α of 0.05, the minimum sample size was calculated to be 387. We recruited a total of 1596 participants; thus, the sample size was adequate.

2.5. Statistical analysis

Data were analyzed using IBM SPSS Statistics version 23.0. The Q test was used for outlier testing. Eating window was assessed for normality through histogram analysis and presented as means and SDs. Independent sample t-tests and ANOVA were used to compare subgroups depending on the normality of data distribution, such as age, nationality, and region of residence, etc. If the multi-collinearity and Residual distribution test fit the criteria, the factors influencing eating window were analyzed using multilinear regression analysis. The start and end times of eating are presented as medians and interquartile ranges (IQRs) and were analyzed using the Chi-square test. Other classified variables are presented as numbers (%) and were analyzed using the Chi-square test. Statistical significance was set at $p < 0.05$ (two-tailed).

3. Results

3.1. Participants

In total, 1726 participants from 31 provinces and municipalities in mainland China were recruited in this cross-sectional study. A total of 90 participants were excluded because of unexplainable data, such as negative eating window (the end time of eating was earlier than the start time of eating) and abnormal weight and/or height values (weight >100 kg or height >250 cm or < 50 cm). Further, 23 underage participants and 17 participants residing outside mainland China were excluded (Fig. 1). The geographic distribution of the participants is presented in Fig. 2. Finally, a total of 1596 participants were included in the analysis. The participant characteristics are presented in Table 1.

3.2. Eating window

Eating window of participants was 13.03 ± 2.02 h (range, 5–19 h), and all subgroups reported eating window of >12 h. For young participants, participants living in urban or comparatively developed areas, and participants having time-fixed jobs, eating window was >13 h. Age, area of residence, GDP, and occupation were significant factors influencing eating window ($p < 0.05$). Eating window of participants from the first-third GDP area was significantly longer than that of participants from the last-third GDP area, while eating window of participants with fixed-time jobs was shorter than that of participants with flexible jobs and those who were students (Table 1).

Meanwhile, after controlling sex, age, nationality, area stratified by GDP, geographical area, body weight and blood glucose, Multiple linear regression analysis revealed that area of residence and occupation were associated with eating window (β, −0.499;

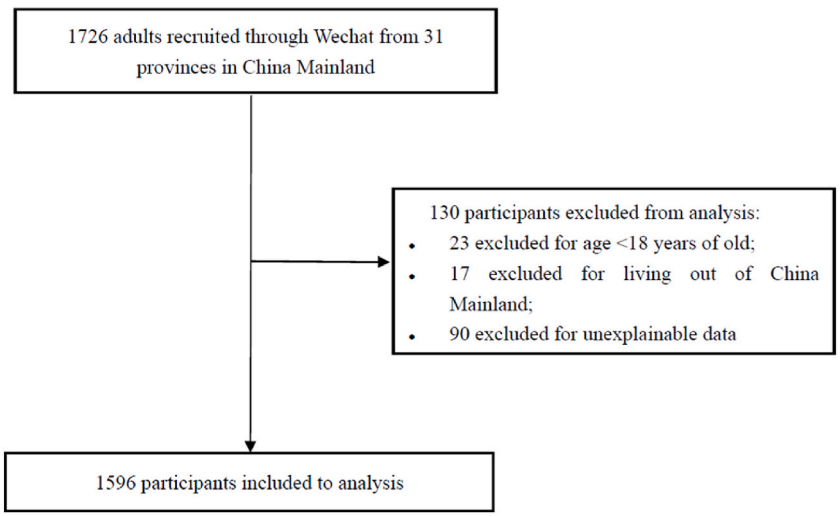

Fig. 1. Flowchart of inclusion and exclusion of the participants.

Fig. 2. Geographic distribution of participants in mainland China.

Table 1
Demographic characteristics and eating window of participants.

Variables		N (%)	eating window (h)	*P* value
Total	–	1596	13.03 ± 2.02	–
Sex	Male	440 (27.6)	12.99 ± 2.15	0.641*
	Female	1156 (72.4)	13.05 ± 1.96	
Age (years)	≤40	1071 (67.1)	13.06 ± 2.08	<0.001#
	41–60	468 (29.3)	13.03 ± 1.89	
	>60	57 (3.6)	12.56 ± 1.79	
Nationality	Han	1465 (91.8)	13.04 ± 2.02	0.554*
	Minority	131 (8.2)	12.93 ± 2.02	
Area of residence	Urban area	1485 (93.0)	13.07 ± 1.99	0.002*
	Rural area	111 (7.0)	12.47 ± 2.24	
Area stratified by GDP	First thirda	1028 (64.4)	13.11 ± 1.92	0.011#
	Middle third	224 (14.0)	13.10 ± 2.09	
	Last third	344 (21.6)	12.74 ± 2.22	
Geographical area	Eastern China	1141 (71.5)	13.10 ± 1.97	0.109#
	Central China	273 (17.1)	12.93 ± 2.15	
	Western China	182 (11.4)	12.70 ± 2.08	
Occupation	Time-fixed	1375 (86.2)	13.09 ± 1.98	0.001#
	Students	122 (7.6)	12.94 ± 2.32	
	Time-free	99 (6.2)	12.29 ± 1.98	
Body weight	Malnutrition	99 (6.2)	13.16 ± 2.22	0.393*
	Normal	944 (59.4)	13.07 ± 2.04	
	Overweight/Obesity	545 (34.3)	12.94 ± 1.94	
Blood glucose[1]	Abnormal glucose	177 (11.1)	12.99 ± 1.72	0.731*
	Normal glucose	1225 (76.8)	13.04 ± 2.04	

Data are presented as mean ± standard deviation or number (%).
* Independent sample t-tests were used.
# ANOVA were used.
[1] In the blood glucose analysis, 194 participants who had not undergone tests for blood glucose levels were excluded.

95% CI, −0.897 to −0.101, p = 0.014; β, −0.309; 95% CI, −0.496 to −0.121, p = 0.001) (Appendix 1).

The first mealtime was clustered at 08:00 (Median, 08:00; IQR, 8:00–9:00). Participants were divided into three categories based on tertiles. Most of the participants (45.24%, 722/1596) preferred to start eating between 08:00 and 09:00 h, while 40.91% (653/1596) and 13.85% (221/1596) preferred to start eating after 09:00 h and before 08:00 h, respectively. Age, nationality, area stratified by GDP, geographical area, and occupation were significant factors influencing the time of the first meal intake ($p < 0.05$, Table 2).

The last mealtime was concentrated at 20:00 (Median, 20:00; IQR, 20:00–22:00). Participants were divided into three categories based on tertiles. Most of the participants (52.26%, 834/1596) preferred to stop eating before 20:00 h, while 22.18% (354/1596) and 25.56% (408/1596) preferred to stop eating at 20:00–21:00 h and after 21:00, respectively. Age and occupation were significant factors influencing the time of the last meal intake (Table 2).

Table 2
Start and end of eating times among participants.

		Start of eating time				End of eating time			
		Before 08:00 h	08:00–09:00 h	After 09:00 h	P-value	Before 20:00 h	20:00–21:00 h	After 21:00 h	*P*-value
Gender	Male	54 (12.3)	190 (43.2)	196 (44.5)	0.164	228 (51.8)	89 (20.2)	123 (23.0)	0.297
	Female	167 (14.5)	532 (46.0)	457 (39.5)		606 (52.4)	265 (23.0)	28 (24.6)	
Age (years)	≤40	108 (10.1)	450 (42.0)[b]	513 (47.9)[b]	<0.001	493 (46.0)	250 (23.3)[b]	328 (30.7)[b,$]	<0.001
	41~60	104 (22.2)[*]	240 (51.3)	124 (26.5)		298 (63.7)	95 (20.3)	75 (16.0)	
	>60	9 (15.8)[*]	32 (56.1)	16 (28.1)		43 (75.4)	9 (15.8)	5 (8.8)	
Nationality	Han	210 (14.3)	673 (46.0)	582 (39.7)[b,$]	0.004	769 (52.5)	326 (22.3)	370 (25.2)	0.640
	Minority	11 (8.4)[*]	49 (37.4)	71 (54.2)		65 (49.6)	28 (21.4)	38 (29.0)	
Area of residence	Urban area	207 (13.9)	675 (45.5)	603 (40.6)	0.654	771 (68.5)	327 (29.1)	27 (2.4)	0.250
	Rural area	14 (12.6)	47 (42.3)	50 (45.1)		63 (56.8)	27 (24.3)	21 (18.9)	
Area stratified by GDP	First third	159 (15.5)	481 (46.8)	388 (37.7)[b,$]	0.002	526 (51.2)	242 (23.5)	260 (25.3)	0.162
	Middle third	28 (12.5)	101 (45.1)	95 (42.4)		121 (54.0)	37 (16.5)	66 (29.5)	
	Last third	34 (9.9)[*]	140 (40.7)	170 (49.4)		187 (54.4)	75 (21.8)	82 (23.8)	
Geographical area	Eastern China	170 (14.9)	525 (46.0)	446 (39.1)[b,$]	<0.001	58 (9.4)	265 (43.2)	291 (47.4)	0.364
	Central China	40 (14.7)	135 (49.4)	98 (35.9)		152 (55.7)	48 (17.6)	73 (26.7)	
	Western China	11 (6.0)a[*,#]	62 (34.1)	109 (59.9)		97 (53.3)	41 (22.5)	44 (24.2)	
Occupation	Time fixed	206 (15.0)	631 (45.9)	538 (39.1)[b,$]	0.001	715 (52.0)	316 (23.0)	344 (25.0)	<0.001
	Students	10 (8.2)[*]	50 (41.0)	62 (50.8)		54 (44.3)[*]	19 (15.6)	49 (40.1)	
	Time free	5 (5.1)[*]	41 (41.4)	53 (53.5)		65 (65.7)[*,#]	19 (19.2)	15 (15.1)	
Body weight	Malnutrition	14 (14.1)	43 (43.4)	42 (42.4)	0.687	41 (41.4)	28 (28.3)	30 (30.3)[b]	0.028
	Normal	128 (13.6)	418 (44.3)	398 (42.1)		477 (50.5)	213 (22.6)	254 (26.9)	
	Overweight/ Obesity	77 (14.1)	259 (47.5)	209 (38.4)		310 (56.9)[*,#]	113 (20.7)	122 (22.4)	
Blood glucose[1]	Abnormal glucose	30 (17.0)	88 (49.7)	59 (33.3)	0.253	102 (57.6)	45 (25.4)	30 (17.0)	0.068
	Normal glucose	169 (13.8)	575 (46.9)	482 (39.3)		639 (52.2)	281 (22.9)	305 (24.9)	

[*] Indicate differences between row groups (First row is the baseline).
[#] indicate differences between row groups (Second row is the baseline).
[b] Indicate difference between the column group (First column is the baseline).
[$] Indicate difference between the column group (Second column is the baseline).
[1] In the blood glucose analysis, 194 participants who had not undergone tests for blood glucose levels were excluded.

3.3. Eating habits

Consumption of regular meals was the dominant eating pattern (n = 1233, 77.3%). Among the remaining participants, 329 (20.6%) preferred irregular meals, while only 34 preferred to eat multiple small meals daily (2.13%). With regard to eating methods, 819

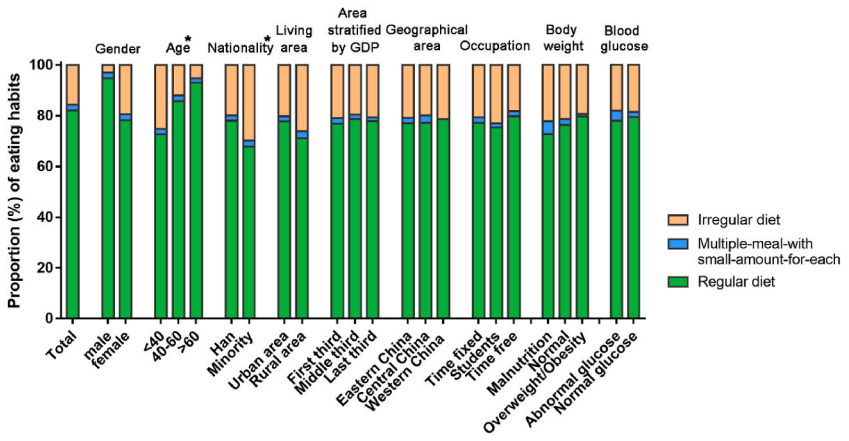

Fig. 3. Influence factors of eating frequency in China Mainland.

participants (51.1%) preferred cooking by themselves, 333 (20.9%) preferred eating at canteens, 227 (14.2%) preferred eating out, and 220 (13.8%) preferred takeout food. Age and nationality were significant factors influencing the eating pattern (Fig. 3). Older participants preferred regular meals daily, and a few individuals aged >60 years exhibited other eating patterns (4/57, 7.02%). In terms of nationality, both Han participants (1144/1465, 78.09%) and minorities (89/131, 67.94%) tended to eat regularly. Almost all influencing factors significantly impacted the participants' eating methods (Fig. 4).

Regardless of sex, age, nationality, occupation, area of residence, and blood glucose level, most participants preferred to eat home-cooked food. In particular, among participants aged >60 years old, 96.49% (55/57) preferred to eat home-cooked food only. Canteens were the most common place to eat for most participants, except for those with free time, who preferred to eat out over eating at canteens. The numbers of individuals who reported takeout food and eating out as the main eating methods were similar.

4. Discussion

Eating window are much longer than the standard eating window of TRE in China.

To our knowledge, this is the first study to investigate eating window in adults in China and explore potential factors influencing this parameter. In previous studies, eating window was defined as an outcome indicator for TRE interventions, and was evaluated using data with essential characteristics or control groups [25–27]. Liu et al. reported that the eating window of adults with obesity in China was about 10.38 ± 1.42 h/day [19], while Gabel et al. reported that eating window of adults with obesity was approximately 11 ± 1 h/day in America [27]. And Terra et al. reported that patients with type 2 diabetes usually fasted for 11.6 ± 1.9 h/day; this indicated that they ate food containing calories for approximately 12 h a day [26]. As for adults without the TRE intervention, Gill et al. and Gupta et al. found that more than half of the participants ate food for more than 15 h/day [17,28].

In this study, eating window was 13.03 ± 2.02 h/day, which is much longer than previously reported in smaller controlled studies in China and much shorter than in previous observational studies. This may because that we report groundbreaking data on the eating window of the Chinese. To our knowledge, this is the largest study to date among studies of eating window worldwide. Our study involved 31 provinces and included 1596 participants. Gill et al. and Gupta et al. investigated the eating window among 156 and 93 healthy adults in the United States and India [17,28], which differed significantly in sample size and geography compared to our study. Furthermore, Gupta et al. recruited spouses who worked shifts, which also increased eating window [28].

Meanwhile, we observed that eating window of participants with diabetes, obesity, or overweight was significantly longer than 8–10 h, which is the usual specified eating window for TRE [25–27]. Previous studies have shown that shorter eating window improve metabolism [17,18], which warrants a trial of TRE in patients with diabetes, obesity, or overweight.

The start and end time of eating should be set individually to improve compliance with TRE.

The times of the first and last meal intake have received less attention. Gabel et al. reported that patients without time-restricted eating usually started and stopped eating at approximately 09:00 h and 20:00 h, respectively [27]. Similar results were observed in the present study. Concerning factors influencing eating window, we observed that younger individuals were more likely to have a longer eating window, and an age of 60 years was the threshold, probably because 60 years is the mandatory retirement age in China. Therefore, participants aged >60 years have more freedom to choose their eating time. Moreover, older individuals typically go to bed early, reducing the likelihood of a night snack. Similarly, eating window of individuals with fixed-time work and those of students were significantly longer than eating window of individuals with flexible jobs. This may also be attributed to the fact that individuals with fixed-time jobs and students often stay up late and work overtime, which could lead to late dinner consumption and food consumption at midnight.

Area of residence also influenced eating window, which was significantly longer among individuals living in cities and regions with a more developed economy than among those living in rural areas and less developed regions. In China, many individuals living in

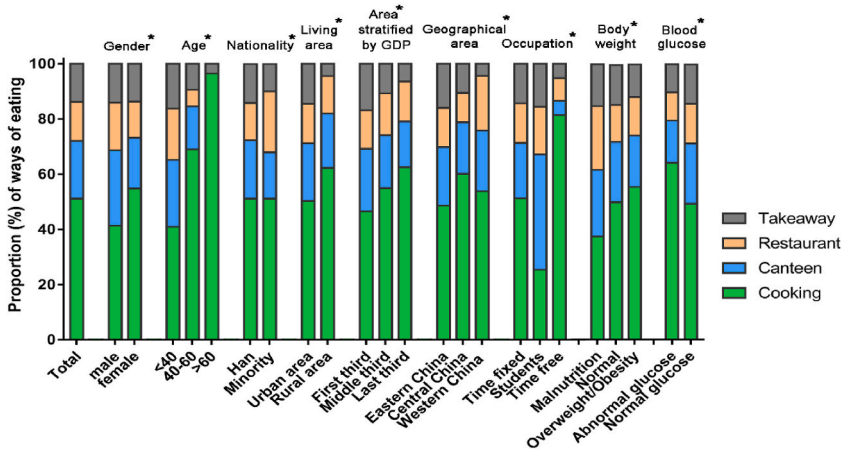

Fig. 4. Influence factors of eating methods in China Mainland.

rural areas typically have two regular meals daily, and they do not have the habit of consuming snacks late at night [29]. However, working late is normal for city dwellers, especially those in economically developed cities, and many individuals may finish work at midnight. Therefore, individuals living in cities require more attention, and delaying the time of the first meal intake may be a good way to control eating window.

In the present study, the time of the first meal intake was earlier than that in the study by Veronda et al., who reported that individuals typically start eating between 10:00 and 11:00 h. However, we observed similar results regarding the time of the last meal intake, which was approximately 20:00 h [24]. This may be due to waking and working times. Veronda et al. reported that individuals usually wake up at 08:00–09:00 h, which is the usual time of starting work in China. Notably, we observed that older participants preferred to start eating earlier. This may be a result of circadian physiology and sleep homeostasis [30]. The sleep of older individuals is characterized by an increased number of awakenings and early morning awakenings, which co-occur with earlier sleeping times [31]. Therefore, older individuals tend to stop eating earlier, which is consistent with our results.

Participants with fixed-time jobs preferred to start eating earlier than students and participants with flexible jobs, probably because most of the students enrolled in this study were undergraduates whose classes often started later. Additionally, participants with flexible jobs had the freedom to sleep in. Regardless of jobs, participants usually finished eating before 08:00 h. Compared to individuals with fixed-time and flexible jobs, students tended to consume their last meal later, probably because students tend to engage in evening activities [32], which caused them to stay up late and eat midnight snacks. In this regard, Veronda et al. reported that evening chronotypes tend to eat late [33].

Nationality, GDP, and geographical area independently influenced the time of the first meal intake, while bodyweight influenced the time of the last meal intake. Minorities preferred to start eating later, as did those living in areas with lower GDP and the western area. Most minorities live in the western area of China, which typically has a lower GDP. This suggests an overlap among these three factors. Sunrise is late in the western area; therefore, individuals usually start eating after 09:00 h, contributing to the observation that minorities and those living in areas with lower GDP begin eating late. Regardless of body weight, overweight, or obesity, most participants preferred to finish eating before 20:00 h, and participants who finished eating after 21:00 h weighed more than those who finished eating between 20:00 and 21:00 h. This may because that work schedule of internet companies usually ends at 21:00 h, and many workers eat dinner after work [34].

4.1. Regular diet and home-cooked meal were dominate eating habits among adults in China

Consumption of regular meals was the dominant eating pattern in this study, consistent with normal work or study patterns. Participants with busy work schedules may often work overtime. Therefore, irregular meals were the second most common eating pattern. Very few individuals reported consuming multiple meals with a small amount of food per meal as the primary eating pattern. This may be because most participants included in our study were workers, which made it difficult for them to eat at work. Moreover, the definition of multiple meals with a small amount of food per meal is ambiguous. It is difficult for participants to distinguish between meals and snacks when they eat at times other than main mealtimes. We also observed that older individuals, especially those aged >60 years, preferred regular meals daily; with age, individuals tend to pay more attention to health and their work intensity decreases, which gives them more time to eat.

Consumption of home-cooked food was the dominant eating methods among all participants and the only eating method for participants aged >60 years in China. Canteens were also common places to eat for most people, except those with free time, who preferred eating out. This may be because individuals with free time do not have a fixed job and do not have the opportunity to eat in canteens. Similar numbers of individuals chose consumption of takeout food and eating out as their main eating methods; this could be related to the rapid development of food delivery in China in recent years, which has facilitated takeout food as a convenient choice.

4.2. Limitations

Our study is the first to focus on eating window and eating habits in China, and we studied eating window by quantifying the eating time quantitatively. However, this study has several limitations. This study was subject to sampling bias, similar to all studies conducted with convenience sampling. The questionnaire was released using a questionnaire star and shared via the social applications of each researcher. Participants were able to find and complete the questionnaire on the Internet. Based on the online questionnaire, which limited the involvement of the older and the participants unfamiliar to electric questionnaire, most of the participants were young and living in urban areas. Meanwhile, all data in our study were self-reported, which increased bias. Moreover, the eating window was calculated based on self-reported eating times. Some negative eating window may be correct, such as starting eating at 7am and ending eating at 4am. However, we excluded these data for quality control because it was difficult to distinguish whether eating ended at 4am or 4pm in the questionnaire. In future studies, larger scale, larger scope, more reasonable sampling method and rigorous eating records should be adopted to address these limitations.

5. Conclusions

This study is the first to investigate eating window and the eating habits of adults in mainland China using a cross-sectional survey. Unlike previous studies in other countries, the present study showed that Chinese patients with diabetes, overweight, obesity, and/or other metabolic disorders typically eat for about 13 h. In the future, prospective studies should explore the influence of eating window and eating habits on metabolism. Our research provides a basis for future studies on eating window and eating habits in China, and the

results suggest that TRE may be a viable dietary practice in mainland China.

Financial support

This study was supported by the Capital's Funds for Health Improvement and Research (2020-3-40914), Peking University Third Hospital Youth Incubation Funds (BYSYFY2021041).

Author contribution statement

Rongsong Tang: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.
Jingpin Wang, Wenhui Zhang: Performed the experiments; Contributed reagents, materials, analysis tools or data.
Wei Fu: Performed the experiments.
Lin Zhuo: Analyzed and interpreted the data.
Jin Yang: Contributed reagents, materials, analysis tools or data.
Qun Wang: Conceived and designed the experiments.
Kun Yang: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank all parties who assisted in disseminating the questionnaires online.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.heliyon.2023.e17233.

References

[1] H. Kolb, S. Martin, Environmental/lifestyle factors in the pathogenesis and prevention of type 2 diabetes, BMC Med. 15 (1) (2017) 131.
[2] P. Riobó Serván, Diet recomendations in diabetes and obesity, Nutr. Hosp. 35 (Spec No4) (2018) 109–115.
[3] R. Estruch, E. Ros, J. Salas-Salvadó, M.I. Covas, D. Corella, F. Arós, et al., Primary prevention of cardiovascular disease with a mediterranean diet supplemented with extra-virgin olive oil or nuts, N. Engl. J. Med. 378 (25) (2018) e34.
[4] EH N, European cardiovascular disease Statistics, 2017.
[5] R.A.H. Adan, E.M. van der Beek, J.K. Buitelaar, J.F. Cryan, J. Hebebrand, S. Higgs, et al., Nutritional psychiatry: towards improving mental health by what you eat, Eur. Neuropsychopharmacol : the journal of the European College of Neuropsychopharmacology 29 (12) (2019) 1321–1332.
[6] J.D. Bremner, K. Moazzami, M.T. Wittbrodt, J.A. Nye, B.B. Lima, C.F. Gillespie, et al., Diet, stress and mental health, Nutrients 12 (8) (2020).
[7] C. Yu, Z. Shi, J. Lv, Y. Guo, Z. Bian, H. Du, et al., Dietary patterns and insomnia symptoms in Chinese adults: the China kadoorie biobank, Nutrients 9 (3) (2017).
[8] F. Brouns, Overweight and diabetes prevention: is a low-carbohydrate-high-fat diet recommendable? Eur. J. Nutr. 57 (4) (2018) 1301–1312.
[9] B. Chester, J.R. Babu, M.W. Greene, T. Geetha, The effects of popular diets on type 2 diabetes management, Diabetes/metabolism research and reviews 35 (8) (2019) e3188.
[10] S. Martín-Peláez, M. Fito, O. Castaner, Mediterranean diet effects on type 2 diabetes prevention, disease progression, and related mechanisms, A Review. Nutrients. 12 (8) (2020).
[11] K. Rees, A. Takeda, N. Martin, L. Ellis, D. Wijesekara, A. Vepa, et al., Mediterranean-style diet for the primary and secondary prevention of cardiovascular disease, Cochrane Database Syst. Rev. 3 (3) (2019), Cd009825.
[12] N. Scannell, A. Villani, E. Mantzioris, L. Swanepoel, Understanding the self-perceived barriers and enablers toward adopting a mediterranean diet in Australia: an application of the theory of planned behaviour framework, Int. J. Environ. Res. Publ. Health 17 (24) (2020).
[13] S. Almoosawi, S. Vingeliene, F. Gachon, T. Voortman, L. Palla, J.D. Johnston, et al., Chronotype: implications for epidemiologic studies on chrono-nutrition and cardiometabolic health, Adv. Nutr. 10 (1) (2019) 30–42.
[14] L. Fontana, L. Partridge, Promoting health and longevity through diet: from model organisms to humans, Cell 161 (1) (2015) 106–118.
[15] E.N.C. Manoogian, A. Chaix, S. Panda, When to eat: the importance of eating patterns in health and disease, J. Biol. Rhythm. 34 (6) (2019) 579–581.
[16] A. Maugeri, S. Kunzova, J.R. Medina-Inojosa, A. Agodi, M. Barchitta, M. Homolka, et al., Association between eating time interval and frequency with ideal cardiovascular health: results from a random sample Czech urban population. Nutrition, metabolism, and cardiovascular diseases, Nutr. Metabol. Cardiovasc. Dis. 28 (8) (2018) 847–855.
[17] S. Gill, S. Panda, A smartphone app reveals erratic diurnal eating patterns in humans that can Be modulated for health benefits, Cell Metabol. 22 (5) (2015) 789–798.
[18] E.F. Sutton, R. Beyl, K.S. Early, W.T. Cefalu, E. Ravussin, C.M. Peterson, Early time-restricted feeding improves insulin sensitivity, blood pressure, and oxidative stress even without weight loss in men with prediabetes, Cell Metabol. 27 (6) (2018) 1212–1221.

[19] D. Liu, Y. Huang, C. Huang, S. Yang, X. Wei, P. Zhang, et al., Calorie restriction with or without time-restricted eating in weight loss, N. Engl. J. Med. 386 (16) (2022) 1495–1504.
[20] C. NHCotPsRo, Criteria of Weight for Adults: National Standards of the People's Republic of China, 2013.
[21] R.M. Leech, A. Worsley, A. Timperio, S.A. McNaughton, Characterizing eating patterns: a comparison of eating occasion definitions, The American journal of clinical nutrition 102 (5) (2015) 1229–1237.
[22] E. Huseinovic, A. Winkvist, N. Slimani, M.K. Park, H. Freisling, H. Boeing, et al., Meal patterns across ten European countries - results from the European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study, Publ. Health Nutr. 19 (15) (2016) 2769–2780.
[23] H. Zhou, Study on the Service Design of White-Collar Nutrition Lunch in First-Tier Cities [Master Degree], Jiangnan University, 2017.
[24] A.C. Veronda, K.C. Allison, R.D. Crosby, L.A. Irish, Development, validation and reliability of the chrononutrition profile - questionnaire, Chronobiol. Int. 37 (3) (2020) 375–394.
[25] K. Gabel, K.K. Hoddy, N. Haggerty, J. Song, C.M. Kroeger, J.F. Trepanowski, et al., Effects of 8-hour time restricted feeding on body weight and metabolic disease risk factors in obese adults: a pilot study, Nutr. Healthy Aging 4 (4) (2018) 345–353.
[26] T.G. Arnason, M.W. Bowen, K.D. Mansell, Effects of intermittent fasting on health markers in those with type 2 diabetes: a pilot study, World J. Diabetes 8 (4) (2017) 154–164.
[27] K. Gabel, K.K. Hoddy, K.A. Varady, Safety of 8-h time restricted feeding in adults with obesity. Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme 44 (1) (2019) 107–109.
[28] N.J. Gupta, V. Kumar, S. Panda, A camera-phone based study reveals erratic eating pattern and disrupted daily eating-fasting cycle among adults in India, PLoS One 12 (3) (2017), e0172852.
[29] D. Jin, M. Lin, G. Li, Survey on dining behavior of residents over 15 years old in Hunan Province, Chinese Journal of Prevention and Control of Chronic Diseases (1) (2007) 68–69.
[30] S. Hood, S. Amir, The aging clock: circadian rhythms and later life, The Journal of clinical investigation 127 (2) (2017) 437–446.
[31] J.F. Duffy, K.M. Zitting, E.D. Chinoy, Aging and circadian rhythms, Sleep medicine clinics 10 (4) (2015) 423–434.
[32] P. Núñez, C. Perillan, J. Arguelles, E. Diaz, Comparison of sleep and chronotype between senior and undergraduate university students, Chronobiol. Int. 36 (12) (2019) 1626–1637.
[33] A.C. Veronda, L.A. Irish, An examination of eating misalignment: the discrepancy between preferred and actual timing of food intake, Chronobiol. Int. 38 (4) (2021) 557–564.
[34] R. Liu, T. Yang, J. Deng, Development of objective Work Environment Scale under "Hidden 996" in China – a method based on formative indicators, Modernization of Management 42 (2) (2022) 17–23.