

The Impact of “Three Zones” Closed-off Management in Communities on Individuals’ Mental Health and Lifestyle During the COVID-19 Pandemic

Yang Yang¹ & Xubo Wei²

¹ Institute of International Cities, Shenzhen Academy of Social Sciences, Shenzhen, China

² Shenzhen Nanshan Party School, Shenzhen, China

Correspondence: Xubo Wei, Shenzhen Nanshan Party School, Shenzhen, China.

Received: September 10, 2022

Accepted: November 11, 2022

Online Published: November 27, 2022

doi:10.5539/ass.v18n11p38

URL: <https://doi.org/10.5539/ass.v18n11p38>

Abstract

The "three zones" closed-off management in communities is an innovative anti-pandemic measure in China that divides communities into lockdown zones, controlled zones, and precautionary zones to contain the spread of the pandemic and reduce the infection rate. This paper aimed to explore the impact of "three zones" closed-off management in communities on individuals' mental health and lifestyle. Two hundred participants were recruited from Shenzhen city, where a seven-day "three zones" closed-off management was implemented, to complete the online survey made available through a link shared via the Wechat group. The study found that during the lockdown period, individuals' positive mental health, unhealthy eating behaviors, physical activity, and sleep quality decreased by 8.5%, 5.4%, 22.0%, and 10.2%, respectively, while sedentary time increased by 21.7% markedly. In addition, residents living in controlled zones had poorer mental health but more physical activities than those residing in precautionary zones; residents living in lockdown zones had worse sleep quality and more sedentary time than those living in precautionary zones. These findings are essential to enrich and improve research beyond public health measures during the pandemic.

Keywords: COVID-19 pandemic, three zones, mental health, unhealthy eating behaviors, sleep quality

1. Introduction

Since 2022, there has been a surge in new confirmed cases of COVID-19 in various regions of China. To effectively contain the spread of the epidemic, the Chinese government has adopted the "dynamic COVID-zero" policy and "three zones" closed-off management in communities (Liang et al., 2022). The "three zones"—lockdown, controlled, and precautionary—are divided according to the local transmission risk and control intensity (see Figure 1). The lockdown zones refer to areas where new infections were reported within the past week, and inhabitants are required to remain at home for a week under closed-off management. Meanwhile, community workers will provide door-to-door services, such as nucleic acid testing and the distribution of everyday necessities. The controlled zones refer to communities where no infections were reported during the preceding week. This region's pandemic prevention and control strategy for the first four days is identical to the lockdown area's. On the fifth day, residents will be permitted to receive food deliveries and take walks at specific locations and at staggered times within the enclosure. The perimeter of the lockdown and controlled zones are precautionary zones. Residents are permitted to leave their area, but they must remain within their subdistrict, and they are encouraged to limit their movement (Shenzhen Health Commission, 2022). Compared to previous home quarantines, the "three zones" closed-off management in communities represents an improvement in pandemic prevention policies. The degree of prevention and control reduces in the lockdown zones, control zones, and preventive zones while the freedom and activity scope expands.

Numerous studies have examined home quarantine's negative impact on an individual's mental health and lifestyle (Ammar et al., 2021; Brühlhart et al., 2021; Proto & Zhang, 2021; Robinson et al., 2022). In terms of mental health, quarantine means less social and physical interaction with others, leading to boredom, depression, and isolation, thus making people distressed and unhappy (Wang et al., 2021). For individuals with mental or physical issues, infection or suspected infection, relatively poor financial status, and residing in regions hard hit by the disease, quarantine can exacerbate the risk of mental illnesses. In addition, the uncertainty of quarantine

durations, the fear of being infected, the possible shortage of supplies, the lack of punctual updates from public health authorities, the economic losses, and the post-pandemic stigma put people under additional strain (Brooks et al., 2021). According to a survey of 56,679 people in China, 34.1 percent of those who experienced quarantine reported at least one psychological symptom, such as anxiety, sadness, insomnia, or acute stress, significantly greater than those who were not quarantined (Wang et al., 2021). Another online survey of 18,000 people in Italy shows that 37% of participants suffer from posttraumatic stress because of the lockdown, and approximately 20% suffer from depression, anxiety, or high-sensitivity stress (Rossi et al., 2020). Besides, a survey of Norwegian adolescents reveals higher depressive symptoms and less optimistic future life expectations during the pandemic (von Soest, et al., 2022). A globally representative sample from countries in Europe, North Africa, West Asia, and the Americas shows that quarantine harms public mental health and emotions, with a more significant proportion of individuals suffering from psychosocial and emotional disorders (Ammar et al., 2021). The psychological effect of home confinement during the COVID-19 pandemic is pervasive and substantial and may be long-term.

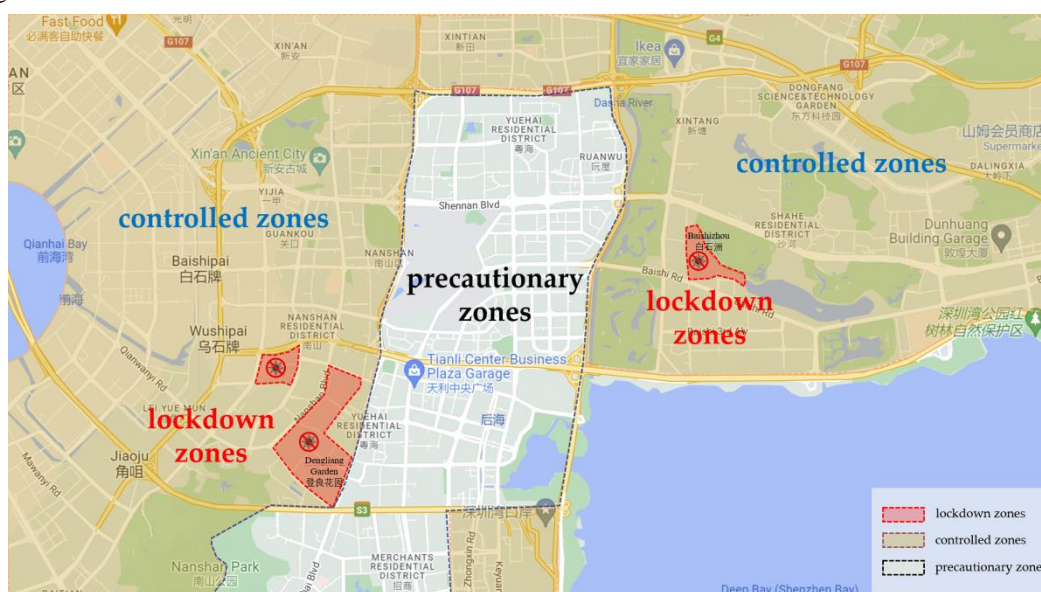


Figure 1. Diagram of "three zones" closed-off management in communities

Individuals' eating behavior is also being impacted by home quarantine (Souza et al., 2022). One point of view is that people eat healthier to strengthen their immune systems and protect themselves against COVID-19. For example, Molina-Montes et al. (2021) examined the COVID-19 confinement impact on adults' eating behaviors in 16 European countries. They found that people's compliance with the Mediterranean diet (MedDiet) attained rapid growth in all countries during the confinement, with the most significant increase in Greece and Macedonia, meaning that people were more willing to form healthy eating habits. A study in Spain also found that during the home confinement period, 57.2% of people increased their fresh food intake (López-Moreno et al., 2020). Another point of view is that people who are worried about COVID-19 may consume more alcohol and eat more unhealthy meals (such as snacks and cakes) to make themselves feel better. Ammar et al. (2020) found in an international survey that people's food consumption and dietary patterns became un-healthier during the lockdown. Yang et al. (2021) also found that 38.2% of the population had more snacks in China's early stages of COVID-19 confinement. In addition, Janssen et al.'s (2021) research on the frequency of food consumption before and during the pandemic among 2,680 residents in Denmark, Germany, and Slovenia showed that the total consumption of fresh food decreased, while the consumption of food with a longer shelf life increased.

Additionally, people's daily routine of physical exercise and sleep has also been disturbed during the quarantine (Massar et al., 2022; Salehinejad et al., 2021). People have much less time for physical activities due to stringent restrictions on going outside (Bu et al., 2021). Based on wearable app data, Di et al. (2020) discovered that Canadians experienced significant declines in high-intensity exercise, low-intensity exercise, and walking steps during the lockdown. It took six weeks for high-intensity practice to return to pre-pandemic levels, while low-intensity exercise and step counts remained significantly lower than pre-pandemic levels. The international online survey by Ammar et al. (2020) showed a sharp decline in physical activity at any level of intensity during home quarantine. In addition, data from Spain and China indicate that 45.9% and 54.3% of individuals engage in less physical activity during lock-downs (López-Moreno et al., 2020; Yang et al., 2021). Although studies have

shown that people slept more and spent more time in bed during periods of lockdown (Trabelsi et al., 2021; Yang et al., 2021), the incidence of sleep disorders was higher than usual. According to statistics, during the COVID-19 pandemic, the global prevalence of sleep disorders was 40.49% (Jahrami et al., 2022). People's sleep quality also worsened during home confinement, with a study in Spain finding that approximately 40.7% of people experienced negative changes in sleep quality (López-Moreno et al., 2020).

In summary, previous research mainly focused on the effects of home quarantine on mental health and lifestyle in the early phases of the COVID-19 pandemic. However, with the continued expansion of the pandemic and people's comprehension of the novel coronavirus, it needs a better understanding of how "three zones" closed-off management in communities, a new strategy for pandemic prevention and control, impact individuals' mental health and lifestyle. Shenzhen, which is geographically close to Hong Kong and has the third highest GDP in China, announced "three zones" closed-off management in communities for the entire city from March 14 to March 20, 2022. So this allows us to answer that question. We first evaluated individuals' mental health and lifestyle changes before and during the community lockdown. And then, we analyzed the impact of lock-down zones, controlled zones, and precautionary zones on individuals' mental health and lifestyle. This study's findings contribute to the literature on home quarantine and give valuable supplements and references for enhancing public health measures during the pandemic.

2. Materials and Methods

2.1 Participants

From March 18 to March 20, 2022, this study distributed 417 online questionnaires to Shenzhen residents in different areas through WeChat groups. After excluding incomplete questionnaires, 200 valid questionnaires were received for an effective response rate of 47.96%.

2.2 Measurement

2.2.1 Warwick-Edinburgh Mental Wellbeing Scale, WEMWBS

The Warwick-Edinburgh mental well-being scale is an effective mental health measuring instrument (Tennant et al., 2007). This study followed Trabelsi et al.'s (2021) methodology and identified 7-items that may have greater clinical significance. Each item uses a Likert 5-point scale, and the overall score ranges between 7 and 35 points. The higher the participants' scores, the more positive their mental health is. A score of 17 or less suggests an increased risk of depression, 18-20 indicates the possibility of depression, 21-27 shows positive mental health, and 28-35 means very positive mental health.

2.2.2 Unhealthy Eating Behavior Survey

The questionnaire for the study on unhealthy eating behavior was developed by Ammar et al. (2020). The questionnaire consists of five questions or prompts on "eating unhealthy food," "binge eating," "snacking between meals," "binge alcohol drinking," and "numbers of main meals per day." The first four questions are on a four-point scale (Never = 0; Sometimes = 1; Often = 2; Always = 3); the options and points for "number of meals" are as follows: "1-2" = 1; "3" = 0; "4" = 1; "5" = 2; ">5" = 3. The more meals people have daily, the higher the chances they will develop obesity and diabetes, so additional meals and snacks between the main meals are seen as unhealthy eating behaviors (Harder-Lauridsen et al., 2017). Adding the scores for each item yields a total score ranging from 0 to 15, showing the participants' unhealthy eating habits. The more a person scores, the less healthy their eating habits are.

2.2.3 International Physical Activity Questionnaire Short Form, IPAQ-SF

The International Physical Activity Questionnaire is a cost-effective method for assessing physical activity. The questionnaire mainly contains the time and frequency of individuals' vigorous physical activities, moderate physical activities, and walking per week. Vigorous physical activities include exercise during which people find breathing harder than usual, such as weightlifting, digging, aerobics, and fast cycling. Moderate physical activities are when people find breathing slightly more complicated than usual, such as light-load exercise, cycling at a uniform speed, or tennis doubles, excluding walking (Craig et al., 2003). According to the official IPAQ-SF guidance, exercises of different intensities are assigned various metabolic equivalents (METs): vigorous physical activities = 8.0 METs, moderate physical activities = 4.0 METs, and walking = 3.3 METs. Therefore, the total number of weekly physical activities can be calculated by adding the METs for each exercise. In addition, sedentary time was measured in this study.

2.2.4 Pittsburgh Sleep Quality Index, PSQI

The Pittsburgh sleep quality index is an assessment of sleep quality that has been extensively validated in

different cultures and populations (Buysse et al., 1989). This study uses 14 questions covering sleep quality, bedtime, quantity, sleep efficiency, sleep disorders, hypnotic drugs, and daytime dysfunction, which are the seven components of sleep quality. Each part contains 0-3 points. The total score from the sum of scores for each piece ranges from 0-21. The lower the scores that people obtain the better their sleep quality.

2.3 Statistical Analysis

In this study, a Shapiro-Wilks normality test based on SPSS 26.0 revealed that the data did not conform a normal distribution. So we used the Wilcoxon signed rank test to analyze individuals' mental health and lifestyle changes before and during the community lockdown. The effect size of the parametric test was calculated using $ES = Z/\sqrt{N}$. ES can be interpreted as follows: small (0.10-0.30), medium (0.30-0.50), large (>0.5), and its statistical significance is set at $P < 0.05$ (Rosenthal, et al., 1994). Finally, we use regression analysis to examine the impact of lockdown zones, controlled zones, and precautionary zones on people's mental health and lifestyle changes.

3. Results

3.1 Demographics

Of the total 200 participants, the average was 34.8 years old. Women accounted for 61.5%. A total of 61.0% of the participants were in precautionary zones. Nearly 70% were from the districts of Nanshan and Futian. A total of 67.5% were married or living with partners. Approximately 66.5% had a bachelor's degree or more. 56.0% of the population had an average monthly income greater than 8,000. 65.0% had received three vaccination doses, and 92.0% were in a healthy state (Table 1). In addition, the number of family members significantly dropped from 3.09 before the community lockdown to 2.97 ($Z = 2.863$, $p = 0.004$, $ES = 0.202$).

Table 1. Demographic characteristics of the participants (n = 200)

Variables	n (%)	Variables	n (%)
Gender		District	
Male	77(38.5%)	Futian	63(31.5%)
Female	123(61.5%)	Nanshan	75(37.5%)
Type of zones		Baoan	7(3.5%)
Lockdown	35(17.5%)	Longgang	17(8.5%)
Controlled	43(21.5%)	Longhua	13(6.5%)
Precautionary	122(61.0%)	Luohu	11(5.5%)
Marital Status		Guangming	11(5.5%)
Single	59(29.5%)	Pingshan	1(0.5%)
Married/Living as couple	135(67.5%)	Yantian	2(1.0%)
Divorced/Separated	6(3.0%)	Vaccination Status	
Education		Unvaccinated	9(4.5%)
High School and below	24(12.0%)	First shot	5(2.5%)
Junior College	43(21.5%)	Second shot	56(28.0%)
Undergraduate	90(45.0%)	Third shot	130(65.0%)
Master or above	43(21.5%)	Health Status	
Monthly Income (¥)		Healthy	184(92.0%)
<3000	17(8.5%)	With risk factors for cardiovascular disease	13(6.5%)
3000-5000	27(13.5%)	With cardiovascular disease	1(0.5%)
5000-8000	44(22.0%)	With Cognitive impairment	2(1.0%)
8000-15000	42(21.0%)		
>15000	70(35.0%)		

3.2 Comparison of Positive Mental Health and Lifestyle Before and During Lockdown

The positive mental health and lifestyle before and during the lockdown are compared in Table 2. First, there is a critical decline in all measurements of positive mental health compared to the days before the lockdown, and the effect sizes were all medium. Positive responses to the prompts, “I’ve been feeling optimistic about the future” and “I’ve been feeling relaxed”, declined by 10.2% ($Z = 6.733, p < 0.001, ES = 0.476$) and 10.8% ($Z = 5.989, p < 0.001, ES = 0.423$), respectively. The total score of positive mental health decreased by 8.5% ($Z = 7.762, p < 0.001, ES = 0.549$), with a relatively large effect size. Overall, during the community lockdown, there was a reduction in positive mental health, and residents expressed worries about the future.

Table 2. Comparison of positive mental health and lifestyle before and during lockdown

Variables	Items	Before Lockdown	During Lockdown	$\Delta(\Delta\%)$	Z	p value	Effect Size
Positive Mental Health	I’ve been feeling optimistic about the future.	3.81±0.83	3.42±1.03	-0.39(-10.2%)	6.733	<.001	0.476
	I’ve been feeling useful.	3.89±0.85	3.57±0.99	-0.32(-8.2%)	5.728	<.001	0.405
	I’ve been feeling relaxed.	3.42±0.92	3.05±1.01	-0.37(-10.8%)	5.989	<.001	0.423
	I’ve been dealing with Problems well.	3.69±0.79	3.32±0.89	-0.37(-10.0%)	6.339	<.001	0.448
	I’ve been thinking clearly.	3.89±0.69	3.66±0.86	-0.23(-5.9%)	5.482	<.001	0.388
	I’ve been feeling close to other people.	3.60±0.86	3.28±0.99	-0.32(-8.9%)	5.618	<.001	0.397
	I’ve been able to make up my own mind about things.	3.97±0.68	3.74±0.85	-0.23(-5.8%)	5.001	<.001	0.354
	Total score	26.26±4.23	24.02±5.20	-2.24(-8.5%)	7.762	<.001	0.549
Unhealthy Eating Behaviours	How likely are you to have an unhealthy diet/food?	1.14±0.61	0.99±0.67	-0.15(-13.2%)	3.378	0.001	0.239
	How often have you found yourself being eating out of control (binge-eating)?	0.68±0.62	0.59±0.65	-0.09(-13.2%)	2.126	0.034	0.150
	How likely are you to have a snack between meals or a late night snack?	1.12±0.60	1.08±0.69	-0.04(-3.6%)	1.041	0.298	0.074
	Do you engage in binge alcohol drinking (5 or more drinks in a sitting)?	0.18±0.44	0.09±0.37	-0.08(-44.4%)	2.717	0.007	0.192
	How many main meals do you eat a day?	0.20±0.47	0.36±0.52	0.16(80.0%)	4.251	<.001	0.301
	Total score	3.32±1.72	3.14±1.67	-0.18(-5.4%)	1.993	0.046	0.141
Physical Activity and Sedentariness	Vigorous physical activities	days/week 2.15±1.95	1.40±1.95	-0.75(-34.9%)	5.605	<.001	0.396
		minutes/day 20.79±30.12	15.77±24.85	-5.02(-24.1%)	3.221	0.001	0.228
		MET 631±1125	455±998	-176 (-27.8%)	3.122	0.002	0.221
	Moderate physical activities	days/week 1.55±1.74	0.92±1.64	-0.63(-40.6%)	5.726	<.001	0.405
		minutes/day 13.70±25.12	11.04±23.51	-2.66(-19.4%)	2.260	0.024	0.160
		MET 181±405	148±447	-33(-18.0%)	2.236	0.025	0.158
	Walking	days/week 3.82±2.38	2.09±2.45	-1.73(-45.3%)	7.670	<.001	0.542
		minutes/day 22.95±33.43	17.99±37.90	-4.96(-21.6%)	3.542	<.001	0.250
		MET 348±598	262±628	-86 (-24.8%)	3.762	<.001	0.266
	Total exercise time	minutes/day 57.44±70.21	44.79±67.18	-12.65(-22.0%)	4.170	<.001	0.295
	MET 1160±1732	866.±1659	-295 (-25.4%)	3.951	<.001	0.279	
Sedentary time	hours/day 5.39±4.10	6.56±5.97	1.17(21.7%)	5.309	<.001	0.375	

Pittsburgh Sleep Quality Index	Sleep quality	1.15±0.79	1.29±0.82	0.14(12.2%)	4.115	<.001	0.291
	Bedtime(minutes)	17.64±16.71	26.75±33.29	9.11(51.6%)	6.697	<.001	0.474
	Sleep duration(hours)	7.16±0.91	7.44±1.34	0.28(3.9%)	3.717	<.001	0.263
	Time laying on bed(hours)	7.98±0.92	8.46±1.43	0.48(6.0%)	5.505	<.001	0.389
	Sleep efficiency	0.33±0.63	0.43±0.72	0.10(30.3%)	2.466	0.014	0.174
	Sleep disorder	1.31±0.77	1.42±0.82	0.11(8.4%)	3.068	0.002	0.217
	Hypnotic drug	0.16±0.50	0.19±0.59	0.03(18.8%)	1.393	0.163	0.098
	Daytime dysfunction	0.70±0.66	0.80±0.78	0.10(14.3%)	2.647	0.008	0.187
	Pittsburgh Sleep Quality Index (PSQI)	5.61±2.82	6.18±3.25	0.57(10.2%)	3.213	0.001	0.227

In terms of unhealthy eating behaviors, the scores for "unhealthy diet/food" and "eating out of control" had decreased by 13.2% when compared to the days prior to lock-down ($Z = 3.378, p = 0.001, ES = 0.301; Z = 2.126, p = 0.034, ES = 0.150$). While there were no significant differences in the frequency of "snacks between meals or a late-night snack," the score for "binge alcohol consumption" dropped by 44.4% ($Z = 2.717, p = 0.007, ES = 0.192$). The overall score for unhealthy eating habits during lockdown decreased by 5.4% ($Z = 1.993, p = 0.046, ES = 0.141$), and a growing trend in the proportion of major meals can be noticed ($Z = 4.251, p = 0.001, ES = 0.301$). In conclusion, the lockdown resulted in a decline in unhealthy eating habits.

In terms of physical activity and sedentary time, the number of days and minutes spent engaging in vigorous physical activity decreased by 34.9% ($Z = 5.605, p = 0.001, ES = 0.396$) and 24.1% ($Z = 3.221, p = 0.001$), respectively, in comparison to the days before to lockdown, and MET decreased by 27.8%. Along with a fall of 18.0% in MET, the number of days and minutes spent participating in moderate physical activity fell by 40.6% ($Z = 5.605, p = 0.001, ES = 0.396$) and 19.4% ($Z = 5.605, p = 0.001, ES = 0.396$), respectively. With a decrease of 24.8% in MET, the number of days and minutes of walking decreased by 45.3% ($Z = 5.605, p = 0.001, ES = 0.396$) and 21.6% ($Z = 5.605, p = 0.001, ES = 0.396$), respectively. Overall, all types of physical activity exhibit a sharp decrease in minutes and MET during the lockdown. But compared to the days before the lockdown, their sedentary time increased from 5.39 hours per day to 6.56 hours per day, a rise of 21.7% ($Z = 5.309, p = 0.001, ES = 0.375$).

Regarding sleep quality, except for hypnotic drugs, other components of the sleep quality index experienced rapid changes during the lockdown of the community. On the one hand, bedtimes were earlier (6%, $Z = 5.505, p = 0.001, ES = 0.389$) while bedtimes were longer (51.6%). On the other hand, the Pittsburgh Sleep Quality Index scores, which measure the quality of sleep, increased by 12.2%, 30.3%, 8.4%, 14.3%, and 10.2%, respectively. Overall, despite spending more time in bed and going to bed earlier, people's overall sleep quality declined.

3.3 The Impact of "Three Zones" on Individuals' Mental Health and Lifestyle

In implementing the "three zones" closed-off management in Shenzhen, the prevention and control intensity in the precautionary zones is the weakest and closest to normal living, providing an opportunity for this study to conduct a quasi-natural experiment. Therefore, we designated the samples from the precautionary zones as the control group and the samples from the lockdown and controlled zones as the experimental group. We applied the principle of differences-in-differences. The following regression model was established to examine the impact of lockdown zones, controlled zones, and precautionary zones on people's mental health and lifestyle changes.

$$\Delta y_i = \alpha + \beta_1 \text{Lockdown zones} + \beta_2 \text{Controlled zones} + X_i + \text{Dummy}_{\text{district}} + \varepsilon_i \tag{1}$$

In this model, i means residents. The independent variable Δy_i represents the changes in scores for mental health, lifestyle, and other variables, which are the measurements before lockdown minus the corresponding number after lockdown, including changes in positive mental health, unhealthy eating behaviors, physical activity, sleep quality, and sedentary time. Since the change in scores for physical activity is starkly different from other variables, we used the formula $\ln(x + \sqrt{1 + x^2})$ for logarithmic processing. *Lockdown zones* and *controlled zones* are the main focused independent variables of this study, which are dummy variables representing the lockdown and controlled zones; if the community where the resident is located is a lockdown zones, *lockdown zones* is equal to 1; otherwise, it is 0; if the community where the resident is located is the controlled zones, *controlled zones* is equal to 1; otherwise, it is 0. In addition, we controlled for residents' characteristic variables X_i , including vaccination, age, sex, education, marital status, work, income, and health condition. Since various districts of Shenzhen may have different policies or ways to implement policies, and the economic development,

industrial structure, and overall residential characteristics vary from district to district, we also controlled the urban fixed effect $Dummy_{district}$ to eliminate the impact of these factors.

Table 3 presents descriptive statistics on changes in individuals' mental health and lifestyle in the "three zones." The controlled zone ranked first in terms of changes in positive mental health, followed by the lockdown zones and precautionary zones; the lock-down zones ranked first in terms of changes in unhealthy eating behavior, sedentary time, and sleep quality index; and the precautionary zones ranked first in terms of changes in physical activity.

Table 3. Descriptive Statistics of Changes in Mental Health and Lifestyle in the “Three Zones”

	Lockdown zone (n=35)				Controlled zone (n=43)				Precautionary zone (n=122)			
	Mean	SE	95% CI		Mean	SE	95% CI		Mean	SE	95% CI	
			lower bound	upper bound			lower bound	upper bound			lower bound	upper bound
Δ Positive Mental Health	2.657	0.647	1.343	3.972	3.860	0.659	2.532	5.189	1.541	0.338	0.871	2.211
Δ Unhealthy Eating Behavior	0.000	0.355	-0.722	0.722	0.605	0.206	0.190	1.019	0.074	0.114	-0.152	0.300
Δ Physical Activity	1.508	0.850	-0.218	3.235	0.011	0.843	-1.690	1.712	2.150	0.436	1.287	3.013
Δ Sedentary time	-2.315	0.422	-3.173	-1.458	-0.279	0.647	-1.584	1.026	-0.604	0.221	-1.041	-0.167
Δ Sleep Quality Index	-1.429	0.463	-2.369	-0.489	-0.233	0.339	-0.917	0.452	-0.443	0.164	-0.767	-0.118

The regression results are shown in Table 4. The results in the first column demonstrate the impact of various zones on residents' positive mental health changes. Compared with the precautionary zone, the controlled zones had a significantly positive impact on individuals' positive mental health changes. In other words, compared with people in precautionary zones, residents in controlled zones suffered a relatively significant decline in positive mental health. In contrast, the lockdown zones showed no sign of affecting mental health. The results in the second column show no difference among individuals in the three zones regarding changes in unhealthy eating behavior. The results in the third column show that, compared with precautionary zones, residents in controlled zones were more active in physical activity. At the same time, there was no change among residents of lockdown zones. We also examined the impact of the lockdown and controlled zones on individuals' sedentary time. In the fourth column, compared with individuals in the precautionary zones, residents in lockdown zones spent more time sitting, while the controlled zones showed no effect. Finally, the last column shows the impact of changes in the sleep quality index. Compared with precautionary zones, lockdown zones have a significantly negative impact on individuals' sleep quality. Compared with people in precautionary zones, residents in lockdown zones have better sleep quality, while the controlled zones show no effect.

Table 4. The impact of “three zones” on individuals' mental health and lifestyle

	(1)	(2)	(3)	(4)	(5)
	Δ Positive Mental Health	Δ Unhealthy Eating Behavior	Δ Physical Activity	Δ Sedentary Time	Δ Sleep Quality
Lockdown zone	0.945 (0.793)	-0.377 (0.302)	-0.459 (1.144)	-1.694*** (0.611)	-1.112** (0.501)
Controlled zone	1.836** (0.915)	0.393 (0.306)	-2.077* (1.244)	0.025 (0.664)	0.174 (0.471)
Observations	200	200	200	200	200
Adjusted R ²	0.096	0.090	-0.036	0.043	0.060
Individual controlled variables	YES	YES	YES	YES	YES
District fixed effect	YES	YES	YES	YES	YES

Note. 1) Robust standard deviations are in brackets. 2) *, ** and *** represent significance levels of 10%, 5% and 1%, respectively. 3) Individual controlled variables include vaccination, age, sex, education, marital status, work, income, and health condition. 4) Logarithmic processing of changes in physical activity was conducted using the formula $\ln(x + \sqrt{1 + x^2})$.

4. Discussion

This study aimed to explore the impact of "three zones" closed-off management in communities on individuals' mental health and lifestyle during the COVID-19 pandemic. The study's results showed significant changes in positive mental health and eating behaviors, physical activity, and sleep.

First, the total score for positive mental health during lockdown dropped by 8.5% compared to before the lockdown, especially regarding two items: "I've been feeling optimistic about the future" and "I've been feeling relaxed." The resurgence of the pandemic revived many uncertainties in the future, making it difficult for people to be relaxed and optimistic. This conclusion is consistent with previous research (Ammar et al., 2021). Although there was a decrease in positive mental health during the lockdown, the average score for this measurement was still higher than 15.8 (Trabelsi et al., 2021), which indicates that the community lockdown had little impact on people's psychological health and that the general public maintained positive mental health. Especially as cities resumed normal operations and students returned to campus, people's overall mental health also recovered. Further analysis showed that controlled zones significantly impacted people's positive mental health changes compared to the precautionary zones. In other words, compared with people in precautionary zones, residents in controlled zones suffered a relatively significant decrease in positive mental health. This is mainly the result of the "three zones" strategy. Although residents in lockdown zones had to accept not leaving their homes, people in controlled zones faced the risk of lockdown at any time despite being under relatively looser restrictions, which led to a more significant fluctuation psychologically and a worse mental condition. Given this, the local authorities should not lose sight of people's psychological states and release information on time to help free them from worry.

Second, the scores for unhealthy eating behavior during the lockdown dropped by 5.4% compared with those before the lockdown. People tended to consume significantly less unhealthy food and avoid binge eating and drinking, which confirms that the pandemic pushed people to eat healthier to strengthen their immunity and prevent COVID-19 infections (Molina-Montes et al., 2021). It is important to note that the score for "How many main meals do you eat a day?" significantly increased, reflecting that people's eating habits become erratic during the lockdown. This could be because people's time is no longer constricted and limited during home isolation, making it difficult to eat at a regular hour. Further analysis found that there was no significant difference in the unhealthy eating behavior of people in the three zones, probably because Shenzhen's policies provided supplies, such as the delivery of medicines, express, and groceries (including fresh vegetables). Regardless of which zones people lived in, their healthy eating behaviors were not significantly affected.

Third, consistent with previous studies (Ammar et al., 2021), the scores for physical activity, whether vigorous physical activities, moderate physical activities or just walking, decreased significantly during the lockdown, among which the decline in walking was the most prominent, reaching approximately 45.3% of the population. Sedentary time rose from 5.39 hours/day before the lockdown to 6.56 hours/per day during the lockdown, an increase of approximately 21.7%. It is explained that people have limited outdoor space during a community-wide lockdown and can only stay at home most of the time. According to the World Health Organization (WHO, 2010), adults aged 18-64 should engage in at least 150 minutes of moderate physical activity or at least 75 minutes of vigorous physical activity per week. The duration and intensity of residents' physical exercise during the lockdown were well below the World Health Organization recommendations. Further analysis found that compared with the precautionary zones, residents in the controlled zones were more engaged in physical activities, which may be how to deal with psychological fluctuations, while residents in the lockdown zones had more sedentary time than those in the precautionary zones. For people in controlled zones, increased physical activity meant no considerable change in sedentary time. Physical activity boosts immunity, reduces inflammation, and is effective in preventing and treating secondary diseases such as heart disease and diabetes. Therefore, the government should encourage residents to continue to engage in physical exercise and reduce their sedentary time under pandemic restrictions.

Finally, the scores for sleep quality increased by 10.2% compared with before the system was implemented, indicating that people's overall sleep quality worsened. Although time in bed and sleep duration rose dramatically, the bedtime, or the sleep latency time, also skyrocketed by approximately 51.6%. There is an excellent possibility that people suffer from poor diet and mood, stress at work, financial insecurity working from home, and experiencing difficulties falling asleep. Further analysis found that residents' sleep quality in the lockdown zone was much worse than that of residents in the precautionary zones. This is mainly because residents in lockdown zones were at home all day and had no space to exercise; besides, they had more sedentary time and might be addicted to Tiktok or mobile games. All these lead to worse sleep quality.

5. Conclusions

"Three zones" closed-off management in communities has played an important role in containing the spread of the pandemic and reducing the infection rate. However, it has also profoundly impacted an individual's mental health and lifestyle. The limitation of this study is the relatively limited sample size, which can be further expanded in the future to support the findings of this study. In addition, quarantine led to the suspension of a large number of business activities, which caused financial losses for many people. Future studies should include the variable of economic status in the overall regression analysis to examine its effect on public mental health and lifestyle.

Acknowledgments

This research was funded by the Special Foundation of Shenzhen Academy of Social Sciences (No.2022AC008).

References

- Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., ... ECLB-COVID19 Consortium. (2020). Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 International online survey. *Nutrients*, *12*, 1583. <https://doi.org/10.3390/nu12061583>
- Ammar, A., Trabelsi, K., Brach, M., Chtourou, H., Boukhris, O., Masmoudi, L., ... Hoekelmann, A. (2021). Effects of home confinement on mental health and lifestyle behaviours during the COVID-19 outbreak: Insight from the ECLB-COVID19 multicenter study. *Biology of Sport*, *38*, 9-21. <https://doi.org/10.5114/biolsport.2020.96857>
- Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *Lancet*, *395*, 912-920. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8)
- Brühlhart, M., Klotzbücher, V., Lalive, R., & Reich, S. K. (2021). Mental health concerns during the COVID-19 pandemic as revealed by helpline calls. *Nature*, *600*, 121-126. <https://doi.org/10.1038/s41586-021-04099-6>
- Bu, F., Bone, J. K., Mitchell, J. J., Steptoe, A., & Fancourt, D. (2021). Longitudinal changes in physical activity during and after the first national lockdown due to the COVID-19 pandemic in England. *Scientific Reports*, *11*, 1-10. <https://doi.org/10.1038/s41598-021-97065-1>
- Buysse, D. J., Reynolds III, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*, 193-213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4)
- Cecchetto, C., Aiello, M., Gentili, C., Ionta, S., & Osimo, S. A. (2021). Increased emotional eating during COVID-19 associated with lockdown, psychological and social distress. *Appetite*, *160*, 105122. <https://doi.org/10.1016/j.appet.2021.105122>
- Craig, C. L., Marshall, A. L., Sjörström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., ... Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*, 1381-1395. <https://doi.org/10.1093/ajph/93.10.1381>
- Di Renzo, L., Gualtieri, P., Cinelli, G., Bigioni, G., Soldati, L., Attinà, A., ... De Lorenzo, A. (2020). Psychological aspects and eating habits during COVID-19 home confinement: Results of EHLC-COVID-19 Italian online survey. *Nutrients*, *12*, 2152. <https://doi.org/10.3390/nu12072152>
- Di Sebastiano, K. M., Chulak-Bozzer, T., Vanderloo, L. M., & Faulkner, G. (2020). Don't walk so close to me: Physical distancing and adult physical activity in Canada. *Frontiers in Psychology*, *11*, 1895. <https://doi.org/10.3389/fpsyg.2020.01895>
- Giuntella, O., Hyde, K., Saccardo, S., & Sadoff, S. (2021). Lifestyle and mental health disruptions during COVID-19. *Proceedings of the National Academy of Sciences*, *118*, e2016632118. <https://doi.org/10.1073/pnas.2016632118>
- Hampshire, A., Hellyer, P. J., Soreq, E., Mehta, M. A., Ioannidis, K., Trender, W., ... Chamberlain, S. R. (2021). Associations between dimensions of behaviour, personality traits, and mental-health during the COVID-19 pandemic in the United Kingdom. *Nature Communications*, *12*, 1-15. <https://doi.org/10.1038/s41467-021-24365-5>
- Harder-Lauridsen, N. M., Rosenberg, A., Benatti, F. B., Damm, J. A., Thomsen, C., Mortensen, E. L., ... Krogh-Madsen, R. (2017). Ramadan model of intermittent fasting for 28 d had no major effect on body composition, glucose metabolism, or cognitive functions in healthy lean men. *Nutrition*, *37*, 92-103. <https://doi.org/10.1016/j.nut.2016.08.011>

<https://doi.org/10.1016/j.nut.2016.12.015>

- Jahrami, H. A., Alhaj, O. A., Humood, A. M., Alenezi, A. F., Fekih-Romdhane, F., AlRasheed, M. M., ... Vitiello, M. V. (2022). Sleep disturbances during the COVID-19 pandemic: A systematic review, meta-analysis, and meta-regression. *Sleep Medicine Reviews*, 101591. <https://doi.org/10.1016/j.smrv.2022.101591>
- Janssen, M., Chang, B. P., Hristov, H., Pravst, I., Profeta, A., & Millard, J. (2021). Changes in food consumption during the COVID-19 pandemic: Analysis of consumer survey data from the first lockdown period in Denmark, Germany, and Slovenia. *Frontiers in Nutrition*, 8, 60. <https://doi.org/10.3389/fnut.2021.635859>
- Liang, W. N., Liu, M., Liu, J., Wang, Y. D., Wu, J., & Liu, X. (2022). The dynamic COVID-zero strategy on prevention and control of COVID-19 in China. *Zhonghua Yi Xue Za Zhi*, 102, 239-242. <https://doi.org/10.3760/cma.j.cn112137-20211205-02710>
- Li, W., Zhang, H., Zhang, C., Luo, J., Wang, H., Wu, H., ... Li, C. (2021). The prevalence of psychological status during the COVID-19 epidemic in China: A systemic review and meta-analysis. *Frontiers in Psychology*, 12, 614964. <https://doi.org/10.3389/fpsyg.2021.614964>
- López-Moreno, M., López, M. T. I., Miguel, M., & Garcés-Rimón, M. (2020). Physical and psychological effects related to food habits and lifestyle changes derived from COVID-19 home confinement in the Spanish population. *Nutrients*, 12, 3445. <https://doi.org/10.3390/nu12113445>
- Massar, S. A., Ng, A. S., Soon, C. S., Ong, J. L., Chua, X. Y., Chee, N. I., ... Chee, M. W. (2022). Reopening after lockdown: The influence of working-from-home and digital device use on sleep, physical activity, and wellbeing following COVID-19 lockdown and reopening. *Sleep*, 45, zsab250. <https://doi.org/10.1093/sleep/zsab250>
- Molina-Montes, E., Uzhova, I., Verardo, V., Artacho, R., García-Villanova, B., Guerra-Hernández, E. J., ... Rodríguez-Pérez, C. (2021). Impact of COVID-19 confinement on eating behaviours across 16 European countries: The COVIDiet cross-national study. *Food Quality and Preference*, 93, 104231. <https://doi.org/10.1016/j.foodqual.2021.104231>
- Proto, E., & Zhang, A. (2021). COVID-19 and mental health of individuals with different personalities. *Proceedings of the National Academy of Sciences*, 118, e2109282118. <https://doi.org/10.1073/pnas.2109282118>
- Robinson, E., Sutin, A. R., Daly, M., & Jones, A. (2022). A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. *Journal of Affective Disorders*, 296, 567-576. <https://doi.org/10.1016/j.jad.2021.09.098>
- Rosenthal, R., Cooper, H., & Hedges, L. (1994). *Parametric measures of effect size*. The Handbook of Research Synthesis. New York: Russell Sage Foundation.
- Rossi, R., Soggi, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., ... Di Lorenzo, G. (2020). COVID-19 pandemic and lockdown measures impact on mental health among the general population in Italy. *Frontiers in Psychology*, 790. <https://doi.org/10.3389/fpsyg.2020.00790>
- Salehinejad, M. A., Azarkolah, A., Ghanavati, E., & Nitsche, M. A. (2022). Circadian disturbances, sleep difficulties and the COVID-19 pandemic. *Sleep Medicine*, 91, 246-252. <https://doi.org/10.1016/j.sleep.2021.07.011>
- Sang, X., Menhas, R., Saqib, Z. A., Mahmood, S., Weng, Y., Khurshid, S., ... Shahzad, B. (2021). The psychological impacts of COVID-19 home confinement and physical activity: A structural equation model analysis. *Frontiers in Psychology*, 11, 614770. <https://doi.org/10.3389/fpsyg.2020.614770>
- Shenzhen Health Commission. (2022). *Shenzhen announced for the first time the unsealing standard of "Three Zones"* [EB/OL]. http://www.sz.gov.cn/szzt2010/yqfk2020/szzxd/content/post_9607769.html.
- Souza, T. C., Oliveira, L. A., Daniel, M. M., Ferreira, L. G., Della Lucia, C. M., Liboredo, J. C., & Anastácio, L. R. (2022). Lifestyle and eating habits before and during COVID-19 quarantine in Brazil. *Public Health Nutrition*, 25, 65-75. <https://doi.org/10.1017/S136898002100255X>
- Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., ... Stewart-Brown, S. (2007). The Warwick-Edinburgh mental well-being scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes*, 5, 1-13. <https://doi.org/10.1186/1477-7525-5-63>
- Trabelsi, K., Ammar, A., Masmoudi, L., Boukhris, O., Chtourou, H., Bouaziz, B., ... ECLB-COVID19 Consortium. (2021). Sleep quality and physical activity as predictors of mental wellbeing variance in older

- adults during COVID-19 lockdown: ECLB COVID-19 international online survey. *International Journal of Environmental Research and Public Health*, 18, 4329. <https://doi.org/10.3390/ijerph18084329>
- Trabelsi, K., Ammar, A., Masmoudi, L., Boukhris, O., Chtourou, H., Bouaziz, B., ... Hoekelmann, A. (2021). Globally altered sleep patterns and physical activity levels by confinement in 5056 individuals: ECLB COVID-19 international online survey. *Biology of Sport*, 38, 495-506. <https://doi.org/10.5114/biolsport.2021.101605>
- von Soest, T., Kozák, M., Rodríguez-Cano, R., Fluit, D. H., Cortés-García, L., Ulset, V. S., ... Bakken, A. (2022). Adolescents' psychosocial well-being one year after the outbreak of the COVID-19 pandemic in Norway. *Nature Human Behaviour*, 6, 217-228. doi:10.1038/s41562-021-01255-w
- Wang, J., Gong, Y., Chen, Z., Wu, J., Feng, J., Yan, S., ... Yin, X. (2020). Sleep disturbances among Chinese residents during the Coronavirus Disease 2019 outbreak and associated factors. *Sleep Medicine*, 74, 199-203. <https://doi.org/10.1016/j.sleep.2020.08.002>
- Wang, Y., Shi, L., Que, J., Lu, Q., Liu, L., Lu, Z., ... Shi, J. (2021). The impact of quarantine on mental health status among general population in China during the COVID-19 pandemic. *Molecular Psychiatry*, 26, 4813-4822. <https://doi.org/10.1038/s41380-021-01019-y>
- World Health Organization. (2010). *Global recommendations on physical activity for health*. World Health Organization.
- Xie, Y., & Zhou, X. (2014). Income inequality in today's China. *Proceedings of the National Academy of Sciences*, 111, 6928-6933. <https://doi.org/10.1073/pnas.1403158111>
- Yang, G. Y., Lin, X. L., Fang, A. P., & Zhu, H. L. (2021). Eating habits and lifestyles during the initial stage of the COVID-19 lockdown in China: A cross-sectional study. *Nutrients*, 13, 970. <https://doi.org/10.3390/nu13030970>

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).