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Associations between changes in social contact pattern and the mental health status of Chinese adults: cross-sectional findings

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ABSTRACT

The study aims to examine the associations between social contact pattern changes and mental health status, including depression, anxiety, and loneliness, among Chinese adults in the context of coronavirus disease 2019 (COVID-19). Data on social contact patterns before and after the outbreak of COVID-19 were obtained from 3511 participants. Mental health (ie, depression, anxiety, and loneliness) was assessed by the 9-item Patient Health Questionnaire, Dark Future Scale, and the 9-scale Three-Item Loneliness Scale, respectively. Poisson regression analyses revealed that the participants who had increased in-person communication were more likely to have mental disorders [depression: prevalence ratio (PR)=1.13, 95% confidence interval (CI): 1.02, 1.26; anxiety: PR=1.15, 95% CI: 1.01, 1.30]. The current study concluded that the in-person communication increase before and after the outbreak of COVID-19 was associated with mental disorders among Chinese adults.

Keywords: social contact pattern, COVID-19, mental health

Abbreviations:
COVID-19: coronavirus disease 2019
PHQ-9: 9-item Patient Health Questionnaire
DFS: Dark Future Scale
TILS: 9-scale Three-Item Loneliness Scale
PR: prevalence ratio
CI: confidence interval

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a severe public health crisis worldwide. By 22 July 2022, nearly 552 million cases and over 6.3 million deaths had been reported globally,[1] with more than 536 million cases of infection and more than 22,990 deaths occurring in China.[2] At the early stage of the pandemic, to curb the fast spread of COVID-19, the Chinese government set up the strictest anti-epidemic strategy since the outbreak in January 2020, including precautions such as maintaining social distancing and stay-at-home orders. As the number of cases decreased, restrictions were eased, but some precautions were still strongly encouraged in most cities, for example, maintaining social distance and reducing mass gathering events and unnecessary visits with relatives and friends,[3] which greatly shifted people's social contact patterns.

Accumulated evidence suggests that lifestyles might affect mental health.[4-8] During the COVID-19 pandemic, when regular face-to-face communication became difficult to achieve, as an alternative, people had no choice but to adopt online communication to maintain relationships with family and friends.[9,10] The rapid change in social contact patterns might potentially affect the mental well-being of individuals. For example, recent studies reported that physical and social network isolation due to the COVID-19 pandemic was associated with negative mental health trajectories.[11,12] An increasing number of studies suggest that the mental health crisis caused by COVID-19 is extremely urgent[13] because the emotional or tangible support available in various ways is critically important, especially in times of crisis.[12]

Although many studies have shown the link between social networks and mental health, few studies have addressed the relationship between social contact pattern changes and mental health, regardless of the social contact patterns that might play a key role in well-being. Therefore, our study aims to estimate the associations between social contact pattern changes and mental health status, including depression, anxiety, and loneliness, among Chinese adults in the context of COVID-19. The current study might provide evidence for policymaking regarding mental health preservation and promotion during infectious disease pandemics.

METHOD

Study design

The current study was designed to investigate the potential impact of social contact pattern changes on mental health in the context of COVID-19 in China. An online questionnaire designed to assess the social contact pattern before and after the outbreak of COVID-19 and mental health status (ie, depression, dark future anxiety, and loneliness) among Chinese adults was administered in March 2021.

Participants

The questionnaire was uploaded to a Chinese online survey platform (www.wjx.cn) on 8 March for data collection. Individuals aged 18 or older were enrolled by snowball sampling. Specifically, one person was invited to fill out the questionnaire first and then was encouraged to forward the survey link to their friends. Specifically, in the first wave, the participants were invited widely from universities, hospitals, government agencies, and communities in Anhui Province via advertisement. Then, the participants who were recruited in the first wave were encouraged to send the survey links to their relatives and friends. The data collection continued until a given time was reached. To decrease the heterogeneity regarding the different stages of epidemic control, the answering period was restricted to one week; participants were requested

to submit their answers by 15 March 2021. At the end of the survey, responses from 3524 participants were obtained.

Participants younger than 18 years old were excluded (n=1). Two measures were taken to guarantee the quality of the answers. First, the time it took for each participant to answer the questions was checked, and participants who had an answering time shorter than 3 minutes were excluded (n=6). Second, potential logical error of the collected data was checked by the investigator. The answers with the crudest logical errors, for example, duplicate responses from the same internet Protocol (IP) address or inconsistent responses between questions, were excluded (n=6). Finally, answers from 3511 participants were left for further analysis, resulting in an effective rate of 99.6%. The highest proportion of the participants came from Anhui (17.9%), followed by Guangdong (9.4%) and Jiangsu (7.8%).

Measurement

The current social contact pattern of the participants was judged by asking the question, "In the current stage when you want to meet your family/friends/colleagues, what sort of communication do you usually adopt?" The options were "A: online communication, eg, chat on We Chat," "B: in-person communication, eg, having dinner together," and "C: both, about half and half." Additional questions were used to explore the social contact patterns of the participants before the pandemic outbreak by asking, "Before the COVID-19 outbreak, eg, Sep 2019, when you want to meet your family/friends/colleagues, what sort of communication did you usually adopt?" with the same options. The answers to the abovementioned questions were compared to determine the social contact pattern changes before the outbreak and at the current stage, ie, each participant's experience of the prevention and control stage. Specifically, the participants were categorized into three groups (Group 1: in-person communication increased; Group 2: online communication increased; Group 3: no change).

Participants' depressive symptoms were assessed with the 9-item Patient Health Questionnaire (PHQ-9),[14] which is widely accepted as a valuable and efficient tool for screening and evaluating depression. The PHQ-9 scale consists of 9 items, with the responses reflecting the frequency of occurrence of depression symptoms. The total score of the PHQ-9 was 27, and a higher score indicated more severe symptoms of depression. Depression was defined as a PHQ score of 5 or greater.[15] The internal consistency test of the PHQ-9 showed good reliability (α=0.960).

The anxiety status of the participants was measured by the Dark Future Scale (DFS), a short and reliable instrument for measuring future anxiety.[16] It measured the participants' feelings and perceptions of dangers and adverse events (eg, 'I am afraid that the problems which trouble me now will continue for a long time'). Participants selected their answers on a scale of 0=decidedly false to 6=decidedly true. The total score was 30, with a higher score indicating more severe anxiety symptoms. Anxiety was defined as a DFS score of 17 or greater.[17] The high internal consistency of the instrument was tested (α=0.927). The Kaiser–Meyer–Olkin (KMO) estimates were 0.899, and the results of Bartlett's test of sphericity were significant (χ^2=13262.034, p <0.001), showing the satisfactory factor structures of the scale.

Participants' loneliness was measured on the 9-scale Three-Item Loneliness Scale (TILS),[18] which measures the overall loneliness of the participants. The scale has three items (eg, 'I feel left out.') and a simplified set of response categories coded 1 (hardly ever) to 3 (often). The total TILS score was 9, with higher scores indicating greater loneliness. Loneliness was defined as a TILS score of 6 or greater.[18] The internal consistency test of the TILS showed good reliability (α=0.872). The Kaiser–Meyer–Olkin (KMO) estimates were 0.739, and the results of Bartlett's test of sphericity were significant (χ^2=5288.321, p <0.001), showing that the factor structures of the scale were satisfied.

Covariates

Covariates in this study included demographic characteristics (age, sex, occupation, education level, monthly income, marital status, urban/rural status, and self-rated health status), health-related behaviors (screen time, self-rated sleep quality, and physical activity), chronic diseases (any), and mental resilience. Continuous ages and urban/rural dwelling status were self-reported by the participants. The occupation status of the participants was divided into two categories: employed and not employed (including retired, unemployed, and student). The educational level was categorized into three categories: primary (0–6 years of education), medium (7–12 years), and college level (more than 12 years), with the participants who identified themselves as students at the time of the survey classified in the college category of education. Participants were divided into two groups according to their monthly income (6000 RMB or below, more than 6000 RMB). Marital status was divided into married and unmarried (including widowed, divorced, and never married). Self-rated health status was divided into very good, good, fair, or bad (poor or very poor). Participants' daily electronic device screen time was divided into three categories (less than two hours, 2–3 hours, and more than 3 hours). Participants' weekly physical exercise frequency was divided into three categories (never, 1–2 days, and more than 3 days). The participants' sleep quality was divided into very good, good, fair, or bad. For chronic diseases, the participants were categorized as either with or without any chronic condition diagnosed by a physician. We also included mental resilience as a covariate, which was evaluated by the 6-item Brief Resilience Scale (BRS) with 30 points.[19] The total score of BRS ranged from 1, 'does not describe me at all to '5, describes me very well. A higher score indicates better psychological resilience. The Kaiser–Meyer–Olkin (KMO) estimates for BRS were 0.819, and the results of Bartlett's test of sphericity were significant (χ^2=10986.740, p <0.001), indicating that the scale holds the appropriate factor structures.

Statistical analyses

To assess the association between social contact pattern changes and mental health (depression, anxiety, and loneliness), a Poisson regression analysis was performed with estimation of prevalence ratios (PR) adjusted for sociodemographic (age, sex, occupation, urban and rural, education, marital status, income), behavioral (physical activity, sleeping quality, screen-time), chronic disease, and mental resilience variables. Sex-stratified analyses were also performed to explore possible effect modification. A sensitivity analysis was conducted by only including the participants who did not report any chronic disease (n=2579) to avoid the potential impacts of the current existing mental disorders.

All of the analyses in the current study were conducted with Stata version 15.1 software (Stata Corp, College Station, TX), and the significance level was set at 0.05.

Ethics

Approval for this cross-sectional survey was obtained from the Institutional Review Board of the First Affiliated Hospital of USTC (IRB identification code: 2021-ky114) and was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

RESULTS

Table 1 summarizes the basic characteristics of the participants. A total of 1453 males and 2058 females participated in the current study. In this study, the mean age was 29.1 for males and 30.2 for females. The majority of the participants enrolled in the current study were

Table 1 Basic characteristics of the participants enrolled in the current study, 2021, China

		Male (n=1453)	Female (n=2058)
Age (mean, standard deviation)		29.1 (8.7)	30.2 (8.8)
Occupation (n, %)			
Employed		945 (65.0)	1404 (68.2)
Not employed (retired/unemployed/student)		508 (35.0)	654 (31.8)
Education (n, %)			
Primary school or lower		360 (24.8)	303 (14.7)
High school		305 (21.0)	441 (21.4)
College		788 (54.2)	1314 (63.9)
Monthly income (n, %)			
≤6000 RMB		625 (43.1)	1156 (56.2)
>6000 RMB		828 (57.0)	902 (43.8)
Marital status (n, %)			
Married		707 (48.7)	825 (40.1)
Not married (single/divorced/others)		746 (51.3)	1233 (59.9)
Urban-rural dwelling (n, %)			
Urban		1142 (78.6)	1651 (80.2)
Rural		311 (21.4)	407 (19.8)
Chronic illness (n, %)			
Yes		457 (31.5)	475 (23.1)
No		996 (68.6)	1583 (76.9)
Self-rated health status (n, %)			
Very good		591 (40.7)	928 (45.1)
Good		432 (29.7)	636 (30.9)
Not good		430 (29.6)	494 (24.0)
Daily screen time (n, %)			
<2h		529 (36.4)	639 (31.1)
2–3h		448 (30.8)	601 (29.2)
>3h		476 (32.8)	818 (39.8)
Physical activity (n, %)			
Never		217 (14.9)	392 (19.1)
1–2 days per week		688 (47.4)	1048 (50.9)
3 days or more per week		548 (37.7)	618 (30.0)
Self-rated sleep quality (n, %)			
Very good		598 (41.2)	842 (40.9)
Good		481 (33.1)	633 (30.8)
Not good		374 (25.7)	583 (28.3)
Mental resilience (mean, standard deviation)		17.96 (5.4)	18.63 (4.8)
Change of social contact patterns (n, %)			
No		924 (63.6)	1285 (62.4)
Yes	In-person communication increased	293 (20.2)	310 (15.1)
	Online communication increased	236 (16.2)	463 (22.5)

employed (66.9%), followed by students (15.1%), unemployed (10.7%), and retired (7.3%). More than half of the males and females were well educated (54.2% of males and 63.9% of females were classified as college category). Most of the participants (78.6% and 80.2% for males and females, respectively) lived in urban areas. A total of 63.6% of the males and 62.44% of females reported no change in social contact patterns before and after the pandemic outbreak. For males, the means of the PHQ-9, DFS, and TILS scores were 10.90, 16.01, and 5.57, respectively, and for females, the corresponding means were 8.93, 15.19, and 5.20, respectively.

Table 2 shows the results of Poisson regression analysis between changes in social contact patterns and mental health status. In the fully adjusted model, the participants who had increased

Table 2 Associations between social contact pattern changes and mental health status, 2021, China

	Depression			Anxiety			Loneliness		
	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI
Both sexes									
Social contact pattern changes									
No change	1504/2209 (68.1)	Ref		990/2209 (44.8)	Ref		1177/2209 (53.3)	Ref	
In-person communication increased	514/603 (85.2)	1.13	1.02, 1.26	353/603 (58.5)	1.15	1.01, 1.30	404/603 (67.0)	1.10	0.98, 1.24
Online communication increased	449/699 (64.2)	0.97	0.87, 1.08	259/699 (37.1)	0.92	0.80, 1.05	329/699 (47.1)	0.92	0.81, 1.04
Male									
Social contact pattern changes									
No change	666/924 (72.1)	Ref		428/924 (46.3)	Ref		531/924 (57.5)	Ref	
In-person communication increased	266/293 (90.8)	1.19	1.02, 1.38	163/293 (55.6)	1.16	0.96, 1.40	220/293 (75.1)	1.19	1.01, 1.41
Online communication increased	171/236 (72.5)	1.03	0.87, 1.22	94/236 (39.8)	0.97	0.77, 1.22	131/236 (55.5)	1.02	0.84, 1.24
Female									
Social contact pattern changes									
No change	838/1285 (65.2)	Ref		562/1285 (43.7)	Ref		646/1285 (50.3)	Ref	
In-person communication increased	248/310 (80.0)	1.07	0.93, 1.24	190/310 (61.3)	1.14	0.96, 1.35	184/310 (59.4)	1.01	0.85, 1.20
Online communication increased	278/463 (60.0)	0.93	0.81, 1.07	165/463 (35.6)	0.89	0.75, 1.06	198/463 (42.8)	0.85	0.72, 0.99

n: the number of participants having the condition (depression, anxiety, or loneliness)
N: the number of participants with a particular social contact pattern
PR: prevalence ratio
CI: confidence interval
Ref: reference
Prevalence ratios and the 95% confidence intervals for depression, anxiety, and loneliness were estimated from Poisson regression model adjusted for sex, age (continuous), occupation (employed, not employed), education (primary school or lower, high school, college), monthly income (≤6000RMB/ >6000 RMB), marital status (married, not married), urban/rural dwelling (urban, rural), chronic illness (yes, no), self-rated health status (very good, good, not good), daily screen-time (<2h, 2–3h, >3h), physical activity (never, 1–2 days per week, 3 days or more per week), sleep quality (very good, good, not good), and mental resilience (continuous).

in-person communication were more likely to have depression and anxiety symptoms (PHQ-9: PR=1.13, 95% CI: 1.02, 1.26; DFS: PR=1.15, 95% CI: 1.01, 1.30). The participants who had increased online communication were not associated with depression (PR=0.97, 95% CI: 0.87, 1.08), anxiety (PR=0.92, 95% CI: 0.80, 1.05) or loneliness (PR=0.92, 95% CI: 0.81, 1.04). The results of the sex-stratified analysis showed that such associations were more apparent in males. The estimation of the effects of the covariates included in the model is shown in Supplemental Table s1.

The results of the sensitivity analysis that included only the participants who did not self-report any chronic disease showed that increased in-person communication was still associated with a higher likelihood of the presence of anxiety (DFS: PR=1.21, 95% CI: 1.01, 1.43) but was not significantly associated with depression and loneliness (PHQ-9: PR=1.15, 95% CI: 0.99, 1.31; TILS: PR=1.02, 95% CI: 0.87, 1.20) (Supplemental Table s2).

DISCUSSION

In the current study, we found that increased in-person communication and mental disorder symptoms were related among Chinese adults in the context of COVID-19. Participants who increased in-person contact after the outbreak were more likely to have mental disorders. To our knowledge, the current study was the first to explore the possible association between social contact pattern changes and mental health among Chinese adults.

COVID-19 outbreaks and the safety measures applied to prevent its spread have resulted in many mental health problems worldwide. It has been reported that more than half of people had mental disorder symptoms during the outbreak of the COVID-19 pandemic in China,[20,21] which was consistent with the high prevalence of mental disorder symptoms in the current study. Previous studies indicated increased mental disorders due to social isolation followed by pandemic outbreaks.[22-24] Interestingly, our cross-sectional study found that the participants who increased in-person communication after the outbreak were more likely to have mental disorders. In general, although in-person social interaction may be protective against negative emotions,[25] eg, anxiety or depression in the context of COVID-19, a stay-at-home strategy may also increase the likelihood of contradictions and conflicts with someone who remains in close contact with others, eg, family members,[26-28] thus inducing mental disorders. Remarkably, the participants enrolled in the study were mainly of a young generation; more frequent household face-to-face contact may be prone to negative emotions caused by perception differences among family members.[29] Traditional family structures in China are usually comprehensive, with children living with their parents and even grandparents. The dramatic ongoing social changes (eg, family plan policy) might induce critical differences in perceptions; when the in-person interaction opportunities passively increase as the result of stay-at-home policies, the likelihood of household conflicts across generations (eg, parent-offspring conflicts)[30] increases. The impact of social contact patterns might differ between younger individuals and elderly individuals; for example, more frequent in-person communications were associated with better mental health among American and Britain elderly individuals,[31] which was contrary to our study. There is also a possibility that participants with mental disorders need more in-person communication.[32] However, we adjusted for chronic condition status to reduce the possibility of such confounding. Furthermore, sensitivity analysis that included only the participants without chronic diseases indicated that apparent mental health problems may not exist before the assessment of social contact pattern changes.

The sex-stratified results of the current study suggest that the associations between increased in-person social contact and negative mental symptoms were more apparent among males.

COVID-19 has adverse health consequences for human beings and aggravates income inequality in China.[33] In China, breadwinning roles have traditionally relied on males rather than females; increased in-person communications may lead to stress and strains resulting in mental disorders.[34] Another explanation is that in-person communication may be related to increased alcohol consumption and related disorders[35] and then generate psychological distress.[36,37]

Strengths and Limitations

The primary strength of the current study was the large sample size. A total of 3511 male and female participants with low and high socioeconomic status from 30 provinces were included in the survey. A number of covariates, including sociodemographic and behavioral factors, were introduced in the analysis; thus, the validation of the results was guaranteed. However, our study was not without limitations. First, the cross-sectional design of this study makes it challenging to draw any causal association between changes in social contact patterns and mental disorders. Additionally, the mental health status of the participants before the COVID-19 pandemic was not known. In the future, longitudinal studies with a more comprehensive design and multiple measures of mental health status are needed to verify the associations. Since the prevention and control of the pandemic might continue for an extended period, our current study results may have stage-specific characteristics. Second, an online survey with a snowball sampling method was adopted, which means that the participants enrolled in the study might be socially similar and may have similar social contact patterns. However, although individuals with relatively higher education levels and socioeconomic status were initially invited, many individuals with low education levels and socioeconomic status were included in the final collected data. Third, the data were obtained by self-report, so the answers from the participants may be prone to being socially desirable. For example, when sporadic cases occur, the government strongly recommends online communication so that the answers related to an individual's social contact communication may not reflect reality. Fourth, we did not specify the relationship and the responsive social contact pattern. The methods of communication adopted may be different for different people, family, or friends, for example, and might impact individuals' mental status to a different extent. However, the relationship-specific social contact pattern was not considered in the current study. Future studies should specify various relationships and corresponding effects to further explore the influence of social contact pattern changes using a longitudinal design. Finally, the participants included in the current study tended to be young, employed, and living in urban areas, which makes it difficult to generalize our findings to the general adult population in China.

Conclusion

In conclusion, the present study revealed that social contact pattern changes caused by the COVID-19 pandemic were associated with mental disorders among Chinese adults. Specifically, in-person communication increases were associated with the presence of mental symptoms, although the causal relationship is unknown, and the potential mechanisms of such linkages need further investigation. Such findings suggest an urgent need for the government to pay more attention to in-person communication as the pandemic expands, ie, a stay-at-home strategy may also increase the likelihood of contradictions and conflicts within families and lead to mental disorders. Therefore, effective interventions, for example, health education and establishing a mental health system, should be taken to deal with such risks.

AUTHOR CONTRIBUTIONS

JZ and SZ made equal contributions.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

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SUPPLEMENTAL MATERIALS

Table s1 Results of the covariates in the Poisson regression analyses examining the associations between social contact pattern changes and mental health status, 2021, China

Covariates	Depression			Anxiety			Loneliness		
	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI
Age (continuous)	–	0.99	0.97, 0.99	–	0.99	0.99, 1.00	–	0.99	0.98, 0.99
Sex									
Male	1103/1453 (75.9)	Ref		685/1453 (47.1)	Ref		882/1453 (60.7)	Ref	
Female	1364/2058 (66.3)	0.95	0.88, 1.04	917/2058 (44.6)	1.05	0.95, 1.16	1028/2058 (50.0)	0.94	0.85, 1.03
Occupation									
Employed	1643/2349 (69.9)	Ref		1172/2349 (49.9)	Ref		1223/2349 (52.1)	Ref	
Not employed	824/1162 (70.9)	0.97	0.88, 1.07	430/1162 (37.0)	0.80	0.71, 0.91	687/1162 (59.1)	1.04	0.94, 1.16
Education									
Primary school or lower	538/663 (81.1)	Ref		363/663 (54.8)	Ref		455/663 (68.6)	Ref	
High school	557/746 (74.7)	0.97	0.85, 1.10	359/746 (48.1)	0.91	0.78, 1.06	452/746 (60.6)	0.96	0.84, 1.11
College	1372/2102 (65.3)	0.87	0.77, 0.98	880/2102 (41.9)	0.89	0.77, 1.03	1003/2102 (47.7)	0.78	0.69, 0.89
Monthly income (RMB)									
≤6000	1134/1781 (63.7)	Ref		707/1781 (39.7)	Ref		876/1781 (49.2)	Ref	
>6000	1333/1730 (77.1)	1.19	1.09, 1.29	895/1730 (51.7)	1.15	1.04, 1.29	1034/1730 (59.8)	1.22	1.11, 1.35
Marital status									
Married	1101/1532 (71.9)	Ref		656/1532 (42.8)	Ref		874/1532 (57.0)	Ref	
Not married	1366/1979 (69.0)	0.97	0.88, 1.06	946/1979 (47.8)	0.99	0.89, 1.12	1036/1979 (52.3)	0.95	0.85, 1.05
Urban-rural									
Urban	1961/2793 (70.2)	Ref		1297/2793 (46.4)	Ref		1498/2793 (53.6)	Ref	
Rural	506/718 (70.5)	0.99	0.89, 1.10	305/718 (42.5)	1.02	0.89, 1.17	412/718 (57.4)	1.00	0.89, 1.13
Chronic illness									
Yes	794/932 (85.2)	Ref		629/932 (67.5)	Ref		633/932 (67.9)	Ref	
No	1673/2579 (64.9)	0.86	0.78, 0.94	973/2579 (37.7)	0.70	0.62, 0.78	1277/2579 (49.5)	0.84	0.75, 0.93

Self-rated health									
Very good	979/1519 (64.5)	Ref		761/1519 (50.1)	Ref		743/1519 (48.9)	Ref	
Good	758/1068 (71.0)	1.05	0.95, 1.17	455/1068 (42.6)	0.92	0.82, 1.17	560/1068 (52.4)	1.02	0.91, 1.15
Not good	730/924 (79.0)	1.14	1.02, 1.27	386/924 (41.8)	0.95	0.82, 1.09	607/924 (65.7)	1.21	1.07, 1.36
Daily screen time(h)									
<2	841/1168 (72.0)	Ref		633/1168 (54.2)	Ref		639/1168 (54.7)	Ref	
2–3	781/1049 (74.5)	1.02	0.92, 1.12	550/1049 (52.4)	1.04	0.92, 1.17	598/1049 (57.0)	1.02	0.91, 1.15
>3	845/1294 (65.3)	0.97	0.87, 1.08	419/1294 (32.4)	0.77	0.67, 0.88	673/1294 (52.0)	1.05	0.93, 1.18
Physical activity (day/week)									
Never	427/609 (70.1)	Ref		290/609 (47.6)	Ref		336/609 (55.2)	Ref	
1–2	1288/1736 (74.2)	1.04	0.93, 1.16	869/1736 (50.1)	1.01	0.88, 1.16	970/1736 (55.9)	1.02	0.90, 1.16
≥3	752/1166 (64.5)	0.92	0.82, 1.08	443/1166 (38.0)	0.84	0.72, 0.98	604/1166 (51.8)	0.96	0.83, 1.10
Sleep quality									
Very good	929/1440 (64.5)	Ref		762/1440 (52.9)	Ref		723/1440 (50.2)	Ref	
Good	805/1114 (72.3)	1.11	1.01, 1.23	451/1114 (40.5)	0.88	0.78, 1.00	611/1114 (54.8)	1.07	0.95, 1.20
Not good	733/957 (76.6)	1.24	1.11, 1.39	389/957 (40.6)	0.97	0.85, 1.12	576/957 (60.2)	1.22	1.08, 1.39
Mental resilience (continuous)	–	0.97	0.96, 0.98	–	0.97	0.96, 0.98	–	0.96	0.95, 0.97

n: the number of participants having the condition (depression, anxiety, or loneliness)
N: the number of participants with a particular characteristic
PR: prevalence ratio
CI: confidence interval
Ref: reference
Prevalence ratios and the 95% confidence intervals for depression, dark future anxiety, and loneliness were estimated from Poisson regression model including sex, age (continuous), occupation (employed, not employed), education (primary school or lower, high school, college), monthly income (≤6000RMB/ >6000 RMB), marital status (married, not married), urban/rural dwelling (urban, rural), chronic illness (yes, no), self-rated health status (very good, good, not good), daily screen-time (<2h, 2–3h, >3h), physical activity (never, 1–2 days per week, 3 days or more per week), sleep quality (very good, good, not good), mental resilience (continuous), and social contact pattern changes (no change, in-person communication increased, online-communication increased). Results of social contact pattern changes with mental health status are presented in Table 2.

Table s2 Poisson regression analysis of changes of social contact patterns and mental health status among the participants who did not report any chronic disease

	Depression			Anxiety			Loneliness		
	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI	n/N (%)	PR	95%CI
Social contact pattern changes									
No change	1043/1647 (63.3)	Ref		621/1647 (37.7)	Ref		815/1647 (49.5)	Ref	
In-person communication increased	292/364 (80.2)	1.15	0.99, 1.31	179/364 (49.2)	1.21	1.01, 1.43	220/363 (60.4)	1.02	0.87, 1.20
Online communication increased	338/568 (59.5)	0.95	0.84, 1.08	173/568 (30.5)	0.87	0.73, 1.03	242/568 (42.6)	0.87	0.75, 1.01

n: the number of participants having the condition (depression, anxiety, or loneliness)
N: the number of participants with a particular social contact pattern
PR: prevalence ratio
CI: confidence interval
Ref: reference
Prevalence ratios and the 95% confidence intervals for depression, anxiety, and loneliness were estimated from Poisson regression model adjusted for sex, age (continuous), occupation (employed, not employed), education (primary school or lower, high school, college), monthly income (≤6000RMB/ >6000 RMB), marital status (married, not married), urban/rural dwelling (urban, rural), chronic illness (yes, no), self-rated health status (very good, good, not good), daily screen-time (<2h, 2–3h, >3h), physical activity (never, 1–2 days per week, 3 days or more per week), sleep quality (very good, good, not good), and mental resilience (continuous).