Prevalence, trends, and correlates of long COVID in mainland China after the policy shift: findings from two cross-sectional surveys

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Abstract

Background

The long-term consequences of the Chinese COVID-19 wave in 2022 remain unknown. To clarify the health outcomes of COVID-19 survivors after the wave of Omicron in 2022 and reveal related factors of sequelae symptoms.

Methods

Two cross-sectional studies conducted in August of 2023 and 2024 respectively. A total of 47464 participants from general population in mainland China. All participants completed an online questionnaire for evaluation of symptoms and characteristics.

Results

These two surveys included 28718 and 18746 participants, respectively. The prevalence of long COVID was 52.34%, showing a gradual decline over time, with fatigue being the most prevalent symptom. Female gender, aged 18–59, having any chronic diseases or mental disorders and drinking were positively associated with long COVID (odds ratio > 1, $P < 0.05$). Conversely, maintaining a regular sleep-wake, combining meat and vegetable diets, consuming vegetables, dairy products, and animal foods daily, sunbathing at least 5 hours per day, having a satisfactory neighborhood relationship and community environment and vaccination demonstrated significant inverse associations with long COVID (odds ratio < 1, $P < 0.05$).

Conclusions

Long COVID remains one of the major health challenges and is influenced by a variety of factors. Monitoring, identifying, and treating risk groups based on relevant factors is of great public health significance. Community-based programs promoting nutrition and sleep hygiene, combined with sustained vaccination, could help reduce the burden of long COVID. Integrating screening and management into routine primary care for high-risk groups, alongside a national surveillance system, represents an actionable policy direction.

Background

Since the outbreak of the COVID-19 pandemic, globally, over 776.8 million confirmed COVID-19 cases and over 7 million fatalities have been recorded by 10 November 2024 [1]. Increasing evidence suggests that many infected individuals experience persistent somatic symptoms or organ dysfunction several weeks or months after infection, which is known as long COVID [2]. Typical symptoms include fatigue,

chronic cough, impaired smell or taste, chest pain, thirst, brain fog, concentration difficulties, dizziness, gastrointestinal symptoms, hair loss, and anxiety, among others [3]. Those with long COVID were at increased risk of varying adverse outcomes, such as diabetes, cardiovascular disease, neurological diseases, mental health issues (including depression, anxiety, and sleep disorders) which are associated with reduced physical function and health-related quality of life [4–9].

Long COVID has emerged as one of the primary challenges currently facing global healthcare systems. The World Health Organization (WHO) defined long COVID for adults as: post-COVID-19 condition occurs in individuals with a history of probable or confirmed SARS-CoV-2 infection, usually 3 months from the onset, with symptoms that last for at least 2 months and cannot be explained by an alternative diagnosis [10], affecting an estimated 140 million people worldwide [11]. A cohort study in China indicated that the proportion of patients with at least one sequelae symptom decreased from 68% at 6 months to 49% at 12 months [12]. This decreasing trend over time is supported by other studies on hospitalized survivors in Wuhan, which reported prevalence rates of 43.2% at 1 year versus 19.8% at 2 years [13], and 68% at 6 months versus 55% at 2 years [14]. A population based, longitudinal cohort study in Switzerland suggested that the prevalence of sequelae symptoms considered to be related to COVID-19 decreased from 28.9% at six months to 20.3% and 18.1% at 12 and 24 months, respectively [15]. These symptoms tend to evolve slowly and fluctuate towards improvement. However, a significant proportion of patients with long COVID have also reported no improvement. It is worth noting that 54% patients still experienced at least one sequelae three years after the onset of symptoms according to a longitudinal cohort study about discharged COVID-19 survivors in China [16]. Other studies have also shown that a considerable number of COVID-19 survivors still encounter problems in various health fields [17–23].

Any patient with COVID-19 may experience long COVID irrespective of the severity of their infection or the intensity of the treatment they received [24–26]. Long COVID has been demonstrated to be associated with female gender [18–21, 27], comorbidity [21, 22, 27], and the severity of the acute illness [10, 18, 20, 22, 23, 27, 28]. However, previous studies have predominantly focused on the impact of demographic characteristics on outcomes, with less attention given to the effects of factors such as lifestyle, dietary habits, and living environment. Moreover, existing studies have often grouped various long-term symptoms together for analysis, rather than categorizing them based on symptom characteristics, such as respiratory symptoms, cardiovascular symptoms, and so on. At the end of 2022, China began to comprehensively implement the open policy of COVID-19 nationwide [29], and subsequently, almost everyone experienced an unprecedented large-scale infection peak [30]. After this extensive outbreak, the main epidemic strain was Omicron [31], and the dominant subvariants were BF.7, BA.5.2, XBB, and JN.1 [32], which was different from the dominant subvariants circulating before 2022. However, the longer-term consequences of the Chinese wave remain unknown. Research on the long COVID in China is limited, having focused primarily on hospitalized patients in Wuhan, and infections with earlier SARS-CoV-2 variants, or on individual symptom [13–16, 18, 20–22, 28].

A better understanding of long COVID symptoms and risk factors is necessary to manage this condition effectively within healthcare systems. This study aimed to clarify the health outcomes and changes over

time of COVID-19 survivors after the wave of Omicron in 2022, and to comprehensively reveal the impact of various influencing factors on different human body systems from a categorical perspective.

Methods

This cross-sectional study was approved by the Ethics Committee of Hebei Medical University (2023001). Informed consent was obtained from all participants or their legal guardians prior to the survey. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.

Study design and participants

The data were gathered from two cross-sectional surveys conducted by Hebei Medical University in August of 2023 and 2024, respectively. Hebei Medical University recruited approximately 1500 university student investigators through its official platform. The student investigators came from 31 provinces of the Chinese mainland, ensuring the representativeness of the survey data at a national level. Each investigator was assigned to survey more than 20 subjects, thereby ensuring a total of approximately 30000 respondents. The electronic questionnaire was distributed via an online platform known as "Questionnaire Star" (accessible at https://www.wjx.cn/), and convenient sampling techniques were used to recruit participants from mainland China. To enhance representativeness and mitigate selection bias, this study employed multiple strategies: strengthening investigator training to broaden recruitment, combining with-face-to-face surveys for-some older adults or individuals with-limited digital literacy, and implementing the platform's duplicate submission prevention feature, which utilizes Internet Protocol address restrictions to ensure response independence.

We excluded participants with any of the following characteristics, logical filtering, withing 3 months after COVID-19 infection, non-COVID-19 infected individuals and repeatedly surveyed participants. Of all the 70514 screened participants in two surveys, 47464 cases were included finally in this study with 28718 cases in the first survey and 18746 cases in the second survey, respectively (Supplementary Figure S1).

Definition of long COVID

The definition of long COVID adopted in this study was based on the WHO definition and a previous study in mainland China [10, 33]. However, as symptoms data were self-reported and not medically confirmed, this approach likely overestimated the prevalence. Therefore, we adopted a stricter definition for our analysis: long COVID was defined as the persistence or emergence of two or more new symptoms at least three months after the initial SARS-CoV-2 infection, lasting for a minimum of two months without an alternative explanation.

The symptoms were basically categorized into the following six categories, including general symptoms (fatigue, joint pain, muscle pain, rash, hair loss, and other general symptoms), cardiovascular symptoms (chest pain, chest distress, palpitation, hypertension, stenocardia, and other cardiovascular symptoms), respiratory symptoms (cough, dyspnea, nasal congestion, sore throat, and other respiratory symptoms), neural symptoms (headache, dizziness, hyposmia, hypogeusia, stroke, memory loss, aprosexia, and other neural symptoms), digestive symptoms (diarrhea, constipation, nausea or vomiting, loss of appetite, and other digestive symptoms) and all other symptoms (such as urinary symptoms, endocrine symptoms, hepatic injury, dyskinesia, and any other symptoms).

Statistical analysis

Characteristics and long-term health consequences of COVID-19 survivors were presented as medians (IQRs) for continuous variables and as n (%) for categorical variables. We categorized COVID19 survivors into either long COVID or non-long COVID groups according to the presence of at least one sequelae symptom. For the comparison of characteristics between long COVID and non-long COVID groups, we used the χ^2 test, Fisher's exact test, or Mann-Whitney U test as appropriate. We visualized changes in prevalence of long COVID symptoms between 3 and 24 months after infection using line chart. To explore factors associated with long COVID, univariate logistic regression analysis was used to identify potential influencing factors. A stepwise selection process was used in multivariate logistic regression model. All tests were 2-sided, and $P < 0.05$ was considered as statistically significant. All statistical analyses were performed with the use of R software version 3.6.4 (R Project for Statistical Computing).

Results

Patient Characteristics

In this study, a total of 47464 participants were included. Among the respondents, the median age was 21 (IQR: 19–34), 62.0% participants were females, 19.5% participants had a history of chronic diseases, 35.5% participants had a history of mental diseases, 64.2% respondents had ≥ 3 doses vaccination. Statistically significant differences were observed between the long COVID groups for all characteristics except for gender and income ($P < 0.05$) (Table 1, Supplementary Table S1).

Table 1
Overall Characteristics of Participants.

	Participants, No. (%)			*P* value
	All	**no long COVID (N = 22621)**	**long COVID (N = 24843)**	
Age, median (IQR), years	21 (19–34)	20 (19–29)	22 (19–37)	< 0.001
< 18	2919 (6.1)	1656 (7.3)	1263 (5.1)	< 0.001
18–59	43762 (92.2)	20614 (91.1)	23148 (93.2)	
≥ 60	783 (1.6)	351 (1.6)	432 (1.7)	
Gender				
Male	18026 (38.0)	8663 (38.3)	9363 (37.7)	0.176
Female	29438 (62.0)	13958 (61.7)	15480 (62.3)	
Living area				
Urban	33297 (70.2)	15484 (68.4)	17813 (71.7)	< 0.001
Rural	14167 (29.8)	7137 (31.6)	7030 (28.3)	
Working status				
Employment	43071 (90.7)	21041 (93.0)	22030 (88.7)	< 0.001
Unemployment	3293 (6.9)	1134 (5.0)	2159 (8.7)	
Retirement	1100 (2.3)	446 (2.0)	654 (2.6)	
Marital status				
Unmarried or divorced, widowed	33043 (69.6)	16743 (74.0)	16300 (65.6)	< 0.001
Married	14421 (30.4)	5878 (26.0)	8543 (34.4)	
Level of education				
Less than junior college	13785 (29.0)	6387 (28.2)	7398 (29.8)	< 0.001
Junior college or higher	33679 (71.0)	16234 (71.8)	17445 (70.2)	
Per capita monthly income,				
< 1500	5348 (11.3)	2481 (11.0)	2867 (11.5)	0.063
1500–5000	26354 (55.5)	12539 (55.4)	13815 (55.6)	
> 5000	15762 (33.2)	7601 (33.6)	8161 (32.9)	

Abbreviation: IQR, interquartile range.

	Participants, No. (%)			*P* value
	All	no long COVID (N = 22621)	long COVID (N = 24843)	
Vaccine doses				
0–1	2555 (5.4)	1056 (4.7)	1499 (6.0)	< 0.001
2	14454 (30.5)	7042 (31.1)	7412 (29.8)	
3	29002 (61.1)	13820 (61.1)	15182 (61.1)	
≥ 4	1453 (3.1)	703 (3.1)	750 (3.0)	
Abbreviation: IQR, interquartile range.				

Prevalence of Long COVID

The prevalence of long COVID was 52.34% (n = 24843). Moreover, the prevalence of specific syndrome categories was as follows: general symptoms (53.56%), cardiovascular symptoms (22.42%), respiratory symptoms (36.98%), neural symptoms (43.13%), and digestive system (28.22%). The most common symptoms were fatigue (41.64%), cough (22.48%), memory loss (21.31%), sore throat (19.29%), nasal congestion (19.04%), headache (18.82%), dizziness (16.65%) and loss of appetite (14.88%). Furthermore, we stratified participants by age and gender to determine the prevalence of individual symptoms (Fig. 1).

Moreover, as the recovery time post-infection increased, the prevalence of these long COVID symptoms gradually declined. Overall, 58.2%, 23.3%, 40.5%, 47.6%, 30.7% participants reported general symptoms, cardiovascular symptoms, respiratory symptoms, neural symptoms, and digestive symptoms at 3 months after infection based on the survey data in 2023, respectively. Over time, the proportion of infected individuals reporting long COVID symptoms decreased to 49.9%, 18.8%, 33.9%, 39.2%, and 24.8% at 6 months, respectively. (Fig. 2, Supplementary Table S2).

Predictive Factors of Long COVID

The univariate and multivariate logistic analysis (unless noted otherwise, all odds ratios [ORs] are adjusted) suggested that females were significantly associated with long COVID (OR, 1.17 [95% confidence interval, CI, 1.12–1.22]) (Supplementary Table S3). Nevertheless, the females were negatively related to respiratory symptoms (OR, 0.93 [95% CI, 0.89–0.98]) (Fig. 3, Supplementary Table S4). In the sensitivity analysis, we divided the participants into three age groups and two surveys, found that females in the < 18, 18–59 age groups were positively correlated with long COVID, while no such association was observed in individuals older than 60 years (Supplementary Table S5, Table S6).

Participants aged 18–59 had significantly higher odds of long COVID compared with under 18 years old (OR, 1.21 [95% CI, 1.11–1.32]). Moreover, having any chronic diseases (OR, 2.19 [95% CI, 2.07–2.31]),

mental disorders (OR, 2.98 [95% CI, 2.85–3.11]) or infected with COVID-19 more than once (OR, 1.53 [95% CI, 1.47–1.60]) were positively related to long COVID and various classified symptoms (Fig. 3, Supplementary Table S3, Table S4). The sensitivity analysis yielded similar results. (Supplement Table S5, Table S6, Table S7).

We also analyzed the impact of lifestyle, dietary habits and living environment on long COVID as these factors were closely linked to underlying health conditions. Overall, drinking had a significantly increased risk ratio (OR, 1.23 [95% CI, 1.17–1.29]). Conversely, maintaining a regular sleep-wake (OR, 0.81 [95% CI, 0.77–0.84]), adhered to a healthier diet (combining meat and vegetable diets, OR, 0.83 [95% CI, 0.78–0.87]), consuming vegetables (OR, 0.83 [95% CI, 0.79–0.88]), dairy products (OR, 0.91 [95% CI, 0.85–0.98]), and animal foods (OR, 0.91 [95% CI, 0.86–0.96]) daily, sunbathing at home at least 5 hours per day (OR, 0.93 [95% CI, 0.89–0.98]), having a satisfactory neighborhood relationship (OR, 0.81 [95% CI, 0.75–0.87]) and community environment (OR, 0.71 [95% CI, 0.66–0.75]) demonstrated a significant negative association with long COVID (Supplementary Table S3). Sensitivity analyses stratified by age, gender and survey time confirmed that a healthy diet, positive lifestyle, and suitable living environment were inversely related to long COVID. No significant association was found between consuming dairy products, sunbathing at home at least 5 hours with long COVID in the 2023 survey, nor for daily dairy consumption in the 2024 data. Detailed results showed in the Supplementary Materials (Supplement Table S5, Table S6, Table S7).

Based on the vaccine history of the participants, we evaluated the association between vaccination and long COVID, and a significant negative association (OR < 1) was observed. First, compared with individuals who had received 0–1 dose, those who were vaccinated had lower odds of long COVID (2 doses: OR, 0.85 [95% CI, 0.77–0.93]; 3 doses: OR, 0.87 [95% CI, 0.79–0.95]; ≥4 doses: OR, 0.81 [95% CI, 0.70–0.93]) (Supplement Table S3). Second, an even stronger negative association was observed for three doses versus two doses in relation to cardiovascular and digestive symptoms (Supplement Table S4). Third, receiving booster shots (≥ 4 doses) was associated with lower odds of respiratory, nervous symptoms and digestive symptoms compared to 2 or 3 doses (Supplement Table S4). However, the 2024 survey only found an association between three vaccine doses and long COVID (Supplement Table S6). The reason might be that the survey in 2024 took place too long after the vaccination, to the point where the vaccine no longer had a protective effect. Additional associated factors were residing in rural areas, working status and marital status (Fig. 3, Supplement Table S3).

Specifically, for different categorize of symptoms, the impact of the aforementioned factors is basically consistent with their impact on the overall population except for some subtle differences. Keeping a regular sleep-wake was not significantly correlated with cardiovascular symptoms. A negative association was observed between daily dairy consumption and neural symptoms only. No such association was found for daily sunbathing (≥ 5 hours) with respiratory symptoms. Conversely, daily vegetable and animal food intake, satisfactory neighborhood relationships, and a good community environment were all inversely related to all symptom categories. In contrast, drinking, chronic or mental

diseases, and multiple COVID-19 infections showed positive correlations with all categorize of symptoms (Supplementary Table S4).

Discussion

The current understanding of long COVID prevalence and its associated factors in China is remains limited. In this study, we assessed the long-term effect of 28718 and 18746 Chinese residents, in August 2023 and 2024 respectively. Our findings delineated the epidemiological characteristics of long COVID and identified multiple related exposure factors. Overall, 52.34% of participants reporting long COVID symptoms. This study identified multiple related factors and provided valuable insights for identifying and monitoring of populations susceptible to long COVID.

Before this study, there were limited data on the prevalence of long COVID at 2 years after the wave of Omicron infections in 2022. Studies have reported varying prevalence at different time points after acute infection, such as 54% at 3 years [16], 8.89% at 6 month [21], 12.7% at 90–150 days [17], 32.6% at 60 days [34], 87% at 60 days [35], and 96% at 90 days [36]. Consistent with our findings, a previous study of 74075 Chinese participants have investigated the symptoms and influencing factors of COVID-19 among and found that the prevalence of at least one long-term symptom over one year was as high as 49% [33].

Many cross-sectional and cohort studies have identified fatigue as the most frequently reported symptom following recovery from acute COVID-19, with reported prevalence varying widely, such as 80.2% [37], 63.7% [27], 3.38% [21], 33.7% [23], 25.3% [20] and 52.2% [19]. The prevalence in our study (41.46%) was consistent with rates reported in other long COVID studies conducted in China [12, 14]. Furthermore, our findings aligned with prior research indicating that symptoms such as headache [15, 27, 37–40], memory loss, and difficulty concentrating (aprosexia) [15, 19, 20, 27, 39] are commonly reported in long COVID.

Pre-existing medical conditions were associated with long COVID, such as asthma [22, 41], type 2 diabetes [42], hypertension [43], poor mental health [40, 44] and autoimmune diseases [33]. Our research showed that have any common chronic diseases or mental disorders were positively associated with long symptoms (OR > 2).

Multinational evidence has indicated that advanced age was positively related to long COVID [19, 36, 45]. In contrast, two studies in the US [46] and China [21] have reported negative association between long COVID with older age (≥ 60, > 64 years). Our research showed that individuals aged 18–59 were linked to a higher prevalence of long COVID than those under 18, whereas individuals aged 60 or above were associated with a lower prevalence. Multiple studies have also observed positive association between long COVID and female [18–21, 23, 25, 27, 33, 37, 40, 43, 46–51], which was similar to our results.

Before the SARS-CoV-2 virus became widely prevalent in China, the majority of people had already been vaccinated against COVID-19. Our findings suggested a negative correlation between COVID-19

vaccination (≥ 2 doses) and long COVID. This aligned with prior research in China suggesting that vaccinated patients had a significantly negative association with long COVID [23, 33].

Compared to other studies, nutritional status and living environment were two important modifiable factors that our study particularly focuses on. Nutritional status had a direct bearing on inflammation and, subsequently, on the immune response. Therefore, a diversified and balanced diet can contribute to the improvement of the immune response to viral infections such as SARS-CoV-2 [52]. In this study, several lifestyle factors including a healthier diet, daily intake of vegetables, dairy, and animal foods, and a regular sleep-wake showed significant correlations with long COVID. This finding suggested that healthy and nutritionally balanced diet not only improve the immune response to viral infections such as SARS-CoV-2 [53], but also might be negatively related to long COVID. Similarly, a comfortable indoor and outdoor environment was equally beneficial to both physical and mental health. The worldwide population have been under stressful situations due to the ongoing COVID-19 pandemic. Modern life, with daily stress, sleep deprivation and an unbalanced diet, can contribute to the initiation of a chronic low-inflammation status, which can negatively affect the immune system. A satisfying community environment and neighborly relations can reduce stress and elevate one's mood. Our research data confirmed that sunbathing at home at least 5 hours per day, a satisfactory community environment and neighborhood relations were inversely related to long COVID.

From a public health perspective, our results have several implications. Protective lifestyle and environmental factors point to actionable community strategies. Programs promoting nutrition and sleep hygiene may help prevent long COVID at the population level. Sustained vaccination campaigns remain critical, not only for acute COVID-19 but also to reduce long-COVID sequelae. The high prevalence among women, aged adults, and individuals with pre-existing conditions calls for the integration of long COVID screening and management into routine primary care. A national long-COVID surveillance system would further enable timely monitoring and response.

Limitations

Although this study was relatively large scale as compared to other surveys, this study had several limitations. First, due to the nature of this study being cross-sectional, causal relationships cannot be established. Nevertheless, the objective of this study was to identify related factors instead of causes of long COVID. Second, the questionnaire survey employed convenience sampling conducted by student investigators via social networks, which may introduce bias in the demographic characteristics of the sample. For instance, it may lead to an over-representation of younger, highly educated individuals, or those connected to student social circles, and may ignore the elderly and young children unfamiliar with electronic devices. The elderly demographic, who potentially bears a significantly greater burden of both COVID-19 and its long-term symptoms, was inadequately represented in this study. This selection bias may limit the generalizability of the study's findings to a broader and more diverse population. Third, the survey data were based on the respondents’ self-perceptions of long COVID symptoms, rather than on accurate objective clinical assessment, which may result in overestimation or underestimation of

symptoms prevalence. Even with the use of a stricter definition of long COVID, the reported prevalence may still be overestimated. In addition, the questionnaire includes 35 common long COVID-19 symptoms and the proportion of female participants in our study (62.0%) was higher than previous study [33], which may lead to overestimation of the prevalence of long-term COVID-19. Future studies on the prevalence of long COVID in a large population that is representative of China and utilizes probability-based sampling strategies are warranted.

Conclusions

This study found that more than half of the survey respondents had long COVID symptoms after the nationwide large-scale infection of Omicron. Moreover, as the recovery time post-infection increased, the prevalence of these symptoms gradually declined. Multiple related factors for long COVID were identified, including sociodemographic characteristics, lifestyle, medical history, dietary habits, and living environment. Long COVID will remain a global challenge to health care system and economy. In order to effectively deal with long COVID, it is crucial to strengthen the diagnosis and treatment of long COVID and raise public awareness of the identified risk and protective factors.

Abbreviations

Abbreviation	Full Term
CI	Confidence interval
IQRs	Interquartile ranges
ORs	Odds ratios
World Health Organization	WHO

Declarations

Ethics approval and consent to participate

This cross-sectional study was approved by the Ethics Committee of Hebei Medical University (2023001). Informed consent was obtained from all participants or their legal guardians prior to the survey. The research was conducted in compliance with the principles of the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors contribution

Concept and design: M.Y.L., Y.X.M.; Acquisition of data: Y.J.W., Y.J.Z., J.F.L., J.L., X.Z.; Data collection and cleaning: Y.J.W., J.F.L., J.L.; Statistical analysis and data visualization: X.L.R., Y.Y., Z.W.L., Z.C.Z., X.L.Z., X.Z.; Writing original draft: X.L.R., Y.Y., Y.X.M., M.Y.L.; Review and editing: M.Y.L., Y.X.M., X.L.Z. All authors read and approved the final manuscript.

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Figures

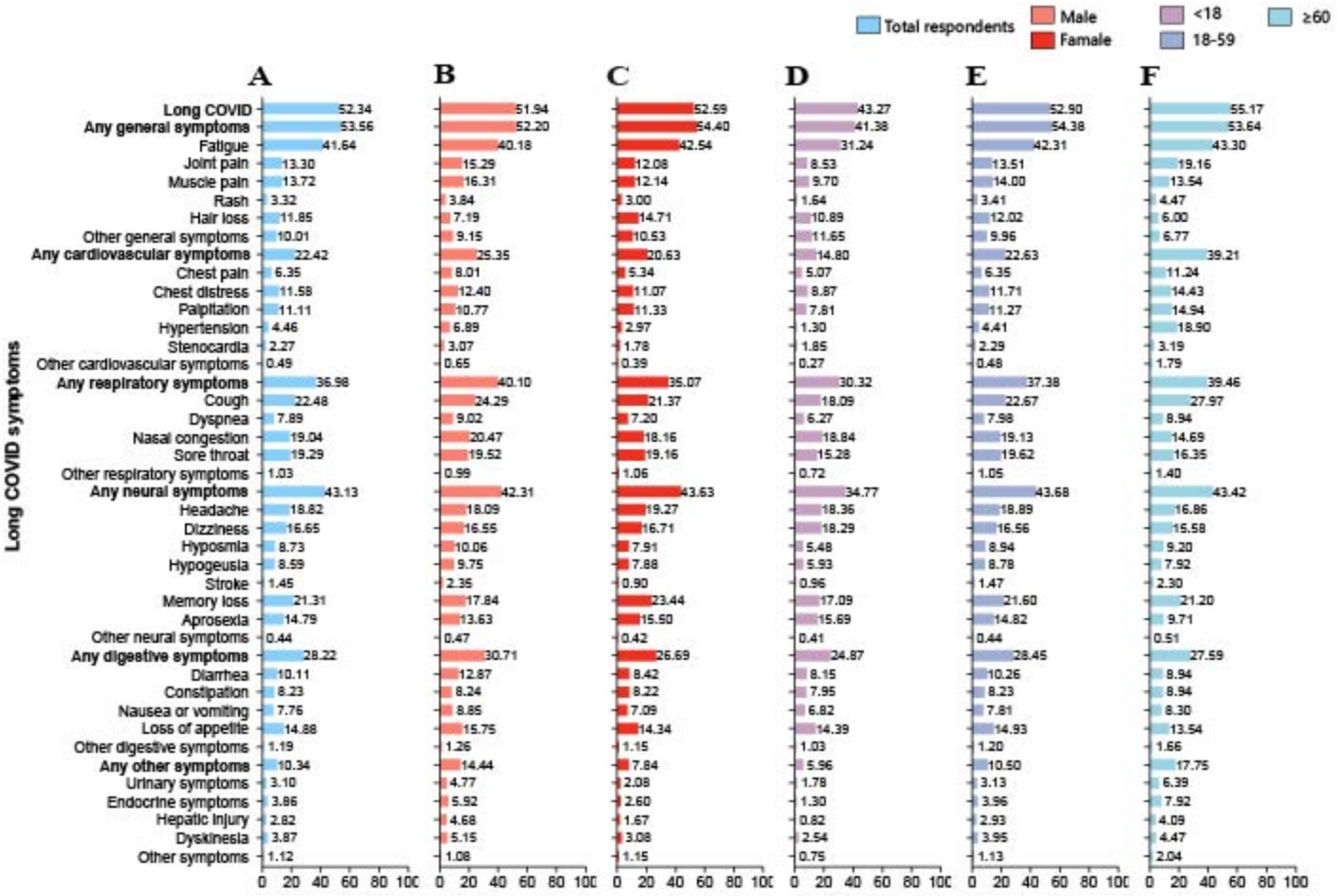

Figure 1. Prevalence of long COVID symptoms based on total respondents(A), different gender (B–C) and age group (D–F)

Figure 1

Prevalence of long COVID symptoms based on total respondents(A), different gender (B–C) and age group (D–F).

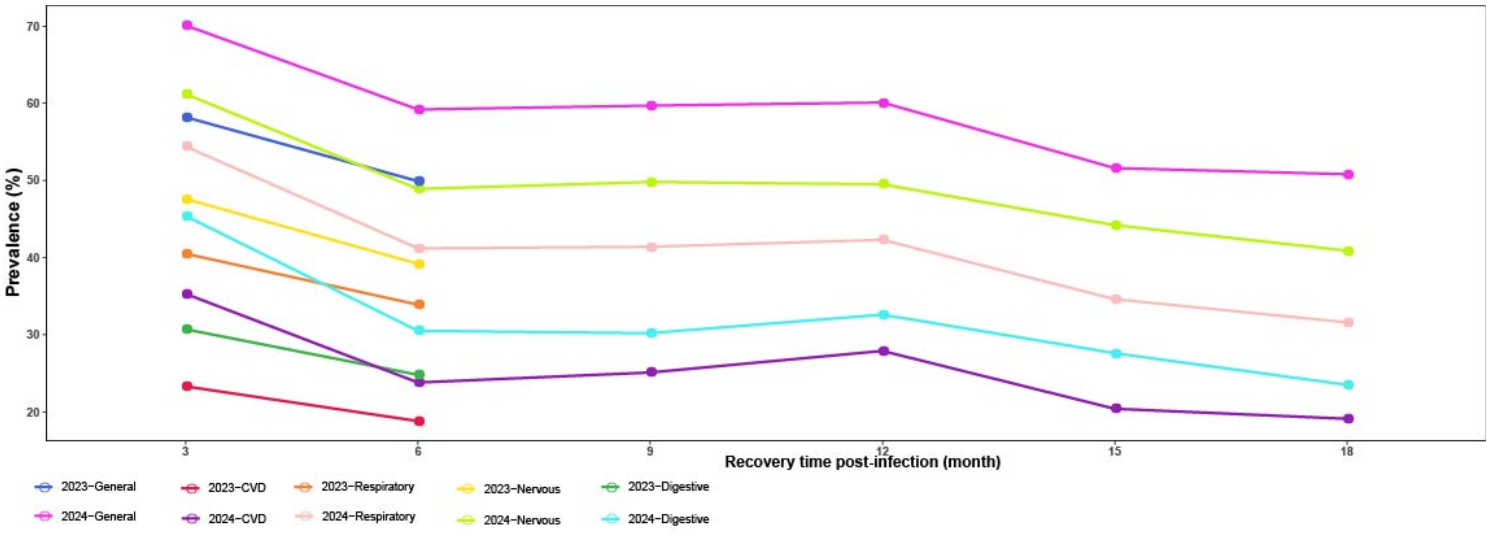

Figure 2. Prevalence of long COVID symptoms based on two surveys over time

Figure 2

Prevalence of long COVID symptoms based on two surveys over time.

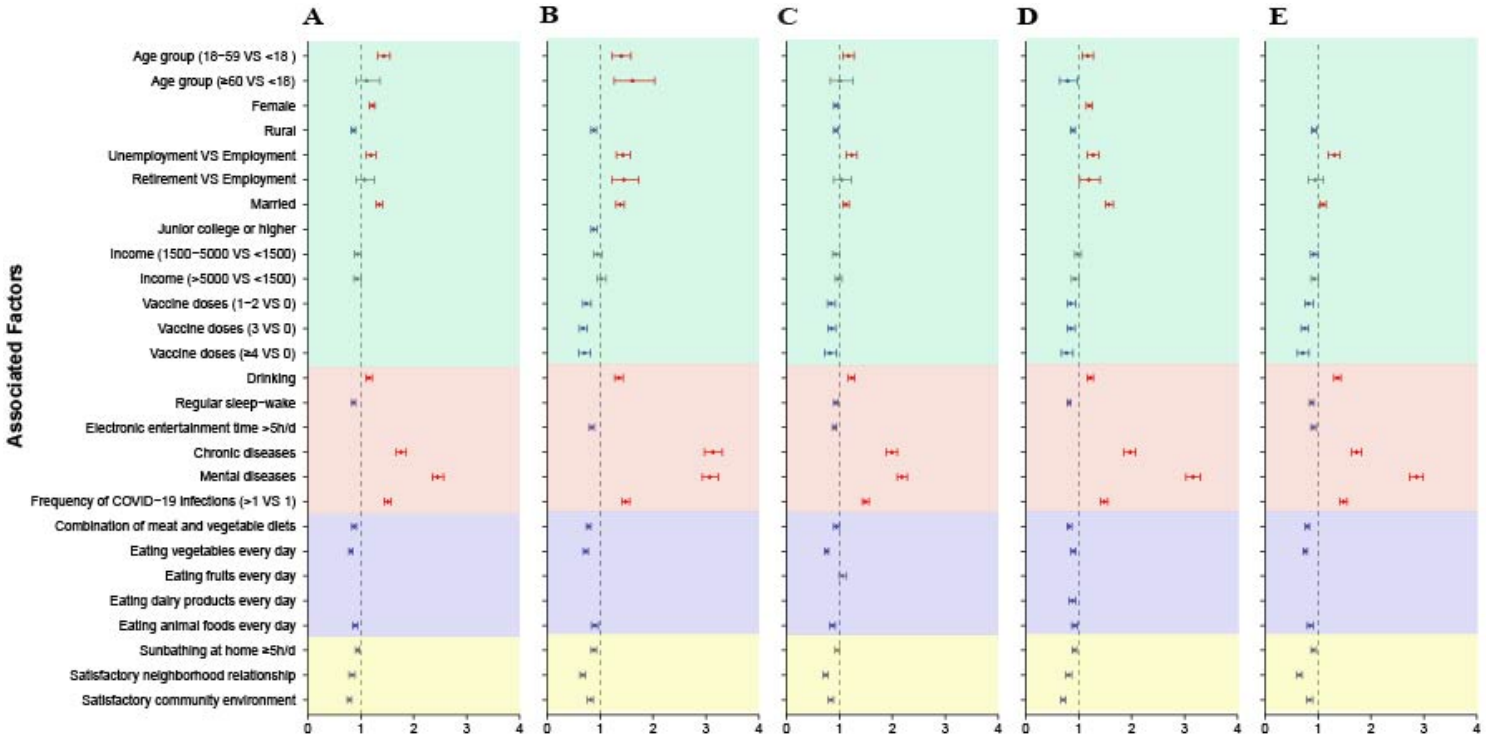

Figure 3. The impact of related factors to long COVID symptoms. (A) General symptoms (B) Cardiovascular symptoms (C) Respiratory symptoms (D) Neural symptoms (E) Digestive symptoms

Figure 3

The impact of related factors to long COVID symptoms. (A) General symptoms (B) Cardiovascular symptoms (C) Respiratory symptoms (D) Neural symptoms (E) Digestive symptoms.

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