Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Global health and human well-being are continuously challenged by the ongoing coronavirus disease 2019 (COVID-19) pandemic. Considering the high number of patients who recovered from COVID-19 worldwide, the health status and the sequelae after recovery, not only in the acute phase of infection, deserve comprehensive attention. Evidence that patients with COVID-19 still have long-term symptoms 1–6 months after hospital discharge indicates that COVID-19 infection can affect multiple organ systems, including the heart, liver, kidneys, muscle, digestive, and nervous functions, not just the respiratory system [1–3]. Furthermore, potential risk factors associated with long-term outcomes for convalescents have also been identified, such as sex, age, body mass index, and disease severity [4–5]. However, only a few studies have focused on the self-body perception of convalescents, whereas blood samples were collected for clinical laboratory assessments, including 55 indicators of hemocyte subgroups and multiple organ-related biochemistry. This study potentially provides a more comprehensive understanding of the COVID-19 prognosis (see Supplementary materials online for detailed methods).

Participants included in this study were patients with COVID-19 (n = 136) infected at the early stages of the pandemic in early 2020 in Macheng, Hubei, China, and a sample of controls without COVID-19 (n = 125). Of the healthy controls, 35 were from the same residential community where the patients reside, and the other 90 were recruited as clear controls in Beijing at the end of 2020, where no cases were reported. Participants in the three follow-ups included asymptomatic, mild, moderate, severe, and critical cases diagnosed during their acute phase (Table S1 online). The questionnaire includes 30 indicators focused on COVID-19 convalescents, whereas blood samples were collected for clinical laboratory assessments, including 55 indicators of hemocyte subgroups and multiple organ-related biochemistry. The questionnaire includes 30 indicators focused on COVID-19 convalescent symptoms 1 year and 2 years post-discharge. About 60.5% (46/76, 95% confidence interval [CI]: 49.5%–71.5%) of visits, epidemiological questionnaires were used to investigate the subjective feelings of convalescents, whereas blood samples were collected for clinical laboratory assessments, including 55 indicators of hemocyte subgroups and multiple organ-related biochemistry. This study potentially provides a more comprehensive understanding of the COVID-19 prognosis (see Supplementary materials online for detailed methods).

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The questionnaire includes 30 indicators focused on COVID-19 convalescent symptoms 1 year and 2 years post-discharge. About 60.5% (46/76, 95% confidence interval [CI]: 49.5%–71.5%) of
COVID-19 convalescents still reported at least one symptom 1 year post-recovery, and 47.5% (38/80, 95% CI: 36.6%–58.4%) reported symptoms at 2 years. At 1 year, the discomforts mainly include fatigue (25/76, 33.9%), myasthenia (19/76, 25.0%), hair loss (17/76, 22.4%), and sleep difficulties (14/76, 18.4%), which are similar to data from previous COVID-19 1-year long-term follow-up [6]. A longitudinal cohort study of COVID-19 survivors showed that 68% of patients had at least one sequelae symptom at 6 months, which decreased to 49% at 12 months post-COVID-19 infection [7]. Simultaneously, inpatient medical records of participants were collected in the acute phase, and results showed that the proportion of patients with underlying diseases was much lower than...
those with discomfort during the follow-up (Table S2 online). Furthermore, we found that 22 (28.9%) 1-year convalescents presented circulatory symptoms (chill, sweat, palpitations, etc.), 19 (25.0%) physical pain (joint pain, myalgia, chest pain, or headache), and 16 (21.1%) respiratory system-related symptoms (chest distress, shortness of breath, etc.). At 2 years, fatigue (15/80, 18.8%), muscle weakness (7/80, 8.8%), and hair loss (7/80, 8.8%) ratios were significantly lower ($P = 0.0431$, 0.0065, and 0.0185, respectively). Most 2-year symptoms decreased compared with 1 year (Table 1).

In general, alopecia can be attributed to systemic diseases, febrile disease, drugs, stressful events, and nutritional deficiencies, among others [8]. This form of chronic alopecia might be caused by multiple factors, including physical infection, psychosocial factors, and even drug therapy [9]. A systematic review of psychiatric effects of the COVID-19 pandemic showed a series of manifestations of mental symptoms about the disease complications, such as stigma, forgetfulness, or traumatic memories of severe illness among people infected with COVID-19 [10]. Especially, the so-called “stress-sensitive” scalp conditions can be affected by increased psychosocial pressures. In our study, most hematologic indicators related to blood cell counts of COVID-19 convalescents are in a relatively normal state, such as most of the white blood cell and platelet counts. Numerically, the red blood cell and most related indicators (hemoglobin, red blood cell distribution width-coefficient of variation, mean corpuscular hemoglobin) showed statistical differences between the convalescents and healthy controls, and the 2-year indicators were closer to the healthy controls than 1 year. The overall abnormal rates of red blood cell counts were 26.4% (20/76) and 8.5% (5/59) in 1- and 2-year convalescents, with a statistical difference ($P = 0.0149$). However, compared with 1 year, the 2-year proportion of mean corpuscular volume above the normal range significantly increased from 2.6% (2/76) to 37.3% (22/59) ($P < 0.0001$).

As for the white blood cells, the total count in convalescents was not different from that of healthy controls and was basically within the normal range. The abnormal white blood cell count rate decreased from 18.4% (14/76) to 10.2% (6/59). Most platelet values were within the normal range and showed no difference between 1 year and 2 years. Regarding the abnormal rates, 1- and 2-year platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively. The percentage of mean platelet volume below platelet abnormalities were similar, i.e., 14.5% (11/76) and 15.3% (9/59), respectively.
(P < 0.05), with abnormal rates of 17.1% (13/76), 19.1% (12/63), and 22.0% (13/59), respectively. The average troponin I level shows a downward trend from 6 months to 2 years, with abnormal (higher) rates of 20.6% (7/76) at 6 months, 0 at 1 year, and 1.7% (1/59) at 2 years. The overall myoglobin trend gradually increases over time with the abnormal lower rates of 64.7% (22/34) at 6 months, 55.9% (19/34) and higher 5.9% (2/63) at 1 year, and 8.5% (5/59) at 2 years (Fig. 1e, f and Table S4 online). Myocardial injury and inflammatory response-related indicators, such as creatine kinase, lactate dehydrogenase, troponin I, pro-brain natriuretic peptide, and C-reactive protein, are significantly higher in patients with COVID-19 at an acute stage. In our study, continuous follow-up data showed that the majority of 1- and 2-year COVID-19 convalescents had normalized these indicators, particularly troponin I. Some participants with critical troponin I levels in 6 months gradually confluent with healthy levels at 1 and 2 years. During the dynamic tracking of some biochemical markers at 6 months to 2 years post-COVID-19, the conclusion of abnormal lipid metabolism and myocardial function impairment was confirmed during the recovery period (Fig. S1c online), which verified the conclusion of a pro-

### Table 1

Symptoms of the COVID-19 convalescents during 1 year and 2 years follow-ups.

| Item                                | 1 year n = 76 | 2 years n = 80 | P-value<sup>c</sup> |
|-------------------------------------|---------------|----------------|---------------------|
| Post-discharge discomfort, <sup>b</sup> n (%) | 46 (60.5)     | 38 (47.5)      | 0.103               |
| Fatigue                             | 25 (33.9)     | 15 (18.8)      | 0.043<sup>c</sup>   |
| Muscle weakness                     | 19 (25.0)     | 7 (8.8)        | 0.007<sup>c</sup>   |
| Hair loss                           | 17 (22.4)     | 7 (8.8)        | 0.019<sup>c</sup>   |
| Sleep difficulties                  | 14 (18.4)     | 17 (21.3)      | 0.658               |
| Hypertension                        | 12 (15.8)     | 10 (12.5)      | 0.555               |
| Decreased appetite                  | 3 (3.9)       | 4 (5.0)        | 1.000               |
| Taste disorder                      | 1 (1.3)       | 3 (3.8)        | 0.621               |
| Smell disorder                      | 1 (1.3)       | 6 (7.5)        | 0.117               |
| nMRC score, <sup>d</sup> n (%)      |               |                |                     |
| 0                                   | 45 (59.2)     | 60 (75.0)      | 0.036<sup>c</sup>   |
| 1                                   | 27 (35.5)     | 15 (18.8)      | 0.018<sup>c</sup>   |
| 2                                   | 3 (3.9)       | 5 (6.3)        | 0.720               |
| 3                                   | 1 (1.3)       | 0              | 0.487               |
| 4                                   | 0             | 0              | Not applicable      |
| Pain, n (%)                         | 19 (25.0)     | 10 (12.5)      | 0.045<sup>c</sup>   |
| Joint pain                          | 7 (9.2)       | 2 (2.5)        | 0.092               |
| Myalgia                             | 6 (7.9)       | 2 (2.5)        | 0.159               |
| Chest pain                          | 5 (6.6)       | 1 (1.3)        | 0.110               |
| Headache                            | 2 (2.6)       | 6 (7.5)        | 0.278               |
| Circulatory symptoms, n (%)         | 22 (28.9)     | 11 (13.8)      | 0.020<sup>c</sup>   |
| Feeling cold                        | 17 (22.4)     | 3 (3.8)        | 0.001<sup>c</sup>   |
| Excessive sweating when mild exercise/rest/sleep | 11 (14.5) | 7 (8.8) | 0.263               |
| Palpitations                        | 6 (7.9)       | 0              | 0.012<sup>c</sup>   |
| Arrhythmia                          | 2 (2.6)       | 3 (3.8)        | 1.000               |
| Respiratory symptoms, n (%)         | 16 (21.1)     | 24 (30.0)      | 0.201               |
| Chest distress                      | 10 (13.2)     | 6 (7.5)        | 0.244               |
| Shortness of breath                 | 6 (7.9)       | 7 (8.8)        | 0.847               |
| Cough                               | 4 (5.3)       | 8 (10.0)       | 0.267               |
| Sore throat or foreign body sensation | 4 (5.3)     | 2 (2.5)        | 0.434               |
| Sensitive to dust                   | 0             | 1 (1.3)        | 1.000               |
| Gastrointestinal symptoms, n (%)    | 9 (11.8)      | 2 (2.5)        | 0.023<sup>c</sup>   |
| Hematochezia                        | 2 (3.9)       | 0              | 0.113               |
| Constipation                        | 3 (3.9)       | 1 (1.3)        | 0.358               |
| Nausea                              | 2 (2.6)       | 1 (1.3)        | 0.613               |
| Hemolymphatic symptoms, n (%)       | 7 (9.2)       | 0              | 0.006<sup>c</sup>   |
| Gum bleeding                        | 6 (7.9)       | 0              | 0.012<sup>c</sup>   |
| Jaundice                            | 2 (2.6)       | 0              | 0.236               |
| Urinary symptoms, n (%)             | 6 (7.9)       | 3 (3.8)        | 0.319               |
| Copious                             | 3 (4.0)       | 1 (1.3)        | 0.358               |
| Dysuria                             | 1 (1.3)       | 1 (1.3)        | 1.000               |
| Urinary calculi                     | 1 (1.3)       | 0              | 0.487               |
| Limb edema                          | 1 (1.3)       | 0              | 0.487               |
| Proteinuria                         | 0             | 1 (1.3)        | 1.000               |
| Comorbidities, n (%)                | 23 (30.3)     | 16 (20.0)      | 0.139               |
| Hypertension                        | 10 (13.2)     | 8 (10.0)       | 0.537               |
| Diabetes                            | 5 (6.6)       | 4 (5.0)        | 0.741               |
| Chronic gastric disease             | 3 (3.9)       | 2 (2.5)        | 0.676               |
| Chronic pharyngitis                 | 3 (3.9)       | 1 (1.3)        | 0.358               |
| Chronic liver disease               | 2 (2.6)       | 2 (2.5)        | 1.000               |
| Cardio-cerebrovascular diseases     | 2 (2.6)       | 2 (2.5)        | 1.000               |
| Lung cancer                         | 2 (2.6)       | 2 (2.5)        | 1.000               |

<sup>a</sup> P value of Chi-square/Fisher’s exact test between 1 year and 2 years.

<sup>b</sup> Overall proportion of convalescents who reported at least one discomfort after discharge.

<sup>c</sup> There are significant differences between the two time points (α = 0.05).

<sup>d</sup> mMRC score: modified British Medical Research Council score. Percentages may not add up to exactly 100% due to rounding. The higher the score (range 0–4), the more severe the dyspnea.
teomic analysis by Chen et al. [15]. In particular, triglyceride levels in convalescents tended to deviate more from normal over time.

To investigate the potential impact of the disease severity of the patients during the acute phase on the duration and health status of after recovery, we conducted stratified analysis and the results showed that few significant differences were found among the patients with different severity (Fig. S2 online).

Since the COVID-19 outbreak, the clinical characterization of COVID-19 convalescents showed a certain level of sequelae persistence [2]. We gathered characteristics and laboratory test results from the first group of patients with COVID-19 during the pandemic in their convalescent stage from 6 months to 2 years post-recovery. Overall, the convalescents had well physical recovery from their illness, and most of convalescent indicators were within the normal range, with some markers observed moving closer to healthy levels over time from 1 to 2 years post-recovery. However, some convalescents still had physical symptoms and showed incomplete recovery of some blood parameters (e.g., triglyceride, myoglobin, alkaline phosphatase).

Our study has several limitations. First, although over 50% of the patients in Macheng have been recruited within our convalescent cohort in the study, the sample size is still small, especially considering the ones who fully participated in all three consecutive follow-up visits. However, when participants at all three consecutive follow-up visits were extracted for additional analysis, findings were consistent with that of the existing results (Table S5, Fig. S3 online). Second, the healthy controls in this study did not match well with the COVID-19 convalescents, especially the concomitant diseases. Nevertheless, this study mainly used the before-after self-comparison based on the longitudinal results involving 6 months to 24 months. Furthermore, we used both data from the healthy populations from the local community of Macheng and Beijing where no epidemic was reported in early 2020. Third, the presence or absence of symptoms was investigated solely based on the questionnaire.

This study involved a cohort of COVID-19 convalescents who recovered from the first wave of the pandemic and examined both symptoms and accessible laboratory tests. We found that during the period from 6 months to 2 year-recovery, most of the health indicators recovered, but some did not fully return to normal. Through the long-term follow-up, this study provides new insights into the prognosis of COVID-19 patients. Broader follow-up populations of COVID-19 and long-term longitudinal studies are needed to further address the continuing effects of SARS-COV-2 in convalescents.

Author contributions

Guizhen Wu, William J. Liu, and George F. Gao designed and supervised the study. Hao Lin, Xueyuan Liu, Jie Zhang, and Xayin Guo designed the questionnaire. Jie Zhang, Xueyuan Liu, Maoshun Liu, Lei Li, Jinmin Tian, and Xayin Guo collected the samples and conducted field investigations. Heiqiang Sun, Jie Zhang, Xueyuan Liu, Hao Lin, and Maoshun Liu conducted the sample processing and testing. Hao Lin, Xueyuan Liu, Lei Li, Maoshun Liu, Jinmin Tian, Jinxian Gan, Zhangfu Chen, Xin Wang, Ying Lin, and Danni Zhang conducted data entry. Shaobo Dong, Yaning Liu, Xiaoshan Zhang, Peipei Liu, Ke Xu, Xuantian Zhou, and Hao Liang provided technical support and investigation assistance. Hao Lin, William J. Liu, and Xueyuan Liu analyzed and interpreted data. Hao Lin, William J. Liu, and Heiqiang Sun wrote the initial draft of the manuscript. All authors contributed intellectually and approved the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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Appendix A. Supplementary materials

Supplementary materials to this short communication can be found online at https://doi.org/10.1016/j.scib.2022.06.025.

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