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QUALITY OF HEALTH OF HOSPITALIZED COVID-19 PATIENTS IN THE POST-COVID PERIOD: TWO-YEAR FOLLOW-UP STUDY

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Accumulating evidence indicates a high prevalence of long-term negative consequences of COVID-19. Their final assessment is possible only after their complete disappearance, which, given the ongoing registration of negative assessments of the health status of some hospitalized COVID-19 patients, is impossible in the near future. Taking this into account, further study of post-Covid consequences in dynamics is relevant. **The purpose of the study** was to determine the quality of life and health of patients in the long-term period (24 months) after hospitalization for COVID-19-associated pneumonia. **Material and methods.** The study was conducted on data from 158 patients with moderate and severe severity who were hospitalized during the first wave of coronavirus infection in the period 09/01/2020-11/30/2020. To assess the quality of life in the post-Covid period the VR-12 questionnaire was used. The study involved conducting structural and frequency analysis, assessing the consistency of answers to the questionnaire using Cronbach's alpha and the chi-square test, calculating the nonparametric Spearman rank correlation coefficient, and non-serial correlation coefficients. To identify factors influencing health assessments, a linear regression model was built. Ordered logistic regression was estimated to identify factors influencing the distribution of responses to additional questions. **Results.** The analysis showed an insignificant difference between the physical component summary (PCS) and mental component summary (MCS) of the respondents. A connection was found between age and the risk of deterioration in self-esteem of health. It was possible to identify a significant difference in the self-assessment of the quality of physical and mental health in men and women, taking into account adjustment for age, two years after suffering from pneumonia, and also to substantiate the non-significance of RDS during hospitalization, given the significance of a high percentage of lung damage for the lower self-assessment of health of persons who had suffered coronavirus infection of moderate and severe severity. **Conclusion.** The results are largely consistent with studies conducted in other countries, indicating an uneven change in post-Covid consequences and emphasizing the importance of individual recovery programs taking into account the severity of the disease, age and gender of patients.

Keywords: post-Covid consequences, long-COVID, VR-12, mental health index, physical component summary, mental component summary.

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Introduction. The COVID-19 coronavirus pandemic has led to a significant increase in the number of hospitalizations, deaths and related complications in the acute period of the disease [5]. Long-term symptoms were already shown in the first year of the disease, such as persistent anosmia, weakness, fatigue, shortness of breath and others, which were detected in 80% of cases after the disease and significantly reduced life expectancy [15]. Cases of persistence of these symptoms for more than 2 months after more than 3 months from the moment of illness began to be isolated separately and were subsequently defined as long-COVID syndrome [4]. In addition to the noted symptoms, patients with long-COVID were more likely to experience adverse pulmonary events such as progression of pulmonary fibrosis and respiratory failure, as well as cardiovascular consequences - an increase in the frequency of sudden deaths, atrial fibrillation, heart failure, myocardial infarction and strokes [14, 18]. These consequences together determined a lower quality of life and more frequent use of medical care after discharge in people with long-COVID compared with those without long-term symptoms [13]. However, , a small proportion of those who were unable to fully return to work remains even after two years [26]. All this leads to higher estimates of the economic burden, determined not only by rising health care costs, but also by declining labor productivity.

A particular challenge in research on long-COVID syndrome arises from its heterogeneous clinical picture and corresponding symptoms [21]. Systematic reviews [20, 23] and meta-analyses [8] contribute to the synthesis of the results of numerous studies. In order to study the long-COVID syndrome more deeply, both diagnostic studies in outpatient settings and various surveys (EQ-5D-5L, SF-36, VR-12, PHQ-9 and others [19]) were conducted on purpose of better understanding quality of life and psychological status of COVID-19 survivors. It is believed that post-Covid symptoms persist from 3 months to 2 years in 80% of patients [9]. Recent studies compare the conditions of people who have had COVID over the past two years [22]. After 2 years, most studies report improvement in the condition of COVID survivors [11], but still worse than in the control group [19]. However, those with severe disease course, and especially those who required hospitalization and intensive care unit stay,

had a higher incidence of persistent symptoms [25]. Moreover, at a 2-year follow-up, the number of difficulties/problems at work decreased in comparison to the 1-year follow-up period [26].

It should be noted that both the presence of post-Covid complications and long-COVID symptoms significantly reduce the quality of life of patients [6]. At this point in time, in the Russian Federation there is an insufficient number of studies on this topic [2].

The aim of the study: to study the quality of life and health of patients in the long-term period (24 months) after hospitalization for COVID-19-associated pneumonia.

Methods. The study included 400 patients hospitalized at the BSMU clinic in 2020 for COVID-19-associated pneumonia of moderate and severe severity in the period 01.09.-30.11.2020 in the first wave of coronavirus infection. To assess the quality of life in the post-Covid period of patients hospitalized for COVID-19, the international questionnaire VR-12 was used. The choice of this scale as the main analysis tool was due to three reasons: firstly, the questionnaire allows you to assess both the physical and mental health of the respondent, and secondly, it is quite short - it includes only 12 questions, unlike broad surveys VR-36 or SF-36, thirdly, the questions have multiple answer options corresponding to a three-point to six-point Likert scale, which increases the reliability of the survey results.

Official permission was obtained from the authors for the use of the VR-12 scale in this study [12]. The VR-12 questionnaire “The Veterans RAND 12 Item Health Survey (VR-12)” is a standardized questionnaire developed based on the RAND 36 Veterans Health Survey (VR-36), which in turn was developed based on the RAND SF-36 MOS version 1.0 ." VR-12 contains 14 questions, 12 of which are basic and constitute an assessment of the health status of the respondent. Based on the answers to 6 questions of the questionnaire (1, 2a, 2b, 3a, 3b, 5), after recoding, a summary indicator of physical health (PCS index) was determined, taking into account both the respondent’s general perception of his health and physical limitations and problems, including presence of physical pain. Based on responses to the other 6 questions (4a, 4b, 6a, 6b, 6c, 7), a mental health composite score (MCS index) was calculated, taking into account role limitations due to emotional problems, energy fatigue, social functioning and mental health. Both indices (PCS and MCS) could take a value in the range of 0-100 points, where 100 corresponded to an absolute indicator of health, and 0, on the contrary, to the absence of health in the questionnaire. If the respondent refused to answer any of the questions, then some of the answers could be restored: for pairs of answers 2a and 2b, 3a and 3b, 4a and 4b, 6a and 6b, if one of them was missed, the score was restored according to the answer to the second question.

Even more, additional questions 13 and 14 should be noted (8 and 9 in the questionnaire), that are not taken into account in the health quality assessment indices, which made it possible to modify them in comparison with the original questions of the VR-12 scale, based on the purpose of the study: 8. “How would you assessed your health now compared to what it was immediately after being discharged from the Covid hospital?”; 9. “How would you rate your emotional problems now compared to what they were like immediately after leaving the Covid hospital? (for example, a state of depression or anxiety).” To answer these questions, five options were offered according to a Likert scale.

Based on the data from electronic medical records of patients at the BSMU clinic in Ufa who were hospitalized during the period 09.01.2020-11.30.2020 for viral pneumonia caused by COVID-19, an electronic database was created. The observational study was a continuous retrospective one. The following information was collected for the selected patients: gender, age, body mass index, duration of hospitalization, presence of respiratory distress syndrome, percentage of lung damage based on computer tomography data, transfer of the patient to invasive or non-invasive ventilation, presence of concomitant diseases (arterial hypertension, diabetes mellitus, chronic renal failure, chronic heart failure, history of stroke or myocardial infarction, chronic obstructive pulmonary disease). The assessment of health quality based on the VR-12 questionnaire was carried out in the period 1.11.2022-25.11.2022 through a telephone survey. To make it easier to fill out the questionnaire and increase the speed of the survey, special software was developed, implemented using the cross-platform execution environment “Nodejs” in the JavaScript language. To interact with the database, the SQL Server database management system was chosen; access was achieved by creating an external tunnel using the ngrok service.

As a result, out of 400 selected patients, it was not possible to reach 157 by telephone, and 42 patients refused to answer the questionnaire; 11 patients were reported by relatives about their death. Of 190 remaining respondents who began the survey, only 152 answered all questions in the survey. For 6 respondents, it was possible to restore the missing answers according to the rules of the questionnaire. As a result, complete information according to the VR-12 questionnaire was collected on 158 patients (68 men and 90 women) hospitalized two years ago with viral pneumonia in the COVID hospital.

The study was conducted in compliance with the Declaration of Helsinki and was approved by the local ethics committee of the Federal State Budgetary Educational Institution of Higher Education BSMU of the Ministry of Health of Russia, protocol No. 5 of May 20, 2020. All patients signed informed consent to participate in the study.

For statistical analysis of the obtained questionnaire data, we used the capabilities of the statistical data analysis environment R (version 4.3.1), namely the libraries “MASS”, “caTools”, “erer”, “dplyr”, “DescTools”. To assess the distribution of the PCS and MCS indices, the frequency of responses to the questionnaire, and the analysis of demographic and clinical characteristics of the respondents, the median (me), interquartile range (IQR: Q1 – Q3) and frequency of occurrence were calculated, respectively. To visualize the distribution of answers to questions, a hitmap and distributions of PCS and MCS indices – histograms and boxplots – were built. The assessment of the consistency of answers to questionnaire questions forming indices of physical and emotional (mental) health was checked using Cronbach's α, considering that if its value is statistically significantly different from zero, then the answers are consistent. To assess differences in the distribution of answers to questions 8 and 9 of the VR-12 questionnaire, the chi-square test was used.

To assess the relationship between the PCS and MCS indices and various factors (age, body mass index and percentage of lung damage), the nonparametric Spearman rank correlation coefficient was calculated; to evaluate the relationship between the index values and gender, the presence of respiratory distress syndrome (RDS), non-sirial correlation coefficients were calculated. It was considered that a relationship between characteristics was present if the corresponding p-value of deviation of the null hypothesis that the correlation coefficient

was equal to zero did not exceed 0.05.

To identify factors influencing the values of the PCS and MCS health assessment indices, linear regression equations were built; to identify factors influencing the distribution of answers to additional questions 8 and 9, ordered logistic regression equations were built. The statistical significance of regression coefficients and latent variable cut points (in ordered regression) was tested using a t-criterion according to the determined standard error (SE) of the coefficients. To parameterize the regression coefficients, we used: for linear regression – the least squares method, for ordered logistic regression – the maximum likelihood method. The interpretation of the modeling results for linear regression was carried out on the basis of incremental analysis, for ordered logit regression - based on the calculation of the marginal effects of the influence of each factor.

Results. After processing the data from the VR-12 questionnaire in order to to assess the quality of health of patients hospitalized 24 months ago for viral pneumonia, physical and mental health indices were separately calculated: PCS and MCS, respectively. Table 1 presents the results of the epidemiological and sociological analysis for VR-12 respondents.

Analysis of physical and mental health indicators (PCS and MCS indices), calculated two years after hospitalization for covid pneumonia, indicates the relative well-being of respondents: there is a significant shift to the right (towards high assessments of health quality) for both indices. This is clearly visible in the histograms and boxplots of the PCS and MCS indices (Fig. 1 and 2, respectively). The results of the correlation analysis (n=158) confirmed the consistency of the physical and mental health indices - the Spearman correlation coefficient was r=0.75 (p<0.001).

All responses to questions were consistent: Cronbach's α calculated for responses forming the PCS and MCS indices, respectively, were α=0.74 (p<0.001) and α=0.69 (p<0.001). This indicates the reliability of the results obtained and the validity of the conclusions drawn from the analysis of the results of the VR-12 survey.

Correlation analysis carried out on the basis of calculating Spearman's correlation coefficients (r) and biserial correlation coefficient (rb) to assess the influence of demographic and epidemiological indicators of the respondent on the values of the PCS and MCS indices revealed the presence of a connection between the indices and age (p<0.001), gender (p<0.001), the presence of arterial hypertension (p<0.001); between the PCS index and the presence of diabetes mellitus (p<0.01), between the MCS index and the % of lung damage on CT (p<0.05) (Table 2).

For a convenient interpretation of the impact of factors on health quality indicators, taking into account their cross-influence, multifactor linear regression equations were constructed. Since the objective of the study was to analyze how viral pneumonia due to infection with COVID-19 affected the quality of health after 2 years, the main regressors in the models were considered the % of lung damage (according to CT) and the presence of RDS, adjusted for the gender and age of the respondent. Table 3 summarizes the assessment results for each of the health indices separately: the coefficient of the regressor ± standard error (SE), p-level of deviation of the null hypothesis that the coefficient is equal to zero. Table 3 also provides an indicator of the quality metric for assessing the regression equation (R2, coefficient of determination), which provides information on how much the identified factors explain changes in health indices.

The regression analysis showed the presence of a negative effect of age (p<0.001) on the assessment of the quality of health two years after suffering from "covid" pneumonia: thus, an increase in the respondent's age by one year compared to the average age (56.5 years) reduces the assessment of physical health in on average by 0.8 points, and mental health assessment by 0.5 points. It is noteworthy that the male gender of the respondent on average provides an increase in the physical health score by 11.5 points, and mental health by 9.5 points (p<0.001). The presence of respi-

Table 1

Clinical and demographic characteristics of the surveyed patients

Continuous features: median (me) and interquartile range (*IQR: Q1 – Q3*)		Frequency characteristics: absolute frequency (proportion in %)	
Age. years	56.5 (45.75-66.5)	Gender (male)	68 (43)
PCS index	75 (51.04-91.67)	Availability of RDS	16 (10.1)
MCS Index	74.17 (58.54-85.83)	AH	54 (34.6)
Body mass index	28.68 (25.57-32.01)	CHF	13 (8.3)
Height. m	1.65 (1.6-1.74)	CRF	9 (5.8)
Weight. kg	80 (70-90)	History of myocardial infarction	4 (2.6)
% lung damage (according to CT)	40 (28-49)	History of stroke	4 (2.6)
		COPD	4 (2.6)
Duration of hospitalization. days	11 (9-13)	Diabetes	28 (18)
		Mechanical ventilation/ NIV	0 (0)

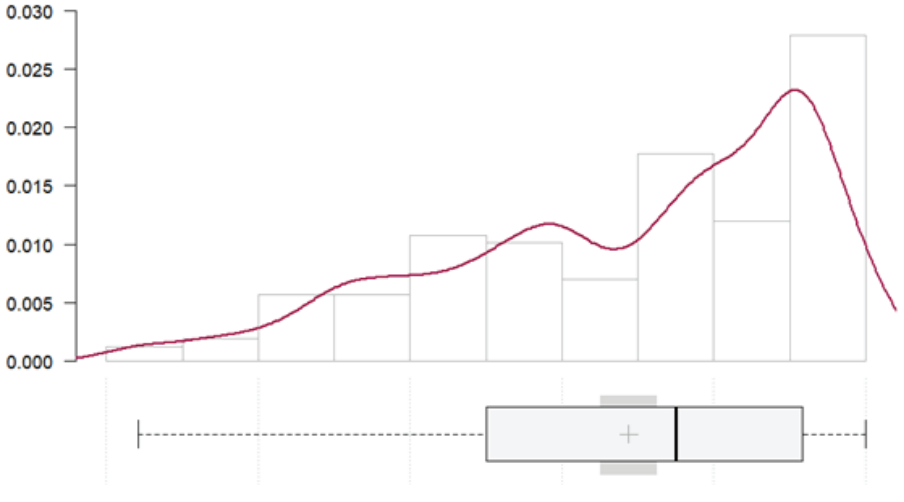

Fig. 1. Distribution histogram and boxplot of the PCS physical health index according to the VR-12

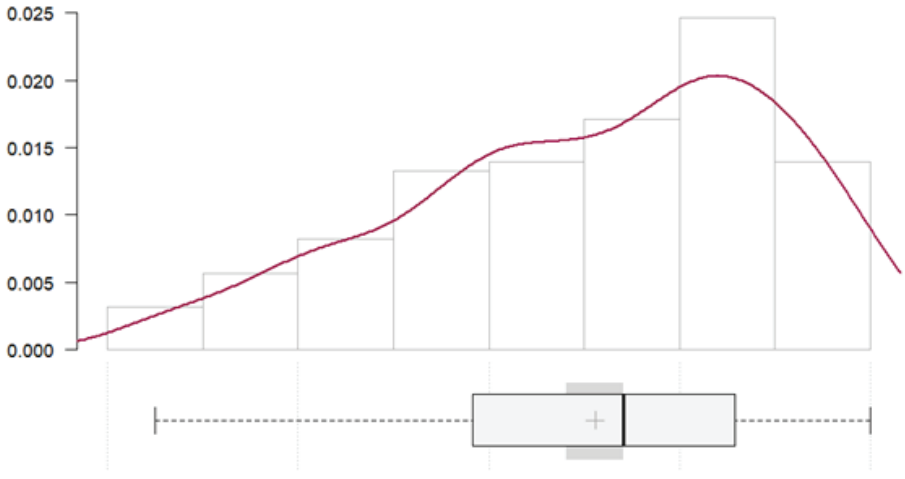

Fig. 2. Distribution histogram and boxplot of the MCS mental health index according to the VR-12

ratory distress syndrome during hospitalization for COVID-19 does not affect the self-assessment of the mental and physical health of the respondent in any way (p>0.2). The degree of development of COVID-19-associated pneumonia during hospitalization affects only the mental health indicator (p<0.05), where a 1% increase in the area of lung damage reduces the MCS score by an average of 0.15 points.

Frequency analysis of answers to additional questions 8 and 9 of the VR-12 questionnaire is presented in Table 4. According to the chi-square test, there were no differences in the distribution of answers to questions (p>0.1). The overwhelming majority of respondents responded that they felt better two years after hospitalization: for physical health - 86%, for mental health - 79.7%. However, 2.6% of respondents noted a significant deterioration in their health.

The modeling carried out on the basis of ordered logistic regression of answers to questions 8 and 9 of the VR-12 questionnaire made it possible to identify the influence on the probability of answer only of the age of the respondent (p<0.001), the other factors considered (male gender, the presence of RDS and the area of lung damage (%)) did not provide (p>0.15). The results of estimating the ordered regression coefficients using the maximum likelihood method are summarized in Table 5 – the coefficient of the regressor ± standard error (SE), p-level of rejection of the null hypothesis that the coefficient is equal to zero.

Since only the age of the respondent had a significant impact on the probability of choosing a certain answer to questions 8 and 9, the marginal effects were calculated only for this factor. Increasing the age of the interviewee by 1 year compared to the average age reduced the probability of hearing the first answer option in questions 8 and 9 by 0.017 and 0.012 points, respectively. Hearing the second answer option, on the contrary, increased the probability by 0.01 and 0.005 points, respectively, the third option increased the probability by 0.05 and 0.05 points, the fourth option increased the probability by 0.001 and 0.002 points, the fifth option increased the probability by 0.001 and 0.001 points, respectively.

Table 2

Values of Spearman correlation coefficients (*r*) and biserial correlation coefficient (*rb*) for PCS and MCS indices, *p*-level

Index	Age	BMI	% lung damage	Presence of AH	Presence of DM	Presence of RDS	Male gender
PCS	r=–0.44 p<0.001	r=–0.13 p=0.125	r=–0.08 p=0.334	r_b=0.56 p<0.001	r_b=0.31 p=0.005	r_b=0.09 p=0.499	r_b=0.60 p<0.001
MCS	r=–0.33 p<0.001	r=–0.07 p=0.394	r=–0.21 p=0.041	r_b=0.64 p<0.001	r_b=0.12 p=0.124	r_b=–0.07 p=0.542	r_b=0.54 p<0.001

Table 3

Results of linear regression assessment of physical (PCS) and mental health (MCS) indices according to the VR-12

Influence factor	PCS	MCS
	Regression coefficient±SE, *p*-level	
Age	–0.79±0.13**. p<0.001	–0.49±0.10**. p<0.001
Gender (male)	11.48±3.46**. p<0.001	9.51±2.79**. p<0.001
RDS (availability)	0.91±5.78. p=0.875	–0.08±4.67. p=0.985
% lung damage (CT)	–0.11±0.09. p=0.265	–0.15±0.07*. p=0.045
Free member of society	104.39±8.11**. p<0.001	89.32±6.55**. p<0.001
R^2	0.267	0.207

*, ** - coefficient is statistically significant at p<0.05 and p<0.001, respectively.

Discussion. Our use of the VR-12 scale to assess the quality of physical and mental health 24 months after hospitalization for COVID-19 showed a slight difference between the mental health index (MCS) and the physical health index (PCS) of respondents (74 points versus 75), and MCS<PCS. Similar differences using the same VR-12 scale were found in another study [17], where out of 304 participants surveyed, depression, post-traumatic stress and fatigue were more often observed between 9 and 26 months after the onset of the disease, and these symptoms manifested themselves less strongly 26 months later than after 9 months from the onset of the disease. A longitudinal study [22], conducted on the basis of the health questionnaire (GHQ-12) in the period 1 and 2 years after the illness, also noted the emergence of mental and physical health problems in 45 respondents who had COVID-19, and after 2 years these problems become less pronounced. In another study [26], based on a survey of patients admitted to the intensive care unit for pneumonia associated with COVID-19, according to the health quality assessment scales CIS-8, CFQ-14, HSDS after 1 and 2 years, it was shown that if the physical health problems of the respondents do not change over time, then with regard to mental health the situation only significantly worsens. In general, the VR-12 scale has been quite successfully used

Table 4

Distribution of answers to questions 8 and 9 of the VR-12

Answers	Question 8: How would you rate your health now compared to what it was like immediately after being discharged from the Covid hospital?	Question 9: How would you rate your emotional problems now compared to what they were like immediately after leaving the Covid hospital? (for example, feeling depressed or anxious)	*p*-level
Much better now than after hospitalization	95 (60.1%)	83 (52.5%)	*p*=0.174
Slightly better than after hospitalization	41 (25.9%)	43 (27.2%)	*p*=0.799
On the same level	14 (8.9%)	22 (13.9%)	*p*=0.157
Slightly worse than after hospitalization	4 (2.6%)	6 (3.8%)	*p*=0.521
Much worse now than after hospitalization	4 (2.6%)	4 (2.6%)	*p*=1.0

to assess health status in the post-Covid period, allowing one to show changes in self-assessed health status after an infection [16, 17].

Many studies devoted to assessing the quality of life and health in the post-Covid period use linear regression tools to assess the influence of various factors on the health score, measured according to various scales (VR-12, EQ-VAS, EQ 5D 5L, etc.) after various periods after the illness (3-6-12 and 24 months), an adjustment for the patient's age is always taken into account, since at an older age, other things being equal, the self-assessment of the quality of health is always lower than that of younger people. For example, in one study [10], age was a statistically significant risk factor for a decrease in the health quality score assessed according to the EQ-5D-3L scale. In our study, both when examining the assessment of physical and mental health according to the PCS and MCS scales, respectively, and when examining differences in the assessment of general condition 2 years after hospitalization (according to questions 8 and 9), age was a risk factor for deterioration in self-assessment of one's own health.

Our study revealed a significant difference in self-assessment of the quality of physical and mental health in men and women, adjusted for age, two years after COVID-19 - associated pneumonia (by 11.5 and 9.5 points, respectively). Similar results were obtained by many scientists studying the impact of COVID-19 on the quality of health in the post-Covid period. For example, in a study by Kuryllo T. et al (2023) they did not find gender differences in physical weakness during an observation period of 3 to 6 months after an infection, but after 6-12 months of observation they recorded significant gender

Table 5

Results of the ordered logistic regression assessment of answers to questions 8 and 9 according to the VR-12

Influence factor	Answer to question 8	Answer to question 9
	Regression coefficient±SE, *p*-level	
Age	0.071±0.015*. *p*<0.001	0.048±0.013*. *p*<0.001
Gender (male)	0.062±0.352. *p*=0.860	0.056±0.329. *p*=0.866
RDS (availability)	–0.049±0.567. *p*=0.930	0.212±0.491. *p*=0.666
% lung damage (CT)	–0.014±0.010. *p*=0.164	–0.009±0.008. *p*=0.342

* - coefficient is statistically significant at p<0.001.

differences in the assessment of physical health [24]. In particular, the authors noted that women experienced greater impairment in physical functioning, including decreased strength, walking shorter distances, and higher neurological load, even 1 year after hospitalization. A study by Huang L. et al (2021) showed that the use of corticosteroid therapy, widely used in the treatment of viral pneumonia in the first wave of COVID-19, contributed to the development of fatigue syndrome or muscle weakness 12 months after hospitalization specifically in women [3]. A Russian study based on a survey of 84 people found that women were more likely to report symptoms associated with deteriorating health 12 months after contracting COVID-19 [1]. Finally, a systematic review conducted by Sylvester S.V. et al. in 2022 led to the conclusion that, in general, female patients were more likely to have long-COVID-19, that is, female gender was a risk factor for chronic fatigue and symptoms of mood/behavioral disorders and other symptoms in the post-Covid period [23].

Our study showed that the presence of RDS during hospitalization did not predict the risk of deterioration in mental and physical health assessments two years after COVID-19. This result is consistent with a study by Heubner L. et al (2022), which showed that although RDS was associated with in-hospital mortality, in the medium term, RDS occurring during hospitalization was not a predictor of death [7]. At the same time, the authors showed that the presence of RDS influenced a decrease in quality of life, but this conclusion was made on the basis of an examination of patients 1 year after discharge, and not 2 years, as in our study. In addition, in our study there was no transfer to mechanical ventilation in any of the surveyed patients who had RDS. In the above study, on the contrary, in people with RDS in 27% of cases, not only mechanical ventilation was required, but also extracorporeal membrane oxygenation. It is noteworthy that in the work of Heubner L. et al. (2022), the percentage of lung damage was not a predictor of low physical health assessment (according to the VR-12 scale) 2 years after hospitalization for COVID-19 [7]. Similar results were obtained by Gulyaev P.V. et al (2022), who showed that the severity of the viral disease did not affect the physical condition after 12 months [1]. At the

same time, we found that a high percentage of lung damage, on the contrary, was a predictor of lower self-esteem of mental health according to the MCS scale even 2 years after hospitalization. This may be due to the fears and anxiety that arose after suffering COVID-19 in severe and moderate forms, which requires separate additional research.

Conclusion. The burden of COVID-19 is determined not only by the high mortality rate during infection, but also by the severity and long-term persistence of its complications. Our analysis of the quality of life showed that even after two years after the illness, some patients still have low self-esteem of their health. At the same time, there is a significant difference in the self-assessment of the quality of physical and mental health in men and women, taking into account adjustment for age - the indicators of the quality of life of women were lower. It was found that the presence of RDS during hospitalization is not a predictor of the risk of worsening mental and physical health scores two years after COVID-19, while age is a risk factor for worse self-esteem of one's own health, and a high percentage of lung damage is a risk factor for lower self-esteem mental health according to the MCS scale even 2 years after hospitalization. The study expands the understanding of the recovery trajectory of patients with COVID-19 and emphasizes the importance of individual recovery programs taking into account the severity of the disease, age and gender of patients.

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