Original Article

# Rehabilitation of elderly patients with metabolic and post-COVID syndrome.

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## ABSTRACT

The COVID-19 pandemic has dramatically changed the lives of people around the world. Millions of patients have experienced the infection in various forms, from mild symptoms to extremely severe conditions. Over time, it became clear that some patients, even after the acute phase, experience various sequelae that can lead to persistent changes in the body and a reduced quality of life. This prolonged course of the disease has been termed "long COVID" or "post-COVID syndrome" (PCS).

It is known that the largest number of hospitalizations and deaths worldwide associated with the novel coronavirus infection occur among the elderly. Atypical clinical presentations, polymorbidity, polypharmacy, and the presence of geriatric syndromes occupy a special place in the care of geriatric patients. Metabolic syndrome (MS) is characterized by the simultaneous presence of obesity, hypertension, dyslipidemia, and hyperglycemia, which leads to an increased risk of cardiovascular disease. MS affects nearly 35% of the adult population in the United States, and its prevalence increases with age.

## Keywords

metabolic syndrome; obesity; post-COVID syndrome; insulin resistance; elderly patients, rehabilitation.

## INTRODUCTION

Elevated blood pressure is the most common component of MS, and hypertension is present in nearly 80% of patients with MS[1]. Epidemiological data indicate a consistent correlation between obesity and hypertension, and obesity predisposes to a greater risk of developing hypertension, although the mechanisms of this correlation remain unclear[2].

Metabolic syndrome is of great relevance in the modern medical and scientific context due to its high prevalence among adults (approximately one-quarter of the world's population) and its status as a leading cause of cardiovascular mortality. The WHO has declared metabolic syndrome a "21st century pandemic" [3], prompting the medical community to develop increasingly effective methods not only for treating its components but also for prevention and rehabilitation[4].

Metabolic syndrome is a multidisciplinary problem and includes a mandatory component—central obesity—and at least two additional components: elevated triglyceride levels, decreased HDL levels, elevated blood pressure, and elevated fasting plasma glucose[6].

Key factors exacerbating the problem of metabolic syndrome include obesity, insulin resistance, and chronic inflammation. The obesity epidemic, which has engulfed many countries, has become the leading cause of the development of metabolic syndrome: since 1975, the number of people with overweight and obesity has tripled. Insulin resistance, as a central pathogenetic mechanism, leads to carbohydrate metabolism disorders, hyperglycemia, and ultimately to type 2 diabetes. Low physical activity, excessive consumption of high-calorie foods rich in simple carbohydrates and fats, smoking, and alcohol abuse also contribute to the aggravation of the problem.

Methodology has a significant impact on public health and the economy. The cost of treating

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the consequences of metabolic syndrome, such as cardiovascular disease and diabetes, accounts for up to 20% of healthcare budgets in high-income countries. Furthermore, it reduces people's ability to work, increases the number of sick days, leading to significant productivity losses and an increased socioeconomic burden. The medical and social consequences of metabolic syndrome include high risks of cardiovascular disease, type 2 diabetes, cancer, and neurodegenerative diseases. People with metabolic syndrome have a two- to three-fold increased risk of myocardial infarction and stroke, and a five-fold increased risk of developing diabetes. These chronic diseases significantly impair patients' quality of life, often leading to depression and decreased social activity.

Metabolic syndrome also varies by age and gender. Among women, the syndrome most often develops after menopause, due to hormonal changes. Low-income groups are more likely to experience metabolic syndrome, as they have limited access to healthy eating and healthcare.

Global efforts are underway to combat metabolic syndrome. The World Health Organization and national governments are implementing programs aimed at preventing obesity, reducing sugar and saturated fat consumption, and promoting physical activity. Research projects are focused on exploring new biomarkers, therapeutic targets, and personalized treatment approaches.

Metabolic syndrome represents a significant challenge for healthcare systems in the 21st century. Its impact extends far beyond medicine, affecting the economy and quality of life for millions of people. Effectively addressing this problem requires coordinated efforts across healthcare, science, and public initiatives aimed at lifestyle changes and creating favorable conditions for the prevention and early detection of the syndrome.

Older adults represent the largest group of patients with metabolic syndrome and often require outpatient rehabilitation, which can enhance their quality of life and improve the efficacy of pharmacological treatments[7]. Among the various rehabilitation approaches, dietary modifications and physical therapy[8–10] are the most accessible and have shown the highest effectiveness. Nevertheless, the World Health Organization (WHO) reports that the global rehabilitation needs of patients remain largely unmet.

In light of the above aspects, the problem of rehabilitation of elderly patients with metabolic syndrome remains a cornerstone in improving the quality of life and requires more in-depth study to optimize its principles at the outpatient stage.

Metabolic syndrome (MS) is a pathophysiological determined complex of interrelated risk factors including abdominal obesity, insulin resistance with impaired glycemic control, arterial hypertension, and atherogenic dyslipidemia[11]. The combined presence of these disorders significantly increases the likelihood of developing cardiovascular events such as myocardial infarction and stroke, and significantly accelerates the manifestation of type 2 diabetes mellitus (T2DM) and the progression of its complications. MS is currently considered not only as a diagnostic category but also as a key link in the pathogenesis of chronic noncommunicable diseases that determine the structure of overall morbidity and mortality in the population [12].

According to the International Diabetes Federation (IDF, 2022), the global prevalence of metabolic syndrome ranges from 20% to 35% among the adult population. This indicator varies depending on the diagnostic criteria used (IDF, NCEP ATP III, WHO), the sex and age structure of the surveyed groups, as well as geographic and socio-economic factors[13].

**The aim of this study is:** To study the quality of life of elderly patients with post-COVID syndrome and metabolic disorders during outpatient rehabilitation.

## MATERIALS AND METHODS

The study was conducted at the State Enterprises of the Republic of Kazakhstan on the Right of Economic Management Nos. 2, 21, 26, and 32, Almaty. The study was approved by the Local Ethics Committee No. 22/129 dated April 2, 2024.

Data were collected at the State Enterprises of the Republic of Kazakhstan on the Right of Economic Management Nos. 2, 21, 26, and 32 from 118 patients attending a rehabilitation course at the Active Ageing Center. Anamnesis was collected and quality of life was assessed. Anthropometric measurements (height, weight, waist circumference, hip circumference), instrumental examination (blood pressure measurement), and laboratory test results (total cholesterol, triglycerides, LDL, HDL, glucose, glycosylated hemoglobin, and antibodies to immunoglobulin G COVID-19) were used.

Patients with metabolic and post-COVID syndrome were diagnosed according to WHO recommendations. Patients were interviewed to identify risk factors, comorbidities, and assess the impact of the disease on their daily lives. Complaints at presentation were recorded, including increased fatigue, shortness of breath during physical exertion, elevated blood pressure, chest pain, sleep disturbances, and decreased exercise tolerance. Additionally, data on comorbidities and conditions was collected.

The medical history included the time of onset of symptoms, the nature and dynamics of complaints, the presence of exacerbations and remissions, as well as previous treatment and its effectiveness. The medical history included history of COVID-19, family history (family history of cardiovascular disease, diabetes, obesity), unhealthy habits (smoking, alcohol consumption), a detailed diet and eating habits, and physical activity level. Particular attention was paid to comorbidities such as type 2 diabetes mellitus, hypertension, dyslipidemia, and obesity.

Quality of life was assessed using the standardized SF-36 (Short Form-36 Health Survey Questionnaire), one of the most widely used and validated instruments for assessing health status and quality of life, approved by the WHO for use in clinical and epidemiological studies. An adapted version of the questionnaire, validated for the population of Kazakhstan, was used.

Quality of life is a multidimensional concept that includes physical, mental, social, and emotional components[14]. In clinical practice and healthcare, a tool for measuring health-related quality of life is widely used to assess how a disease affects patients' subjective well-being. This tool is a 36-question questionnaire known as the SF-36[15].

The SF-36 questionnaire included four scales:

1) physical functioning (PF);

2) Role Functioning Related to Physical Condition (RP);

3) Pain Syndrome (BP);

4) General Health Status (GH).

Each scale is rated on a scale from 0 to 100, where 0 represents the worst possible quality of life and 100 represents optimal quality of life for the corresponding indicator.

Methodology:

The survey was administered to patients individually, in person, with prior oral information about the purpose and procedure of the study. All participants provided voluntary consent to participate. Completing the survey took an average of 10 to 15 minutes. The questionnaires were completed in the presence of the researcher to prevent errors and misunderstandings. The results were interpreted as follows: 0-40 points represent low quality of life, 41-60 points represent average quality of life, and 61-100 points represent high quality of life.

The physical examination included blood pressure measurement, body mass index (BMI) assessment, waist and hip circumference measurements, and a skin assessment for acanthosis nigricans.

Laboratory and instrumental diagnostic tests included fasting glucose levels, a lipid panel (triglyceride, LDL, and HDL levels), glycosylated hemoglobin (HbA1c), and a glucose tolerance test.

The study involved 118 elderly patients attending the Active Ageing Center in Almaty, Kazakhstan. Participants were a randomized group of older adults leading an active lifestyle and interested in maintaining and improving their health. The mean age of the patients was 72.0 ± 5.7 years. The study included 111 women and 7 men. Patients were divided into 3 groups. The control group consisted of 34 patients with MS (controls) who did not undergo rehabilitation due to their refusal to participate in the rehabilitation program. The main group consisted of 34 patients with MS who underwent rehabilitation. The third group consisted of 50 patients with metabolic syndrome and post-COVID syndrome (post-COVID) who underwent rehabilitation.

Rehabilitation was implemented using a comprehensive approach, including nutritional adjustments, physical activity, psychological support, and condition monitoring. A personalized nutrition plan was developed based on the patient's daily calorie intake (according to the Harris-Benedict equation) with the goal of a 10-15% calorie deficit, an optimal daily balance of macronutrients and micronutrients, and an emphasis on foods with a low glycemic index, high fiber content, and reduced saturated fat and salt content. Each patient was trained in food selection, meal planning, meal preparation techniques, portion control, plate design, and hunger and satiety assessment using a special scale. Physical activity consisted of moderate aerobic exercise

(Nordic walking, gymnastics) five times a week for 30-40 minutes and strength training twice a week for 45 minutes.

Psycho-emotional support was provided using motivational counseling methods, elements of Acceptance and Commitment Therapy (ACT), and basic behavioral intervention techniques. The work was conducted in group meetings aimed at increasing stress resilience, developing sustainable intrinsic motivation for lifestyle changes, and improving eating behavior. Participants also received individual counseling on emotional overeating, disruptive eating habits, and maintaining a rehabilitation regimen. To evaluate the effectiveness of the intervention, key indicators were monitored, including keeping a food and physical activity diary and monitoring blood pressure, glucose levels, weight, and volume. The method used allowed for a comprehensive impact on the metabolic health of the subjects, reducing stress levels, improving eating habits and physical activity, which contributed to the achievement of sustainable positive changes in health.

The main focus of the diet is on reducing the load on metabolism, controlling blood sugar levels, and improving gastrointestinal function. Fast carbohydrates (sweets, baked goods, white bread) are limited, and consumption of high-glycemic index grains is reduced, with preference given to whole grains and legumes. Saturated fats (fatty meats, sausages, butter) are eliminated, and instead lean protein foods are included in the diet: fish, chicken, turkey, legumes, eggs, and low-fat dairy products. Fiber plays an important role, sourced from vegetables, greens, whole grain cereals, nuts, seeds, and berries. Salt is limited to 5 grams per day, and the consumption of salty foods (canned goods, pickles, fast food) is minimized. Carbonated drinks, fruit juices, and processed sweets are excluded, and natural sweeteners (erythritol, stevia) are used as an alternative. Sample diet: Breakfast: omelet with greens and tomatoes, whole-grain bread, green tea; snack: a handful of nuts, plain unsweetened yogurt; lunch: baked fish with stewed vegetables, a serving of quinoa; afternoon snack: low-fat cottage cheese with a spoonful of honey and flax seeds; dinner: salad with turkey, spinach, and avocado, dressed with olive oil.

Physical activity is aimed at maintaining a healthy weight, improving cardiovascular health, and strengthening muscles. Aerobic exercise 4-5 times a week for 30-40 minutes is important: walking (7,000-10,000 steps per day), swimming (to reduce stress on joints), and therapeutic exercise (warm-ups, flexibility and coordination exercises). Strength training was conducted twice a week, including bodyweight exercises (squats, push-ups, planks), exercises with light dumbbells (1-3 kg) for the arms, back, and abdominal muscles, as well as stretching and yoga to improve joint mobility and relieve stress.

Psycho-emotional support included group stress management sessions using mindfulness techniques, breathing exercises, art methods, and participation in support groups. Individual work with patients was aimed at changing eating behavior, overcoming emotional eating, strengthening intrinsic motivation, and reducing anxiety. The counseling utilized elements of cognitive behavioral therapy, acceptance and commitment therapy (ACT), as well as self-observation and reflection techniques adapted for outpatient rehabilitation.

Monitoring was conducted through keeping a food and activity diary, which records food consumption, quantity, meal times, types of physical activity, and overall well-being. Key indicators are monitored regularly: blood pressure (morning and evening), glucose levels (if prediabetes or diabetes), weight, and waist and hip measurements (once a week). This comprehensive approach allows for systematic health improvement, adjustments to nutrition and physical activity strategies, and early detection of changes in the body.

### Statistical processing.

Statistical analysis was performed using the SPSS v25 statistical software package for Windows, employing standard variation statistics algorithms.

Results for quantitative indicators were expressed as M ± m, where M is the mean of the sample and m is the standard deviation.

A two-tailed Student's t-test was used to compare mean values. Qualitative variables were expressed as absolute (n) and relative (%) values. Differences were considered significant at $p < 0.05$. When comparing more than three groups, the F-test was used. The F-test was determined using standard formulas. Changes were considered significant at F values less than 0.05 and F was greater than the critical f-test. During the study, **analysis of variance (ANOVA)** was used to evaluate differences between the three patient groups (control, study, and post-COVID syndrome). ANOVA allows

for the study of variance within and between groups to determine whether factors influence the variable.

For each group, an F-statistic is calculated, which represents the ratio of the between-group variance to the within-group variance. The higher the F-value, the higher the probability that the differences between the groups are not due to chance. The significance level (p-value) indicates the likelihood that the observed differences could have arisen by chance. If $p < 0.05$, the differences are considered statistically significant.

$$t_э = \frac{|M_d|}{\sigma_d / \sqrt{N}}, \quad df = N - 1$$

where $M_d$ is the average difference between the values; $\sigma^1_d$ is the standard deviation of the differences.

## RESULTS

The study revealed that 98% of patients had chronic conditions typical for this age group, including musculoskeletal disorders. Patient comorbidities are presented in Table 1.

**Table 1.** Comorbidities in patients with metabolic and post-COVID syndrome

| Characteristics of patients (n - 118) | Control group (n – 34) **without rehabilitation** | Main group (n – 34) | Group with metabolic and post-COVID syndrome (n – 50) | P |
|---|---|---|---|---|
| Ischemic heart disease | 8 (9.3) | 14 (42.4) | 17 (51.5) | 0,653 |
| Injuries | 9 (10.47) | 12 (36.3) | 14 (42.4) | 0,798 |
| Atherosclerosis | 14 (16.28) | 19 (57.5) | 22 (66.6) | 0,567 |
| Diseases of the digestive system | 13 (15.12) | 11 (33.3) | 14 (42.4) | 0,605 |
| Diseases of the kidneys and urinary tract | 11 (12.79) | 14(42.4) | 13 (39.3) | 0,522 |
| Respiratory diseases | 8 (9.3) | 14 (42.4) | 12(36.3) | 0,879 |
| Other concomitant diseases | 9 (10.47) | 21(63.6) | 19 (57.5) | 0,412 |

Among 118 patients, stage 1 hypertension was detected in 5 patients, representing 4.2%. Stage 2 hypertension was recorded in 53 patients (44.9%), and stage 3 hypertension was recorded in 60 patients, representing 50.8% of the total sample.

Among the 118 patients, concomitant metabolic disorders were distributed as follows: 30 patients (25.4%) were diagnosed with type 2 diabetes mellitus, 72 patients (61.0%) had isolated dyslipidemia, and 16 patients (13.6%) had a combination of type 2 diabetes mellitus and dyslipidemia.

Digestive system disorders were observed in 22 patients (65%) in the control group, 11 patients (33.3%) in the study group, and 21 patients (42.4%) in the post-COVID syndrome group. Although the differences between groups were more pronounced, they did not reach statistical significance (p=0.0769).

Kidney and urinary tract diseases were diagnosed in 7 patients (20.5%) in the control group, 6 patients (17.6%) in the study group, and 10 patients (20%) in the post-COVID syndrome group. Respiratory diseases were observed in 8 patients (23.5%) in the control group, 7 patients (20.5%) in the study group, and 17 patients (34%) in the post-COVID syndrome group. Finally, other comorbidities were identified in 9 patients (26.4%) in the control group, 6 patients (17.6%) in the study group, and 13 patients (26) in the post-COVID syndrome group. In all cases, differences between groups remained statistically insignificant.

The study analyzed body weight indicators in patients in three groups: the study group, the control group, and the post-COVID group (Figure 1). The study and post-COVID groups underwent a rehabilitation program, including nutritional modification and physical activity, while the control group did not receive such interventions.

Descriptive statistics showed that the average body weight in all groups was comparable based on the first measurement (weight), but the second measurement showed a decrease in body weight in the study group and especially in the post-COVID group. Thus, the average weight based on the second measurement was 79.56 kg in the study group and 77.58 kg in the post-COVID group, while in the control group it reached 86.97 kg.

Results of a one-way analysis of variance (ANOVA) confirmed these observations. For the first measurement of body weight, the differences between the groups did not reach statistical significance (F = 1.696; p = 0.188), while for the second measurement, reliable between-group differences were revealed (F = 6.788; p = 0.002). This may indicate the effectiveness of the implemented rehabilitation program aimed at normalizing body weight and metabolic status of patients.

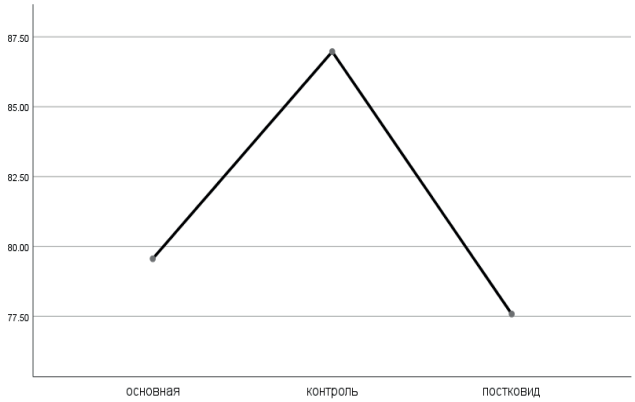


**Figure 1**. Weight of patients in the main, control, and post-COVID groups

Thus, it can be concluded that rehabilitation measures including a balanced diet and moderate physical activity contribute to weight loss, especially in patients with post-COVID syndrome. These results highlight the importance of a comprehensive approach during the recovery period and the need to implement it in clinical practice.

The analysis showed that before the start of rehabilitation, waist circumference values were statistically comparable between the study, control, and post-COVID groups. However, after the rehabilitation program, which included dietary intervention and physical activity, a significant decrease in waist circumference was recorded in both the study and post-COVID groups, compared to the control group, which did not undergo the intervention (p = 0.003). (Figure 2).

Thus, these data confirm the effectiveness of the rehabilitation program in reducing visceral fat, which can be considered an important component of the prevention and treatment of metabolic disorders in patients, including those with post-COVID syndrome.

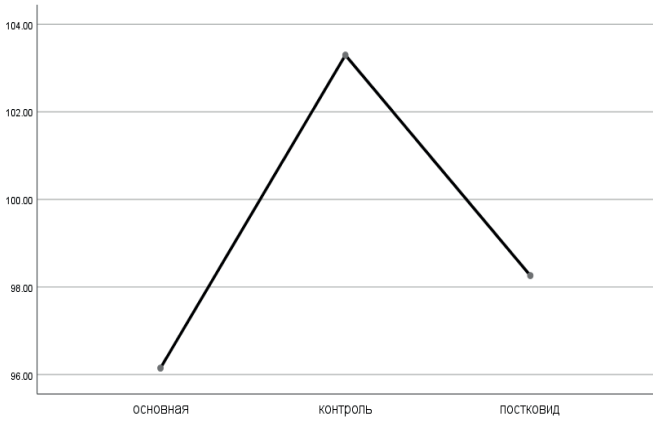


**Figure 2.** Waist measurements in patients in the main, control, and post-COVID groups after rehabilitation.

To assess changes in hip circumference between the intervention, control, and post-COVID groups, a one-way analysis of variance (ANOVA) was conducted on two measurements: before and after rehabilitation.

Before the intervention, hip circumference in patients in the three study groups was statistically comparable. After the rehabilitation program, which included nutrition and exercise, a moderate decrease in hip circumference was observed in both the intervention and post-COVID groups; however, the differences between the groups did not reach statistical significance (p = 0.163). (Figure 3)

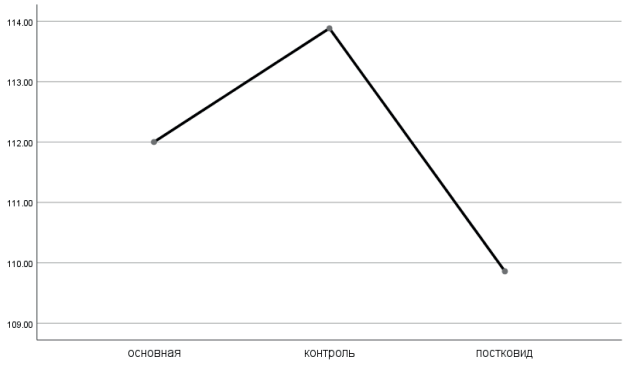


**Figure 3.** Thigh circumference indicators in patients of the main, control and post-COVID groups after rehabilitation

However, the observed positive dynamics in the intervention groups may indicate the potential effectiveness of comprehensive rehabilitation in reducing peripheral fat mass and warrants further study in larger samples.

After completing the rehabilitation program, which included nutritional modification and measured physical activity, significant improvements in physical functioning were recorded in both the intervention and post-COVID groups. ANOVA results showed highly significant differences between the groups ($F = 28.763$; $p < 0.001$).

The average PF values at the second measurement were:

- in the main group – 78.26 points (SD = 8.90),
- in the control group – 54.88 points (SD = 12.57),
- in the post-COVID group – 80.36 points (SD = 11.14).

Thus, in the intervention group, there was an increase in physical functioning by 22.7 points compared to the initial measurement, and in the post-COVID group, by almost 19 points. In the control group, where no interventions were performed, the changes were minimal and statistically insignificant (an increase of ~3.4 points) (Figure 4).

These results demonstrate a significant effect of comprehensive rehabilitation on improving patients' physical functioning. At the initial stage, the groups were comparable on the PF scale, but after completing the intervention, participants in the intervention and post-COVID groups showed significant improvements.

These data confirm that the inclusion of targeted interventions, in particular diet therapy and measured physical activity, can significantly improve physical activity and daily living functions, especially in individuals with COVID-19 and metabolic disorders. Given the statistical significance ($p < 0.001$) and effect size, such programs can be recommended for wider clinical use. The study assessed the effectiveness of a comprehensive rehabilitation program, including nutritional modification and measured physical activity, on physical and role functioning in patients across three groups: the main group, the control group, and the post-COVID group. At baseline, differences between the groups on the SF-36 Physical Functioning (PF) scale were not clinically significant ($F = 4.533$; $p = 0.013$), and on the Physical Role Functioning (RP) scale, they were not statistically significant at all ($F = 1.964$; $p = 0.145$), allowing the groups to be considered comparable in terms of impairment levels at baseline. After completion of the rehabilitation intervention, significant improvements were recorded on both scales in the main and post-COVID groups. Thus, a significant difference was observed between the groups on the PF scale ($F = 28.763$; $p < 0.001$): the average level of physical functioning was 78.26 points in the main group and 80.36 points in the post-COVID group, while in the control group it was only 54.88 points. A similar picture was noted for the RP scale: $F = 27.218$; $p < 0.001$, where the values were 84.41 and 85.78 points in the main and post-COVID groups, respectively, compared to 56.03 points in the control group. These data indicate a pronounced positive effect of rehabilitation on the restoration of physical and role functions in patients, especially those who have had COVID-19, and confirm the clinical significance of integrating nutrition and physical activity programs into the structure of restorative treatment for metabolic disorders.

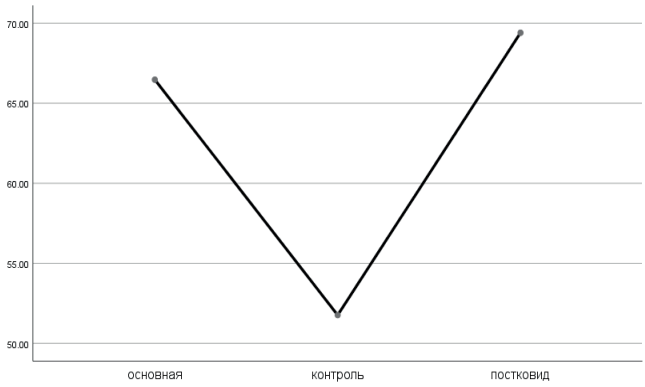


**Figure 4.** Level of physical functioning in patients in the main, control, and post-COVID groups

An analysis of the dynamics of general health using the GH (General Health) scale from the SF-36 questionnaire demonstrated that before the intervention, differences between the main, control, and post-COVID groups were not statistically significant ($F = 0.743$; $p = 0.478$), indicating that the groups were initially comparable in subjective assessments of general well-being. However, after completion of the comprehensive rehabilitation program, which included a balanced diet and physical activity, a significant improvement in GH was recorded in both the main and post-COVID groups (Figure 5).

The results of the analysis of variance confirmed the presence of statistically significant differences between the groups at the repeated assessment ($F = 17.128$; $p < 0.001$), indicating a significant improvement in subjective health in patients who received the rehabilitation intervention. Considering that the GH scale assesses the overall perception of physical and

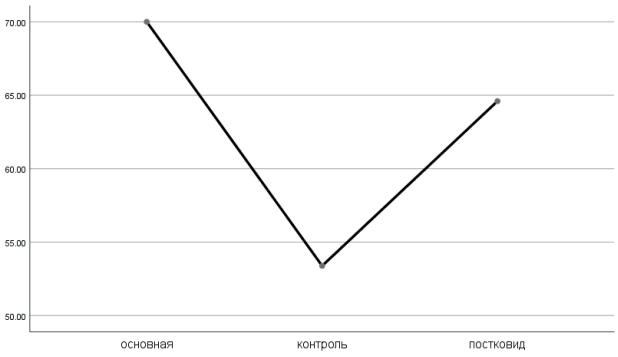


**Figure 5.** General health indicators in patients in the main, control and post-COVID groups.

psychosocial well-being and ranges from 0 to 100 (where higher values correspond to better well-being), the registered increase in scores indicates positive dynamics. Thus, the rehabilitation program had a clinically significant impact on improving overall health, especially in patients with post-COVID syndrome and metabolic disorders, emphasizing its effectiveness and potential for implementation in outpatient and inpatient practice.

## DISCUSSION

The study comprehensively assessed the condition of elderly patients with metabolic syndrome and concomitant post-COVID syndrome, as well as analyzed the effectiveness of an outpatient rehabilitation program, including diet therapy and measured physical activity.

The study cohort comprised 118 elderly patients, with women representing the vast majority (94%). Among the participants, there was a high prevalence of metabolic syndrome components, including arterial hypertension, dyslipidemia, insulin resistance, and type 2 diabetes. Elevated body weight, body mass index (BMI), and waist circumference in most respondents confirmed abdominal obesity and increased cardiometabolic risk. Furthermore, some patients experienced manifestations of post-COVID syndrome, including fatigue, decreased physical activity, and emotional instability. At the pre-rehabilitation stage, patients in all three groups (main, post-COVID, and control) were comparable in anthropometric and metabolic characteristics, ensuring sample homogeneity and the validity of the comparative analysis. Furthermore, no significant differences were found in the SF-36 scales (physical functioning, pain, general health), allowing the groups to be considered equivalent at baseline.

The implementation of the outpatient rehabilitation program in the main and post-COVID groups was accompanied by significant improvements in clinical, functional, and quality-of-life parameters compared to the control group, which did not receive systematic intervention. Specifically, the following were recorded:

- Weight loss ($p = 0.002$);

- Waist circumference reduction ($p = 0.003$);

- Increased SF-36 scores: physical functioning (PF), role functioning (RP), pain intensity (BP), and general health (GH) (all $p < 0.001$);

- Improved psychoemotional state in post-COVID patients, including reduced anxiety, fatigue, and sleep disturbances.

The most significant improvement was observed in the group of patients with post-COVID syndrome, indicating their increased vulnerability but also their high responsiveness to rehabilitation. This confirms the need for a differentiated approach to elderly patients, taking into account their history of viral infections, functional reserve, and comorbidities.

These results demonstrate that outpatient interventions, including nutritional support, controlled physical activity, and quality of life monitoring, can significantly improve the health and subjective well-being of elderly patients with MS. This is particularly important in the context of healthcare reorganization in the post-pandemic period, when the role of long-term care programs, home monitoring, and personalized prevention is increasing.

From a public health perspective, this study emphasizes that outpatient rehabilitation should be considered an integral part of the management of patients with MS, especially in the elderly. Including patients in non-pharmacological intervention programs allows for:

- minimize the risk of complications and hospitalizations;

- improve adherence to therapy;

- stabilize metabolic parameters;

- improve quality of life and functional independence.

The study results confirm the need to integrate comprehensive rehabilitation approaches into primary care practices, involving a general practitioner, a

dietitian, a physical therapy instructor, and, if necessary, a psychologist. Furthermore, the data obtained provide the basis for developing models for the dynamic monitoring of elderly patients with metabolic syndrome, including the use of digital technologies, motivational strategies, and educational components.

Thus, the study demonstrated that a structured outpatient rehabilitation program is an effective tool for improving the metabolic and functional status of elderly individuals with metabolic syndrome, including those with post-COVID-19 disorders. This confirms the feasibility of its further implementation and scaling up as part of the prevention of chronic noncommunicable diseases and health promotion in the elderly population.

According to some researchers, the main goal in elderly patients with metabolic syndrome is not only achieving target blood pressure levels but also maintaining a comfortable standard of living, whereby lowering blood pressure should not lead to cognitive impairment. Therefore, we started with low doses of drugs, giving preference to complex rehabilitation, conducting, like other researchers, careful clinical observation of patients [16-20].

## CONCLUSIONS

1. The implementation of an outpatient rehabilitation program, including dietary intervention and dosed physical activity, ensured improvement in somatometric parameters and quality of life. Body weight in patients in the post-COVID group decreased from 86.97 kg to 77.58 kg, and in the main group – to 79.56 kg (ANOVA: $F = 6.788$; $p = 0.002$). Waist circumference in patients significantly decreased ($p = 0.003$), and physical functioning on the PF scale increased from 55.59 to 78.26 points in the main group and from 61.5 to 80.36 in the post-COVID group ($F = 28.763$; $p < 0.001$).
2. The greatest positive effect was recorded in patients with metabolic and post-COVID syndrome, who showed the greatest improvements after the intervention in the PF (an increase of ~19 points), RP (85.78 versus 56.03 in patients in the control group; $F = 27.218$; $p < 0.001$), BP ($F = 10.906$; $p < 0.001$), and GH ($F = 17.128$; $p < 0.001$) scales. This confirms the high effectiveness of outpatient comprehensive rehabilitation and the feasibility of its implementation in clinical practice for patients who have recovered from COVID-19.

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**Conflict of Interest**: The authors declare no conflict of interest.

**Ethical clearence:** This study was conducted in accordance with ethical standards. Ethical approval was obtained from the appropriate institutional review board, and informed consent was secured from all participants prior to data collection.

### Authors's contribution

Data gathering and idea owner of this study: Kudabaeva V.ZH.

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Data gathering: Tolybekova A.A , Seidalin A.O.,

Writing and submitting manuscript: Abilkassimova G.E., Aumoldayeva Z.M.

Editing and approval of final draft: Mansharipova A.T., Mansharipov D.,

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