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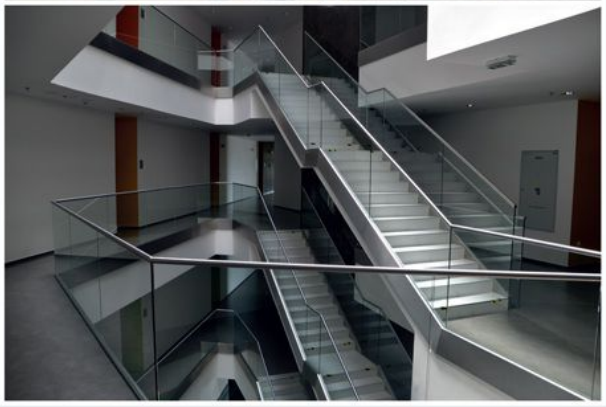

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Reviewers

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EDITORIAL

Dear Readers,

The journal "Zdravotníctvo a sociálna práca" (*Health and Social Work*) was renamed in 2021 to International Journal of Health, New Technologies and Social Work.

Our long-term effort is to gradually acquire for the journal European significance and be included in international databases. Starting with issue No. 4 in 2016, the journal accepted the Harvard style of referencing, and changed guidelines for the authors. The aim of the changes was to move closer to the standard in international journals published in English in the area of health and helping professions. The editors are aspiring for registration in other relevant international databases. Since last 2020 the journal has published all articles in English only.

The journal "Zdravotníctvo a sociálna práca" (*Health and Social Work*) was established in 2006 at Faculty of Health and Social Work blessed to P.P. Gojdič in Prešov and St. Elizabeth University College of Health and Social Work in Bratislava. In 2020, the journal celebrated its 15th year of publication.

Previously professional journal, within 5 years developed into an international, peer-reviewed scholarly journal, published quarterly (4 issues per year). The journal were published by the St. Elizabeth University of Health and Social Work in Bratislava. The journal became international in 2009. The journal was published and distributed in the Slovak Republic and also in the Czech republic.

Since 2011, the journal is published both in print and as electronic issues, available from: www.zdravotnictvoasocialnapraca.sk. Starting by issue No. 3 in 2014, the scope of the journal has broaden and the journal is covering health sciences, such as Public Health, Nursing, Laboratory Medicine, but also helping professions such as Social Work or Pedagogy. Collaboration with Faculty of Health and Social Work of Trnava University in Trnava was initiated.

The journal is indexed in the following databases: Central and Eastern European Online Library – CEEOL (since 2018), Bibliographia Medica Slovaca (BMS), and Slovak reference database CiBaMed.

The part of journal is Supplementum, to publish abstracts from international conferences organized by the St. Elizabeth University of Health and Social Work in Bratislava. In 2020, the conference was planned, similarly to last year, in Ustroń, Poland. Due to the unfavorable epidemiological situation, the conference was postponed by the organizers to October 2021.

Prof. Miron Šramka, MD, DSc.
redactor-in-chief

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Artificial Intelligence to Rehabilitation for Post-COVID syndrome

Umelá inteligencia v rehabilitácii postcovidového syndrómu

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ABSTRACT **Introduction**: Coronavirus disease affected the whole world and has not only economic but also serious health consequences. Vaccination against the virus reduces the number of diseases, but new variants of the virus also threaten the vaccinated population, and the number of hospitalized patients is still growing.

Research objectives: To monitor COVID-19 consequences on the central nervous system in the world and to look for new treatment options for patients with post-COVID syndrome.

Material and methods: To monitor the treatment of patients after long-term hospitalization with the help of new approaches realized through virtual reality. How to use motor, sensory, psychological, and cognitive rehabilitation respectively telerehabilitation for an optimal individual approach to patients.

Conclusion: We proposed monitoring of patients with acute post-COVID syndrome, especially from a neurological and psychological point of view, and prepared a new way of rehabilitation for the motor and psychological consequences of patients using virtual reality and artificial intelligence for optimal patient treatment.

Keywords: COVID-19, Central nervous system, rehabilitation, virtual reality, artificial intelligence

ABSTRAKT **Úvod**: Choroba COVID-19 zasiahla celý svet a má nielen ekonomické, ale aj vážne zdravotné dôsledky. Očkovanie proti vírusu síce znižuje počet ochorení, ale nové varianty vírusu ohrozujú aj očkovanú populáciu a počet hospitalizovaných pacientov stále pribúda.

Ciele výskumu: Monitorovať dôsledky COVID-19 na centrálny nervový systém vo svete a hľadať nové možnosti liečby pre pacientov s post-COVID syndrómom.

Materiál a metódy: Monitorovať liečbu pacientov po dlhodobej hospitalizácii pomocou nových prístupov realizovaných prostredníctvom virtuálnej reality. Ako používať motorickú, senzorickú, psychologickú a kognitívnu rehabilitáciu, respektíve telerehabilitáciu, pre optimálny individuálny prístup k pacientom.

Záver: Navrhli sme monitorovanie pacientov s akútnym post-COVID syndrómom, najmä z neurologického a psychologického hľadiska, a pripravili sme nový spôsob rehabilitácie motorických a psychologických dôsledkov pacientov s využitím virtuálnej reality a umelej inteligencie pre optimálnu liečbu pacientov.

Kľúčové slová: COVID-19, Centrálny nervový systém, rehabilitácia, virtuálna realita, umelá inteligencia

INTRODUCTION

In March 2020, the World Health Organization declared COVID-19 a pandemic and a threat to international public health (WHO COVID-19, 2021). The new RNA coronavirus *SARS-CoV-2* causes COVID-19 and is similar to the *SARS-CoV* virus of 2002 and shows a strong agreement with influenza virus H5N1. Therefore, it is important to monitor the consequences of the SARS pandemic and previous pandemics.

Between 2018 and 2020, the influenza virus H1N1 caused Spanish influenza, which infected more than 500 million people worldwide (Barro *et al.* 2020), representing about 30% of the world's population. Influenza has killed 50 to 100 million people (Tumpey *et al.* 2005; Taubenberger *et al.* 2006), representing about 4% of the world's population, with the Spanish influenza pandemic caused major economic and healthy global consequences (Aassve *et al.* 2021). Viruses *SARS-CoV* (2002 and 2004) and MERS (first in 2012, later in 2015 and 2018) were monitored but were not as prevalent as Spanish influenza or COVID-19.

The worldwide population of reported cases of coronavirus infection in August 2021 exceeded 200 million (Worldometer COVID-19, 2021). In addition, we face persistent threats posed by different coronavirus variants, with increasing health consequences for the global population. The COVID-19 pandemic has an impact on social and economic life. Due to widespread uncertainty and new circumstances, the pandemic poses global economic problems. For more than a year, the number of diseases has been steadily increasing, countries have closed, international trade has fallen sharply, and GDP has fallen sharply in all countries of the world (The World Bank, 2021).

We now know that the impact of the COVID-19 pandemic has not only economic but also health consequences, known as Post-Covid Syndrome. (Šramka *et al.* 2021). Long-term neurological and psychiatric adverse effects of COVID19 may include depression, insomnia, decreased cognitive ability, and accelerated aging (Tsutsui *et al.* 2021). Coronavirus vaccination reduces the number of diseases on COVID-19 with the formation of an immune community, but new variants of the virus also pose a greater risk to the vaccinated population. Therefore, it is necessary to monitor a long-term extensive assessment of the physical and mental state of the population and it is necessary to prepare for the period after COVID, which can last several years. These are immediate challenges even during the COVID-19 pandemic for new population health care research.

PANDEMIA OF COVID-19

The first cases of COVID-19 occurred in Wuhan, China. Most East Asian countries have taken strict quarantine measures to bring the pandemic under control. At the end of 2020, densely populated parts of western Asia as Iran, Iraq, Israel, Jordan, Lebanon, Armenia, and Georgia were affected by the pandemic. In yearly 2021, the COVID-19 situation worsened in the populated parts of India (Worldometer 2021). In the summer of 2021, the delta coronavirus variant

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was imported from India to Europe and the USA. The United States is the country most affected by the number of coronavirus diseases, but the pandemic mortality rate is relatively low. The number of deaths has increased significantly in the elderly population over the age of 60, in contrast to Spanish influenza (NCHS 2021).

Worldwide, younger people are more at risk for post-COVID syndrome due to adverse mental health symptoms. During the pandemic, polls from more than 600 US universities saw an increase in anxiety and trauma compared to previous years (CCMH 2021). At the beginning of 2021, Europe was hit by the British variant of the coronavirus and the situation deteriorated rapidly up to May. As a result of increased vaccination, the situation has improved worldwide since May 2021, mainly in Europe and the USA. Since August 2021, the third wave in Europe has begun with an increase in the delta variant of the virus (Worldometer 2021). However, many countries are monitoring post-COVID syndrome and are looking for a solution to treat these patients as quickly as possible so that they do not have more serious consequences of the disease. Both Slovakia and the Czech Republic have approved the possibility of treatment by approving rehabilitation and treatment in spa facilities.

COVID-19 and the Central nervous system

Protecting the population from COVID-19 and its consequences requires the necessary clinical, diagnostic, and epidemiological studies. A distinction must be made between complications such as hypoxic encephalopathy, acute neuropathy including infectious, para-infectious, and post-infectious encephalitis, stroke-related conditions, mental illness caused by the new *SARS-CoV-2* coronavirus. Recognition of neurological disease associated with COVID-19 patients in whom the infection is mild or asymptomatic will be challenging. Neurological disorders are more common in the central nervous system (CNS), the peripheral nervous system (PNS), and the psyche (PS). They may occur in the absence of other clinical signs (Sramka *et al.* 2020b). Acute cerebrovascular disease is another serious complication of COVID-19.

Clinical signs of neurological disease associated with COVID-19 and the effects of coronavirus on the nervous system lead to neurological and psychiatric diseases (Varatharaj *et al.* 2020). Published changes and diseases have been reported as impaired mental status, encephalopathy, encephalitis, neuropsychiatric diagnoses, psychosis with the neurocognitive dementia-like syndrome, and affective disorders (Ellul *et al.* 2020). Post COVID-19 syndrome has been studied in hospitalized patients in Italy with a mean length of stay of 18 days from April to October 2020 (Janiri *et al.* 2021). Post-traumatic stress disorder after severe COVID-19 infection was found in more than 30% of patients at that time.

POST-COVID TREATMENT

Patients who have overcome the acute phase of COVID suffer for many months from chronic fatigue syndrome and symptoms, a condition called post-COVID syndrome (Šramka et al. 2021). Practical experience since the onset of the pandemic has shown that patients have motor, nervous, sensory, and mental changes manifested by anxiety and depressive disorders (Varghese, *et al.* 2020). These changes can have a negative effect on people's thoughts, feelings, and behaviors, and can impair the ability to be fully functional in daily activities (Masan *et al.* 2021a).

In addition to conventional treatment based mainly on rehabilitation, there are also methods based on blood plasma and ozone therapy (Masan *et al.* 2021b). New approaches are realized by virtual reality with the use of motor, sensory, psychological, and cognitive rehabilitation as well as research investigated by means of

analyzes using artificial intelligence, in the field of patient rehabilitation (Sramka *et al.* 2020a).

Telerehabilitation

Telerehabilitation is the provision of rehabilitation services at a distance using telecommunications technology. It is the provision of services in medical disciplines, including physiotherapy, cognitive rehabilitation, speech therapy, and occupational therapy. It provides aspects of patient care, including counseling, diagnosis, physical evaluation, treatment, education, and training (Šramka *et al.* 2020a; Brehon *et al.* 2021; Masan 2021c). Discontinuation of rehabilitation due to the COVID-19 pandemic affected not only motor symptoms but also patients' quality of life. Most of the consequences of a pandemic manifest themselves at a later stage and with long-term consequences. Physical, mental, cognitive, and emotional complications of post-Covid syndrome are observable in patients after discharge from the hospital to the home environment and require individual rehabilitation (Brehon *et al.* 2021).

The rehabilitation program affects walking, muscle endurance, level of physical activity, and quality of life. Early respiratory rehabilitation, including mobilization and psychological support, is suitable for patients with respiratory problems after discharge from the hospital, which can be supported by telerehabilitation. The therapist selects the appropriate exercise tasks for the home exercise program so that the patient can exercise according to the instructional material and instructions.

Cognitive rehabilitation is considered appropriate for patients with brain disease, and for the consequences of the social and psychological consequences of COVID-19. Prior to the COVID-19 pandemic, the use of telerehabilitation at a very low level was 4.9% (Quinn *et al.* 2020). At present, the number of applications in smartphones as well as tools for monitoring the activity of individuals to increase physical activity and use has increased to more than 8.9%. Telemedicine and telerehabilitation will be useful as treatments for the functional consequences of a COVID pandemic (Hatcher *et al.* 2020; Langer *et al.* 2021). Other benefits of therapeutic telerehabilitation are lower costs and convenience of rehabilitation at home, as well as reduced travel costs (Chen *et al.* 2020; Jimenéz-Pavón *et al.* 2020).

Post COVID-19 syndrome requires rehabilitation care for patients due to physical, respiratory, and neurological symptoms (Mao *et al.* 2020; Wang *et al.* 2020). Patients with COVID-19 undergoing intensive care experience a functional decline due to organ dysfunction, cognitive changes, and psychological consequences (depression and anxiety) after prolonged hospitalization (Mao *et al.* 2020; Wang *et al.* 2020). A systematic review of articles analyzed successful telehealth assessment methodologies and measured service quality through patient and provider satisfaction, economic benefits, and clinical outcomes (Brehon *et al.* 2020).

Virtual reality

It uses computers that generate a three-dimensional virtual environment to elicit a specific movement and motor response from the client. The virtual environment can be displayed through a computer screen, or fully absorbs the environment using a visual display and feedback device. It is about learning new motor skills that are reflected in the real world (Lacko 2020). Rehabilitation of patients after overcoming neurodegenerative diseases, post-traumatic conditions, and stroke is one of the key elements in restoring their overall mobility and in many cases of returning to normal life (Mašán *et al.* 2020, Masan 2021c).

The possibilities of using virtual reality in combination with classical approaches to the rehabilitation of patients were explored in the rehabilitation of the upper and lower limbs as well

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as the improvement of the mental state (Ruzicky *et al.* 2020). The impact of a hybrid approach using the classical approach of rehabilitation and virtual reality was evaluated. The virtual environment has a direct impact on the quality of individual rehabilitation exercises. Patients prefer a realistically processed 3D scene, in which it is possible to move comfortably in space and focus directly on the activity performed (Sramka *et al.* 2020a).

During the rise of COVID-19 in New York, the COVID-19 hospital unit selected patients and VR staff with three categories of experience: Guided Meditation, Exploration of natural environments, Cognitive Stimulation games. Participants commented that the use of VR was useful in coping with isolation, and could be implemented within the context of clinical care for COVID-19 patients (Kolbe *et al.* 2021).

ARTIFICIAL INTELLIGENCE APPLICATIONS FOR COVID-19

The COVID-19 pandemic has highlighted the need for rapid and workable predictions of health threats. Searching for social media data to track flu and other events in real time ("Nowcasting") has become a major focus on public health, informatics and other disciplines. One cited example of using search query data to predict disease is Google Flu Trends (Guo *et al.* 2021).
The use of digital technologies, such as mobile applications, the global positioning system, the social network, transaction data and other personal contact tracking information, has significantly contributed to reducing the spread of COVID-19 infection. Based on the large amount of labeled clinical data, artificial intelligence can aid clinical diagnosis and prognosis by identifying COVID-19 signatures on X-ray radiographs, CT scans, and blood sample data that differ from those associated with respiratory diseases such as COVID-19 (Poo *et al.* 2021).

Heart rate trends in the population indicated the presence of infection. In 2020, they assessed whether population trends in seasonal respiratory infections, such as influenza, could be identified using wearable Fitbit sensors that collect data on resting heart rate and sleep (Radin *et al.* 2020). Sensor data from Fitbit users in five U.S. states have been shown to be able to estimate the incidence of influenza-like illnesses at the state level using autoregressive models. The same methodology can be used to predict the spread of COVID-19 pandemic (Carriere *et al.* 2021).

While digital data from these sources have a huge potential for monitoring and understanding human behavior, this data stream lacks information about the experiences of the data generators. Most current methods do not make sufficient use of the possibilities of human thinking, which make it possible to solve problems that computers have failed to solve as the human brain is able to make correct predictions (Wojcik *et al.* 2021).

Artificial intelligence for post-COVID-19 syndrome

If the patient has neurological problems, he can be treated with the classic method of spa treatment. Post-Covid syndrome can last for more than 6 months and it is advisable to prepare procedures that may be different for diseases of the peripheral nervous system, central nervous system and mental state. Treatment requires communication through questionnaires to help monitor the patient's condition. To determine the treatment procedure using, in addition to the classic method of rehabilitation, also new methods that can be used in telerehabilitation. Linking research into telerehabilitation methods with artificial intelligence will help to better understand the usefulness of these technologies as a result of a pandemic (Wang *et al.* 2020). Several studies have focused on measuring the impact and

feasibility of telehealth initiatives taken during a pandemic (Wosik *et al.* 2021).

In 2021, the use of artificial intelligence for telerehabilitation and other relevant digital health solutions to address the consequences of the COVID-19 pandemic have been analyzed in more detail (Gunasekeran *et al.* 2021). They examined a large number of reports using artificial intelligence (45%) and big data analysis (36%), and found that for various clinical and research applications, they focused mainly on telehealth (40%), digital communication (11%) and digital screening (9%). The results suggest that there is an increasing need for digital health technologies and highlight the need for better digital health studies, such as artificial intelligence and big data processing (Gunasekeran *et al.* 2021).

A range of digital health technologies and a new environment for digitizing clinical trials to cope with a pandemic are in place (Whitelaw *et al.* 2020). The digital pandemic preparedness and response initiatives used in the pandemic are shown in Table 1 below.

Table 1. Functions and Digital technology used in Pandemic preparedness

Functions	**Digital technology**	**Countries**
Tracking	Data dashboards; migration maps; machine learning; real-time data from smartphones and wearable technology	China; Singapore; Sweden; Taiwan; USA
Screening for infection	Artificial intelligence; digital thermometers; mobile phone applications; thermal cameras; web-based toolkits	China; Iceland; Singapore; Taiwan
Contact tracing	Global positioning systems; mobile phone applications; real-time monitoring of mobile devices; wearable technology	Germany; Singapore; South Korea
Quarantine and self-isolation	Artificial intelligence; cameras and digital recorders; global positioning systems; mobile phone applications; quick response codes	Australia; China; Iceland; South Korea; Taiwan
Clinical management	Artificial intelligence for diagnostics; machine learning; virtual care or telemedicine platforms	Australia; Canada; China; Ireland; USA

In Canada, Alberta Health Services has launched a TeleHealth service focused on the rehabilitation needs of people with acute and chronic musculoskeletal, neurological and other conditions affected by the COVID-19 pandemic. This service allows patients and caregivers to speak directly to rehabilitation physicians and specialists, physiotherapists (Carriere *et al.* 2021). In Canada, the artificial intelligence system allowed a more meaningful interpretation of a telephone conversation during a conversation to record patient characteristics, such as the frequency of certain keywords (such as patient-reported conditions or symptoms, keyword comparisons) between different callers and geo-graphies, and to find correlations between topics discussed in each session. (Brehon *et al.* 2021).

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In the United Kingdom, artificial intelligence research was conducted for individual home rehabilitation in patients suffering from neurodegenerative diseases during the COVID-19 pandemic (Vourganas *et al.* 2021). Similar recommendations have been made with physiotherapists, rehabilitation physicians, neurologists, psychologists, and psychiatrists (Sramka *et al.* 2020a).

DISCUSSION

Research for the treatment of post-COVID-19 syndrome should focus on detecting and eliminating changes in motor, nervous, sensory and mental disorders. The aim will be to examine the impact of rehabilitation, telerehabilitation and virtual reality on reducing fatigue, stress and improving the patient's cognitive functions through an individual optimized procedure. The main parts of research in the field of neurological telerehabilitation will be:

- new medical devices and diagnostic tools, emphasis on new home and mobile technologies,
- new proposals for the human-biotechnology interface (multimedia communication, virtual reality, speech recognition for an individual approach),
- new telerehabilitation services in environments of well-controlled patient research methodologies,
- reliable and valid methods of evaluation of proposed solutions using artificial intelligence to optimize rehabilitation after post-COVID-19.

The final goal of the research will be:

- prepare an interdisciplinary approach to long-distance telerehabilitation,
- adjust the organization of rehabilitation centers in order to provide new telerehabilitation services,
- adapt the area of clinical prescribing to new rehabilitation,
- to prepare postgraduate education of health professionals, specialists in a new type of rehabilitation.

CONCLUSION

Since 2020, the consequences of the COVID-19 pandemic on motor, nervous, sensory functions and mental disorders have been increasing. This increase is in people who have undergone stressful diagnoses, illness and isolation. Similar to depression, they have a high level of inflammation. Inflammatory signals can alter the way the brain produces the neurotransmitters serotonin, norepinephrine, and dopamine, which help nerve cells communicate. The relationship between inflammation and mental disorders has been confirmed by post-traumatic stress disorder.

From the current review of post-pandemic publications, it is important to identify possible consequences for COVID-19 diseases such as post-COVID syndrome, disseminated intra-vascular coagulation, respiratory insufficiency, neurological, sensory, neurodegenerative diseases, and cognitive decline.

Research is needed to monitor patients with acute post-COVID syndrome based on gender, medical history, geographical distribution, ethnicity, and other characteristics. The objectives of the future project can be identified as follows:

1. New research methodologies for the study of the consequences of the disease on COVID-19 mainly from the neurological and psychological point of view.
2. To define the consequences of the COVID-19 disease and prepare a method of rehabilitation and optimal treatment not only for the respiratory consequences, but also for the motor and psychological consequences of the disease.
3. To prepare quantitative and qualitative questionnaires and tests for comparing the

condition of patients after COVID-19 disease focused on motor, neurological and psychological consequences.
4. To analyse of quantitative and qualitative questionnaires and tests of treated patients by the proposed methods.
5. To apply artificial intelligence to the optimal way of rehabilitation and treatment with monitoring of patients in the long term.
6. To evaluate suggestions for rehabilitation of post pandemic syndromes in the next waves resp. other than COVID-19.

Proposals to implement a project focused on the current state of patients. In the case of a call from EU funds, it is possible to implement the project in cooperation with other workplaces at home and abroad with doctors, physiotherapists, rehabilitation workers, psychologists and computer scientists in European countries.

Conflict of Interest
None

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Nervous System Response to SARS-CoV-2 Infection

Reakcie nervového systému na infekciu vírusom SARS CoV-2

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ABSTRACT

Introduction: The Coronavirus (COVID-19) disease has caused a global pandemic over the past year, accompanied by various neurological manifestations. The *SARS-CoV-2* virus may be regarded as an opportunistic pathogen of the brain. It enters the intracranium through the olfactory ganglion cell, retrograde axonal transport from peripheral nerve endings, or via haematogenous or lymphatic routes.

Main body: The COVID-19 infection can cause neurological disorders, encephalopathy, impaired consciousness, confusion, agitation, seizures, ataxia, headache, anosmia, ageusia, neuropathies, and neurodegenerative diseases. The majority of the infected cases were asymptomatic or displayed flu-like symptoms, such as shortness of breath, fever, sore throat, cough, myalgia, loss of taste and smell, fatigue, and sleep disturbances. More than one-third of patients developed neurological symptoms affecting the central nervous system, peripheral neural system, and skeletal muscles. The common risk factors include neurodegenerative diseases, genetic variations, cerebrovascular diseases, and metabolic risk factors such as diabetes mellitus or hyperlipidaemia. The present article provides the latest findings in this field.

Conclusion: The consequences of the disease include the need to receive long-term care and professional rehabilitation. From a neurological and psychological point of view, the monitoring of patients with acute post-COVID-19 syndrome will facilitate the provision of professional rehabilitation for nervous, motor-skill, and psychological problems. It will make it possible to use telerehabilitation and artificial intelligence to provide optimal treatment to patients.

Keywords: Post-COVID-19 syndrome, nervous system disorders, neurodegenerative diseases, fatigue, sleep disorders

ABSTRAKT

Úvod : Ochorenie koronavírusom (COVID-19) spôsobilo za posledný rok globálnu pandémiu spojenú s množstvom neurologických prejavov. Vírus SARS-CoV-2 je možné považovať za oportúnny patogén mozgu, ktorý vstupuje do intrakránia čuchovou gangliovou bunkou, retrográdnym axonálnym transportom z periférnych nervových zakončení, alebo hematogénnymi, lymfatickými cestami.

Jadro práce: Ochorenie COVID-19 má za následok vznik neurologických porúch, encefalopatie, poruchy vedomia, zmätenosti, agitácie, záchvaty, ataxiu, bolesti hlavy, anosmiu, ageúziu, neuropatie a neurodegeneratívne choroby. Väčšina prípadov bola asymptomatická, alebo mala príznaky podobné chrípke, dýchavičnosť horúčku, bolesti v krku, kašeľ, myalgie, stratu chute a vône, únavu, poruchy spánku. Viac ako tretina pacientov má neurologické symptómy na CNS, PNS a kostrových svaloch. Medzi rizikové faktory patria neurodegeneratívne choroby, genetické variácie, cerebrovaskularne ochorenia, metabolické rizikové faktory, ako je diabetes mellitus alebo hyperlipidémia. Článok prináša najnovšie poznatky z tejto oblasti.

Záver: Následky ochorenia vyžadujú dlhodobú, odbornú rehabilitáciu. Monitorovanie pacientov s akútnym post-COVID syndrómom, z neurologického a psychologického hľadiska, umožní odbornú rehabilitáciu pre nervove, motorické a psychické dôsledky. Umožní aplikovať telerehabilitáciu a umelú inteligenciu na optimálnu liečbu pacienta.

Kľúčové slová: Postcovidový syndróm, poruchy nervového systému, neurodegeneratívne choroby, únava, poruchy spánku

INTRODUCTION

The Coronavirus (COVID-19) disease has caused a global pandemic over the past year, accompanied by various neurological manifestations. *SARS-CoV-2* can be considered as an opportunistic pathogen of the brain that enters the brain through the olfactory ganglion cell, retrograde axonal transport from peripheral nerve endings, or via haematogenous or lymphatic routes. It can cause neurological disorders, encephalopathy, impaired consciousness, confusion, agitation, seizures, ataxia, headache, anosmia, ageusia, neuropathies, and neurodegenerative diseases. The consequences and manifestations of the COVID-19 disease on the nervous system have been reviewed in the publication by Khatoon *et al.* (2021).

As of the end of July 2021, *SARS-CoV-2* has infected almost 195 million people worldwide and caused the death of 4.2 million people. The majority of the infected cases were asymptomatic or displayed flu-like symptoms, such as shortness of breath, fever, sore throat, cough, myalgia, loss of taste and smell, and fatigue (Wrapp *et al.* 2020). SARS-CoV is neuroinvasive in nature (Netland *et al.* 2008, Li *et al.* 2016), it enters the central nervous system (CNS) by infecting endothelial cells of the blood-brain barrier (BBB) and epithelial cells of the blood-CSF barrier, through retrograde axonal transport, the synapse-connected route after entering the peripheral nerve endings of the respiratory system (Bohmwald *et al.* 2018), neurons of the enteric nervous system (ENS), and also through blood circulation (Baig *et al.* 2020, Khatoon *et al.* 2020). It can enter the nervous system directly through the olfactory nerve, blood circulation, ENS and its sympathetic afferent neurons (Khatoon *et al.* 2020).

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Neurological manifestations associated with COVID-19

More than one-third of COVID-19 patients developed neurological symptoms affecting the CNS, PNS, and skeletal muscles (Mao *et al.* 2020; Helms *et al.* 2020) (Table 1, Table 2).

Table 1. Neurological symptoms affecting the Central Nervous System

Publication	Clinical presentation
	CNS Diseases:
Moriguchi et al. 2020	Headache, fatigue, seizures, decreased consciousness, and meningism.
Sohal et al. 2020	Weakness, altered mental status, and seizures.
Wong et al. 2020	Ataxia, oscillopsia, and bilateral facial weakness.
Dugue et al. 2020	Bilateral leg stiffening and sustained upward gaze.
Helms et al. 2020	Agitation, confusion, corticospinal tract signs, ischaemic attack, epilepsy, and cognitive impairment.
Mao et al. 2020	Impaired consciousness, seizures, limb twitching, and loss of consciousness.
Poyiadji et al. 2020	Disturbed mental status, ANE.

Table 2. Neurological symptoms affecting the Peripheral Nervous System

Publication	Clinical presentation
	PNS manifestations:
Camdessanche *et al.* 2020	Paraesthesia in hands and feet, weakness in limbs with areflexia and loss of vibration sense, and dysphagia.
Toscano *et al.* 2020	Flaccid, areflexic limb weakness, facial weakness, dysphagia, facial diplegia, areflexia, limb paraesthesia, and ataxia.
Zhao *et al.* 2020	Weakness of limbs, fatigue, areflexia, and neurological symptoms.
	Skeletal muscle disease:
Jin *et al.* 2020	Weakness and tenderness in lower limbs.
	Taste and smell dysfunction:
Lechien *et al.* 2020	Taste and smell dysfunction
	Ischemic stroke:
Elkhider *et al.* 2020	Neuropathy, focal neurological deficit, and altered mental status.
Beyrouti *et al.* 2020	Hemiparesis, impaired consciousness.
Oxly *et al.* 2020	Hemiplegia, impaired consciousness, dysarthria, dysphasia, and sensory deficit.

By direct activation of immune response and neurotoxicity, *SARS-CoV-2* causes damage in a host's body. Moreover, it leads to a cerebral vascular injury that increases the risk of chronic brain damage, because of the damaging effect of multifocal cerebral ischaemia or haemorrhage, endothelial and BBB dysfunction, and upregulation of pro-inflammatory cytokines within the brain (Tsivgoulis *et al.* 2020).

CENTRAL NERVOUS SYSTEM MANIFESTATIONS

Headache and dizziness

Headaches and dizziness are the most common neurological symptoms in COVID-19 patients (Mao *et al.* 2020, Guan *et al.* 2020, Roy *et al.* 2020). Headache can be considered as a precursor of viral meningitis or encephalitis and can often be the predictive symptom of cerebrovascular disease (Wang *et al.* 2020).

Anosmia and hypogeusia/ageusia

In adults, post-viral anosmia is one of the major reasons for olfactory dysfunction (Giacomelli *et al.* 2020) and hypogeusia/ageusia in the infected patients (Roy *et al.* 2020). The majority of patients experienced at least one or both of these dysfunctions (Giacomelli *et al.* 2020). Anosmia was reported as the first symptom of olfactory system disorders (Heidari *et al.* 2020).

Cerebrovascular events

In the middle of the ongoing pandemic period, cerebrovascular events (ischemic strokes, intracerebral haemorrhage, and cerebral venous sinus thrombosis) were reported in COVID-19 patients (Morassi *et al.* 2020, Li *et al.* 2020) who succumbed to respiratory failure (Li *et al.* 2020, Varatharaj *et al.* 2020). In most of the cases, strokes were reported in elderly patients with a prior history of stroke along with other comorbidities (such as hypertension and diabetes). Stroke in patients under the age of 50 years was reported to occur during the course of infection with an average duration of 10–12 days (Grau *et al.* 1995, Oxley *et al.* 2020). COVID-19 patients with stroke have a significantly higher in-hospital mortality rate (Benussi *et al.* 2020).

Encephalopathy

Encephalopathy in COVID-19 patients shows common symptoms such as headache, fatigue, fever, and neck rigidity, or even seizures, strokes, agitation, altered consciousness, coma, and focal neurological defects. A case of viral meningo-encephalitis was reported (Moriguchi *et al.* 2020) in a young man of 24 years who was unconscious and experienced generalised convulsions. Encephalitis is a clinical manifestation of COVID-19. Agitation and confusion of varying degrees are both diffuse cortico-spinal tract signs (Helms *et al.* 2020). Acute necrotising encephalopathy also occurs in COVID-19 patients (Poyiadji *et al.* 2020).

Seizures and SARS-CoV-2

Virus particles directly invade cerebral arteries and cause vasculopathy (Gilden *et al.* 1996, Nagel *et al.* 2010). COVID-19 patients may also have swollen legs and purple bruising due to blood clots. They may also experience blood clotting abnormalities (Karuppan *et al.* 2021). Clotting in small arteries lessens cerebral oxygen supply and leads to ischemic stroke. An infected patient with a history of diabetes, hypertension, and on kidney dialysis without known seizures developed multiple episodes of new-onset seizures during infection and died shortly after the onset of seizures (Sohal *et al.* 2020). The new-onset seizures in COVID-19 patients (Asadi-Pooya *et al.* 2020, Hwang *et al.* 2020) may be related to intravascular coagulopathy.

Hypoxia and brain damage

Pneumonia leads to alveolar and lung tissue damage. This inflammation and oedema affect the exchange of oxygen at the alveolar–capillary interface and leads to brain hypoxia (Abdennour *et al.* 2012). Symptoms of poor judgement, lack of coordination, and temporary loss of memory can also arise as a result of brain hypoxia. It can even lead to coma, seizures, and brain death (Fugate *et al.* 2017). COVID-19 can also lead to CNS damage and neurological symptoms without directly invading the brain itself. Hypoxia in COVID-19 patients can cause brain damage (Xu *et al.* 2020).

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PERIPHERAL NERVOUS SYSTEM (PNS) MANIFESTATIONS

Guillain-Barre syndrome

Guillain-Barre syndrome (GBS) is a condition in which the host's immune system mistakenly starts attacking the PNS. GBS is also a common reason for acute flaccid paralysis. It can be associated with viral infections such as H1N1, Zika, and influenza (Vellozzi *et al.* 2014). The association between GBS and COVID-19, symmetric weakness and areflexia in both legs and feet along with impaired sensation to light touch and pinpricks (Zhao *et al.* 2020) all prevail in male patients (Alberti *et al.* 2020). A case of a male patient showing GBS in association with COVID-19 infection was reported, where the patient did not have any previous neurological history (Abu-Rumeileh *et al.* 2020). Immuno-globulin treatment was shown to be effective in the treatment of COVID-19 patients with GBS symptoms (Joob *et al.* 2020). It remains to be determined whether *SARS-CoV-2* itself causes GBS, or is secondary to other infections such as dengue (Jin *et al.* 2020).

Myopathy

The skeletal muscle damage of myopathy is observed in COVID-19 patients, ranging from an asymptomatic increase in creatine kinase and lactate dehydrogenase to rhabdomyolysis (Suwanwongse *et al.* 2020). COVID-19 patients share symptoms including myalgia, weakness, and fatigue with other viral illnesses (Wang *et al.* 2020). In cases of rhabdomyolysis in the pandemic period, COVID-19 patients experienced significant elevations of levels of serum myoglobin, lactate dehydrogenase, and creatine kinase (Suwanwongse *et al.* 2020, Colizzi *et al.* 2020). Hepatic and renal disease may also be risk factors for myopathy.

Somatic Symptoms

Somatic Symptom Disorder (SSD) was observed in COVID-19 patients. SSD is associated with disturbing emotions, impaired cognition and behaviour, nausea, headache, chest discomfort, dizziness, and palpitations. A case of a 16-year-old child with extreme and persisting health concerns was reported to respond rapidly to low doses of antidepressant and antipsychotic drugs (Yifan *et al.* 2020).

Intensive care unit (ICU) nurses were found to be vulnerable to SSD with varying and overlapping symptoms which were mainly associated with the failure of personal protective equipment (Barello *et al.* 2020). Health care workers showed increased irritability, a change in food habits, insomnia, and muscle tension (Goularte *et al.* 2021, Naskar *et al.* 2020, Nilsson et al. 2020).

Similarities between neurological manifestations of *SARS-CoV* infections

Current and prior coronavirus (CoV) infections share similarities in neurological manifestations. Encephalitis is the most common neurological manifestation in SARS-CoV infection (Morfopoulou *et al.* 2016 ; Xu *et al.* 2005 ; Arabi *et al.* 2015 ; Romero-Sanchez *et al.* 2020, Dorche *et al.* 2020). In post-infections of *HCoV-OC43* and *SARS-CoV-2*, disseminated encephalomyelitis was commonly observed. The neurological manifestations associated with *SARS-CoV-1*, *MERS-CoV*, and *SARS-CoV-2* include headache, ischemic stroke, encephalitis, encephalopathy, seizures, and neuropathy. Intracerebral haemorrhage was also observed in *MERS-CoV* and *SARS-CoV-2*, while myopathy and anosmia were observed in *SARS-CoV-1* and *SARS-CoV-2* (Solomon *et al.* 2020).

Neurodegenerative diseases and *SARS-CoV-2*

The long-term post-infectious complications of *SARS-CoV* can be associated with neurodegenerative diseases (Zhou *et al.* 2013; Lippi *et al.* 2020; Tavassoly *et al.* 2020; Dolatshahi *et al.* 2021). The infection can cause several neurological disorders, including encephalitis, protein aggregation, neuro-

degeneration, and Parkinsonian or dementia symptoms (Grozdanov *et al.* 2014). *SARS-CoV*'s invasion into the CNS increases BBB permeability to both cytokines and peripheral leukocytes which in turn induces the activation of microglia cells and their maturation into the neurotoxic phenotype, thereby contributing to the propagation of neurodegenerative processes (Domingues *et al.* 2017, Steenblock *et al.* 2020). Viral replication in neurons can promote unfolded protein response, and impair proteostasis, thus leading to the accumulation of misfolded protein and subsequent aggregation (Zhou *et al.* 2013, Tavassoly *et al.* 2020, Brooks *et al.* 2020a,b.). The common risk factors of COVID-19 and neurodegenerative diseases include genetic variations and metabolic risk factors such as diabetes mellitus or hyperlipidaemia.

Post-COVID-19 fatigue

Several potential contributing factors for patients after COVID-19 infection have been published (Rudroff *et al.* 2020). It is necessary to distinguish fatigue from depressive mood, sleep disorders, and comorbidities (Rudroff *et al.* 2016). Post-COVID-19 fatigue is defined as a *decrease in physical and/or mental performance*. After viral infections, physical, cognitive, and psychological impairments persist for multiple years (Tansey *et al.* 2007; Lam *et al.* 2009). Fatigue is a debilitating symptom after having recovered from COVID-19 (Goertz *et al.* 2020, Arnold *et al.* 2020, Mandal *et al.* 2020). *SARS-CoV* is neuroinvasive, it can use haematogenous and neuronal dissemination to penetrate the CNS (Talbot *et al.* 2008, Desforges *et al.* 2014, Desforges *et al.* 2019; Pezzini *et al.* 2020), thus changing neurotransmitter levels of dopamine and serotonin (Meeusen *et al.* 2006; DeLuca *et al.* 2009; Cordeiro *et al.* 2017; Costa *et al.* 2020), intrinsic neuronal excitability, inflammation, and demyelination.

Delorme *et al.* (2020) used F-fluoro-deoxyglucose-positron emission tomography (FDG-PET) to measure cerebral glucose metabolism in COVID-19 patients with fatigue. They found frontal hypometabolism and cerebellar hypermetabolism, which may have an impact on fatigue. An association between cerebral hypometabolism and fatigue has been demonstrated in patients with neurological disorders (Roelcke *et al.* 1997, Bakshi *et al.* 2000, Blinkenberg *et al.* 2001) and cerebral hypometabolism causes depression. Longer periods of physical inactivity may cause decreased motor neuron excitability, e.g. inhibition (Lulic *et al.* 2017; Campbell *et al.* 2019), and may contribute to fatigue (Asadi-Pooya *et al.* 2020; Tankisi *et al.* 2020).

Fatigue can be caused by stress, anxiety, and fear (Morgul *et al.* 2020). Quarantine, social distancing, and isolation may have unintended consequences in recovering COVID-19 patients, such as post-traumatic stress symptoms, anxiety, confusion, depression, and anger (Morgul *et al.* 2020; Satici *et al.* 2020; Brooks *et al*. 2020). It is essential to distinguish COVID-19 fatigue from depression, somnolence, and apathy. Serotonin and dopamine may alter the levels of other neurotransmitters, such as acetylcholine (Cantor *et al.* 2010; Uversky *et al.* 2020) responsible for mood, stress, anxiety, depression, fatigue, and cognitive changes. *SARS-CoV* causes skeletal muscle pain, muscle weakness, and injury occurrence (Snijders *et al.* 2015; Jin *et al.* 2020; Li *et al.* 2020). *SARS-CoV* can induce skeletal muscle myopathies (Always *et al.* 2014; Ferrandi *et al.* 2020) in older adults (Ryder *et al.* 2017) and patients with dystrophies (Wu *et al.* 2019). Fatigue may be further compounded in older people by age-related loss of function and skeletal muscle wasting (Always *et al.* 2014). Fatigue increases the seriousness of and mortality in diabetic patients with COVID-19 (Zhu *et al.* 2020; Singh *et al.* 2020; Leung *et al.* 2020).

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Fatigue is dependant on the environment and physical capacity of individuals. Temperature and humidity can affect the physical abilities of patients (Mecenas *et al.* 2020). Self-isolation, lockdown, and social isolation may have negative impacts on individuals (Taylor *et al.* 2019; Masan 2021). Experiencing anxiety and distress about the pandemic while also not being physically active during quarantine may lead to increased fatigue. Cardiovascular disease, hypertension, diabetes, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, and cancer all have fatigue as a common symptom.

Central factors can be studied via neuroimaging procedures such as FDG-PET to measure changes in glucose metabolism (Kindred *et al.* 2015; Fietsam *et al.* 2020), psychological factors with neuropsychological tests (Proessl *et al.* 2018; Workman *et al.* 2020; Workman *et al.* 2020 a) and peripheral factors can be evaluated by comparing alterations in the electromyography signal with maximum force or power output (Proessl *et al.* 2018; Workman *et al.* 2020 b).

COVID-19 and sleep

Sleep dysfunction can be seen commonly in COVID-19 infected patients and also those staying home because of the lockdown. They reported acute stress disorder, anxiety, poor concentration, failing work performance, depressive symptoms, and insomnia (Physiopedia 2020). There is a two-way link between sleep and immune function. Activation of the immune system alters sleep and affects the innate and adaptive immune systems. Sleep strengthens the immune system whereas a lack of sleep weakens it. Depending upon the time and magnitude of the inflammatory responses generated by the immune system, sleep can be increased in duration and in intensity but can also be disrupted (Gualano *et al.* 2020). Mental health problems were associated with sleep disturbances, insomnia, a higher risk of disorders (Huang *et al.* 2020), and disturbed sleep quality (Partinen *et al.* 2021). Sleep disturbances, insomnia, nightmares, sleep apnoea, fatigue, exhaustion, and REM sleep have a relationship to COVID-19 disease and psychiatric or other physiological disorders. Anxiety about getting infected and not being able to go to work, being confined at home all day, losing sunlight – all these factors disrupt people's internal clock and sleep patterns (Dempsey *et al.* 2010).

AI and smartphone technology were used to identify moderate to severe sleep disorders during the pandemic period. (Schlarb *et al.* 2020). Children aged 5–10 years and their parents showed reduced sleep patterns during COVID-19 (Kim *et al.* 2021). A one-hour increase in nocturnal sleep duration was associated with lower odds of COVID-19. Severe sleep disorder was associated with greater odds of COVID-19 (Prasad *et al.* 2021). Work burnout was associated with greater odds of COVID-19 including greater disease duration and severity.

A brain disease analysis shed light on neurological manifestations of SARS-CoV, identified both direct and indirect links with the infection (Chen *et al.* 2013), and reported the genes which were influenced by the SARS-CoV proteins directly or indirectly and were also known to be associated with sleep apnoea and which take part in obstructive sleep apnea. These genes have also been reported to be associated with neurological diseases, suggesting the association of sleep obstruction with neurologically related disorders, and vice versa.

People with a history of neurological or sleep-related disorders are more prone to COVID-19 infection, and vice-versa (Alimoradi, Broström, *et al.* 2021). The nervous system and the sleep cycle are connected in a two-way manner: any disturbance in one can cause a disturbance in the function of the other as well. It is essential to focus on sleep and the neurological complications of COVID-19.

CONCLUSION

Coronavirus disease 2019 (COVID-19) has caused a global pandemic over the past year, accompanied by

various neurological manifestations. The SARS-CoV-2 virus may be regarded as an opportunistic pathogen of the brain. It enters the intracranium through the olfactory ganglion cell, retrograde axonal transport from peripheral nerve endings, or via haematogenous or lymphatic routes. The transport can also take place by way of intercellular connections through nanotubes (Tiwari1, Koganti *et al.* 2021).

It can cause neurological disorders, encephalopathy, impaired consciousness, confusion, agitation, seizures, ataxia, headache, anosmia, ageusia, neuropathies, and neurodegenerative diseases. The majority of the infected cases were asymptomatic or displayed flu-like symptoms, such as shortness of breath, fever, sore throat, cough, myalgia, loss of taste and smell, fatigue, and sleep disturbances. More than one-third of COVID-19 patients developed neurological symptoms affecting the CNS, PNS, and skeletal muscles. The common risk factors include neurodegenerative diseases, genetic variations, cerebrovascular diseases, and metabolic risk factors such as diabetes mellitus or hyperlipidaemia.

The consequences of the disease include the need to receive long-term care and professional rehabilitation. From a neurological and psychological point of view, the monitoring of patients with acute post-COVID-19 syndrome will facilitate the provision of professional rehabilitation for nervous, motor-skill, and psychological problems. It will make it possible to use telerehabilitation and artificial intelligence to provide optimal treatment to patients (Ružický *et al.* 2021). A responsible and recurring effort to highlight the importance of a more comprehensive, particularly proactive, approach in the current epidemiological situation is needed (Horňáček 2021).

Conflict of interest

The authors declare there is no conflicts of interest in the connection with the published article.

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Problems associated with skeletal muscle damage after SARS-CoV-2 virus infection at the elderly, performed therapy

Problemy osób starszych związane z uszkodzeniem mięśni szkieletowych po zakażeniu wirusem SARS-CoV-2, podejmowane terapie

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ABSTRACT

Introduction: The coronavirus pandemic caused by *SARS-CoV-2* has brought many negative aspects not only on a global scale, but has also led to negative individual impacts on human health and quality of life.

Research objectives: The article presents basic information about *SARS-CoV-2* virus infection and, based on the literature review, suggests potential factors affecting skeletal muscles and their damage. At the same time, the necessity of performing physical exercises in the process of treatment and physical activity were indicated as an effective prophylactic measure.

Core of work: Skeletal muscles play very important roles, above all they enable the performance of movements and they are also responsible for biochemical processes in the human body. *SARS-CoV-2* infection causes muscle damage and loses mass. There are significantly weakened at the time of the covid-19 disease. In addition, the need to remain immobile during treatment exacerbates pathological changes. The infection is much less likely and the changes in the organs become more intense at the elderly. Health complications do not only concern the period of acute infection, they also occur in convalescents.

Conclusion: Well-known studies has figured out new information and report other symptoms linked with the diseases Covid-19 including psychical problems such as anxiety, depression and physical problems with the immunity, mobility, skeletal and muscles.

Keywords: elderly person, *SARS-CoV-2* virus, damage to skeletal muscles, physical exercises

Streszczenie

Wprowadzenie: Pandemia koronawirusa wywołana przez *SARS-CoV-2* przyniosła wiele negatywnych aspektów nie tylko w skali globalnej, ale również doprowadziła do negatywnego indywidualnego wpływu na zdrowie i jakość życia człowieka.

Cele: W artykule przedstawiono podstawowe informacje o zakażeniu wirusem *SARS-CoV-2*, na podstawie literatury wskazano potencjalne czynniki uszkadzające mięśnie szkieletowe oraz ich uszkodzenia. Wskazano jednocześnie na konieczność wykonywania ćwiczeń fizycznych w procesie leczenia, a na aktywność fizyczną jako skutecznego środka profilaktycznego.

Podstawowe badania: Mięśnie szkieletowe pełnią bardzo istotne role, przede wszystkim umożliwiają wykonywanie ruchów, ponadto odpowiadają za procesy biochemiczne w organizmie człowieka. Zarażenie wirusem *SARS-CoV-2* powoduje uszkodzenie mięśni, w trakcie choroby zmniejszają swoją masę i ulegają znacznemu osłabieniu. Dodatkowo konieczność przebywania w bezruchu podczas leczenia potęguje patologiczne zmiany. Osoby starsze znacznie gorzej przechodzą zakażenie, a zmiany w narządach uwidaczniają się bardziej intensywnie. Powikłania zdrowotne nie dotyczą tylko okresu ostrej infekcji, występują również u ozdrowieńców.

Streszczenie: Dobrze znane badania dostarczyły nowych informacji i zgłosiły inne objawy związane z chorobami Covid-19, w tym problemy psychiczne, takie jak lęk, depresja i problemy fizyczne z odpornością, mobilnością, szkieletem i mięśniami.

Słowa kluczowe: osoba starsza, wirus *SARS-CoV-2*, uszkodzenie mięśni szkieletowych, ćwiczenia fizyczne

INTRODUCTION

Information about the first patient with Covid-19 appeared on December 8 in 2019 and it has been spread from Wuhan, China. The disease is caused by the *SARS-CoV-2* virus (*Severe Acute Respiratory Syndrome, Coronavirus 2*), which mainly causes damage to the respiratory system. The risk of infection with the virus is particularly high in people with elevated BMI and people who are in the group of the elderly (Edwards *et al.* 2021). It has been mainly transferred by the respiratory tract (droplet transfer), the risk of transmission may also occur through direct and indirect contact or in the mother's womb and passes to the fetus. Airway production drops in exhaled air are formed by the rapid flow of air in the upper airways. They might occur during breathing, conversations, sneezing and coughing. At peak inspiratory flows during normal breathing, air velocities in the upper airways reach high velocities. This strong flow of air over a thin (5 μm to 10 μm) layer of mucus lining the airways breaks the surface of the mucus into small droplets, just as the wind blows above the water surface. The nature and extent of the decay depends on the surface properties of the mucus itself (Watanabe *et al.* 2005). Within a year and a half, new variants of the virus have emerged that are more contagious and resistant to treatment. It leads to having difficulties and other challenges in the fight against the Covid-19 pandemic (Hryniewicz *et* Dubiel 2020).

The coronavirus enters the nose and throat and penetrates the circulatory, respiratory, nervous and digestive systems, as well as the skin and tissues, through ACE2 receptors. *SARS-CoV-2* virus infection causes various symptoms and affects all systems and organs of the human body. The symptoms of the disease are well known (Odyniec, Rożniewski 2020; Martinez- Fierro *et al.* 2021), although they are very diverse and heterogeneous. The first symptoms after infection include sore throat, dry cough, smell and taste, diarrhoea or vomiting. The pulmonary alveoli are damaged in the respiratory system, causing

difficulty in exchanging air at an intensity that does not cause the slightest risk, up to acute respiratory failure requiring intensive treatment (Chen *et al.* 2020). Myocardial infarction and inflammation, arrhythmias and heart failure are common pathological conditions in the circulatory system. Thromboembolic complications are very common and life-threatening, both during the acute period of the disease and after recovery (Zhao *et al.* 2021; Gasecka *et al.* 2021).

Significant pathologies and numerous complications occur in the nervous system. The most dangerous is a stroke, especially in the elderly and people with multiple diseases. The so-called mild symptoms, which are very important for the quality of functioning and quality of life, are brain fog, concentration and short-term memory are impaired, and confusion is also recorded. These pathologies may persist for a longer period after the infection has passed (Taquet *et al.* 2021, Šramka *et al.* 2020) and are often accompanied by anxiety and depression. *SARS-Cov-2* infection in the kidney can manifest itself as acute renal damage in previously ill people or as an exacerbation of existing chronic kidney disease, also in dialysis patients (Hirsch *et al.* 2021). Skin symptoms include pseudo-chilblanes, maculopapular rash, urticarial and vesicular lesions, and those associated with vascular occlusion (Tan *et al.* 2021).

The *SARS-CoV-2* virus causes a severe systemic disease in the elderly, the research studies indicate problems in the muscular system. Skeletal muscles are the largest fibber in the human body and affected by *SARS-CoV-2* (Nasiri *et al.* 2020). One of the first symptoms of virus infection is muscle pain (declared about 35% - 50% of patients), and there is also inflammation of the muscles and / or dermatomyositis. Rapid fatigue and muscle weakness are also symptoms of a virus-induced disease (Zhu *et al.* 2020). The extent and duration of pathological changes in muscle fibre is related to the severity of the disease (Finsterer *et* Scorza 2021). Observations and experience in the treatment of patients indicate that changes in skeletal muscles are closely related to abnormal lung images, and at the same time have a negative prognosis, especially in the elderly group (Zhang 2020). The exact mechanism of skeletal muscle damage in patients with COVID-19 is uncertain and unambiguously described in the literature. As at this stage of knowledge, there are unpredictable long-term consequences for convalescents. Furthermore, it is not possible to determine the effects caused by virus mutations, because skeletal muscles perform other important functions in the body in addition to static and dynamic work, for example during glucose metabolism.

NECESSARY PHYSICAL ACTIVITY FOR SENIORS

Observations of physical activity in the elderly suggest motor passivity and even a tendency to limit any activities and physical activities. This phenomenon is worrying, so as a properly dosed physical effort is very valuable for the efficiency and functioning of virtually all organs and systems, especially in the elderly. Movement in various forms has a positive effect on the human body almost immediately, improves muscle performance and endurance, improves balance, strengthens cognitive function, reduces the level of anxiety. In addition, it reduces the risk of cardiovascular disease and diabetes and reduces overweight (Pelliccia *et al.* 2021). During a pandemic, the role of physical activity increases as it help to improve the functioning of the immune system and significantly stimulates it. During exercise, muscles produce compounds that improve the function and functioning of the immune system and reduce inflammation in the body (Sallis *et al.* 2020). Therefore, muscles, which make up 30-40% of body weight, become a strong ally in the fight against the effects of infection, but only when the muscles work.

Unlike other healthy manifestations (diet, rest), physical performance decreases with age.

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Therefore, exercise and physical activity of the elderly and / or people with chronic diseases play a preventive and therapeutic role. At the same time, they play a crucial role in improving the comfort of everyday activities.

In this age group, cardiological diseases and so-called civilizations disease cause several health complications. Before starting physical activities, leasing after health injuries, it is necessary to visit a doctor to assess the health condition. It is needed to be consulted by the physiotherapist again. Prepare the exercises or physical activity performed, the participant should learn the ability to self-control their health. First, practitioners must learn to measure heart rate and regulate blood pressure. It is important to recognize shortness of breath, chest pain, relative and other disturbing effects. Exercise dosing should be completely safe according to current endurance skills. The existing rule of classification of difficulty, load should be increased to prepare the body for higher doses of exercise (Pelliccia *et al.* 2021). The most common anticipated physical activity for older adults is 150 minutes of intense or 75 minutes of intense physical activity per week, or equivalent combustion of the two methods. It is best to develop activities and games to open the priesthood, in green areas. The simplest form of exercise is walking at a speed of about 4.5 km / h.

EFFECTS OF THE PANDEMIC

The COVID-19 pandemic has changed reality in virtually all areas of health, social and professional life, and many seniors are still active. The pandemic period is a period of widely understood isolation. Older people have significantly reduced their physical activity, in line with the recommendations of anti-virus experts and following information from the media. The vast majority have changed their behavior so far, increasing the sedentary lifestyle even more. Direct contacts with the environment, as well as leaving the house, were kept to a minimum. Such behavior of older people as instructed resulted in a significant decline in health. The effectiveness and efficiency of the following systems have been reduced: the musculoskeletal, circulatory and respiratory systems. In addition, restrictions caused by extensive blockages promote adverse health behaviors that increase the risk of other diseases. The main mistakes are unhealthy eating habits and increased alcohol consumption (Grabowski *et al.* 2021). At this point, attention should also be paid to limited access to medical care and services. The impossibility of direct contact with the doctor, as well as the performance of diagnostic and control tests (including prophylactic) have caused an increase in health problems.

Many elderly people have become infected with the coronavirus, and a large group of this population has died. Most often due to respiratory and circulatory complications. Reclamation survivors, especially people after severe and very severe disease, currently have a number of complications that significantly limit the possibility of full and efficient living.

REASONS OF SKELETAL MUSCLE DAMAGE IN PATIENTS WITH COVID-19

Based on the available literature review, it is extremely difficult to identify one reason of skeletal muscle damage. Most likely, skeletal muscle pathology is the result of several interrelated factors.

1. Older people usually declare less physical activity, so they do not build up the reserves that might be needed for prolonged immobilization and subsequent convalescence. Changes in muscle structure and physiology in the elderly are very significant (Pitscheider *et al.* 2020). In addition, the forced abdomen in hospitalized patients and necessary in the treatment of critically ill patients restricts movement.
2. Elderly people get sick more often, metabolic and inflammatory disorders (obesity,

neoplastic and cardiovascular diseases, diabetes) are reported, and there are often problems with proteins and energy.

3. Hormonal disorders (testosterone) favor skeletal muscle damage (Zhou *et al.* 2021).
4. Sarcopenia can weaken the strength and endurance of the muscles of the elderly (Strzelecki *et al.* 2011).
5. The need for intubation and the introduction of forced mechanical ventilation accelerates protein loss. Necessary medications given to critically ill patients (eg. Dexamethasone) can also cause muscle damage and further immobilization of the supine (Welch *et al.* 2020).
6. Catabolism consists in the decomposition of complex chemical compounds into simpler molecules, most often proteins. Restricting food consumption causes the body to react and reach for carbohydrates, fats and proteins (Głażewski *et al.* 2020). Because most protein is found in the muscles, they begin to lose their volume due to catabolism.
7. Malnutrition and inflammation are considered important factors in the development of cytokine storms in people suffering from COVID-19. There is a very rapid release of cytokines, proteins that stimulate other cells of the immune system to respond to specific reactions. Excess cytokines directly destroy and damage many organs, including skeletal muscle, which degenerate (Welch *et al.* 2020).
8. Nausea and vomiting, which are symptoms of Covid-19 infection, can cause general weakness and lack of energy. Another cause of muscle pathology associated with malnutrition is anorexia, nausea and vomiting, which are very common symptoms in some patients with COVID-19. Lack of adequate energy supply is a major factor in the breakdown of protein in the body (Zhan *et al.* 2020).

IDENTIFIED SKELETAL MUSCLE DAMAGE CAUSED BY THE COVID-19 DISEASE

Knowing the effects of the COVID-19 pandemic suggest the presence of many pathologies, including in the muscular system. The biggest problems concern hospitalized patients, especially long-term patients with mild symptoms and no symptoms. The functional efficiency required to perform even simple motor tasks and daily self-service activities is significantly reduced. General weakness and shortness of breath at work and physical activities are closely related to limited muscle strength.

Body composition was assessed by computed tomography (CT) (Ufuk *et al.* 2020), numerous and significant metabolic changes and quantitative reductions in net body weight (LBM) were observed (Gualtieri *et al.* 2020). This process is noticeable in patients with concomitant obesity. Dystrophic skeletal muscle damage has been observed in the elderly during hospitalization (Jin et Tong 2020). Researchers have linked muscle damage to often significant weight loss (Haraj *et al.* 2021).

In 27% of hospitalized patients, laboratory tests have shown a significant increase in biomarkers of muscle loss, such as creatine kinase (CK) (Disser *et al.* 2020). Elevated levels of keratin kinesis have been observed in elderly patients with severe ones and concomitant comorbidities (Pitscheider *et al.* 2020). Higher CT values indicate damage and / or inflammation of the heart and skeletal muscle. Another worrying symptom of kidney failure is the breakdown of muscle cells. Magnetic resonance imaging (MRI) rhabdomyolysis in these patients is caused by *SARS-CoV-2* virus infection and the symptoms are characteristic (Strzelecki *et al.* 2011). When conscious, the patient initially reports symptoms such as: muscle tenderness, muscle pain, swelling (may occur after the patient has been hydrated), muscle stiffness and contractures with subsequent weakening and loss of function (only in muscle

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groups affected by rhabdomyolysis). Dark or reddish-brown urine is associated with the presence of myoglobin.

Sick elderly people complain of worsening lung ventilation due to impaired respiratory muscle efficiency. During the diagnosis of pulmonary fibrosis, the cross section of the pectoral muscles was observed and evaluated. Research findings clearly indicate a decrease in respiratory efficacy. This applies to critically ill patients of all ages (Ufuk *et al.* 2020).

Studies in the convalescent group have shown that the contractile force of the quadriceps (54%) and biceps (69%) decreased from normal (Paneroni *et al.* 2021).

A reduction in the action potential of motor neurons has been observed by electromyography in COVID-19 patients with rhabdomyolysis, despite normal nerve conduction (Rosato *et al.* 2020). Damage to motor and sensory fibers has also been observed in patients after several months of convalescence (He *et* Chen 2020). This type of skeletal muscle damage does not have a good prognosis and in the future may cause disability of varying severity, thus worsening the quality of life of convalescents. Decreased mobility and quality of life, especially during a pandemic, are associated with concomitant depression (Paneroni *et al.* 2021), which further complicates the rehabilitation process.

Evaluation of skeletal muscle endurance and physical fitness of patients recovering from COVID-19 can be performed using tests (eg. a six-minute walk or other short tests) and cardiopulmonary tests (exercise tests). Measurements of lower and upper limb circumference and chest mobility may be useful in evaluating the rehabilitation process.

PREVENTION OF SKELETAL MUSCLE DAMAGE IN PATIENTS WITH COVID-19

The principle of medical management in patients with COVID-19 is the complexity of therapy. All health problems, especially comorbidities, should be taken into account. This article is devoted to skeletal muscle, the authors describe prophylaxis in the field of muscle mass and loss of efficacy, and suggest regenerative effects when a pathological process occurs. The use of high-protein proteins with vitamin D at a dose of 100 - 1600 IU / day in daily nutrition is a priority. Muscle strengthening exercises should also be performed (Liao *et al.* 2019). The combination of diet and physical activity will satisfy the energy needs of the body and muscle strength. Active exercise of the upper and lower limbs will improve peripheral circulation and prevent blood clots from occurring. Patients in critical health should be provided with adequate enteral nutrition (proteins and nutritional supplements) and passive upper and lower limb exercises should be performed (Cawood *et al.* 2020). In these patients, it is often necessary to change the position, even when standing on the abdomen. A study (Cengiz *et al.* 2020) indicated the importance of protein and amino acid supplementation in reducing the manifestations of the disease and the consequences of long-term immobile movement.

Another very important element of comprehensive rehabilitation is respiratory kinesiotherapy of patients. The purpose of these exercises is to improve lung ventilation and keep breathing condition at the highest level. Appropriate starting positions for breathing exercises must engage the diaphragm as the primary respiratory muscle and maintain the necessary chest mobility. Independent people also need to be taught to cough. The above frequent change of position also improves pulmonary ventilation. In lying people, kinesiotherapy care consists in stimulating breathing with an emphasis on the work of the diaphragm and the activation of the respiratory muscles of the chest. All patients are advised to be tapped; this procedure cleanses the airways.

Inactive neuromuscular electrostimulation will help maintain the effectiveness of skeletal muscles of upper and lower extremities in a case of lying people. In addition, artificially induced alternating muscle contractions allow blood to flow in the muscles, nourish the tissues and prevent muscle loss. Manual or mechanical massages (Kasprzak *et al.* 2011) and continuous passive movement devices can be effective adjuncts to therapy. They allow passive movements of the limbs with a specific frequency, range of motion in the joints, provide compensation for muscle work while maintaining patient safety.

Any hygienic procedures to which patients are subjected, especially those in critical condition, also have a therapeutic role. Washing with sponges and pads is the perfect complement to physical therapy, as is the forced change of position and position during patient care.

The main goal of physiotherapy in working with patients with COVID-19 is to restore the patient's condition to the level before infection. There are several specific goals for improving all organs affected by the disease process. In the presented work we deal with skeletal muscles, therefore below we will present only suggestions of kinesiotherapeutic care focused mainly on the improvement of muscle strength and general physical fitness (Table 1).

Table 1. Kinesiotherapeutic care taking into account the severity of symptoms and the patient's condition after COVID-19 infection

Patient conditions	Proposed kinesiotherapeutic procedure
Mild form	exercises: breathing, relaxation, active
Severe form (requiring hospitalization)	exercises: respiratory-circulatory, anticoagulant, slow and weighted active, relaxation techniques, general conditioning training (continuous or interval), standing up, bedside exercises, walking;
Very severe form (mechanically ventilated patients)	breathing optimization, prevention of negative effects of immobilization, change of body position, passive exercises, gradual mobilization and mobilization of the patient (antigravity positions), gradual introduction of assisted and active exercises;
Convalescents	general fitness training, aerobic exercises (walking and brisk walking, possibly other more intense forms), breathing and chest stretching, resistance exercises (strength);
Inpatient physiotherapy (not fully functional) is usually performed at the place of residence	after the diagnostics (detailed interview, exercise test, dyspnoea and assessment of general fitness), the patient is qualified in one of the models (A, B, C, D, E), which differ mainly in the intensity of classes;

The goal of physical exercise is to gradually increase the level of activity and the level of tolerance of exercise exercises. The initiation of physical exercise is always based on an assessment of the indications for therapy, the patient's options and an assessment of the course of treatment, taking into account existing and emerging complications. The duration of exercises

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and their pace must be chosen individually, with current assessment of psychophysical parameters and body temperature. Recallants should be instructed to use sunlight to stimulate vitamin D synthesis. Vitamin D increases body resistance and muscle protein synthesis and prevents skeletal demineralization (Rottermund 2012).

CONCLUSION

More and more people are recovering from *SARS-CoV-2* infection, but the effects of the disease are visible in virtually every organ. Due to many pathologies in the body, older people are exposed to much more serious complications than younger people. Regardless of age, each patient has their own specific conditions and predispositions to fight the virus. Isolating society during a pandemic (Shiba *et al.* 2021), the threat and caring for one's own health cause fear and anxiety, especially in the elderly. Recalling the theory of H. Selye (1951), in the case of a long-term stressful situation, even if its strength is not too great, the resources of each person are drastically declining. The result is additional somatic and / or mental symptoms. Observed changes in the psyche, symptoms of depression increase health problems and make it difficult to perform appropriate therapies.

The primary role of skeletal muscle is to maintain an upright position and the ability to move. Therefore, the damage to the muscular system associated with Covid-19 infection affects the functioning of the whole body. One and a half years after the first outbreak of the pandemic, not only the threats and consequences are known, but also the treatment options for the sick. New strains of the virus are more aggressive and dangerous. All health promotion measures should be put in place as soon as possible to give the body a chance to strengthen its reserves. Great importance is attached to physical activity, which can and should be promoted as an excellent preventive factor.

When indicating the basic goals of rehabilitation, we must not forget that the patient with COVID-19 is treated and is treated as a psychosomatic unit, which also has other diseases and health problems. Their neglect during therapy will prolong the return to full condition and achieve satisfaction with the entire rehabilitation process. With good cooperation of treatment teams with the patient, it is possible to restore the functional fitness of the muscles before the disease. In situations of significant pathology and general exhaustion of the organism, this process may prove to be significantly longer (Rottermund *et al.* 2021).

Conflict of Interest

None

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Social Aspects of Death in Stillborn

Sociálny rozmer vnútromaternicového úmrtia

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ABSTRACT **Objective:** Death of the infants related with pregnancy, perinatal and neonatal period may present many diagnostic difficulties..
Methods: The authors of this article report a case of a stillborn infant, which was brought to the autopsy with only partial and confusing information.
Results: It was found later, that the birth was given in the back of an ambulance with assistance of paramedics. The newly born infant showed no signs of life after the delivery. As there were no relevant information at the time of autopsy. The initial hypothesis was that violence against the infant might have been committed.
Conclusions: Comprehensive autopsy findings and supplementary forensic laboratory investigations subsequently excluded this theory. The cause of death was funisitis caused by poor hygienic condition in relation to the social environment. Funisitis is a rare pathological condition determined as inflammation of the connective tissue of the umbilical cord. An important factor that initiated this event was the poor socio-economic status of the patient, returned to belonging to a marginalized community.

Key words: social environment, stillborn funisitis.

ABSTRAKT **Cieľ:** V rámci diagnostiky úmrtí detí súvisiacich s tehotenstvom, perinatálnym a neonatálnym obdobím vyšetrujúci lekár často prichádza do styku s mnohými úskaliami a nezodpovedanými otázkami. Výsledky pitvy a doplňujúcich laboratórnych vyšetrení však túto teóriu vylúčili. Príčinou smrti dieťaťa bola funisitída, zriedkavo sa vyskytujúce zápalové ochorenie spojivového tkaniva pupočníka. Významným faktorom celého prípadu bola socio-ekonmická situácia ako aj príslušnosť k marginalizovanej komunite.
Metódy: Autori tohto článku prezentujú prípad mŕtvonarodeného dieťaťa, ktoré bolo privezené k pitve s neúplnými a zmätočnými informáciami.
Výsledky: Až neskôr po vykonaní pitvy bolo zistené, že dieťa bolo porodené v sanitnom vozidle za asistencie zdravotníckych pracovníkov a po pôrode nejavilo žiadne známky života. Vzhľadom k tomu, že v čase pitvy neboli k dispozícii žiadne relevantné anamnestické údaje, vzniklo podozrenie z možného konania inej osoby voči dieťaťu.

Záver: Výsledky pitvy a doplňujúcich laboratórnych vyšetrení však túto teóriu vylúčili. Príčinou smrti dieťaťa bola funisitída spôsobená zlými hygienickými podmienkami vo vzťahu k sociálnemu prostrediu rodičky. Funisitída je zriedkavo sa vyskytujúce zápalové ochorenie spojivového tkaniva pupočníka.

Kľúčové slová: sociálne prostredie, funisitída. mrtvorodený plod

INTRODUCTION

Of the estimated 130 million infants born each year worldwide, 4 million die in the first 28 days of life. Several factors such as women's status in society, their nutritional status at the time of conception, early childbearing, too many closely spaced pregnancies and harmful practices, such as inadequate cord care, letting the baby stay wet and cold, discarding colostrum and feeding other food, are deeply rooted in the cultural fabric of societies and interact in ways that are not always clearly understood (Lawn *et al.* 2005). Many researches have been undertaken in order to detect the influence of social and biological factors on feto-infant mortality. The medical literature focuses more on the biological factors while the demographic literature focuses on social factors. The awareness by social scientists of the importance of linking both types of factors in order to understand the feto-infant mortality process is not new however (Cramer 1987).. Pathological findings deaths of the infants related with pregnancy, perinatal and neonatal period may present many diagnostic difficulties tend to be often nonspecific, particularly where deaths have been caused by failure to provide adequate care (Horn *et al.* 2004).

METHODS

Case history:

We report a case of a stillborn infant, which was brought to the autopsy with only partial and confusing information. It was found later, that the birth was given in the back of an ambulance with assistance of paramedics. During an initial gynaecological examination, the baby´s head was already visible at the vaginal introitus. The newly born infant, however, showed no signs of life after birth. The respective placenta was subsequently vaginally delivered in hospital. Mother of the stillborn was a 16-year-old Roma adolescent girl, living in poor social conditions, hiding her pregnancy from all family members and friends. She had no gynaecologist supervision throughout the entire pregnancy and she did not attend any prenatal clinic, as well. According to police investigation reports, this woman had the last regular menstrual period eight months before the childbirth, she was practicing sexual activity during almost whole pregnancy, she had the very last sexual intercourse a month before giving birth and she suffered severe recurrent pain in the lumbar region for couple of days prior to delivery.

***Autopsy*:**

The autopsy was performed four days after the birth. The external examination was performed in a systematic manner starting with anthropometric measurements. After all the measurements were completed, thorough inspection of the dead body was performed starting up from the head and followed down by the chest, abdomen, and all extremities. All the orifices were probed and external genitalia and anus were examined. The internal examination was performed using the classical method requiring the removal of the organs in blocks. Subsequently the precise examination of the respective placenta, brought for investigation separately from the dead body, was performed.

The samples removed from tissues and organs for histopathological examination were fixed in

10% buffered formalin, processed, and embedded in paraffin. Nearly all the organs were sampled. Two conventional histological staining methods, including hematoxylin-eosin and phosphor-tungstic acid-hematoxylin according to Mallory (PTHA) staining, had been applied. No histochemical or immunohistochemical stains were used. The tissue blocks were submitted in a predetermined and standardized order.

RESULTS

External examination autopsy findings:
female sex, body length of 44 cm and a weight of 2334 g, local presence of the remnants of vernix caseosa and lanugo on the skin, presence of meconium around the anus, presence of the hair on the head of three centimetres in length, nails extending beyond the tip of fingers, nails non-extending beyond the tip of toes, labia majora overlapping labia minora, subconjunctival petechial haemorrhages, clamped umbilical cord stump with sharply cut endings, early postmortem decomposition processes within the skin of abdominal wall (pseudomelanosis), grey-brownish discoloration and change in consistency of umbilical cord stump (Figure1).

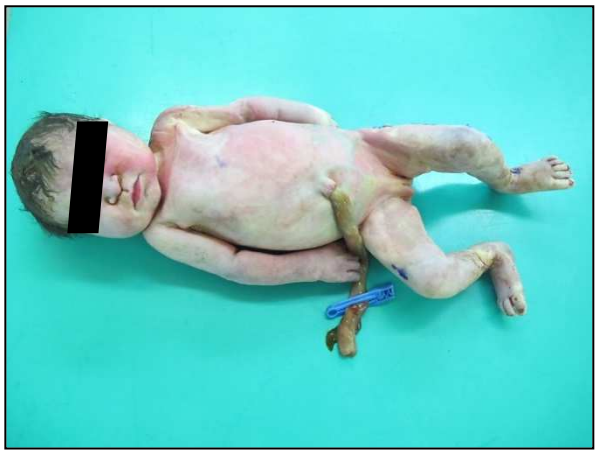

Figure 1. Early postmortem decomposition changes within the skin of the abdominal wall (pseudomelanosis), grey-brownish discoloration of the umbilical cord. No external traces of violence visible on the body of stillborn.

Internal examination autopsy findings:
obliterating umbilical vein thrombosis (Figure 2),

Figure 2. Thrombosis of umbilical vein, gross.

caput succedaneum in parieto-occipital region of the head, brain oedema, soft tissue haematomas in deep upper parts of the neck and root of the tongue, negative lung (Figure 3), stomach and duodenum floating test, subendocardial petechial haemorrhages, non-closed anterior and posterior fontanel, opened ductus arteriosus Botalli, opened foramen ovale.

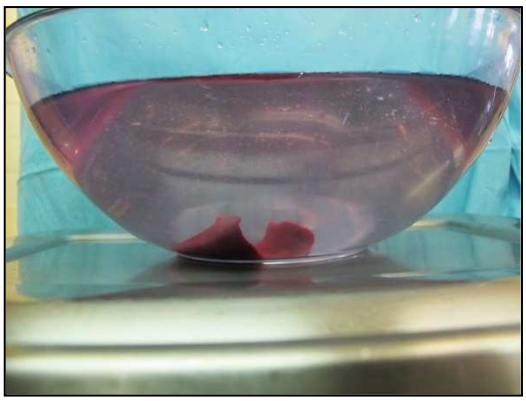

Figure 3. Negative lung flotation test.

Placental and respective umbilical cord autopsy findings:
obliterating thrombosis of all umbilical vessels, marginal placental cord insertion, and focal placental infarctions.

Microscopic histopathological findings:
diffuse purulent inflammation of Wharton´s jelly and all umbilical vessels with their thrombotic occlusion, placental infarctions and delayed

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placental maturation (Figure 4), focal purulent amnionitis, extensive pulmonary atelectasis with disperse presence of meconium and amniotic fluid in alveoli and some bronchioles, oedema of the brain and brainstem, extensive fresh haemorrhages with leukocyte reaction in paravertebral skeletal muscles excised from upper part of the neck and in tongue root, mild autolytic changes of all sampled tissues and organs.

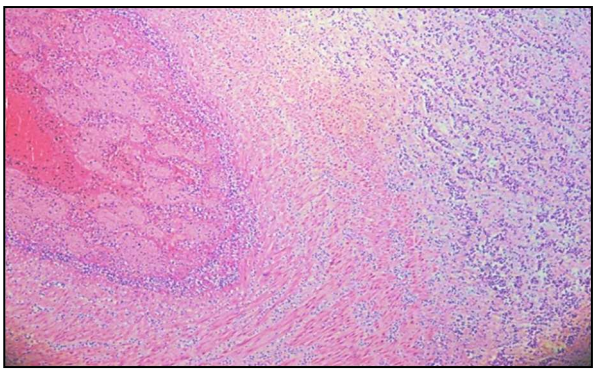

Figure 4 Purulent funisitis (*right*) and vasculitis (*middle*) with obliterating thrombosis of umbilical vein (*left*), microscopic.

Toxicological-chemical analysis results:
in toxicological procedures two methods for analysing blood samples taken from stillborn had been used: Thin Layer Chromatography densitometry (TLC) and Gas chromatograph / Mass selective detector (GC/MS). It revealed the presence of nicotine and caffeine. No drugs or foreign substances, including narcotic drugs and psychotropic substances, had been detected in analysed blood samples.

Radiographic examination:
the whole-body radiographs (posteroanterior and lateral projections) made prior to autopsy revealed no developmental abnormalities, no bone fractures and absence of air inflation within anatomical regions of lungs and stomach (Figure 5).

Figure 5 Radiographs made prior to autopsy – absence of air inflation within anatomical regions of lungs and stomach, no developmental abnormalities or bone fractures presented.

Cause of death:
Funisitis followed by obliterating thrombosis of all umbilical vessels resulting in intrauterine death by asphyxiation. Another serious condition represents histopathological signs of placental insufficiency.

DISCUSSION

The conceptual framework does not show a direct link between the socio-economic variables and the physical characteristics of the infant at birth. As mentioned in Kramer *et al.* (2000), poor socio-economic conditions *lead to unhealthy behaviours, exposure to stress and psychological reaction to stress* which might consequently affect the child's characteristics at birth (preterm delivery, low birth weight...). Kramer *et al.* (2000) explain that women with a low socio-economic status are more exposed, not only to acute (life events) and chronic (difficult life conditions) stressors but also to less social support. These elements influence the mother's health status and of the newborn's health.

The fetal inflammatory response to intrauterine infection manifests as inflammation of the umbilical vessels (vasculitis) and Wharton's jelly (funisitis) (Horvath *et al.* 2014). It is typically associated with any intrauterine infection, which

is often due to a combination of several organisms which may include bacteria, Candida (associated with peripheral funisitis), actinomyces, HSV (associated with necrotizing funisitis) and syphilis (Ornoy and Tenebaum 2006). Funisitis, the inflammation of the umbilical cord determined by histologic examination of the placenta, is evidence of a fetal inflammatory response (Arthurs *et al.* 2013). The inflammatory process may involve the umbilical vein (phlebitis) and one or both umbilical arteries (arteritis) and extend into the Wharton's jelly. Microscopic description may divide funisitis into tree stages: *stage 1* (early stage) represents the umbilical phlebitis - neutrophilic infiltration of the umbilical vein wall, *stage 2* (intermediate stage) represents the umbilical arteritis – neutrophilic infiltration of the umbilical arterial wall and *stage 3* (severe stage) represents the necrotizing funisitis – neutrophilic infiltration through the vessel walls into the surrounding Wharton´s jelly (Yee 2006).

In presented case report the microscopic histopathological examination confirmed diffuse suppurative inflammation (stage 3) of the umbilical cord (purulent funisitis), which was most likely caused by bacteria. The absence of small white-yellowish nodules on the surface of the umbilical cord, together with a microscopic view of the location and the inflammatory infiltrate constitution within the tissue of this structure, indicated that the pathological changes in umbilical cord were caused neither by fungal (yeast) nor viral infection. The extent and the nature of the inflammatory changes and massive vessel thrombosis of the umbilical cord, in association with mother´s anamnesis (severe recurrent lumbar pain lasting for couple of days), suggested that thrombosis following funisitis lasted at least several days. This pathological condition could be assessed as a serious complication of pregnancy, leading to placental insufficiency and subsequent fetal hypoxia and nutritional deficiency. As the autopsy was performed four days after the birth, no evidence of pus had been detected all over nor within the dead body, the grey-brownish discoloration of the umbilical cord was considered to be caused by early postmortem decomposition processes and no relevant information about the birth were provided at the time of autopsy, no swabs for microbiological examinations had been taken.

Infections are not only much more common in premature deliveries, they are indeed probably a main reason for most premature births before 30 weeks of gestation. The predominant opinion now is that amniotic sac infection is a primary cause of premature rupture of membranes and preterm labour at least in those pregnancies that terminate spontaneously before 30 week of gestation. There is also evidence that these infections have an important role in the causation of stillbirth and neonatal deaths). Intrauterine infection with subsequent inflammation of the umbilical cord, fetal membranes and possibly the placenta and fetus can follow haematogenous, transabdominal, transfallopian or direct ascending urinary or genital tract infection. Risk factors for intrauterine infection include, inter alia, the poor genital hygiene and insertion of various foreign objects into vagina (Stanton *et al.* 2006). In presented case, the anamnesis of regular sexual intercourse during pregnancy together with poor hygienic conditions suggested these manners as a potential source of infection.

Stillborn represent a unique group of patients who are inaccessible to most diagnostic tools in utero. Postmortem examination in the case of stillbirth is crucial as it is the procedure most likely to yield a cause of death (Pinar 2004). The basic challenge in diagnostic perinatal pathology is to acquire the maximum information, often from minimal lesions, and with limited knowledge of preceding events. The difficulties are compounded in the antepartum stillborn by the delay between fetal death and delivery. This is not an easy task because there may be limited information regarding the timing of death. The fetal tissues may have lost weight following fetal death, and

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the maceration process may obscure structural details of the tissue. It can also be difficult to distinguish between pathological changes, which preceded fetal death, and the autolytic changes, which followed death (Faye-Petersen 1999).

CONCLUSIONS

The chances of survival of a neonate begin well before birth. The causes attributable to perinatal mortality comprised of various social problems like age of mother, birth order, place of residence, occupation and socioeconomic status. Socially and economically marginalized households are at a higher risk of having a perinatal death. A higher educational level of the parents and an occupation with a steady source of income was found to be protective for the survival of the neonate. Intrauterine fetal death caused by the disease of umbilical cord was due to the inflammatory process followed by the thrombosis of umbilical vessels with subsequent changes in placenta. Only detailed autopsy examination of the body and respective placenta, together with the forensic laboratory investigations could determine the funisitis as the cause of death of the stillborn. Forensically, this rare pathological condition with absence of evident traces indicating homicide, ultimately excluded the initial suspicion of violence committed against the infant. An important factor that initiated this event was the poor socio-economic status of the patient, returned to belonging to a marginalized community

Authorship

All authors have read and approved the final version of the manuscript, and all author listed as co-workers met the criteria for authorship.

Conflict of Interest

The authors declared no conflict of interest in relation to the article.

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Impact of alternative therapeutic techniques on vertebrovisceral relations of liver and gallbladder functional disorders

Vliv alternativních terapeutických přístupů na vertebroviscerální vztahy funkčních poruch jater a žlučníku

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ABSTRACT

Introduction: Functional problems of inner organs influate as well as movement aparrate as quality of life.

Research objectives: This study aims to determine the effect of the therapy protocol that has been developed for patients with functional liver and gallbladder disorders. This protocol consists of yoga asanas focused on influencing the meridians of the liver and gallbladder and regimen measures based on Chinese medicine.

Methods: 20 research subjects were selected based on the examination developed for this study. The subjects were randomly divided into two groups. Group 1 underwent therapy according to the standard indication supplemented by a created therapy protocol. Group 2 underwent only the treatment according to the standard. An examination and a Quality of life questionnaire – Short Form-36 were used to evaluate the therapy's effect. Paired t-test was used to analyse the obtained data, statistical significance on the level $p < 0.05$.

Results: The therapy protocol has statistically significant results.

Conclusion: We recommend continuing this type of research to identify links between inner organs, movement apparat, and quality of life.

Keywords: yoga, Chinese medicine, functional diseases, vertebrovisceral relationships, physiotherapy

ABSTRAKT

Úvod: Funkční problémy vnitřních orgánů mají vliv na pohybový aparát stejně tak jako ovlivňují kvalitu života.

Cíle: Cílem této studie je ověřit účinek terapeutického protokolu, který byl vyvinut pro pacienty s funkční poruchou jater a žlučníku. Tento protokol se skládá z jógových ásan zaměřených na ovlivňování meridiánů jater a žlučníku a režimových opatření založených na čínské medicíně.

Metody: Na základě vyšetřovacího protokolu, vyvinutého pro tuto studii, bylo vybráno 20 probandů. Tito byly náhodně rozděleny do dvou skupin. Skupina 1 podstoupila terapii podle standardní indikace doplněnou o námi vytvořený terapeutický protokol. Skupina 2

podstoupila pouze standardní léčbu. K vyhodnocení účinku terapie bylo použito vyšetřovacího protokolu a dotazník kvality života-Short Form-36. K analýze získaných dat byl použit párovaný t-test a statistická významnost na úrovni $p < 0,05$.
Výsledky: Terapeutický protokol má statisticky významné výsledky.
Závěr: Doporučujeme pokračovat v tomto typu výzkumu pro identifikaci vazeb mezi vnitřními orgány, pohybovým aparátem a kvalitou života.

Klíčová slova: jóga, čínská medicína, funkční nemoci, vertebroviscerální vztahy, fyzioterapie

INTRODUCTION

The lifestyle of the current population, which often includes a sedentary job, low physical activity, significant stress, insufficient rest and sleep, excessive alcohol consumption and smoking, can lead to the digestive tract's functional disorders. The symptoms of these diseases are very diverse and can manifest in different systems of the human body. Examination and therapy of these diseases are often complicated and time-consuming.

Functional diseases can generally be described as a disease state manifested in specific symptoms but without any organic finding. The diagnostics are based on a malfunction of the respective function. Functional diseases of the digestive tract are most often manifested in impaired motility – dysmotility. Simultaneously, there is no organic finding. That is, the use of imaging methods such as X-ray, MRI, CT etc. is irrelevant. This means that the therapist must rely on a thorough clinical examination (Jandová 2001).

The pathogenesis of functional diseases of the gastrointestinal tract is multifactorial. It is not possible to determine precisely which factors are primary and which are secondary. These problems include dysmotility, visceral hypersensitivity, the consequences of inflammation, the relationship between the central nervous system and the digestive tract, and psychosocial factors (Dolina, Hep, Kroupa, Plottová, Přecechtělová 2002).

We assume that healthy organs show physiological movement (mobility and motility). Any adhesion or fixation to another structure leads to organ dysfunction. Due to the interrelationships between internal organs and the musculoskeletal system, reflex changes can be transmitted to distant structures (Barral 2006). Dysmotility disorders do not occur in the liver because there is no smooth muscle. However, the posthepatic syndrome can develop in the liver after viral hepatitis (Mařatka 2007).

The gallbladder and bile ducts are equipped with muscles that ensure transport, storage, and bile delivery. Mobility disorders – dysmotility – can occur here. According to the globally recognised ROME IV criteria, functional diseases of the gallbladder and bile ducts can be defined.

Liver and gallbladder dysfunction include indigestion, discomfort when lying on the left side of the body, chest pain, pain from deep inhaling or exhaling, photophobia, reddening and swelling of the face, pain in the eyeballs, increased intraocular pressure, chronic sinusitis, neck and head pain, joint pain, skin problems (oily skin, itching, xanthomas, acne), sleep disorders, behavioural disorders and depression. All of these difficulties significantly affect the quality of life (Barral 2006). There is a close relationship between spine function/dysfunction and internal organs function. We call these relationships vertebrovisceral (Jandová 2001). When a particular internal organ is affected, specific reflex changes occur in the locomotor system – we call this a visceral pattern. Reflex changes most often manifest themselves as

trigger points, tender points, a change in the joint pattern, a change in the mobility of soft tissues, hyperalgesic skin zones, etc. (Kolář 2009).

In "Western" medicine, there is no comprehensive complex for treating functional diseases of the gastrointestinal tract. The literature gives only general recommendations: lifestyle adjustment, regular eating and influencing psychosocial factors (Švestka 2007). Furthermore, it is also appropriate to include a physiotherapeutic intervention based on a thorough kinesiological examination. You can use, for example, soft tissue techniques, reflexology focused mainly on the area of hyperalgesia skin zones (Tichý 2009), reflex stimulation of internal organs using the pressure on of Chapman points (Ward RC, Jerome JA 1997), or visceral manipulation techniques (Barral 2006). It is also appropriate to include therapeutic physical education in the therapy. We aim to reduce nociception in the relevant circuit of the given innervation segment and thus a reduction in nociception at all levels of the CNS. This mechanism affects the sympathetic nervous system's activity, which is generally increased during the disease and is related to the patient's psychological state (Kolář 2009).

In recent years, there has been an increase in interest in alternative approaches to medicine, among which we can include, for example, traditional Chinese medicine or Ayurveda. The primary factor in increasing the interest of patients and physicians in alternative treatment is mainly their dissatisfaction with modern medicine, which treats mainly the symptoms and not the cause of diseases (Dhanukar, Thatte 2013).

We can describe ***traditional Chinese medicine*** (TCM) as a diagnostic and therapeutic system that has been developing for more than 3,5 thousand years. One of the key philosophical principles of this healing art is the unity of body and mind (Wu 2010). In the Western world, TCM is known mainly in the form of its individual practical disciplines, such as acupuncture, herbal treatment, massage, nutrition, meditation, physical exercise, etc. (Ando 1995).

In TCM, the human body is considered a yin-yang structure. If there is a dynamic balance between the two poles, it means health. If there is an imbalance, it indicates disease. The goal of TCM is to balance the yin and yang aspects of the organism (Ando 1995). The organs in the human body are also divided according to yin-yang. Each of the yin organs forms a pair with one of the yang organs. For example, the liver is a paired organ for the gallbladder. The individual organs have assigned pathways – meridians, through which the life energies of qi flow (Ando 1995).

Some studies use imaging methods such as computed tomography and magnetic resonance imaging and conclude that the fascial network anatomically corresponds to the meridians (Bai, Yuan, Soh 2010). Fasciae form a network in the body that permeates and envelops muscles and organs. Lymphatic and blood vessels pass through the layers of fascia. If the fascia is too tense or dense, it restricts body fluids flow through the bloodstream. The rhythmic pulsation of the fascia is based on the so-called cellular memory. Due to this movement, the fascia can register and correct various deformations. Research has shown that mechanical pressure (e.g. in manual techniques in physiotherapy) or tension and pressure induced by body movement cause miniature contractions and retractions at the cellular level of the connective tissue that supports cellular metabolic processes. This proves the effectiveness of manual therapy and physical exercise on deep energy processes. These studies also suggest that connective tissue fibres may be equivalent to Chinese meridians (Oravcová 2016).

Yoga is teaching related to ***Ayurveda***. These two systems have their roots in the Indian Vedic tradition. Ayurveda is the Vedic art of healing body and spirit. Yoga is the science of self-realisation, conditioned by good physical and

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mental functions (Frawley 2004). Yoga positions – asanas – are among the crucial systems of physical culture. They reflect a deep knowledge of bodily functions and how to remove tension from tissues, organs and joints. Asanas are the primary tool of yoga for creating balance in the body. They are static positions and body movements that aim to release tension, improve flexibility, and ensure maximum energy flow (Frawley 2014).

Pranayama is a compound Sanskrit word (*prana* – breath and *Ayama* – control) and means breath control. *Pranayama* affects the respiratory, circulatory, nervous and locomotor systems. With proper breathing techniques, the internal organs move, thus improving the blood supply to the organs. Pranayama also has a beneficial impact on depression and can reduce tension and stress (Frawley 2014).

RESEARCH OBJECTIVES

One of the goals of this study was to compile and apply an examination according to which it will be possible to diagnose patients with functional liver and gallbladder diseases. Another goal was to create and apply a therapy protocol to treat functional diseases of the liver and gallbladder, consisting of a set of selected yoga asanas and regimen measures based on traditional Chinese medicine teachings. Furthermore, this study aimed to compare the conventional physiotherapy approach with the therapy protocol created for this research.

Our first hypothesis (H1) was that the experimental group (1) would show improvement and significant results at a significance level of $p < 0.05$ for more than half of the symptoms observed in the first part of the examination. Control group (2) will not show significant results at a significance level of $p < 0.05$ for more than half of the symptoms observed in the first part of the examination.

The second hypothesis (H2) was that the experimental group (1) would show significant results at a significance level of $p < 0.05$ in the majority of individual areas of the Short-form-36 quality of life test. Control group (2) will not show significant results at a significance level of $p < 0.05$ in the majority of individual areas of the Short-form-36 quality of life test.

METHODS

Selection of test sample

The study included 20 patients (subjects). All subjects were female, aged 20-63 years. Subjects were included in the study based on the examination that was developed for this study. The examination is divided into two parts. The first part focuses on determining the presence of symptoms that typically occur in the functional liver and gallbladder disease (e.g. headache and dizziness, pain in the cervical spine, photophobia, dermatological problems, etc.). The second part of the examination monitors reflex changes, blockades and changes in movement stereotypes and posture that occur in individuals with functional liver and gallbladder disease (e.g. hypertension of the upper part of the rectus abdominis muscle, palpation sensitivity of the cranial base on the right, palpation pain of the pes anserinus, etc.). The diagnostic protocol is visible on Picture 1 (anamnestic protocol- part 1) and Picture 2 (kinesiologic protocol- part 2) below. For each positive item, the patient receives one point. To be included in the study, they must had more than half of the points separately in both the first and second part of the examination. Patients less than 18 years of age, patients with organic heart disease, cancer, infectious diseases, spinal cord injury, severe mental disorders, epilepsy and pregnant women were not included in the study.

Anamnesis	Input	Output	Effect	Signs
Illness of liver or gall bladder in anamnesis				
Tendinopathy, entezopathy or muscle cramp (intensity 0-10)				
Pain or changed range of motion of Rig or Left shoulder joint (intensity 0-10)				
Pain of cervical spine (intenzity 0-10)				
Pain of head or eyes (intenzity 0-10)				
Vision deterioration				
Fotofobia				
Dizziness (0-10)				
Repetitive ischias				
Pain in liver or gall bladder meridian (acc to TCM)				
Female menstruation problems (pain, PMS, irregular cycle, coagula) (intensity 0-10)				
Disorders of metabolism (alcohol, lipids), flatulence (intensity 0-10)				
Sleeping failures (deep sleeping without regeneration, interrupted sleeping) (intensity 0-10)				
Workoholism, working overloading				
Depression, manic-depression, changed manner (on scale 0-10)				
Dermatological problems (acne, oily skin, itchy skin, reducing the quality of nails etc.) (intensity 0-10)				
Abuzus: alcohol				
Intake of peroral anticonception				

Picture 1: Anamnestic protocol- diagnostic protocol – part 1

Kinesiologic protocol	Input	Output	Effect	Sings
Standing posture – right semiflexion of the trunk				
Decreased mobility of the cervical and thoracic spine				
Hypertension of cranial part of rectus abdominis				
Hypertension of descedent part of right m. trapezius				
Hypertension of paravertebral thoracic muscles (Th7 - Th10)				
Higher palpation sensitivity of the right lower scalp area				
TrPs mm. Intercostales in Th7 - Th10 level				
Blockade of Th7 - Th10 segents (palpation senstitvity of proc. spinosus, proc. transverzus and posterior ribs area)				
Blockade of C4 - C5 (palpation sensitivity of proc. spinosi and tranversi)				
Blockade of caput fibulae, distal tibiofibular joint and V. metatarzal bone on the right side				
Decreased range of motion of the shoulder joint on the right or left side				
Breathing stereotype: inhalation only on left side				
Maximal inhalation or exhalation is painful				
Painful palpation in the lower abdomen				
Painful palpation of pes anserinus				

Picture 2: Kinesiologic protocol– diagnostic protocol part 2

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Picture 3: Therapeutical asanas (author archives)
A – *pranajama* in *vadžrasana*, B – *tadasana* (targeted on feet), C – *mardžariasana*, Ca – -wall support by right leg, Cb – automobilization of SI joint by outward rotation of right leg, Da – *bear posiotion*, Db- *adhomukhashavasana* (roof position), E – *parighasana*, F – *vrksasana*, Ga – *marychyasana starting position*, Gb – ipsilateral rotation in *marychyasana*, Gc – contralateral rotation in *marychyasana*, H – *budžangasana*, I – *urdhvamukhasvanasana*, Ja – *kapotasana starting position*, Jb – *kapotasana final position*, K - *balasana*

20 subjects were randomly divided into two groups; group 1 was experimental; group 2 was a control one. Each group underwent two therapies per week for one month (a total of 8 therapies).

Group 1 (experimental)

Subjects from group 1 underwent therapy according to the doctor's indication, supplemented by a set of yoga asanas that aimed to influence the meridians of the liver and gallbladder (these asanas had to be practised by the subjects every day). List of asanas are visible below on Picture 3. In addition to the indicated therapy, patients also repeatedly underwent yoga training to eliminate incorrect performance of yoga positions. These subjects also had to adhere to regime measures based on the teachings of traditional Chinese medicine. These recommendations include, for example, changing the diet, limiting the use of alcohol, cigarettes and medications that are not indicated by a doctor (especially analgesics), taking measures to reduce stress, getting enough sleep and more. These recommendations are listed below. Daily yoga exercise and regimen measures had to be followed for one month.

Group 2 (control)

Subjects underwent therapy as indicated by the medical doctor without yoga and Chinese medicine recommendations and restrictions.

Regimen restrictions for liver and gall bladder meridian:

1. Don't intake alcohol during the whole therapeutic process. Restrict smoking as much as possible.
2. Decrease all pills which are not indicated by medical doctors.
3. Avoid stress as much as possible.
4. Reduce work stress and keep these rules for physical working:
    1. The physical workload must not exceed your individual capabilities.
    2. Rest, do regular breaks.
    3. Avoid one-sided load.
    4. Alter the heavy and light workload.
    5. Manipulate properly with loads.
    6. Use the auxiliary means, for example, hydraulic jacks.
    7. Observe work safety.
    8. Use protective equipment.
5. Keep these rules during psychical working:
    1. Keep ergonomic seating or standing position (acc to therapies recommendation).
    2. Ensure good lighting conditions in the workplace.
    3. Learn to relax. Observe regular breaks (5-10 minutes every 2 hours) during monotone work.
    4. If you are in a leading position, learn to delegate tasks for employees.
    5. If you are a subordinate and feel tired due to many tasks, don't be afraid to say.
    6. Choose work according to your options.
    7. 30 minutes every day - take your own relaxation (listening to music, bath, massage ...)
    8. 2 times a week for a 45-minute walk.
6. Keep enough sleep (8 hours a day, keep regularity - recommended 22:00 - 6:00).
7. Avoid the semi-finished products from the menu and replace the frozen food with fresh ones. Furthermore, discard animals (lard, butter, fat meat, sausages), eggs, tartar, mayonnaise, fish (salmon, mackerel, caviar), pastry and sweets. Avoid fried dishes. The preparation of food, barbecue and baking is also inappropriate. It is recommended to be cooked in water, treatment, or food preparation in a pressure cooker.
8. Arrange vegetables (especially leaf and root), fruit - approx. 2ps per day (especially peaches, apples, pomegranates, melons, citruses), herbs (basil, bay leaf, laurel, rosemary, dill), fresh ginger, honey, Draw syrup, rice syrup - in small quantity, red meat.

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Data Collection

Data collection took place from October 2018 to January 2019 in physiotherapy private practice. To evaluate the effects of the therapy, the researchers used an examination compiled for the study's needs and the Czech translation of the Short-Form 36 quality of life test (SF-36).

The examination and SF-36 were completed during the first and last therapy.

Data analysis

Data from the examination (parts 1 and 2 separately) and the SF-36 quality of life test obtained at the entrance and exit examinations were compared to evaluate the results.

A table created in Microsoft Excel and officially published on the Institute of Health Information and Statistics of the Czech Republic was used to calculate the score of the SF-36 test. All measured data were written into spreadsheets in Microsoft Office Excel 2007. Based on normality tests, a paired t-test was used to test statistical significance. The data are presented as arithmetic mean ± standard deviation. Statistical significance (p) was assessed at the level of critical values of 0.05. The results were evaluated as statistically significant at $p < 0.05$.

RESULTS

The results were divided into three groups. The first group compares the data from the first part of the examination, i.e. the symptoms occurring in patients with functional liver and gallbladder disease. The second group compares data from the second part of the examination, i.e., reflex changes, blockages and changes in movement stereotypes and posture in patients with functional liver and gallbladder disease. In the third group, the data obtained during the SF-36 examination are compared.

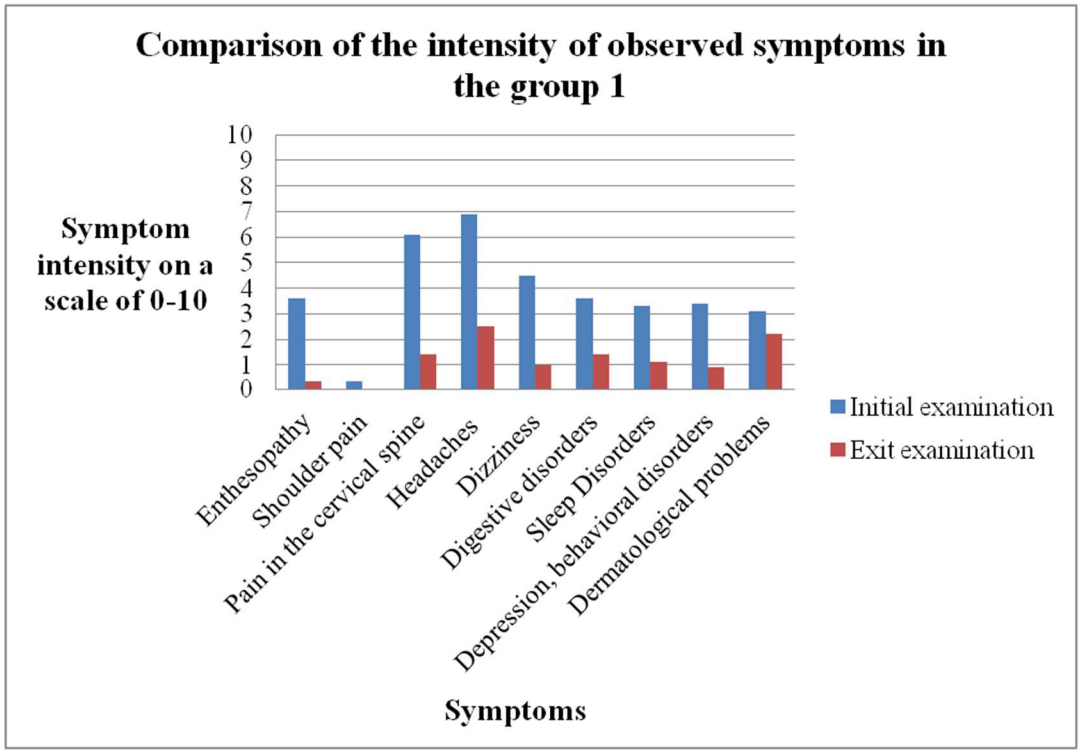
Examination Part 1 – symptoms occurring in patients with functional liver and gallbladder disease

In the first part of the examination, subjects evaluated the intensity of symptoms on a scale of 0–10 (0 – the least possible difficulties, 10 – the greatest possible difficulties). Graph 1 compares the average values of the intensity of difficulties in group 1 (experimental group). Graph 2 compares the average values of the intensity of difficulties in group 2 (control group).

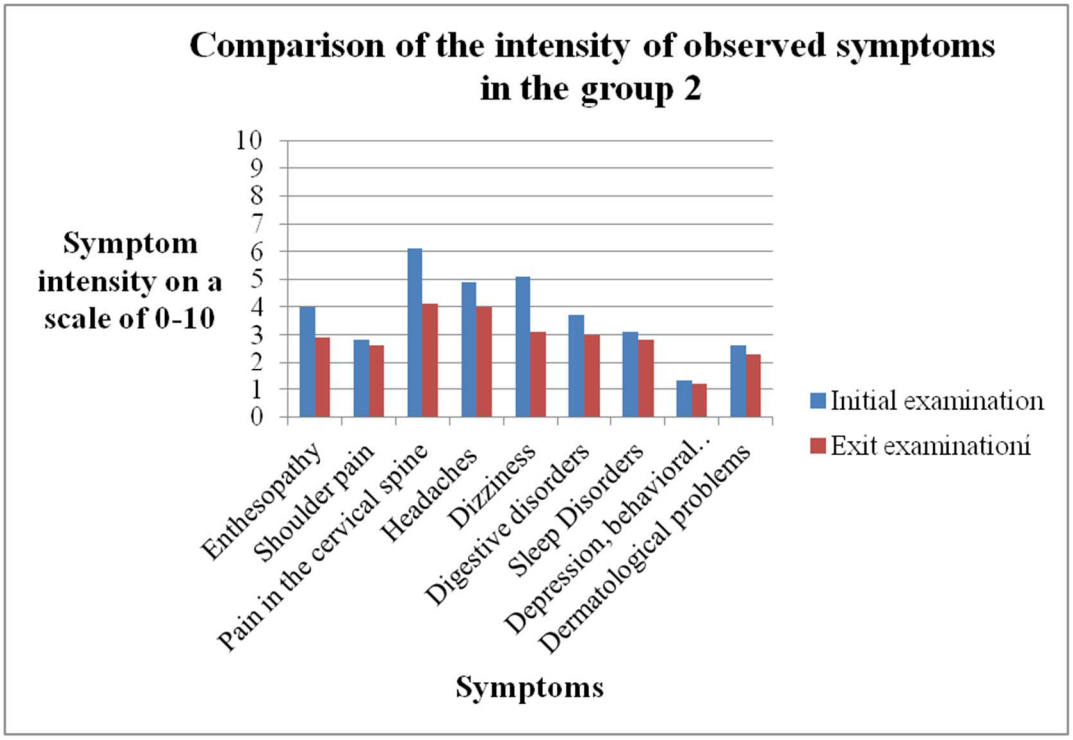
A paired t-test was performed for the intensity of difficulties of individual symptoms at the initial and final examination, separately for groups 1 and 2. Paired t-test values are shown in Table 1. Results of paired t-test for group 1: except for the symptom of "pain and limited shoulder joint mobility", there was a statistically significant improvement in all symptoms. There was a statistically significant improvement in "digestive disorders" (at $p<0.05$), and a statistically highly significant improvement in the other symptoms (at $p <0.01$).

Results of paired t-test for group 2:

There were statistically highly significant improvements in the symptoms of "Cervical pain" and "feeling dizzy" (at $p <0.01$), in the symptoms of "headache" and "sleep disorders" there was a statistically significant improvement (at $p<0.05$). There were no statistically significant changes in other symptoms.



Graph 1: Comparison of average values of the intensity of difficulties from the entrance and exit examination in group 1



Graph 2: Comparison of average values of the intensity of difficulties from the entrance and exit examination in group 2

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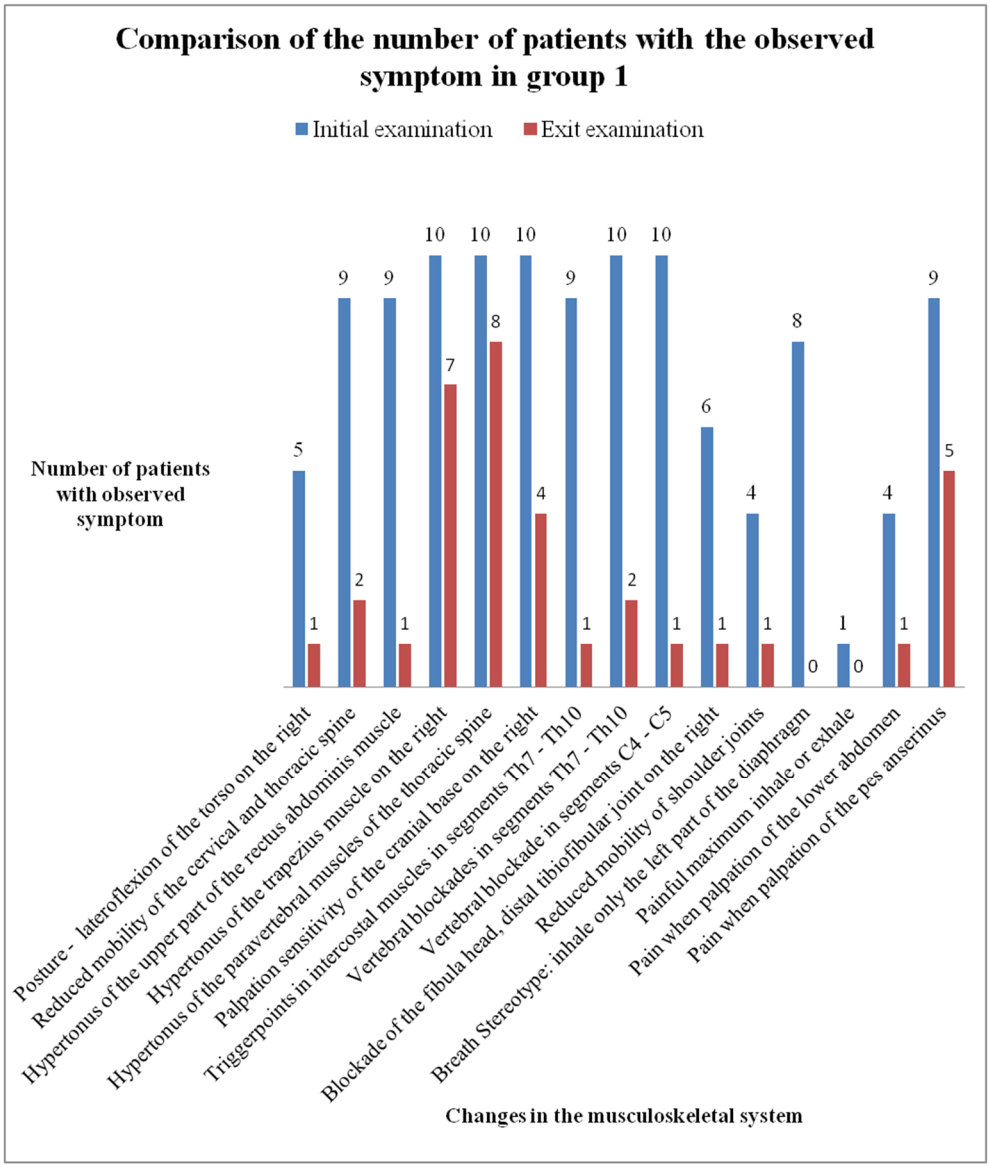
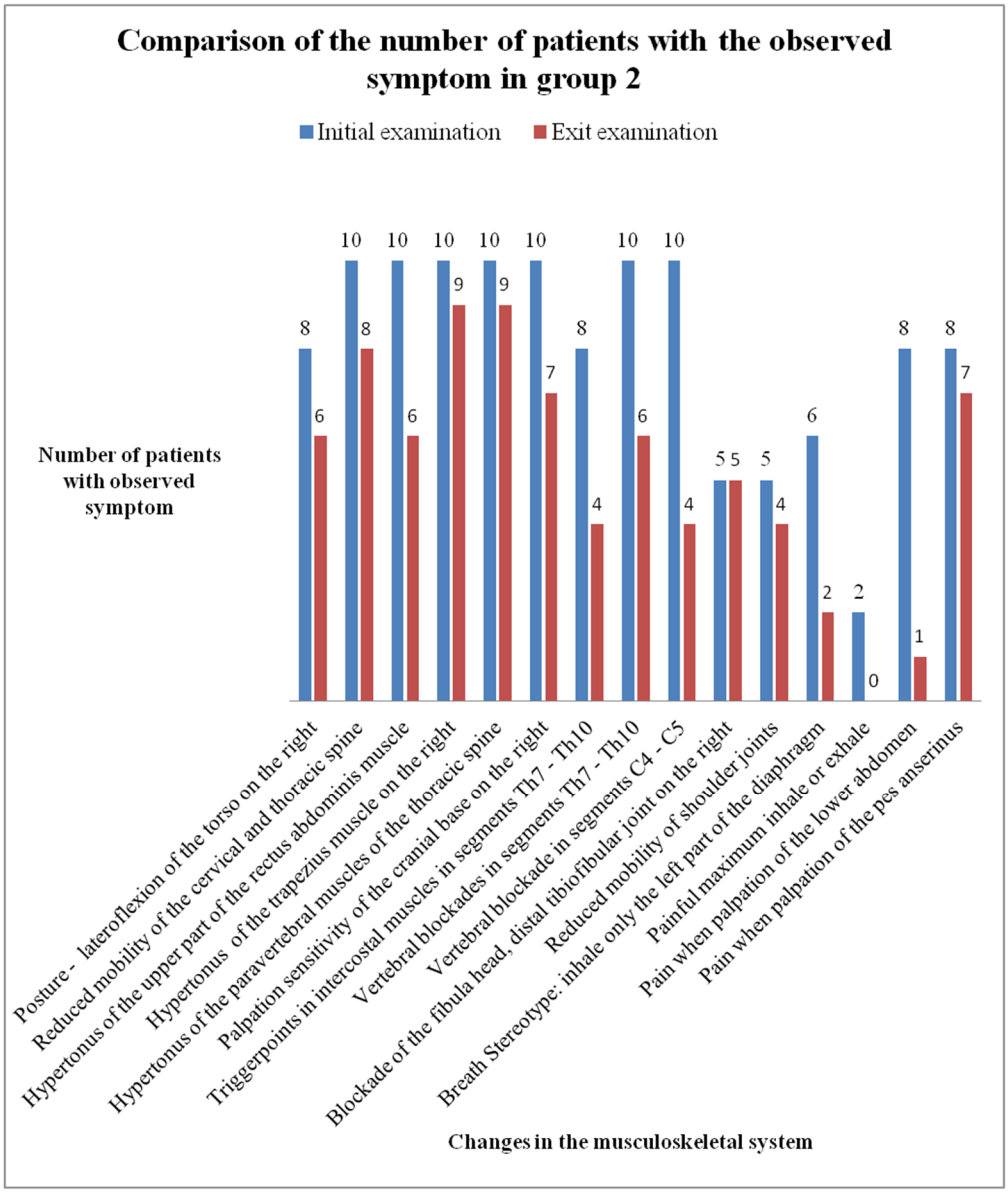


Graph 3: Examination Part 2 - comparison of the number of patients with a specific symptom at the initial and exit examination in the first group 1

Table 1: Examination Part 1 - values of the paired t-test for group 1 and group 2

	Entheso pathy	Shoulder pain	Pain in the cervical spine	Headaches	Dizziness	Digestive disorders	Sleep disorders	Depression, behavioral disorders	Dermatological problems
Paired t-test Group 1	0,0034	0,1717	0,0001	0,0005	0,0023	0,0140	0,0072	0,0099	0,0094
Paired t-test Group 2	0,1070	0,3876	0,0024	0,0271	0,0094	0,0863	0,0406	0,3392	0,0967



Graph 4: Examination protocol Part 2 - comparison of the number of patients with a specific symptom at the initial and exit examination in the first group 2

Table 2: SF-36 - values of the paired T-test for group 1 and group 2

	Physical functioning	Physical role functioning	Emotional role functioning	Vitality	Mental health	Social role functioning	Bodily pain	General health perceptions	Health changes
Paired t-test Group 1	0,0050	0,0473	0,0055	0,0055	0,0016	0,0210	0,0050	0,0009	0,0479
Paired t-test Group 2	0,0124	0,0091	0,0415	0,0688	0,1188	0,0072	0,0043	0,0357	0,0691

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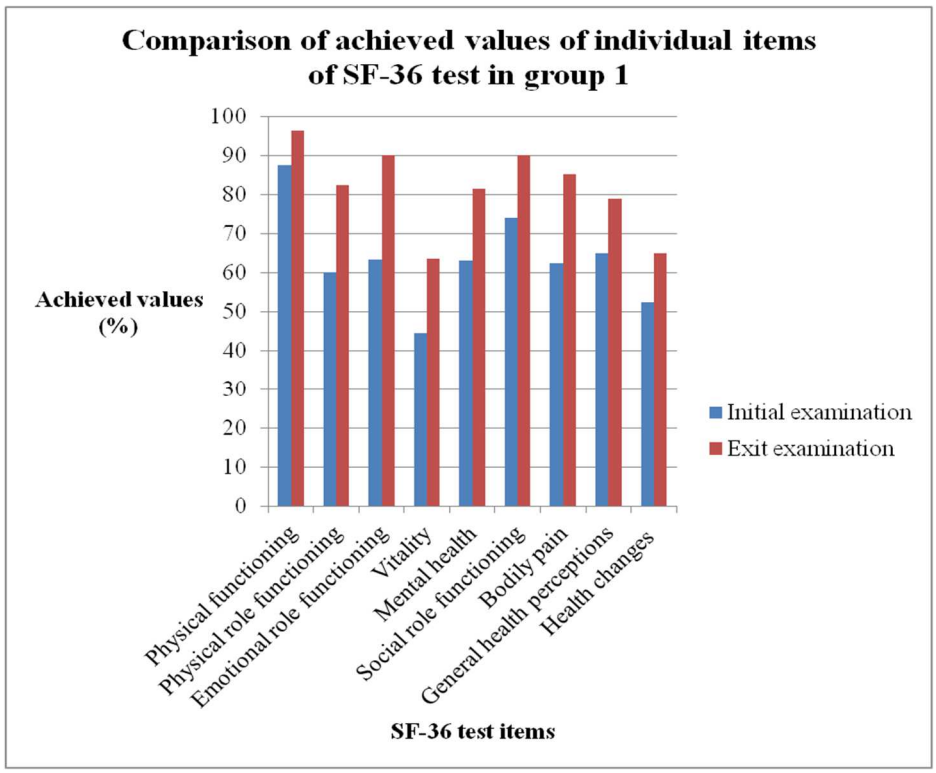
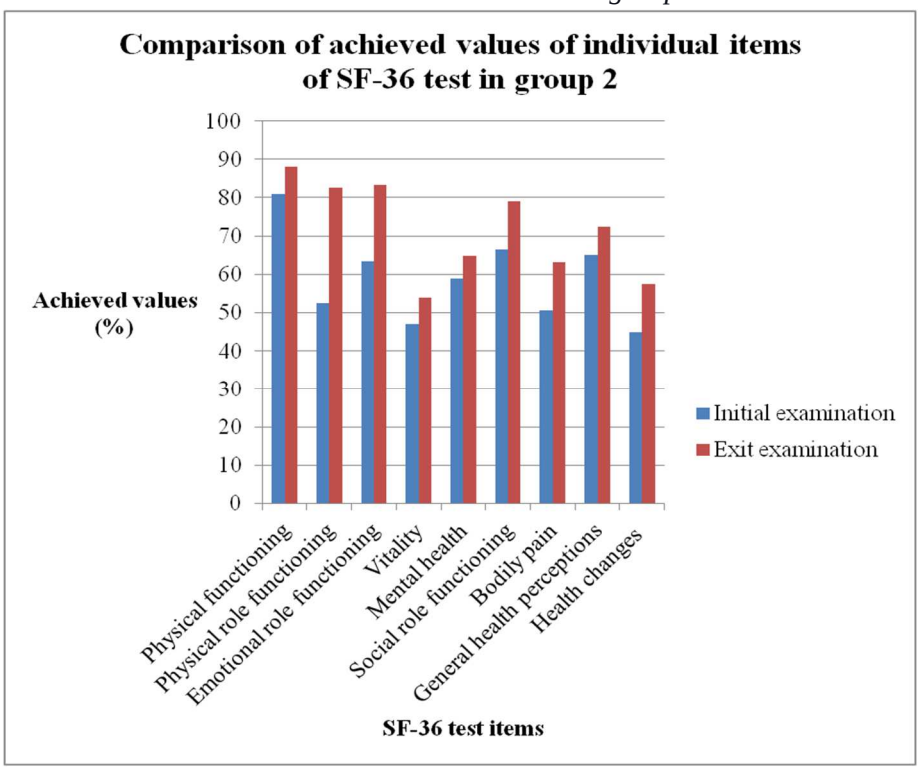


Graph 5: Comparison of average values of individual areas of the SF-36 at the entrance *and exit examination in group 1*



Graph 6: Comparison of average values of individual areas of the SF-36 at the entrance and exit examination in group2

Examination Part 2 – the presence of reflex changes, blockages, changes in movement stereotypes and posture in patients with functional liver and gallbladder disease

In the second part of the examination, we looked for changes in the musculoskeletal system in individuals with functional liver and gallbladder diseases. If a functional change occurred on the musculoskeletal system, then it was marked as 1. If it did not occur, then it was evaluated as 0. In group 1, there was a reduction in the number of patients with a specific change in the musculoskeletal system in all the items. In 11 items out of a total of 15, there was a 75–100% decrease in the number of patients with a specific change in the musculoskeletal system. In group 2, there was a reduction in the number of patients with a specific change in the musculoskeletal system in all items except the parameter of "blockade of the fibula head, distal tibiofibular joint, V. metatarsus on the right", where the number of patients remained the same as before the intervention. The difference between the initial and exit examinations was not as large in group 2 as in group 1. In 9 items out of a total of 15, there was a maximum of a 30% decrease in the number of patients with a specific change in the musculoskeletal system. There was a 40–60% decrease in the number of patients for 3 items. Only in 3 items was the decrease in patients with a specific change by 60-100%.

SF-36

SF-36 consists of 9 items. The questionnaire's individual areas are designed so that a higher score signals a better health-related quality of life. The Score ranges from 0 to 100% for each item. We calculated the average values for each of the 9 test items. The average values for the initial and exit examinations were compared separately for group 1 and group 2. Graph 5 shows a comparison of the average values of the individual areas of the SF-36 test at the initial and exit examinations in group 1. Graph 6 shows a comparison of the average values of the individual item of the SF-36 test at the initial and exit examination in group 2. A paired t-test was also performed. The paired t-test values are shown in Table 2. In group 1, there was a statistically significant improvement in 3 items (at $p < 0.05$) of the SF-36 test. There was a statistically significant improvement in the remaining 6 items (at $p < 0.01$). In group 2, there was no statistically significant improvement in 3 items of the SF-36. There was a statistically significant improvement in 3 items (at $p < 0.05$). The remaining 3 items showed a statistically highly significant improvement (at $p < 0.01$).

CONCLUSION

The examination was compiled based on the studied literature. Findings regarding reflex changes and symptoms in patients with functional liver and gallbladder disease were drawn mainly from Visceral Therapy, authored by Jean-Pierre Barral (Barral 2006). This information was compared with the findings of Traditional Chinese Medicine (TCM), where a significant correlation was found. One of the shortcomings of this study is that all data are obtained only by subjective evaluation from subjects or therapists (examination, quality of life test SF-36). If further studies are performed, it would be appropriate to include an objective approach to examining patients.

Furthermore, it would be advisable to evaluate whether the examination created for this study is a suitable evaluation tool for patients with functional liver and gallbladder diseases. Alternative approaches, such as TCM, Ayurveda, or yoga, are treatment systems focused mainly on prevention. These treatment systems lead patients to take responsibility and control over their own health. A treatment protocol for this study was also built on the same assumption. Subjects were

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instructed to adjust their lifestyle and incorporate daily yoga practice into their lives. We must ask whether the set of yoga asanas is really effective for patients with functional liver and gallbladder disease or whether the effect is given only by regular physical activity.

Further research comparing the created sequence of yoga asanas for patients with functional liver and gallbladder disease with randomly selected yoga asanas would be beneficial. Hypotheses H1 and H2 were confirmed. The study achieved statistically significant results, but it should be noted that a small number of subjects participated in the study. It would therefore be appropriate to continue further research with a larger number of subjects. According to TCM, the results show that the therapy, which included yoga and regimen measures, has a more significant effect on the quality of life, reducing the intensity of difficulties and the frequency of reflex changes, blockades, and other changes in the musculoskeletal system in the sample of patients. As this is a pilot study, it is not possible to compare the results obtained.

The article lifts the yoga exercising and regime restriction for health. The main output is a recommendation for professionals to add a holistic approach to conventional therapy. It is also important to educate professionals in yoga, Ayurveda and combine standard physiotherapy with these “alternative” types of treatment.

Conflict of interest

There is no conflict of interest from any authors and helping researches in this study and paper.

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No funding was received.

Ethical consideration

Ethical approval for this study was obtained from a formally constituted ethical committee of Charles University, Faculty of physical education and sport under No.182/2018. Procedures followed during this study are following the Helsinki Declaration of 1975, as revised in 1983.

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