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STROKES - ASSOCIATION WITH PHYSICAL ACTIVITY AND COVID -19. REHABILITATION AFTER STROKE SUCH AS MUSICGLOVES THERAPY

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ABSTRACT

This article is a systematic review of strokes, their classification, diagnosis and the influence of physical activity on the incidence, taking into account training intensity.
In addition, this publication addresses the aspect of the relationship between strokes and COVID-19. Also included is information on an innovative method of upper limb rehabilitation in stroke patients - Music Glove.
Aim of study and materials:
In order to describe the impact of physical activity on the risk of stroke, taking into account all the above-mentioned aspects, a review of the PubMed, Google Scholar, ResearchGate, Elsevier and ViaMedica databases was conducted. Finally, 24 review articles, meta-analyses, case reports, clinical and comparative studies were included, and WHO guidelines and other scientific literature were used as support.
Conclusion: Strokes are the second most common cause of death worldwide, as well as the most common cause of disability. One of the important, modifiable, and often overlooked risk factors for a stroke incident is a lack of or low physical activity. It is worth emphasizing that a positive effect is attributed to regular, moderate physical activity. High-performance, high-intensity sports can be dangerous in terms of the risk of stroke.

KEYWORDS

Stroke, Physical Activity, COVID - 19, Competitive Sports, Therapy Musicgloves

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1. Introduction - stroke

A stroke is defined as a sudden occurrence of focal or generalized brain dysfunction lasting more than 24 hours, caused exclusively by vascular causes related to cerebral blood flow [1; 1]. Moreover, according to the latest WHO (World Health Organization) definition, a stroke is also diagnosed when the changes last less than 24 hours or when an ischemic focus is clearly confirmed by neuroimaging studies [2; 1]. This entity is classified according to etiopathogenesis into ischemic and hemorrhagic stroke. The former accounts for about 85% of cases, and 15-40% of them have a cardiovascular background [2; 3]. The remaining 10% are hemorrhagic strokes, 5% subarachnoid hemorrhages and up to 0.5% venous strokes [5]. Ischemic stroke is the second most common cause of death in the world and the first cause of permanent disability, including loss of physical fitness in adults [4; 5].

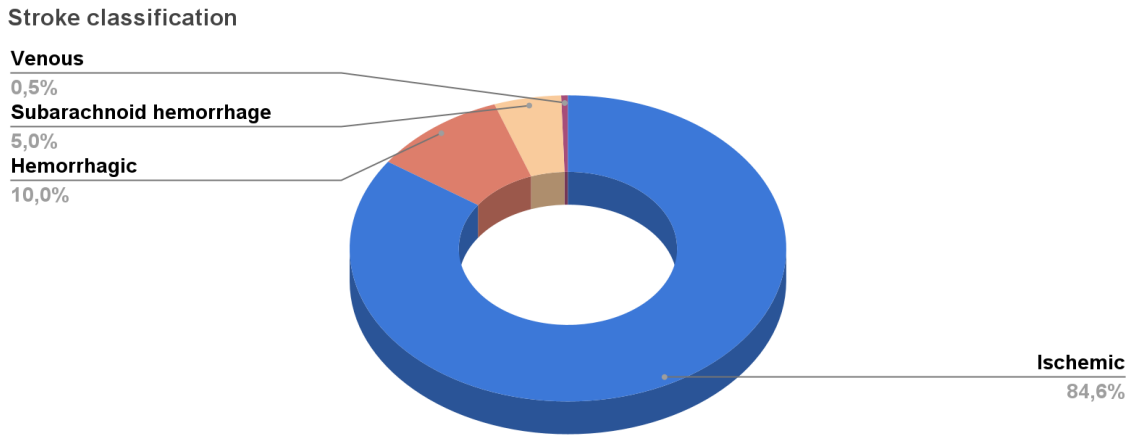

Fig. 1 *Classification of strokes.*
Hemorrhagic stroke accounts for about 85% of cases, ischemic stroke 10%, subarachnoid hemorrhage 5%, and venous stroke from 0.1-0.5%. The pie chart was made using MS Excel.

2. Initial diagnosis of stroke - FAST

The FAST test, which includes detection of symptoms such as sudden weakness of facial muscles, e.g., drooping corner of the mouth (face), weakening of the upper limb (arm), difficulties in speech (speech) and a reminder of the importance of quick medical help (time), is a simple tool available to anyone who comes into contact with a person with stroke symptoms, not only healthcare personnel.

3. Positive impact of physical activity on the risk of stroke

Physical activity is an important factor in maintaining physical and mental health [8]. The beneficial effect of physical exercise has been demonstrated in relation to circulatory system diseases: ischemic heart disease, hypertension, stroke, lipid disorders, diabetes, metabolic syndrome, osteoporosis, and obesity and overweight [8; 1]. The study by Oczkowski et al. showed that physically active people, both women and men, have a 20-30% lower risk of stroke, both ischemic and hemorrhagic [13]. Increased physical activity reduces

the incidence of cardiovascular disease, including stroke [18]. A cohort study found a 25% lower risk of stroke or death (RR=0.75; 95% CI, 0.69 to 0.82) in highly active individuals compared with those with low activity [18]. In case-control studies, highly active individuals had a 64% lower risk of stroke (RR=0.36; 95% CI, 0.25 to 0.52) than their low-activity counterparts. When combining these two types of studies—cohort and case-control—the overall risk of stroke or death due to stroke was 27% higher in physically inactive or low-activity individuals compared with those with high activity [18]. In addition, similar results were observed in moderately active individuals compared to inactive individuals (RRs of 0.83 for the cohort, 0.52 for case-controls, and 0.80 for both combined) [18].

A review of 15 independent prospective cohort studies involving over 750,000 individuals found that individuals who engaged in the recommended level of physical activity of 30–40 minutes per day had a 12–29% lower risk of stroke compared to inactive individuals [19]. These studies demonstrated equal benefits in both sexes.

In contrast, another study, which included only women, found that regular walking, even at a moderate pace, was associated with a lower risk of stroke, both general and ischemic [20]. A meta-analysis of cohort studies was conducted to assess the effect of physical activity on stroke risk and to examine whether this effect differed between men and women [20].

Thirteen cohort studies published between 1986 and 2005 were analyzed, according to the MOOSE guidelines. Additionally, a gender-stratified analysis was performed. It was found that moderate physical activity was associated with an 11% reduction in the risk of stroke (RR = 0.89, 95% CI 0.86–0.93), and high PA with a 19% reduction (RR = 0.81, 95% CI 0.77–0.84) compared to low levels of activity [21]. In men, moderate physical activity was associated with a 12% reduction in risk (RR = 0.88, 95% CI 0.82–0.94), and high PA with a 19% reduction (RR = 0.81, 95% CI 0.75–0.87). In women, high physical activity was associated with a 24% risk reduction (RR = 0.76, 95% CI 0.64–0.89), while moderate physical activity did not show a significant risk reduction [21]. Most studies indicate a greater benefit of physical activity in reducing the risk of stroke in women. Among women, a reduction in the risk of stroke of 11–72% was observed, with most results in the range of 20–40% [22].

4. Negative impact of intense physical activity on the risk of stroke

Despite the fact that physical activity is a factor minimizing the risk of thromboembolic events, there are cases of strokes in athletes and people who train for competition[8]. One of them is the case of a young man who suffered a stroke due to diving. The patient had a patent foramen ovale [17].

Physiological symptoms of overtraining affect all organs and systems [8]. Studies indicate an exponential relationship between the risk of hemorrhagic stroke and the level of physical activity undertaken [23]. Extremely intense and competitive physical activity is associated with a higher risk of hemorrhagic stroke, especially if patients have other risk factors, such as cerebral aneurysms or patent foramen ovale [23].

In addition, the Oslo Ischemia Study analyzed an increase in blood pressure above normal during intensive exercise in the context of the development of stroke [24]. The study suggests that a large difference between systolic blood pressure at rest and during maximum effort may increase the risk of stroke, regardless of the level of blood pressure at rest [24].

5. Patients' knowledge of the impact of physical activity on the occurrence of stroke

Regular physical activity plays a major role in effective preventive action (both primary and secondary) of lifestyle diseases. Regular physical activity - 3-4 times a week and aerobic activity of medium or high intensity lasting at least 30-40 minutes is recommended for primary prevention of stroke. This will significantly reduce the occurrence of hypertension, diabetes, obesity, and secondarily leading to an increased risk of stroke

The study among 96 patients hospitalized in the Department of Neurology and Epileptology with the Stroke Department, who had a stroke with deficits in motor functions, aimed to assess the patients' knowledge about the relationship between their disease and low physical activity [11]. Patients answered questions about modifiable risk factors for strokes on the 9th day after the stroke incident [11].

Women had more knowledge than men, and the most frequently indicated and first mentioned risk factor was arterial hypertension [11]. Only 7 respondents admitted to too little physical activity before the stroke. 89 patients did not indicate physical activity as a risk factor for stroke. Interestingly, respondents indicated mainly strictly medical factors such as arterial hypertension, carotid artery stenosis and atrial fibrillation [11].

In the study conducted at the Independent Public Health Care Facility in Mława, 60 patients after stroke were included in the Hospital Emergency Department [10]. 40% of the respondents were women and 60% men [10]. The group was divided into age subgroups. A statistical medical survey was conducted using the diagnostic survey method, taking into account sociodemographic and social and living factors. The largest number of respondents - 20 people, had a stroke after the age of 60, of which 33.4% were men and 26.6% were women [10]. In the age group 51-60 years, 11 men and 6 women suffered a stroke, and in the age group 41-50

years 4 men and 3 women. Patients assessed their knowledge of risk factors and stroke prevention as follows: very good - 9 people (15%), good - 30 people (50%), sufficient - 20 people (33.3%), and poor - 1 person (1.7%) [10]. Out of 60 patients, 34 were able to indicate the cause of the stroke [10]. The largest percentage of respondents - 48.3% indicated arterial hypertension as a potential cause of stroke, followed by 18.3% other heart diseases, and 16.7% of respondents indicated atherosclerosis. 10% of respondents considered a history of stroke to be the greatest risk factor [10]. The smallest percentage of patients - 6.7% (4 people) were people who believed that diabetes was the most common cause of stroke.

The next question concerned knowledge of modifiable risk factors for stroke and the level of this influence. A group of 13 people (21.7%) stated that physical activity has a very large impact on the occurrence of stroke [10]. 55% of respondents believed that this impact is large, and 18.3% that it is small. Three patients from the study group (60 people) stated that moderate exercise has no impact on the occurrence of stroke [10]. The largest number of respondents would like to deepen their knowledge of stroke in the following areas: rehabilitation, as many as 20 people (33.3%), on the subject of: acquiring self-observation and self-control skills, including knowledge about the impact of exercise - 16 people (26.7%). 12 people (20%) showed a desire to change their lifestyle, mainly their diet and increased physical activity. A quick return to full physical fitness, and thus a desire for rehabilitation, was reported by 58 people (96.7%). Only 2 people considered post-stroke rehabilitation to be irrelevant in the convalescence process [10].

6. Physical activity after stroke

Returning to physical activity after a stroke is not always possible. According to data from the National Stroke Association, 10% of stroke patients recover almost to full motor functions and mental state [6]. 25% of patients lose physical fitness to a minimal degree, and 40% to a moderate or severe degree - requiring rehabilitation [6]. 10% of people require placement in long-term medical care facilities due to the lack of possibility of active rehabilitation [6].

The most important element of the rehabilitation process is the stimulation of the brain's neuroplasticity, i.e. the ability to create new neuronal connections in response to damage [1]. Sensory disorders affect about 80% of patients after a stroke incident, and in 60% of them they persist for more than 6 months [1;1, 2].

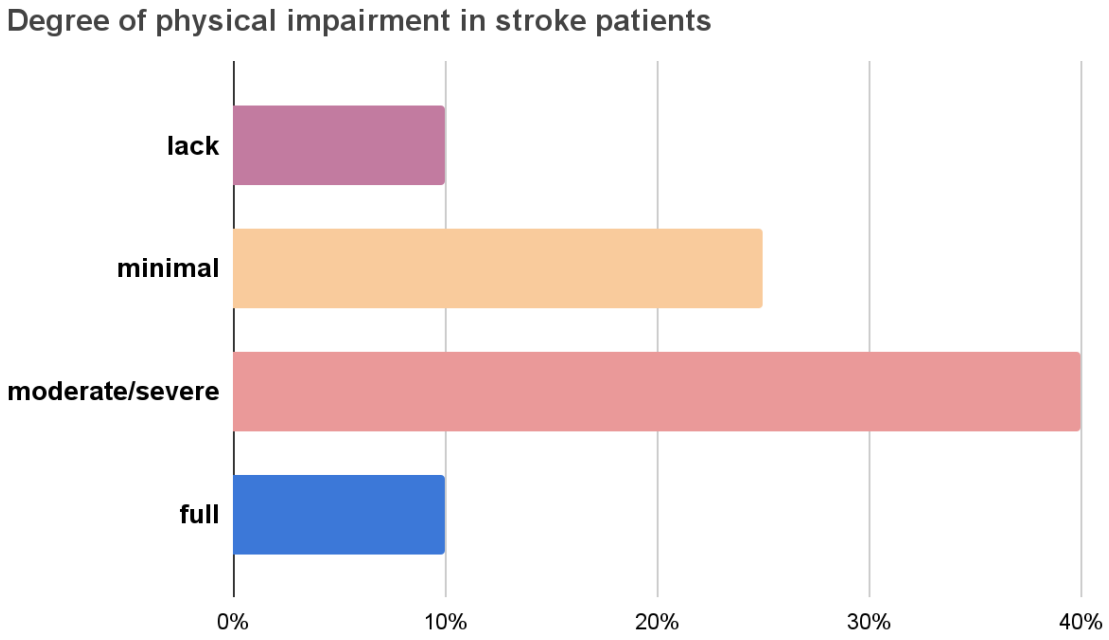

Fig. 2. *The graph shows individual percentage values depending on the degree of loss of physical fitness in stroke patients. 10% of stroke patients regain full physical and mental fitness [6]. 25% of patients lose physical fitness to a minimal degree, and 40% to a degree requiring rehabilitation, classified from moderate to severe [6]. 10% of people lose physical fitness almost completely [6].*
The bar graph was made using MS Excel.

A simple tool for assessing the fitness of a stroke patient is the modified Rankin scale, which we present below.

0 points	the patient does not report any complaints
1 point	the patient reports minor complaints
2 points	a slight degree of disability, the symptoms do not prevent independent functioning
3 points	symptoms significantly impair daily functioning, completely independent existence is not possible
4 points	symptoms definitely prevent independent functioning, but the constant presence of a caregiver is not required
5 points	the patient is completely dependent on the environment
6 points	death

Fig. 3. *The table presents a 7-point scale that assesses the patient's fitness after a stroke, 0 points corresponds to the best condition of the patient and 6 points is equivalent to death.*

7. MusicGloves Therapy

One of the innovative methods of treating sensory and motor disorders is MusicGloves therapy. It involves performing a series of exercises to the rhythm of music with the hand affected by post-stroke deficits using a sensory glove [1]. This solution engages the areas of the brain responsible for motor coordination, memory and learning [1]. In a study involving 12 post-stroke patients with moderate hemiparesis, a comparison of exercise performance was made in patients with and without the use of the MusicGlove glove. The study group performed motor tasks with the MusicGlove glove for 9 hours over 3 weeks, and the control group performed the same exercises without support for the same period [1]. The study showed a higher average result on the Box and Block Test (BBT) (12+/-4 MG1 vs 7+/-5 MG2) [1;6]. A similar independent 3-week study by Zondervan et al. [1; 5] among 17 patients did not show a significant improvement in the box and block test result between the control and the study group. However, it proved that MusciGlove is a more qualitative therapy in terms of movement and more efficient in terms of the time spent by the patient on exercises [1;5]. In another study, Friedman et al. [1;3] compared the effectiveness of MusicGlove therapy and standard, conventional hand exercises. 12 patients performed the recommended exercises at home for 2 weeks in 1-hour sessions 3 times a week. The box and block test result in the group of subjects using MusicGloves was 3.21, and in the group of conventional hand exercises -0.29 [1;3]. Stroke patients rehabilitated using Music Gloves significantly improved their hand function related to grasping small objects than patients trained conventionally, as evidenced by the 9 Hole Peg test result (improvement by 2.14±2.98 compared to -0.85±1.29 pegs/minute; P=0.005) [1,3]

These measurements confirm the hypothesis regarding the improvement of the patient's ability to manipulate small objects and greater precision of movements after therapy involving a large number of repetitions of grasping and oppositional movements of the thumb and finger and promoting afferent stimuli.

8. Strokes and COVID-19

Currently, several years after the outbreak of the COVID-19 pandemic, we have collected data on the impact of SARS-CoV-2 infection on the risk of other health complications - including stroke. As shown by Quanhe Yang and colleagues, COVID-19 increases the risk of ischemic stroke, especially during the first 3 days after the onset of infection. The study participants were 40,000 beneficiaries of the Medicare-Fee-for-Service program in the USA, with a median age of 80.4 years. Importantly, the risk of acute ischemic stroke was higher in the group of people aged 65-74 years than in the group older than 85 years. [9]. The pathophysiological basis of the association between COVID-19 and stroke is an increased risk of thrombotic events in the cerebral vessels, which is caused by an increase in the number of platelets, endothelial dysfunction, and inflammation. Characteristics and Outcomes in Patients With COVID-19 and Acute Ischemic Stroke: The Global COVID-19 Stroke Registry reports that strokes in COVID-19 patients have a worse prognosis and are associated with higher mortality than in people without SARS-CoV2 infection [14]. Laura Williamson and co-authors estimate that there is a twice as high risk of stroke during SARS-CoV2 infection [15].

9. Conclusions

According to WHO 2018, cohort studies, case reports and case reports - control, lack of physical activity is the leading cause of premature deaths, while regular physical activity reduces the risk of heart disease, stroke, diabetes, breast cancer, colon cancer, improves mental performance and quality of life.

Physiological symptoms of overtraining also concern an increased risk of hemorrhagic stroke.

Based on systematic reviews, studies, meta-analysis and case reports, it has been proven that in order to prevent total, hemorrhagic and ischemic strokes, regular, moderate physical activity is recommended for at least 30 minutes a day (brisk walking, jogging, cycling, aerobics).

Studies indicate a low level of knowledge of post-stroke patients about the risk factors of stroke related to an improper lifestyle, in particular insufficient physical activity [11]. Knowledge in this area among the society that has not had a stroke but suffers from other lifestyle diseases is also insufficient [10]. Completely healthy patients are aware of the important role of physical activity in preventing these diseases, however, their compliance with the recommendations of associations is below the norm. I therefore conclude on the basis of research on the significant intensification of educational activities promoting physical activity as important in the prevention of lifestyle diseases, including strokes [10].

A number of studies on the effectiveness of MusicGlove have shown that repeated movement combined with musical stimulation can have a positive effect on the effects of hand sensorimotor disorders therapy in stroke patients. Stroke patients rehabilitated using Music Gloves significantly improved their hand function related to grasping small objects than patients trained conventionally [1;3]. However, there are still no recommendations for the use of MusicGlove Therapy, as further studies on its effectiveness are necessary in a larger number of patients [1].

Disclosures

Author's contribution:

Conceptualization - Aleksandra Woskowska;
Methodology - Weronika Woskowska;
Software - Monika Klimczak;
Analysis - Agata Białek;
Investigation - Magdalena Domisiewicz;
Resources - Magdalena Mendak; Weronika Woskowska
Data curation - Magdalena Mendak, Magdalena Domisiewicz;
Writing - Aleksandra Woskowska;
Preparation - Aleksandra Woskowska; Weronika Woskowska
Visualization - Agata Białek, Anna Hanslik;
Supervision - Monika Klimczak; Magdalena Mendak
Project administration - Aleksandra Woskowska, Weronika Woskowska; receiving funding not applicable.

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