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CIVILIZATION DILEMMA OF QUALITY OF LIFE

Václav HOŠEK

Abstract

The results of human biological and cultural evolution are currently at odds. A prosperous consumer lifestyle as a result of cultural evolution does not provide enough of the adaptive stimuli that man claims as a result of natural biological evolution. The aim of this article is to define civilization dilemmas in relation to the quality of life of modern man. The chosen methods were the methods of analysis, synthesis, induction and deduction applied to the method of anchored theory in the sense of studying the concept as the main category, as well as causal and operational thinking. A synthesis of evidence and a critical and reproducible summary of the results of available publications on the subject were performed as well. The results of the study provide knowledge that quality longevity (delaying senescence) requires a certain degree of hormetic stress, especially in the area of caloric restriction, physical and mental exertion and hardening (salutogenetic quadrivium). The first dilemma analyzed is the autodeterministic discomfort self-limitation of the ascetic type. Within the framework of cognitive dissonance and causal attribution, it leads to the question of whether the advanced discomfort will be balanced by a subsequent comfortable life. The second dilemma analyzed is the use of technological possibilities of biotracking (BZV, biomonitoring), which will be increasingly, in accordance with the progress of knowledge, offered in deciding on the nature of necessary human activities, which can be interpreted as a restriction on freedom of decision. Conclusions: The analyzed dilemmas will increasingly affect a person's quality of life in their self-limiting form.

Keywords

Discomfort dilemma; supervision dilemma; salutogenetic quadriad; hormesis.

1 INTRODUCTION

1.1 The lifestyle in modern civilization

The lifestyle to that modern civilization leads is at odds with the health requirements for human biological prosperity. A result of this fact is a growing rate of "mismatch diseases", the most prominent of which is the obesity epidemic. On the exact data based health promotion and health education, rationalizing for more than a hundred years, are not very effective and the "mismatch diseases" problems are getting worse, together with the rising of living standard globally in the world.

The main reason is a disproportion between the results and the resulting requirements of the roughly five million years of human biological evolution in natural environment and the subsequent, about ten thousand years of the human cultural evolution. Genetic-based biological evolution has evolved into a

"natural", an organism with a musculoskeletal and cardiopulmonary system that needs permanent adaptation stimuli, originally provided by a challenging natural environment that has provided sufficient "training" for all human vital functions. Cultural evolution has taken man out of the natural environment (self-domestication, urbanization) and, on a meme basis, created an accelerating technological civilization which, in its prosperous consequences, freed man from physical exertion and provided him with an excess of preferred food, including living in thermal comfort.

People willingly switched to a comfortable lifestyle with an abundance of food and without strenuous work effort, but with unpleasant health consequences. A demonstrating example is the 50-year history of the small island Pacific state of Nauru, which, after gaining independence, decided to become rich by phosphate mining. For several decades, it

rose to the head of rich countries according to the criterion of GDP per capita. They used the obtained funds rationally, but of course they hired workers for hard work and "lived" well, according to their judgment. After half a century of existence, they have had enough problems. Leaving aside organic, health statistics remain alarming: over 90% of Nauru's citizens are obese (even slightly more men than women) and over 30% have type 2 diabetes. This is not a good balance at all after half a century of civilizational prosperity in the original "tropical paradise". It should be noted that the citizens there are no "savages" or "primitives". Most have a very good education, mostly in foreign schools. Such an "experiment" under natural conditions supports the hypothesis that a prosperous lifestyle can harm the human population in a biodegradable sense.

1.2 History of the problem

Medical research has gradually found increasing evidence that human lifestyle, including nutritional and exercise habits, plays a dominant role among the potential determinants of human mortality (genetics, environmental influences, level of medical care, lifestyle). It has been promoted as part of primary disease prevention, but healthy people do not give much warning. As early as the 1970s, Ukrainian cardiac surgeon Nikolai Amosov as the first declared person's condition to be a health reserve and verified the effect of massive exercise on physical well-being for himself into old age (Amosov, 1980). Aron Antonovsky shifted much of his knowledge in this area with his concept of salutogenesis, derived from the study of the health consequences of the Holocaust, trying to come to terms with what human invincibility is all about (Antonovsky, 1985). As part of the search for salutators, i.e. factors that positively affect human health, a "salutogenetic triad" was introduced as early as 1993, consisting of an interconnected reduction in energy intake, an increase in energy expenditure and hardening (Hošek, 1993). Despite a certain positive citation response, the opinion promoting "inconveniences" has not prevailed as it is in this area.

2 AIM

The aim of this article is to define civilization dilemmas in relation to the quality of life of modern man.

3 METHODS

The chosen methods were the methods of analysis, synthesis, induction and deduction applied to the method of anchored theory in the sense of studying the concept as the main category, as well as causal and operational thinking.

A synthesis of evidence and a critical and reproducible summary of the results of available publications on the subject were performed as well.

4 RESULTS AND DISCUSSION

It is all the more interesting that a similar triad (caloric restriction by 25%, physical exercise and thermoregulatory stimuli) reappeared after 16 years in the experimentally far better-based monograph of David Sinclair, presented as anti-aging drugs (Sinclair, 2020). It is especially interesting that the team of Sinclair's geneticists demonstrate the positive effects of these influences not only in the human area, where it is not methodologically simple, but also in the subhuman area, from the simplest organism of yeasts and octopuses, through vertebrates to humans. It is also psychologically interesting that the intervention trials apparently "ran into" the resistance of the subjects. Their additional statement after the experiments, for example, shows that they managed to comply with the 78% hunger directives. Of course, this was a great deal of discomfort, and even well-paid experimental volunteers failed with a partial starvation.

Theoretically, the aforementioned monograph explains the effectiveness of loads with epigenetic regulators, sirtuins that support mitochondria and have broad healing effects on the body in the fight against sarcopenia, osteopenia, atrophy and other degenerative factors of senescence. Fasting, exercise and heat act as hormesis, ie positive stress that benefits the body. Sinclair has not recently been the only one who praises the positive effects of

stress. Leading physiotherapist Pavel Kolář publishes the monograph "Strengthening with Stress" (Kolář, 2021). In the monograph the author understands strengthening not only in the bodybuilding sense, but as a way to resilience by overcoming natural and model stress situations. The number of professional authorities promoting hormesis has recently increased (Lieberman, 2021; Poněšický, 2021; Vojáček, 2021; Kornatovská and Rehor, 2021, etc.).

It is possible to state, that we arrive at a situation where modern society has liberated man from the struggle with hunger, cold and effort, but this society must return to these "prehistoric" burdens voluntarily in model situations in order to prevent the biodegradable effects of the comfortable life.

On the base of the analysis, synthesis, induction and deduction applied to the method of anchored theory the followed dilemmas.

4.1 Dilemma 1: Acceptance of discomfort

It is natural to prefer pleasure to suffering. Hedonism dominates asceticism, and modern man bases himself on his freedom of choice. Nevertheless, he should be able to accept certain stress-type discomfort constraints in the context of biocognitivity in the interests of his biopsychosocial prosperity and in his anti-senescent efforts.

Lifestyle hormones should include four types of stress, which we call *salutogenetic quadriade, stress quadrivium, or quadruplex*:

1. Reduction of energy intake (fasting), caloric restriction by 25%
2. Increasing of the energy expenditure, at least to the level of health-oriented fitness, ie 10 - 20 MJ / week.
3. Hardening, i.e. adaptation to thermoregulatory loads outside civilization "thermostats".
4. Cognitive training, increased mental effort, especially in senior age.

Psychologically, of course, these are very difficult requirements, negatively motivated. The

legacy of human biological evolution, marked by a constant fight against hunger, is also the tendency to over-consume food, because people were not sure when there would be enough food next time. In this context, food preferences of energy-valuable food (fatty and sweet) have also developed, which have long delayed hunger and are now counterproductive for humans. Movement is purposefully motivated for a person, as an instrumental matter. Autotelic motor skills are mainly represented by juvenile movement. In relation to the discomfort of "ineffective" effort and burden, one is comfortably repulsive. One can move from aversion to acceptance only on the basis of emotions (combat enthusiasm, hunting passion, game interest, dance ecstasy, sports mobilization, crowd imitation, fear and anger reactions, and fanaticism in all kinds).

The second great tool for stress discomfort reducing is rationality, i.e. "justification" of stress in terms of causal attribution and understanding of its effectiveness. Exercise discomfort is a part of workload, it is a prerequisite for reward and logically is the content of professionalism of soldiers, firefighters, police, rescuers and other auxiliary professions, where real and model discomfort can become an obligation. Otherwise, compulsory discomfort is a social problem, justifiable even in prison, because it smells of restrictions on freedom and fascist tendencies. Volunteers, however, have no limits and it is up to each person to react to discomfort, whether it is the burdens imposed by circumstances or the burdens initiated by their own decisions. The third big tool for reducing exercise discomfort is habit. Hardening is the best example of human adaptability, which shows how relatively quickly the inconvenience of contact with a cold environment decreases depending on regular immersions. Regular loads lead to adaptation and in some cases, for example in endurance athletes, one gets used to endogenous opiates, which, due to exertional stress, leach out inside the body and evoke pleasant feelings.

This can lead to dependence on exertion and withdrawal symptoms when training is stopped abruptly. That is why metaphorically sometimes we speak of "sports masochism" and a person who has not experienced sports euphoria has a hard time understanding the paradoxical "joy of suffering" in extreme sports performances.

It follows from the indicated that the best means of overcoming subjective discomfort is spontaneous movement, sports activities and voluntary rational and habitual stressful moments. Motivationally, it is best to understand current discomfort as a means, as an investment in one's own condition, which is an important circumstance of one's own quality of life, i.e. kinesioprotection of quality of life (Hošek, 2016). The reversible theory of emotions, according to which negative emotions usually turn into their opposite, is also helpful. Fear is a joy after overcoming it, after fatigue there is a happy rest, a hungry person is happy to enjoy a reasonable portion of food and a return to the thermos-neutral zone is associated with pleasure. Generally, it is a credo: "comfort to comfort."

The big problem is the level of accepted discomfort, frequency and intensity of selected loads. Due to the fact that the subject faces aversion, he cannot rely on his feelings within bio-tracking or biomonitoring and is grateful for the auxiliary quantification. This brings us to the second civilization dilemma - technological supervision (control) of human activity.

4.2 Dilemma 2: Acceptance of digital surveillance

Technological progress, conditioned by human cultural evolution, gives man ever greater opportunities to expand his potential, e.g. in the field of sensors, body modifications, implantation to the limits of the so-called "cyborgization" of man. In the field of automatically controlled bodily functions, technical progress gives great potential in the field of biological feedback.

The accurate and immediate information, for example, about a person's heart rate can be useful when monitoring a person's rehabilitation after a cardiac procedure, or during sports training (sports tester). The wearable electronics and equipment of ergometers and simulators today offer great opportunities for continuous monitoring of energy expenditure and energy intake, or energy equivalents. These devices are designed to monitor the human regime and alert you to compliance with certain regime limits. Psychologically, it is a "man-machine" relationship. One has to come

to terms with the fact that he is "monitored" and will be alerted to the fulfillment or non-fulfillment of certain stress quotas. Subjectively, he may perceive it negatively as an intervention in his own self-determination, but on the other hand, it provides him with valuable objective data that he can confront with his feelings. In general, these surveillance technologies are on the move and the issue has a response in a societal sense (wiretaps, cameras, etc.). According to the assumptions, modern man will have to accept that in the near future he will do for the most part what the "machine" recommends, i.e. bio-tracking in the field of his bioenergy balance represented by wearable electronics, although this may be negatively perceived as restriction of subjective freedom, objectively it increases the probability of quality of life. Previous experience in human-machine cooperation, in the case of pedometers, exercise bikes, ergometers and other trainers, shows that it is a functioning motivating factor within the HBM (Health-Believe-Model).

5 CONCLUSIONS

The discrepancy between the effects of human biological and cultural evolution leads to the dilemma of voluntary acceptance of hormetic stress in the form of a salutogenetic quadriad. The second dilemma resulting from this is the restriction of decision-making freedom in the sense of bio-tracking by wearable electronics. Acceptance of the two indicated dilemmas will influence anti-senescent thinking and the modern lifestyle of a modern man.

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INFLUENCE OF THE MICROBIOME ON THE QUALITY OF HUMAN LIFE

Marta STĘPIEŃ-SŁODKOWSKA, Bartosz BOLACH, Karina RYTERSKA,
Katarzyna KOZUBAL, Eugeniusz BOLACH

Abstract

The current challenges of health care systems in the world, dedicated to various health problems, are increasingly characterized by a holistic approach to health. Health is closely related to physiologically proper functions and organs and perceptual coordination mechanisms that affect interactions between body systems and organs. One of them is the human microbiome, which consists of microbes that form a biocenosis that can appear from person to person. The aim of the presented study is based on the content analysis of literature sources to show the significant relationship between the human microbiome and nutritional needs, metabolic rate and selected measures of health. The main used method was a systematic review, which includes a critical and reproducible summary of the results of available publications on the human microbiome. The results point to the possibilities of medicine to contribute to the recognition of new possibilities of using the physiological properties of a healthy organism for therapeutic purposes in the field of lifestyle, such as the solution of overweight and obesity, metabolic syndrome, inflammation and chronic allergies. Bacteroides fragilis inducing an anti-inflammatory response has been shown to have a protective reaction. Research suggests that the occurrence of an allergic reaction in children is associated with a reduction in the amount of Lactobacillus and Bifidobacterium bacteria. The results of analyzed studies report that the development of bronchial asthma in children after the first year of life depends on the intestinal flora in the neonatal period. Conclusions: Human microbiome research is an important part of identifying ways to modify style elements and interventions to prevent diseases of civilization.

Keywords

Health; quality of life; microbiome

1 INTRODUCTION

The World Health Organization defines human health as physical, mental and social well-being. Contemporary challenges of health care systems in the world are dedicated to various health problems, however, they are more and more often characterized by a holistic approach to health. This requires taking into account many definitions representing health in various aspects of maintaining health or striving for it, by populations of people of different ages and functioning with disabilities (Leonardi, 2018). Health is the physiologically correct functioning of systems and organs, and the ability to maintain it is an active process involving distinct adaptive mechanisms that coordinate interactions between the body's systems and organs (Ayres, 2020). Homeostasis is the body's ability to maintain health and the proper

functioning of the body in the face of changing external or internal factors.

The gut-brain axis is a coordinated communication system that maintains homeostasis and influences higher cognitive functions and emotions. It plays a significant role in neurological and behavioral disorders (Saulnier et al, 2013). Among the sensory and motor neurons innervating the intestines, there are afferent nerve cells, nociceptor cells whose pericaryons are found in the dorsal and nodal ganglia and are linked to several types of cells in the intestinal wall, such as epithelial, vascular, and immune cells. The possibility of two-way exchange of signals between nerve cells performs immunoregulatory functions; controlling the body's response to pathogens and modulating the sensations related to gastrointestinal dysfunctions, by activating

immune cells and glial tissue in the peripheral and central nervous system.

The development of research on the human microbiome has contributed to a change in the views of clinicians on its importance for maintaining health (Young, 2017). Research has shown that most microorganisms form an ecosystem with the human body that benefits the host-microorganism system. Thanks to this system, the production of nutrients and immune components that protect against pathogenic microorganisms takes place.

1.1 The human microbiome

The term microbiota (or microbiome) was introduced at the turn of the 20th and 21st centuries by Joshua Lederberg. It is used to determine the total number of microorganisms present in and on all multicellular organisms (Szewc, 2017). The conducted research indicates many functions of the human body's ecosystem. It has been shown to participate in the pathogenesis of many diseases and ailments (Sirisinha, 2016).

Bacteria inhabiting the human body form functional assemblies that are able to communicate with each other and the host organism (Rakowska et al., 2016). They have a quorum sensing system, thanks to which stimuli coming from the external environment or from the host are processed in the cytoplasm of the bacterial cell. Through the action of such a mechanism, the number of bacteria is established, actions are synchronized and responses to stimuli are coordinated. It is estimated that the weight of bacteria inhabiting the mucous membranes of the body is approx. 2 kg (Strzępa and Szczepanik, 2013). The intestinal flora is the most numerous and at the same time the most physiologically active. For example, the large intestine hosts microorganisms that constitute up to 50% of the intestinal content. In the physiological state, the most abundant bacteria are *Firmicutes* (64%), *Bacteroidetes* (23%), *Proteobacteria* (8%) and *Acinetobacter* (3%) (Binek, 2012). The composition of the flora varies in individual sections of the digestive tract. For example, the esophagus and stomach are areas of limited development of the bacterial flora. There may

be few organisms in them, such as *Helicobacter pylori*, *Lactobacillus*, *Enterococcus*, *Clostridium*, *Veillonella*. In the physiological state, there is no development of inflammation in the places where microorganisms occur, which is a consequence of the presence of numerous mechanisms that prevent the passage of bacteria beyond the gastrointestinal tract, and also against the development of inflammation if they enter another environment (Strzępa and Szczepanik, 2013). The securing factors include: mucin contained in the mucus of the intestinal epithelium, tight connection of epithelial cells, the so-called intestinal barrier tightness, which is favorably influenced by interleukin 10, transforming growth factor β , insulin-like growth factor 1. On the other hand, interferon γ , tumor necrosis factor, interleukins will have a negative effect; 2, 4 and 13. Severe damage to the intestinal barrier will impair the functioning of the system. This can occur as a result of the presence of pathogenic flora, ischemia or hypoxia in the body. The result will be the occurrence of diarrhea, translocation of bacteria outside the system environment, which may lead to the development of sepsis, especially in the case of impaired functioning of the immune system (Binek, 2015). A protective factor is also the presence of immunoglobulin A (IgA), which has the ability to opsonize, i.e. a mechanism of non-specific immunity, which prevents translocation of bacteria through the intestinal membrane.

1.2 Dysbiosis

Dysbiosis is a sudden change in the composition of the microbiota that leads to disease symptoms. Factors causing it are, for example, a change in diet, a change in the functioning of the immune system, such as a change in lifestyle or stress, as well as antibiotic therapy. Numerous studies (Strzępa and Szczepanik 2013) indicate the destructive effect of antibiotic therapy on the physiological flora of the human body. There is a change in the proportions of the main types of bacteria inhabiting the digestive system. These changes persist up to 2 years after the end of treatment (Wołkowicz et al., 2014). Selected sources indicate that the recovery to the physiological state takes a much longer period of time. It is

related to a reduced resistance to infections with pathogenic bacteria. It is worth mentioning that the newborn microflora is the most susceptible to disturbances in homeostasis. In such a young, developing organism, the process of colonizing the bacterial flora and creating interactions between the host and commensal bacteria has only just begun. Additionally, there is a problem of drug resistance of pathogens, as the death of the physiological flora creates niches for the development of bacteria that are initially resistant to a given antibiotic.

2 AIM

The aim of the presented study is based on the content analysis of literature sources to point out the important relationship between the human microbiome and nutritional needs, metabolic rate and other measures of health.

3 METHODS

The method of systematic review was used. The review process has been well designed and planned to reduce bias and eliminate irrelevant and low quality studies on the topic of human microbiome. A protocol and criteria for inclusion and exclusion were developed, followed by a literature search and screening of abstracts of the studies identified in the search and subsequently selected complete texts. A synthesis of evidence and a critical and reproducible summary of the results of available publications on the subject were performed. Methods of analysis, synthesis, induction and deduction were chosen and applied to the method of anchored theory in the sense of studying the concept as the main category, as well as causal and operational thinking.

4 RESULTS AND DISCUSSION

4.1 The influence of the microbiota of the digestive system on the human body

Microorganisms inhabiting the intestines are an extremely diverse and complex ecosystem (Szewc, 2017). The intestinal mucosa, covered with villi and microvilli, constitutes a significant area of the human body. Due to its importance, it ensures the maintenance of the

organism's homeostasis. The most important functions are immunomodulating, metabolic and structural (Jandhyala et al., 2015). It has been shown that disturbances in the physiological composition of the microbiota are correlated with dysfunctions such as autoimmune, allergic, metabolic diseases such as obesity, type 1 diabetes mellitus, neurodevelopmental and mental disorders; depression, irritable bowel syndrome or non-alcoholic hepatitis.

The research conducted in this area concerns the possibility of modifying the bacterial flora, restoring its biological balance, and transferring microbiota (Szewc, 2017). All in order to maintain a healthy ecosystem balance. In 1954, the term probiotic was introduced by Ferdinand Vergin. He conducted comparative studies related to the harmful effects of antibiotics on microorganisms in the digestive system and the beneficial effects of certain types of microorganisms on the entire ecosystem. In 1965, the definition of a probiotic already included a number of microorganisms that stimulated the growth of other species of bacteria. In the following years, these definitions were still modified. Current, given by the World Health Organization, states that they are live microorganisms that, when given in an appropriate amount, have a beneficial effect on the health of the host. In the event of disturbed intestinal microbiological balance, in selected diseases, intestinal microbiota transfer is used, i.e. the so-called fecal transplant from a related donor (Evrensel et al., 2016). The growing number of metabolic diseases caused by intestinal dysbiosis prompts us to undertake further research on intestinal microbiota transfer procedures from healthy, tested donors for people with disorders.

Physiological bacterial flora is involved in the synthesis of vitamin K, the production of biotin and folic acid, as well as the absorption of magnesium, calcium and iron ions (Mroczyńska et al., 2011). Ensures obtaining energy from the breakdown of polysaccharides. Bacteria also take part in the production of fatty acids, which are a source of energy for intestinal epithelial cells, ensuring its continuity. They are a source of butyric acid, which affects the continuity of the epithelium and is anti-inflammatory by reducing the concentration of pro-inflammatory

cytokines. They induce the formation of mucin, which protects the epithelium from toxins and pathogenic bacteria.

The literature on the subject emphasizes the importance of bacterial microflora for human health and functioning (Malferheiner, 2016; Skrzydło-Radomańska, 2016; Rakowska et al., 2016). The closest relationship was observed in inflammatory bowel diseases; in the gastrointestinal tract of Crohn's disease patients. The cell membrane of Bacteroidetes and Proteobacteria bacteria contains lipopolysaccharide, which strongly stimulates the immune system. Another disease that depends on the microflora is diverticular disease and functional disorders of the digestive system. Another related to the microbiome is obesity (Heiman, 2016). Nutrition is the most important factor in shaping the body flora. The epidemic of civilization diseases results from the reduction of dietary diversity, which results in the depletion of the physiological flora. The food you eat goes to the intestines, where it is transformed into particles absorbed into the blood. The prevalence of incorrect nutrition rules; High-carbohydrate and high-fat diets, and above all highly processed diets, deprive the microbiome of the necessary nutrients, which makes it impoverished, and the developing dysbiosis leads to the development of many diseases, e.g. obesity. The flora of the developing child is influenced by the nutritional habits of the mother - women during pregnancy and also in the pre-conception period (Kinsner, 2018; Kinsner and Kazimierska, 2018). The flora is also influenced by additives used in food to improve the taste, texture, aroma and prolong its shelf life (Supreme Chamber of Control, 2018). The permissible doses used for food should not be harmful, however, as the Report shows, as much as 14% of the tested samples of food products exceed the permissible standards. In addition, when establishing the standards, the accumulation of these substances is not taken into account, and the deposition in the tissues leads to many dysfunctions, including inflammation. Chronic inflammation can lead to diseases within the intestine, causing eg Lesniewski-Crohn disease, ulcerative colitis or irritable bowel syndrome, metabolic and autoimmune diseases. In obese people, an increase in the percentage of

Firmicutes as compared to the *Bacteroidetes* type has been demonstrated. This condition is related to the fact that *Firmicutes* bacteria largely metabolize nutrients, which predisposes them to obesity. A relationship between the amount of adipose tissue and the microbiome was also observed in mice that had been deprived of the physiological flora, and instead, flora was transplanted from obese individuals. After two weeks, they had a significant increase in body fat. Studies have also shown a relationship between the microbiota and the development of colorectal cancer. Bacteria that produce butyric acid with its help inhibit the growth of cancer cells, and also induce apoptosis, i.e. death of these cells. Others are involved in the synthesis of toxic and carcinogenic compounds.

The composition of the microbiome is associated with the development of allergies in people with a genetic predisposition (Strzępa and Szczepanik, 2013). In this case, *Bacteroides fragilis* inducing an anti-inflammatory response has been shown to have a protective reaction. Research suggests that the occurrence of an allergic reaction in children is associated with a reduction in the amount of Lactobacillus and Bifidobacterium bacteria. There are also reports that the development of bronchial asthma in children after the first year of life depends on the intestinal flora in the neonatal period.

4.2 The influence of the microbiome on the oral cavity

The oral cavity plays a significant role in picking up and grinding food. The ingested food is soaked in saliva and ground in order to effectively assimilate the necessary nutrients in all sections of the gastrointestinal tract. Physiologically, the oral mucosa and the salivary glands - innervated paired organs - are involved in this. The oral cavity is a specific environment for the colonization of various types of bacteria. Such an environment is created thanks to the supply of food, water, and various pollutants and pathogens ingested with them. In the state of physiological immunity of the organism, typical microorganisms in the oral cavity do not pose a pathogenic risk. However, due to the imbalance

of the microflora composition, pathological conditions may appear. With a slight intensification of changes, they may appear locally and periodically. Oral bacteria colonize from the birth of a new organism. Initially, these were Gram-positive cocci, *S. salivarius*, Gram-negative *Lactobacillus* and selected anaerobic bacteria (Gliński and Kostro, 2015). The bacteria in the mouth are diverse; others on the surface of the teeth (most often lactic acid bacteria) and in the interdental gaps, others on the surface of the tongue and the walls of the mouth. The composition of the physiological bacterial flora may slightly change under the influence of food intake or oral hygiene. However, most of the microorganisms remain constant regardless of these differences. As the organism develops and grows, the microflora changes. In adults, it includes aerobic bacteria (*Strepto-coccus spp.*, *Pasteurella multocida subsp. Multocida*, *P. multocida subsp. Septica*, *P. multocida subsp. Gallicida*, *P. canis*, *Moraxella spp.*, *Flavobacterium sensu lato*, *Pseudomonas spp.*, *Corynebacterium spp.*, *Neisseria animaloris*, *N. veaveri*, *N. zoodegatis*, *Ureaplasma spp.*, *Bergeyella zoohelcum*, *Mycoplasma feliminutum*, *Nocardia spp.*, *Capnocytophaga Canimorsus*, *C. cynodegmi*), and anaerobic bacteria (*Bacteroides spp.*, *Porphyromonas spp.*, *Wolinella spp.*, *Peptostreptococcus anaerobius*, *Clostridium spp.*, *Actinomyces viscosus*, *Eusobacterium spp.*). The oral microflora is characterized by properties such as the ability to adhere and to congregate and, consequently, to form bacterial biofilms. Aerobic and anaerobic bacteria, their metabolic products and salivary glycoproteins form a sticky deposit on the tooth surface, which leads to the development of dental plaque. The bacteria and the metabolic products they emit penetrate the gingival gap between the tooth and the free edge of the gum, and along with the growing layer of sediment, change its conditions into microaerophilic, i.e. those that facilitate the colonization of the oral cavity by pathogenic bacteria causing lesions. Emerging infections accumulate Gram-negative proteolytic bacteria, such as *Porphyromonas spp.* and *Tannerella spp.* In such a situation, the bacteria change the interdental gap into a deep pathological gingival pocket, which in turn may initiate periodontitis. The oral cavity

connects with the upper respiratory tract, which is inhabited mainly by gram-positive bacteria, with a composition similar to the skin.

4.3 The influence of microbiota on the nervous system

The interplay between the gut and the brain is currently under intense consideration. It has been established so far that early disturbances of the intestinal flora related to the way of feeding in the neonatal and infancy period, perinatal conditions, and exposure to drugs may cause dysfunctional states in response to stress in later life. Studies on mice have shown intestinal dysbiosis, unsealing of the intestinal barrier, disturbances in the synthesis of tryptophan, dopamine and serotonin in the presence of early separation from the mother and chronic stress. The result of such changes in the body may be an increased concentration of cortisol, as well as the appearance of depressive and anxiety behaviors (Foster et al., 2017; Kornatovska and Rehor, 2021). Patients with depressive disorders were diagnosed with an incorrect ratio of *Proteobacteria*, *Bacteroidetes*, *Actinobacteria* to *Firmicutes*.

Some bacteria are able to produce neuroactive substances which affect how the brain functions. The communication of the microbiota with the central nervous system occurs primarily through the vagus nerve, the hypothalamic-pituitary-adrenal axis, the immune system or metabolites produced by the microbiota. Especially in recent years, a number of relationships between the substances produced by the bacteria that make up the microbiome and the functioning of the brain have been observed. It has also been noticed that the intestinal microbiota may participate in neurodevelopmental and neurodegenerative processes. Moreover, these studies reveal a relationship between the functioning of the microbiome and mental functioning, which is particularly reflected in depressive and anxiety disorders. A relationship has also been observed between the functioning of the digestive system and mental condition - stressors or an inadequate diet may contribute to a change in the composition of the intestinal microbiota, which may affect the functioning of the brain and mind.

The literature also describes the relationship of the microbiome with autism spectrum disorders (Binek, 2015). A change in the intestinal flora has been noticed in children with autism. A 10-fold increase in the number of Clostridium bacteria compared to healthy children was diagnosed. These bacteria produce neurotoxins that cause symptoms in the form of functional disorders. The intestinal microbiome influences the development of the brain, and the effect of the action is a change in behavior, and by affecting the central nervous system also on the response to stress (Gliński and Kostro, 2015).

5 CONCLUSIONS

Research and the microbiota of the human body have been going on almost from the beginning of the development of microbiology. The development of biology and medicine contributes to the recognition of new possibilities of using the physiological properties of a healthy organism and using them for therapeutic purposes of sick people. The development of molecular, breeding and diagnostic techniques is of great importance in scientific research. All scientific studies will contribute to the creation of new therapeutic agents and methods for patients, such as probiotics or transfers of the microbiome to the organism in need, which will translate into the quality of life of people with health disorders.

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PROMOTING SELF-EFFICACY AS ONE OF THE BASIC SALUTOPROTECTIVE RESOURCES IN DEALING WITH CHALLENGING LIFE SITUATIONS WITH A FOCUS ON THE COVID PANDEMIC -19

Markéta ŠVAMBERK ŠAUEROVÁ

Abstract

The theoretical basis of the contribution is a literature search focused on the use of various salutoprotective resources in dealing with challenging life events, not only concerning the current situation but also within a historical context, and the author's experience of providing psychological intervention during the Covid-19 pandemic. The awareness of an individual's own self-efficacy can be considered as a crucial salutoprotective resource in coping with challenging life situations, while an essential factor influencing the quality of self-efficacy is the manner of family and school education and the degree of attention paid to its development in these environments.

The thrust of the contribution is to suggest ways to develop self-efficacy awareness as a fundamental salutoprotective source of wellbeing in the time of the pandemic, both in family and school education.

Keywords

Psychological intervention; pandemic covid 19; mental health; quality of life.

1 INTRODUCTION

A crucial circumstance for the focus of the paper is the actual state of mental health of the current population as a result of the long-term adverse pandemic situation that has been ongoing since March 2020.

In this context, a working group of the Government Mental Health Council (GMHC) has initiated an inquiry into the impact of the pandemic on the mental health of the population. According to a study by the National Institute of Mental Health, the prevalence of current mental illness has increased from 20% to 30%. The risk of suicide has increased 3 times, depression has increased 3 times, and anxiety disorders have increased 2 times. The frequency of binge drinking, drinking large amounts of alcohol on one occasion, has also increased.

The survey also mapped psychological difficulties in children and adolescents. According to an investigation by the Czech School Inspectorate, 10 000 children were not involved in distance learning at all, so the mental health and development of these children may be at significant risk now and in the future.

Increased stress during an emergency, especially fear and concern for one's own health and the health of loved ones, or societal uncertainty and helplessness in relation to interventions, are common causes of mental illness symptoms in children and young people. This includes a lack of information and tools to deal with the situation. In children, sleep disruption, lack of stimulation, lack of sporting activities, little privacy, conflicts within the family, etc., can all lead to mental discomfort (Salomon, 2020). Also alarming is the data from the Safety Line, which registered during the COVID-19 epidemic in the Czech Republic up to 30% increase in calls with the topic of domestic violence, 30% increase in personal problems and psychological problems or 30% increase in the topic of Internet problems, including sexual abuse (Salomonová, 2020).

Health impacts have also been analysed for university teachers (processing of the RHS survey is still ongoing) and health professionals. The Ministry of Health has set up a collegiate psychological support line for health workers who were on the front line and often treated patients with infection, working overtime and

having to react and adapt quickly to changes in their working patterns. Experts on the other side of the line helped healthcare workers to manage these stressful situations (Vojtěch, 2020).

As already mentioned, the topic of mental health and the care of bio-psycho-social balance is taking on even greater importance in the context of the COVID-19 epidemic than it did before. It affects the entire population of the country, as it has major implications not only for the quality of life of individuals and their families or loved ones, but also for the functioning of the state and its economy.

The Ministry of Health, in accordance with the WHO, OECD and other supranational organizations, has perceived the seriousness of the impact of the COVID-19 epidemic on the mental health of the Czech population from the very beginning and has been trying to mitigate the impact of the globally challenging situation through various support initiatives. Some of the support activities have included the establishment of a toll-free mental health first aid line, the creation of public referrals on the Ministry's website, and methodological support to psychiatric hospitals and outpatient clinics, both in terms of adapting care and human rights. An inter-ministerial working group was set up under the Council of Government to prepare comprehensive recommendations for measures to mitigate the impact of COVID-19 on mental health, based on a mapping of the situation. It was also proposed to create a network of health crisis centres attached to hospitals so that there would be one in each region (Vojtěch, 2020).

However, we must also take care of our own mental health and balance on an individual level, each on our own. An important component of salutoprotective resources in this individual care is the promotion of healthy self-reflection and the development of personal competencies in self-efficacy.

Despite the fact that we already have a network of Mental Health Centres in the Czech Republic, which is being further developed, it is necessary to increase the availability of psychotherapeutic and psychosocial support services, to accelerate work on the legislative framework,

methodologies and reimbursement in the field of telemedicine, and to target the prevention funds of health insurance companies also to support psychological resilience. There is significant scope for wellness counselling (wellness coaching, personal development in wellness, quality of life support and bio-psycho-social harmony) in mental health promotion.

As can be expected, the negative impact of the pandemic will continue to affect the lives of individuals and society, so it is more than desirable to look for ways to support the mental balance of each individual.

2 OBJECTIVE

The aim of the text is to emphasize the importance of self-protective activities and self-management in the maintenance of health and mental harmony and to offer personal development techniques useful in wellness counselling to support the acquisition and maintenance of bio-psycho-social balance.

In this context, the text offers activities - techniques - to develop self-efficacy as an important component of salutoprotective resources and the promotion of mental balance.

3 METHODOLOGY

The basic methodological bases were data obtained from the survey of the working group of the RVDZ (Government Council for Mental Health) and the National Institute of Health, as well as the continuous analysis of the development of the mental state of long-term clients from the PPP Pelhřimov (Educational and Psychological Counselling), the Counselling Centre of the College Palestra, the Academy Palestra and the GYOA Pelhřimov.

The results of the COVID-19 survey, which was carried out in the period from spring to summer 2021 under the auspices of the Council of Universities (working group led by Mgr. Soukup, the author of the paper is a member of the working group), all universities in the Czech Republic were contacted (including private and two state universities), the results are still being processed, however, they show a clear trend speaking about the

more frequently reported subjective feeling of reduced quality of life, reduced frequency of physical activities, more frequent depressive emotional tuning, increase in work duties and lack of appreciation of teaching work in challenging conditions (both financially and in terms of verbal appreciation); there were also frequent responses talking about a reduction in salary, i.e. a deterioration in the overall standard of living.

A significant factor is the author's long experience with personal development projects and training in holistic coaching (e.g. Šauerová, 2011, Švamberk Šauerová, 2018, 2019).

The target recipients of the offered service/activities can be any clients in wellness services from adolescents to elderly seniors (the prerequisite is already developed abstract thinking in adolescents, adequate intellect and absence of significant cognitive difficulties in clients).

4 RESULTS AND DISCUSSION

4.1 The position of the self-efficacy component in the complex construct of well-being

The concept of quality of life and mental balance is often linked to the concept of well-being, which can be understood as personal well-being. Šolcová and Kebza (2004) state that personal well-being is "an assessment of the quality of life as a whole". Levin and Chatters (1998, cited in Kebza and Šolcová, 2003) state that personal well-being is often understood as part of quality of life. According to these authors, quality of life consists of two dimensions, namely subjective and objective personal well-being.

Subjective personal well-being consists of psychological personal well-being (life satisfaction, happiness, mood, positive and negative affectivity, etc.), self-esteem, self-validation and personal coping.

Under the term objective personal well-being we can imagine, for example, the state of health of the organism, socio-economic status, etc. (Kraivalová, 2012).

Šolcová and Kebza (2009, p. 129) emphasize that within the concept of well-being it is "a long-

term emotional state in which an individual's satisfaction with his or her life is reflected". At the same time, they agree that personal well-being should be measured through specific cognitive components (life satisfaction, morale) and emotional components (positive, negative emotions) and this construct is consistent across different situations and stable over the time (Šolcová, Kebza, 2005).

Thus, if we consider the self-efficacy component (the development of which we are interested in) as a part of the well-being construct in this context, then we must understand it as an interactive component - and one that affects not only the cognitive domain, but also the emotional part.

In terms of analysing the meaning of well-being, it is worth noting that we encounter two main theoretical approaches.

One is linked to the concept of subjective well-being (SWB) and is defined in terms of satisfaction with life and the balance of positive and negative emotional states, which in different concepts emphasize a different component of positive emotional state - e.g. concepts of Ikigai, Feng shui, Hygge (cf. Jandová, 2021).

The second is associated with the concept of psychological well-being (PWB) and is defined in terms of a person's engagement with the existential challenges and issues of life. The key concepts here are satisfaction with oneself, with one's life, perception of one's own meaning in life, and personal growth. Here, too, we can cite selected concepts emphasising human engagement - e.g. shinrin-yoku, tai-chi, chi-gong, yoga (cf. Jandová, 2021, Hřebíčková et al. 2010).

In terms of these two concepts, we would then classify the promotion of self-efficacy primarily in the area of psychological well-being, but we cannot neglect the importance of emotional balance.

Healthy lifestyle is undoubtedly important pillar in shaping well-being. A healthy lifestyle includes in particular a healthy regime, which according to Žaloudíková (2009) includes: regular daily routine, healthy diet, sufficient physical activity, adherence to personal hygiene, protection against contagious diseases,

responsible personal behaviour (sexual, work, partner, parental), psychological resistance to harmful influences and addictions (smoking, alcohol consumption, drug abuse), efforts for psychological well-being, efforts for well-being in interpersonal relationships, adequate adaptation techniques in stressful situations, protections against accidents, protection of the environment, minimum contact with unhealthy substances.

Kotulán (2002), for example, takes a similar approach to the definition of the issue, but ranks the individual components of a healthy lifestyle differently:

- health and its importance;
- healthy nutrition;
- sleep;
- physical movement;
- protection against diseases;
- protection from accidents and poisoning;
- environmental health care (Kotulán, 2002).

The deeper aspects of well-being are addressed, for example, by Carol Ryff's multidimensional theory (Ryff and Keyes, 1995), a model that includes six basic dimensions: self-acceptance, positive relationships with others, autonomy, meaning in life, and personal development. In this context, other authors (e.g., Kebza, Šolcová, 2004) have suggested that self-esteem and personal control (mastery) of challenging situations are important components of well-being.

If we summarize the results of a search of various scientific papers devoted to the issue of well-being, then we can agree on the most frequently emphasized factors contributing to the feeling of well-being, namely: self-acceptance, social relationships, autonomy and self-esteem, meaning of life (beliefs), personal experience. All of these factors are then overlaid, or if you like, underlined or accompanied, by the awareness of self-efficacy, in all these dimensions (both in the area of self-acceptance and in the area of establishing healthy social relationships without toxicity, etc.).

4.2 Salutoprotective resources affecting bio-psycho-social balance

If we consider salutoprotective resources in the care of bio-psycho-social balance, then it is necessary to mention especially factors of psychological nature, especially positive thinking. Many stress factors cannot be changed in a significant way (e.g. air quality, exposure to a pandemic, a natural disaster).

In addition to positive thinking, we consider such dimensions of health as coping with stress and overexertion, relaxation, and preference for a positive life scenario (cf. Starý, 2008, Šauerová, 2012). Other important salutators include sufficient physical activity, a varied, balanced diet, sufficient rest (sleep), and adequate psychohygienic habits.

It is often mistakenly assumed that by providing people with information, they can already make the right choices and act in the interests of their health. The current situation and the frequent misinformation and hoaxes that have made it impossible to reflect on the whole situation in a healthy way have shown this.

With regard to the focus and goal of the paper - the proposal of methods to increase self-efficacy - the personal characteristics of a person are a decisive factor for the formation of mental balance. Temperament traits play an important role, and in times of pandemics, besides the dimension of emotional lability - stability, the dimension of extraversion - introversion plays a significant role (cf. Švamberk Šauerová, 2020, Diener, 2009). Similarly, this experience (that temperamental personality characteristics have a greater influence on a person's satisfaction compared to objective life events) has been reported, e.g., by Costa et al., 1987; Suh et al., 1996.

Other important personal characteristics are conscientiousness, friendliness and openness to new experiences, of which the closest relationships exist between personal well-being, emotional stability and conscientiousness, followed by personal well-being, extraversion and friendliness, and finally, the weakest relationship exists between personal well-being and openness to new experiences (Blatný, 2010).

Other personality characteristics that have an impact on the experience of personal well-being include self-esteem (higher values are associated with a better experience of personal well-being) or J. B. Rotter's locus of control (internal locus of control is associated with a positive impact on well-being), resilience and resilience to discomfort. In building personal well-being, it is necessary to consider, in addition to the already mentioned concept of self-efficacy (A. Bandura), the concept of hardiness by S. Kobas or the concept of Sense of coherence by A. Antonovsky.

4.3 Techniques for promoting self-esteem and self-efficacy

Techniques for building healthy self-reflection, increasing self-efficacy and social and individual responsibility for each of us are an important part of salutoprotective resources for dealing with challenging life situations. In the following, we focus on describing techniques that can be used in wellness counselling for personal development of the client and for building mental balance.

4.3.1 Who am I, exactly?

An important condition for increasing self-efficacy is especially adequate knowledge of oneself. Very simply, the Personality Profile technique can be used for this analysis (e.g.

Švamberk Šauerová, 2018); we can also use unfinished sentences (e.g. I am a parent... my child... my partner.... When my employer orders.... When a colleague does a well-done task...). Questions should be answered with the first thought that comes to the person's mind, without thinking too long. When thinking about the answer, the result would be influenced by "control mechanisms", so we emphasize spontaneous response. As part of developing self-knowledge, it is then useful to read and reflect on the answers at some distance and think about what the type of answer triggered in us. Another technique that can be used for this is Self-Monitoring.

4.3.2 Self-Monitoring

Self-monitoring means that one keeps a record of one's own actions and experiences. The records are kept in the form of a diary; a self-reflective diary can be a similar technique. We can record anything - feelings, how social interactions went, how well we are doing in keeping to our work schedule, our own resolutions to change our lifestyle, what situations made us feel good, what makes us feel guilty or weak. Simple recording charts can also be used to self-monitor a particular phenomenon (here, life attitude change) - see Figure 1.

Figure 1 Record sheet

Date	Time	Place	Other people present	Activity/thought/situation	Reaction of the surroundings / My thoughts, feelings	The following events after the reaction of the surroundings, thoughts, feelings	Notes

4.3.3 Self-reflective diary

The self-reflective diary is in written form and can be very well used for the personal development of anyone. In it we write down our experiences, insights from the process of

our own personal development.

Self-reflective journals can serve us as a benchmark to monitor the effectiveness of our own self-efficacy enhancement.

Example

Figure 2 Example of the components of a content analysis of an evaluation

Components	Examples of questions
Rational	What I've accomplished? What I can do better? Where I have reserves?
Affective	What were my feelings about the activity? In what ways do I feel a change?
Psychosomatic	Do my feelings reflect into the somatic area? How do I breathe during the activity?
Evaluative/Assessing	How did the activity enrich me? Does it benefit me?

4.3.4 SWOT analyses

Related to personal development and increasing self-efficacy competencies as an important salutoprotective resource in the search for psychological balance is a technique commonly encountered in project management. This is a SWOT analysis, which is very useful for both promoting self-reflection and increasing self-efficacy (in the sense of I can do it, I will overcome it).

The four quadrants are the basis of the technique:

- Strengths (what we are good at)
- Reserves (what we could "improve")
- Opportunities - anything in our external environment that can help us - e.g. good social relationships with colleagues, friends, quality leisure activities, interesting work.
- Threats - anything that can harm us from the external environment - e.g. toxic environment at work, negative social events, poor social relationships, etc.

Fig. 3 SWOT analysis

Strengths	Reserves
Opportunities	Threats

Closely related to the SWOT analysis is the use of time-management techniques, which help to better organize time, divide time for work and rest activities and help to find time resources for activities contributing to mental health (see e.g. Švamberk Šauerová, 2018).

4.3.5 My achievements

The exercise leads to a natural acceptance of one's own success while strengthening the awareness of one's own self-efficacy, and builds appropriately on previous techniques (related to the attributional and cognitive styles already mentioned).

Plain paper and pencil will suffice. Let's try to list our achievements this week/month in 10

min. Let's try to write as many as possible. Next, we can try to write down the achievements we have made this year. Those who like graphically pleasing material can use the cards from the career diary - the Be creative cards.

After completing the list, it is possible to reflect on who else has contributed to our success, which achievement we are most happy about, and whether we have shared it with anyone. If someone else has participated in it, we can proceed to the technique of Sharing the Joy (more closely Švamberk Šauerová, 2018).

4.3.6 Self-strengthening

Self-strengthening is applied as a common type of strengthening, with the difference that

the person himself determines when and with what the strengthening occurs. This method is usually used in the early stages of behaviour change. We reward ourselves for behaving in a desirable way. Of course, it is necessary for everyone to find their own particular way of rewarding. Such a reinforcer can be really

anything (an interesting film, a small thing we buy, a sticker with a smile on the mirror, on the PC monitor or on the fridge). For adolescents, using a weekly motivational calendar may be a good way of self-empowering - see Figure 4.

Figure 4 Motivational planning calendar



(foto Švamberk Šauerová, calendar made by Albi)

For some, the aforementioned "journaling" may be a booster.

Another kind of reinforcer can be self-evaluation. Despite the fact that Czechs have a reserved attitude towards self-praise, experience shows that it is very often an effective tool for change.

Graphical representation of our partial achievements on the way to the goal also seems to be a very effective reinforcer. It is possible to use one's own creative potential to create a graphic.

4.3.7 Hardening as increasing resistance to discomfort

In addition to promoting self-efficacy awareness, the basic techniques to promote self-reflection include increasing resilience to discomfort, hardening to uncomfortable situations, and building confidence to achieve goals. Hardening can be addressed in family education, and is important not only on the physical level (cold, cold water, "pebble in the shoe", hunger, thirst), where we try to delay the satisfaction of the need briefly (with respect for the child's safety), but also on the psychological level (resistance to teasing in the group, etc.).

4.3.8 Visualisation of a pleasant stimulus

Visualisation is an important part of many psychological techniques and coaching. It is about creating a specific idea (image) regarding our behaviour. The best way to do this is to visualize the goal we want to achieve (imagine exactly what it will look like when we reach the goal).

We can also visualize a pleasant stimulus that will currently evoke something positive in us, conjure up a mental smile. This floods the whole body with positive energy, leading to the skill of coping much better with the surrounding stimuli. However, a positive mental attitude most often leads to the fact that even "unpleasant" circumstances tend to be perceived positively and unhappily.

In order to make the best use of the visualization technique, it is advisable to prepare a "reservoir" of positive situations and stimuli where we purposefully "reach" whenever we naturally feel unwell. We should have these ideas placed somewhere where we then draw from that place. The place where we hide them is entirely up to us, we just have to remember initially where to "reach" for the source of positive thinking.

5 CONCLUSIONS

To summarize our considerations, it can be stated that the basic characteristics of anyone who seeks to change their personal development, who is interested in increasing self-efficacy and who intends to increase their mental balance through the preventive choice of salutoprotective ways of behaviour, even in times of such an unusual and complex demanding life situation as the Covid 19 pandemic, are in particular: healthy self-reflection, adequate self-esteem, natural authority, adequate awareness of their own self-efficacy.

It is the consciousness of self-efficacy that can be considered a key salutoprotective factor in building mental well-being and the overall concept of bio-psycho-social balance in the current social situation. The possibilities of developing self-efficacy need careful attention, both at the level of various educational activities in the field of non-formal and informal education, but also at the level of guided educational projects at all levels of formal education.

It can be expected that promoting and developing everyone's awareness of their own self-efficacy will have a significant societal impact.

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POST COVID-19 OUTDOOR PHYSICAL INTERVENTION EFFECTS ON BODY COMPOSITION IN PERSONS WITH INTELLECTUAL DISABILITIES

Zuzana KORNATOVSKÁ, Matthew BOWES

Abstract

In 2021, the Global Wellness Institute demonstrates the growing interest of the entire population in improving of overall health and immune function through various outdoor physical activities. The objective of the study was to exam a potential of outdoor physical activities in relation to the Covid-19 lock down in a group of people with intellectual disability. Material and methods: 50 persons (26 males, 24 females) with mild (15 persons) and moderate (35 persons) intellectual disabilities, aged 18-45, from the Czech Republic, registered in Special Olympics International associations. All subjects were until the physical intervention in Covid-19 lock down regime, i.e. without any indoor or outdoor physical activities. Before the examinations, all participants and their legal representatives signed an informed consent. The Assessment of body composition measured (using Tanita Leicester, and tetrapolar multi-frequency bioelectrical impedance device InBody 230) was used to assess body weight, BMI, body fat percentage and total muscle mass. The 2 weeks outdoor physical intervention focused on fitness improvement was applied. The obtained data were subsequently processed anonymously with security in accordance with the applicable GDPR and Helsinki Declaration directives. During the intervention applied outdoor activities were performed only to the extent appropriate to the physical and mental potential of the participants. Relationships of dependent variables to the sex of the subjects, the experiment, and its individual phases were evaluated by a repeated measures ANOVA model. Results and Conclusions: The intervention led to the significant improvement of body composition, the participants decreased significantly in body fat percentage and increased significantly in muscle mass.

Keywords

Covid-19 pandemic; intellectual disability; outdoor physical activities; body composition.

1 INTRODUCTION

Disability is a physical or mental condition that limits a person's movements, senses, or activities at all. The term "disability" is becoming increasingly used in postmodern society along with the development of medicine that can treat very severe disorders of the human organism. The affected features can be compensated by intact functions. The English term "disability" has become an umbrella at international level in terms of functional disorders and activities. Since 2001 he has been operating the International Classification of Functioning, Disability and Health (ICF). This document defines the term "disability" as "a reduction in functional abilities at the individual or company level that arises when a person with his or her health condition encounters environmental barriers".

This definition corresponds with the view of experts (Smith, 2008; Marcus, Forsyth, 2008; Winnick, Porretta, 2020) who perceive people with disease or disability as a person whose problem arose on the basis of dynamic interaction between a person and environment.

The current trend of health and social care represents the civic model which emphasizes the active social participation of people with disabilities in society. It is necessary for the scientific and research activities of professionals from different professions to support this intention to ensure that disabled citizens are provided with the highest possible degree of autonomy, i.e. decision-making on their own destiny, so that they can participate as much as possible in the life of society. Of course, it is also necessary to gain the support of the general public in order to create conditions for

people with disabilities for as much autonomy as possible.

A very specific group at risk of diseases of civilization and risks of poor lifestyle are persons with intellectual disability. This is because, compared to people with physical disability, there are great sport limitations in the cognitive sphere, i.e. perception, memory, the right reactions in the environment, whether it is orientation in space or adequate decision-making with respect to the given situation (rules, environment, communication, safety during exercises).

In addition to physical health and physical compensation, outdoor physical activities bring mental compensation to persons with intellectual disabilities (Haywood, Getchel, 2018). Válková (2009) states that the American Association on Mental Retardation (AAMR) defines intellectual disability as a significant limitation of existing performance in a social context. According to the AAMR, 7 dimensions of adaptive behavior are declared. If a person fails in at least 3 of them, a person with reduced intellect can be considered:

- Intellectual functions
- Emotional and voluntary imbalances
- Adaptive behavior (failure in at least 3 areas out of 7): self-care, housework, health, safety, decision-making, leisure skills, communication.

It means that in present a multifunctional model of intellectual disability (otherwise called the "ecological model") according to the AAMR is increasingly emphasized. In this concept, intellectual disability is characterized by the interaction between the individual and the social environment (Kornatovská, Rehor, 2021).

Basic specifics of outdoor physical activities for persons with intellectual disability, the trainers are advised to observe some crucial didactic principles, i.e. adequate demonstration; context; maintaining motivation. It is recommended to create the right basic outdoor stereotypes (walking, running, manipulation, etc.); to improve movement control; to improve balance; to increase running, swimming, etc. In addition, persons with intellectual disabilities submit information in such a way as to involve as many senses as possible. Using various didactic aids

to concretize abstract expressions. Great verbalization can be confusing for a person with intellectual disability (Krejčí, Kornatovská, 2017).

Balemans, Bolster (2019) declare that a physically fit and active lifestyle has merit for each individual with intellectual disability, but reduced fitness in combination with higher energy demands during walking results in a high physical strain of walking and consequently a low metabolic reserve. This can cause fatigue during walking and limited walking ability, which are among the most reported complaints in this group. Monitoring, and improving of outdoor activities is therefore essential in rehabilitation of youth with intellectual disability in order to develop a proper fitness status, to participate in outdoor physical activity with peers, and to prevent a health in aging.

The principle of proportionality is particularly important in view of the degree and type of disability. An important element is a game, which allows better attention retention. In the context of open learning opportunities in nature (walking, hiking, elements of experiential education in nature) in people with intellectual disability outdoor activities as athletics, walking, yoga, aquatic activities based on the active experience of movement learning. They are easy-to-implement yet accessible physical activities with a fast and effective effect of integration and inclusion (Whatley, Waelde, Harmon, 2018; Maheshwarananda, 2005). Nature-based programs may be of benefit and support to the health of cancer survivors. These positive health effects were reported for a wide range of program activities, including gardening programs, therapeutic landscapes, dragon boat racing and other outdoor programs. The majority of nature-based programs that specifically address the needs of childhood and AYA cancer survivors can be categorized under the umbrella term of adventure programs (Jong, Mulder, Kristoffersen, Stub, Dahlqvist, Viitasara, Lown, Schats, & Jong, 2022).

According (Krejčí, Vacek, 2021) Covid-19 pandemic represents an exceptional experience in the whole world and still is going through touched everybody. Never before has health and wellness declined so fast. Covid-19 pandemic nor only affected physical health, but

also cause unprecedented levels of stress. Uncertainty, forever lasting and constantly changing restrictions became unmanageable for many people. Already published studies on levels and forms of stress related to depression and mental illness indicate that numbers of individuals suffering from the disease increased by 50- 60% in all age categories. The proactive approach which focuses on a more holistic approach is not widely actively promoted or practiced, even when it is generally accepted that prevention of disease on principles of wellness is the only way to prevent the increasing problems healthcare systems are facing.

The basic dimensions that are regularly monitored are body height and body weight (Gawlik, Zwierchowska, Celebanska, 2018). Persons with intellectual disabilities generally go through the same developmental stages as the intact population, but in some periods the development of psychomotor competences is more limited. A general problem at the time of the Covid-19 pandemic may be hypokinesia, artificially induced by daily sitting - at home, spending time with IT technologies, etc. This brings health problems and complications related to body composition, excess weight, faulty posture (Gao, Wang, Piernas, Astbury, Jebb, Holmes, 2022; Kornatovská, Rehor, 2021).

2 OBJECTIVE

The objective of the study was to exam a potential of outdoor physical activities in relation to the Covid-19 lock down in a group of people with intellectual disability.

Based on the objective of the study the Hypothesis is declared: The applied 2-week outdoor intervention leads to the significant improvement of muscle mass in the participated subjects with intellectual disability.

3 METHODS

3.1 Material and procedure

The sample of subjects was conducted from 50 participants (age interval 18-45, age overage 35.6 years), 26 males (age interval 18-45, age overage 39.6 years) and 24 females (age interval 18-45, age overage

33.1 years). The monitored subjects were selected from persons with mild and moderate intellectual disabilities, aged 18+, from the Czech Republic, registered in Special Olympics International associations. All participated subjects until the applied outdoor physical intervention were staying in one year Covid-19 lock down regime, i.e. without any indoor or outdoor physical activities. Before the examinations, all participants and their legal representatives signed an informed consent. The 2 weeks outdoor physical intervention focused on fitness improvement was applied in subjects. The research procedure and intervention was carried out in a mountain sports complex in the Czech Republic in the form of a sport camp focused on outdoor training and experienced education. This means that all monitored subjects lived in one place during the intervention, under the same conditions (accommodation, diet, training time, sleep time, free time). The same intervention was carried out in 4 parallel groups of the participants with intellectual disability, in each group under the leadership of 1 head coach, 2 assistant coaches and 2 other assistants, who helped with organization and help as needed. The obtained data were subsequently processed anonymously with security in accordance with the applicable GDPR and Helsinki Declaration directives. During the intervention applied outdoor activities were performed only to the extent appropriate to the physical and mental potential of the participants.

3.2 Diagnostics

Body height

Body height was measured using the Tanita Leicester Height Measure device with an accuracy of 0.1 cm.

Body composition

A tetrapolar multi-frequency bioelectrical impedance device InBody 230 was used to gain basic body characteristics such as body weight, body fat percentage, and total muscle mass.

3.3 Intervention

During the 2 weeks intervention, every day, 3-phase outdoor training was applied, i.e. early morning training in nature before breakfast

consisting of cross-country running and various types of warm-up in a natural environment on a mountain meadow with views of the mountain panorama. Breakfast was followed by a morning outdoor training session of 3 hours focused on outdoor athletics. Lunch was followed by a 2-hour rest in the room. This was followed by 3rd phase of outdoor training connected with a walk along a tourist route, enriched with experiential games in nature, orientation in nature and overcoming of natural obstacles. After dinner, there was a personal free time with the possibility of voluntary dance or yoga activities or only rest in nature. From 10 p.m., peace and sleep followed. All activities were applied with respect for individual characteristics and potential in a joyful atmosphere. Motor learning was conducted professionally using the appropriate methods of demonstration, motivation, play, fixation and feedback, mostly in a complex procedure.

3.4 Statistics

Relationships of dependent variables to the sex of the subjects, the experiment, and its individual phases were evaluated by a repeated measures ANOVA model.

4 RESULTS AND DISCUSSION

Body weight

Before the intervention, the average body weight of men was 83.3 (83.2, 83.4) and the average body weight of women was 73.1 (70.1, 79.4). The analysis shows that before the intervention the body weight of the monitored men was 10.2 kg higher. After the intervention, the average body weight of men was 82.3 (82.2, 82.4) and the average body weight of women was 72.9 (69.9, 78.7). After the intervention the body weight of the monitored men was 10.1 kg higher. A decrease in body weight was therefore detected in both sexes, in men and in women after the two-week applied intervention, but the analyzed decreases were not statistically significant, i.e. $p < 0.232$ in males; $p < 0.258$ in females (Table 1, Table2).

BMI

Statistical analysis of BMI proved also no significant changes between PRE/POST measurements in monitored males and females subjects with intellectual disability.

Figure 1 Body composition measures in the pre- and post-intervention in men (n=26)

Measure	Pre	Post	p
Body weight (kg)	83.3 (83.2, 83.4)	82.3 (82.2, 82.4)	.232
BMI (kg/m ²)	27.7 (27.5, 27.9)	27.7 (27.6, 27.7)	.384
Fat (%)	26.7 (26.3, 27.5)	25.2 (25.0, 25.5)	<.001
Muscle mass (kg)	30.5 (30.3, 30.6)	31.5 (30.9, 31.9)	<.001

Figure 2 Body composition measures in the pre- and post-intervention in women (n=24)

Measure	Pre	Post	p
Body weight (kg)	73.1 (70.1, 79.4)	72.9 (69.9, 78.7)	.258
BMI (kg/m ²)	25.6 (25.5, 27.9)	25.4 (25.3, 27.7)	.484
Fat (%)	36.7 (36.1, 38.5)	35.3 (34.7, 36.9)	<.001
Muscle mass (kg)	22.5 (20.8, 23.6)	23.4 (21.2, 23.9)	<.001

Before the intervention, the average BMI of men was 27.7 (27.5, 27.9) and the average

BMI of women was 25.6 (25.5, 27.9). The analysis shows that before the intervention

the BMI of the monitored men was only 2.1 point higher compared to monitored women. After the intervention, the average BMI of men was 27.7 (27.6, 27.7) and the average body weight of women was 25.4 (25.3, 27.7). After the intervention the BMI of the monitored men was 2.3 point higher. A decrease of BMI was detected in female group, after the two-week applied intervention, but the analyzed decrease was not statistically significant ($p < 0.484$, Table 1, Table2).

Fat

Before the intervention, the average fat percentage of men was 26.7 (26.3, 27.5) and the average fat percentage of women was 36.7 (36.1, 38.5). The analysis shows that before the intervention the fat percentage of the monitored women was 10% higher compared to the monitored men. After the intervention, the average fat percentage of women was 82.3 (82.2, 82.4) and the average fat percentage of men was 72.9 (69.9, 78.7). After the intervention the fat percentage of the monitored men was 10.1% higher compared to the monitored women. Significant decreasing of the fat percentage was detected in both sexes, in men and in women after the two-week applied intervention, i.e. $p < 0.001$ in males; $p < 0.001$ in females (Table 1, Table2).

Muscle mass

Before the intervention, the average muscle mass of men was 30.5 kg (30.3, 30.6) and the average muscle mass of women was 22.5 kg (20.8, 23.6). The analysis shows that before the intervention the muscle mass of the monitored men was 8 kg higher. After the intervention, the average muscle mass of men was 31.5 (30.9, 31.9) and the average muscle mass of women was 23.4 kg (21.2, 23.9). After the intervention the muscle mass of the monitored men was 7.5 kg higher. Positive significant increasing of the muscle mass was detected in both sexes, in men and in women after the two-week applied intervention, i.e. $p < 0.001$ in males; $p < 0.001$ in females (Table 1, Table2). Based of the analysis, we can state that the hypothesis "The applied 2-week outdoor intervention leads to the significant improvement of muscle mass in the participated subjects with intellectual disability" was verified.

We can discuss in accordance with the interpretations of Benson and Connelly (2020)

the beneficial and positive effect of the outdoor intervention programs on subjects in terms of functional development of body composition and body integration. It seems that the training of outdoor activities, as well as the training of balance, relaxation and breathing exercises in outdoor environment is significant. As confirmed by Korczak, Zwierchowska, (2020), regular controlled physical activities can only be recommended for the persons with intellectual disability, even using mobile applications. We believe that, based on the positive results of the study, we can make recommendations for outdoor intervention program based on experiential education in nature, as a prevention of health complications connected with Covid-19 pandemic (e.g. increased and rapid fatigue, allergic symptoms, asthma, etc.). According to that, it can be argued that men with intellectual disability can respond positively to outdoor exercise intervention, including reducing body fat and increasing muscle mass, thanks to testosterone. However, it is also necessary to discuss the increase in muscle mass and fat loss in women 65+. The authors (Grigoletto, Mauro, Oppio, Greco, Fischetti, Cataldi, et al, 2022; Hoey, Staines, Walsh, et al, 2017) state, that intensive course of outdoor activities may affect the use of protein throughout the body in healthy older women. Participants after the outdoor intervention had lower body fat and higher muscle mass than those who did not practice outdoor activities. Moreover, they also tended to have a better balance. Importantly, practicing outdoor activities systematically, can improve protein utilisation and lead to the maintenance of muscle mass in females even later in life, when muscle loss is common.

5 CONCLUSIONS

Significant positive improvement with important body integration, including fat decreasing and muscle mass increasing, points to the high importance of outdoor activity intervention, which may represent significant part of controlled physical activities for persons with intellectual disability. The findings of the study are new and provide a basis for future research intervention to promote rehabilitation and physical therapy in persons with intellectual disability. We recommend to bring persons with intellectual

disability to outdoor movement skills and to facilitate them to a joyful interest in movement learning in nature. The study results may be useful for specialists of physical therapy, rehabilitation and applied physical activities.

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PREVALENCE OF FRAILTY SYNDROME AND ITS PREDICTORS IN THE POPULATION OF PEOPLE WITH INTELLECTUAL DISABILITY COMPARED TO THE GENERAL POPULATION: A SYSTEMATIC REVIEW

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Barbara ROSOŁEK, Anna ZWIERZCHOWSKA

Abstract

The aim of the systematic review was to evaluate the prevalence of the frailty syndrome (FS) and to identify its predictors in people with intellectual (ID) and developmental (DD) disabilities. It was assumed that in people with ID in adulthood period and early elderly period (20-60 years old) the ageing process (lower mobility in joints, frequent falls, the incidence of the coexist diseases and disability) occurs earlier and more frequent than in general population. The methodology of this systematic review was planned according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A search of electronic databases (PubMed, EBSCO, MEDLINE) was conducted to identify all studies on the incidence of the FS in people with intellectual disabilities from 2010 to 2022 based on the physical and functional status. In contrary to the general population, the assessment of the prevalence of FS among people with ID and DD was performed mostly with multivariant model. Age, gender, coexist diseases, mobility impairment in everyday life activities and Down syndrome were identified as the most frequent predictors of FS among the studied populations. In conclusion, the prevalence of FS among people with ID was diverse (9-27%) and included the following variables: coexisting diseases, coupled disability, intelligence quotient, everyday life activities, dwelling place. Moreover FS was found to occur significantly earlier (from 10 to 25 years) than in general population. Future studies should include the assessment of FS based on both phenotype and multivariant models.

Keywords

Aging; elderly; older adults; frailty.

1 INTRODUCTION

The number of older adults is growing worldwide. The increase in the size of this social group leads to a higher prevalence of geriatric conditions in the population. One of the syndromes characteristic of older adulthood is frailty syndrome (FS) (Mendiratta, Latif, 2021). The word frailty comes from the French word *frêle*, which means: fragile, weak, or delicate (Diaz et al., 2015). The term FS is usually considered a syndrome of weakness, frailty, or depletion of reserves. It is " a multidimensional syndrome of loss of homeostatic reserve (energy, physical, and mental abilities) that promotes the accumulation of deficits, increasing the patient's vulnerability and risk of adverse medical consequences "

(Clegg et al., 2013; Rajabali, Rolfson, Bagshaw, 2016). It is often associated with age. However, the functional status of a person depends primarily on the physiological resources of the body.

FS is a multidimensional geriatric syndrome associated with many adverse consequences including falls (impaired mobility and self-control), the need for care and support for activities of daily living, and higher mortality. The condition also places a significant burden on the health care system (Clegg et al., 2013). Etiological factors of FS include social (poverty, loneliness, low education level) and psychological (depression) determinants, nutrition (malnutrition), polypragmasia, other diseases and their complications (cancer,

endocrine disorders, dementia), and low physical activity (Di Ciaula, Portincasa, 2020; Mendiratta, Latif, 2021). FS is a condition that can be stopped and reversed (Morley et al., 2013).

FS is not an inevitable part of the aging process and does not apply only to older adults, i.e. those over 60 years of age. It also affects younger patients with chronic diseases and cognitive dysfunctions (Bagshaw et al., 2014; Wleklík et al. 2020). A study by Goldfarb, Sheppard, Afilalo (2015) indicated that one in ten older adults develops FS symptoms. In Europe, an estimated 17% of older adults suffer from FS, while its prevalence increases with age, especially among women (Oresanya, Lyons, Finlayson, 2014).

The available scientific literature points to various methods of assessing FS, which focus on two frailty models: one-dimensional (phenotypic) and multidimensional (Pilotto et al., 2020). The phenotypic model identifies frailty based on the presence of at least three of five symptoms: (1) *unintentional weight loss*, (2) *exhaustion*, (3) *low level of physical activity*, (4) *slow walking speed*, and (5) *muscle weakness* (Fried et al., 2001). The multidimensional model assesses frailty based on functional, sensory, and clinical deficits (Pilotto et al., 2020; Rockwood, Mitnitski, 2007). Both cross-sectional observations and longitudinal studies have been used to search for the gold standard for estimating FS regardless of the assessment model. According to Ding, Kuha, Murphy (2017), the longitudinal study design is effective for identifying factors that predict the occurrence of FS. Among other things, the following factors to be predictive of FS include: (1) *chronic disease*, (2) *elevated blood pressure*, (3) *elevated inflammatory markers*, (4) *abnormal blood parameters identifying risk for cardiometabolic diseases*, (5) *unfavorable changes in body physique and composition characteristics (anthropometric measurements)*, (6) *physical activity below levels recommended for the patient's age*, (7) *cognitive and/or depressive disorders*, and (8) *poor social support and polypragmasia* (Ding et al., 2017; Veronese et al., 2017; Wleklík et al., 2020).

In this context, attention should be paid to people with disabilities, especially intellectual

disabilities (ID). Like that of the general population, their life expectancy is extending, and their health problems associated with aging are comparable. It has also been shown that people with ID over the age of 50 had similar symptoms to those of frailty syndrome in older adults over the age of 75 in the general population (Schoufour et al., 2013). Furthermore, studies involving people with ID have indicated that FS symptoms tend to occur earlier and are more severe than in people in the general population, which is associated with earlier mortality (Evenhuis et al., 2012; Schoufour, Echteld, Evenhuis, 2015b).

At the same time, scientific studies conducted on both younger and older populations of adults with ID have demonstrated that these groups are characterized by reduced daily physical activity and reduced body mobility (Celebańska, Gawlik 2013; Chow, Choi, Huang, 2018; Gawlik, Zwierzchowska, Celebańska, 2018; Gawlik et al., 2016; Hsieh et al., 2017). This group also showed a higher prevalence of abnormal blood parameters and body composition components, which are factors for identifying the risk of cardiometabolic diseases (Gawlik et al., 2018; Zwierzchowska et al., 2021). Undoubtedly, this is a reason for the use of prevention in the form of increasing and long-term use of pharmaceuticals, which have therapeutic and supportive effects but long-term selective use can lead to damage in other organs and body systems and also the acceleration of involuntal changes (Brehmer, Weber, 2010; Schoufour et al., 2015b).

Previous one-dimensional (phenotypic) and multivariate studies conducted on individuals with ID confirm that Down syndrome, comorbid dementia trait syndrome, profound ID (IQ \leq 35), age, and motor disabilities are significantly associated with FS (Evenhuis et al., 2012; Evenhuis, Schoufour, Echteld, 2013; Schoufour et al., 2013).

However, identifying FS in people with ID is much more difficult since intellectual disability has a constitutional origin, which consequently always leads to morphofunctional disorders of varying severity with coexisting physical pathologies and lifestyles. At the same time, studying populations with ID using the longitudinal design is not only hampered by

the duration of the research process but also has limitations that stem from ID itself. The internal compensatory mechanisms that take place are individually differentiated due to the morphofunctional characteristics and pathologies of the patients, which significantly limits the identification of symptoms and estimation of the FS scale.

The past decade has seen a significant increase in the interest of researchers in identifying factors for FS in people with ID. Although many hypotheses have been proposed to date, the problem still has not been fully clarified. Given these scientific reports, there is a need for deeper analyses explaining FS and its predictors in the group of people with intellectual disabilities, which will allow the implementation of preventive measures against the occurrence of FS in this group.

2 THE AIM OF STUDY

The aim of this study was to assess the prevalence and identify predictors of FS in a group of people with intellectual and/or developmental disabilities based on a systematic review. It was assumed that in the group of people with ID in adulthood and early older adulthood (20-60 years), the aging processes, manifested by reduced mobility, more frequent falls, comorbidities, and disabilities are more likely to occur at a younger age than in the general adult population.

3 METHODS

Study design

The methodology of this systematic review was planned according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (equator-network.org).

Inclusion and exclusion criteria

In this systematic review, inclusion criteria were (a) cross-sectional study, (b) people with intellectual and/or developmental disabilities ≤ 18 years old, (c) males and/or females, (d) cross-sectional study and/or cohort study, and/or longitudinal study. The exclusion

criteria were as follows: (a) no data on the prevalence of FS, (b) no data on the method used for identification of FS, (c) poor methodological design, and (d) full-text not in English.

Literature search

A search in electronic databases (PubMed, EBSCO, MEDLINE) was conducted by three authors (DC, EG, BR) to identify all studies on the prevalence of frailty syndrome in people with intellectual disabilities from 2010 to 2022. The following methods were used: (a) data mining, and (b) data discovery and classification. As a prerequisite, all studies were performed on populations of people with disabilities including both adults and adolescents. Search terms were combined by Boolean logic (AND/OR) in PubMed, EBSCO and MEDLINE databases.

The search was undertaken using two keyword combinations in English with the assumed hierarchy of their importance: 'frailty syndrome', and 'intellectual disability'. Furthermore, three authors (DC, EG, BR) with expertise in people with intellectual disabilities and frailty syndrome reviewed the reference lists of the included studies and screened Google Scholar to find additional studies. The corresponding authors of the selected publications were also contacted directly if the crucial data were not available in the original articles.

Methodological Quality of Included Studies (Risk of bias)

The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for the analytical cross-sectional study was used to assess the methodological quality of the included studies (Ma et al., 2020). The JBI is known as the newest and the most preferred tool for assessing the methodological quality (risk of bias) of analytical cross-sectional studies [24]. The checklist consists of 8 questions (see Table 1). Each study was read and scored 'Yes', 'No', 'Unsure', or 'Not applicable'. If the criterion was fulfilled, a 'Yes' was assigned to the article, which simultaneously received a score of one, whereas if the criterion was not

fulfilled, a 'No', 'Unclear', or 'Not applicable' was assigned to the article, and the article received a zero score. Each study was read and ranked by three independent investigators (DC, EG, BR). Furthermore, an independent co-author (AZ) was designated to resolve all discrepancies that could occur among investigators during the assessment. The sum of the awarded points (out of a possible 8 points) indicated the methodological quality (risk of

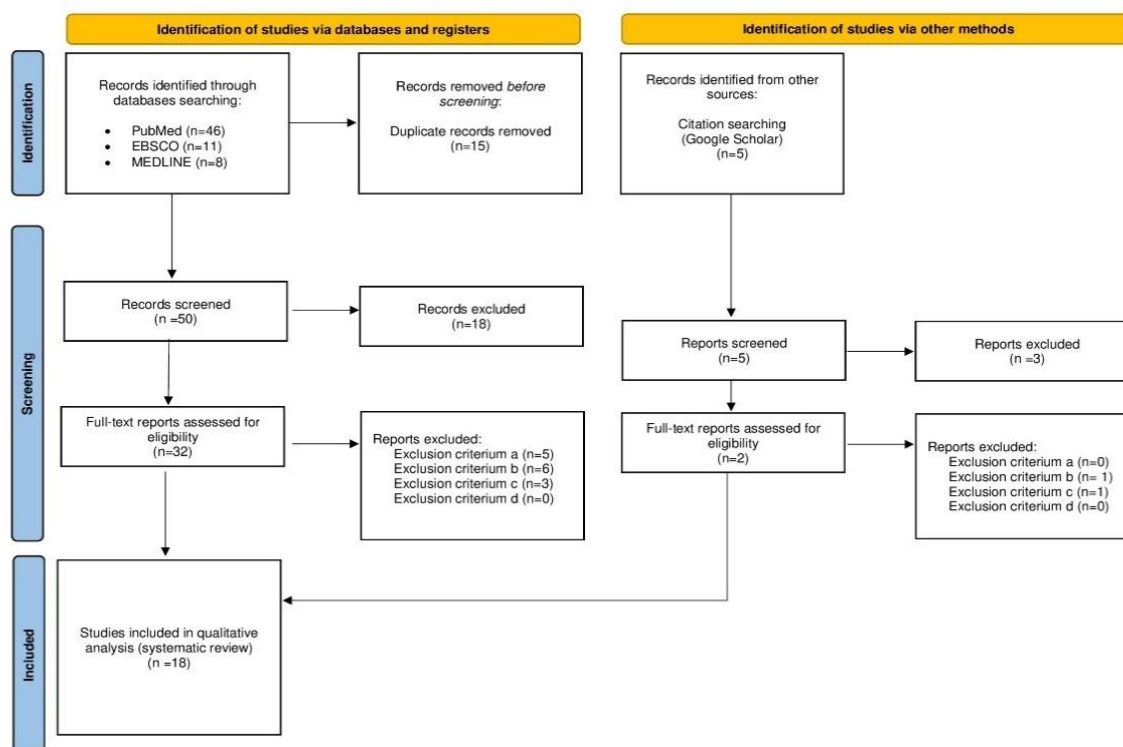
bias), with the higher values representing better quality in the included publications.

4 RESULTS

Study selection and characteristics

The flow of the systematic review is presented in Figure 1.

Figure 1. PRISMA flow diagram detailing the study inclusion process (equator-network.org).



Thirty-two full-text articles were assessed to determine eligibility, while eighteen studies met the inclusion criteria and were subjected to detailed analysis and assessment of their methodological quality (see Table 1).

Over three-fourths of the reports that were assessed for their methodological quality were considered to have 8/8 points of eligibility to be included in the systematic review. Two publications (Brehmer et al.,

2010, Brehmer-Rinderer et al., 2013) were considered to have 7/8 points of eligibility. The initial agreement of the three independent investigators (DC, EG, BR) was 90%. All discrepancies among the investigators were resolved by the expert evaluation by an independent co-author (AZ).

Eighteen full-text articles were finally included in the systematic review (see Tab. 2-3).

Table 1 The assessment of the methodological quality of the included studies (risk of bias) using the JBI method for analytical cross-sectional study and cohort study.

No.	Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Sum
1.	Brehmer, Weber (2010)	Y	Y	Y	U	Y	Y	Y	Y	7/8
2.	Evenhuis et al. (2012)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
3.	Brehmer-Rinderer et al. (2013)	Y	Y	Y	U	Y	Y	Y	Y	7/8
4.	Schoufour et al. (2013)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
5.	Evenhuis (2014)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
6.	Schoufour et al. (2014)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
7.	Schoufour et al. (2015a)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
8.	Schoufour et al. (2015b)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
9.	Schoufour et al. (2015c)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
10.	McKenzie, Ouellette-Kuntz, Martin (2015)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
11.	Schoufour et al. (2016)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
12.	Schoufour, Ehteld, Evenhuis (2017)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
13.	Martin, McKenzie, Ouellette-Kuntz (2018)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
14.	Ouellette-Kuntz, Martin, McKenzie (2018)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
15.	Lee, Ouellette-Kuntz, Martin (2019)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
16.	O'Connell et al. (2020)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
17.	Schoufour et al. (2022)	Y	Y	Y	Y	Y	Y	Y	Y	8/8
18.	Lin, Tseng (2022)	Y	Y	Y	Y	Y	Y	Y	Y	8/8

Q1- Were the criteria for inclusion in the sample clearly defined?; Q2- Were the study subjects and the setting described in detail?;Q3- Was the exposure measured in a valid and reliable way?; Q4- Were objective, standard criteria used for measurement of the condition?;Q5- Were confounding factors identified?;Q6- Were strategies to deal with confounding factors stated?;Q7- Were the outcomes measured in a valid and reliable way?;Q8- Was appropriate statistical analysis used?; Y=yes; N-No; U-unsure; NA-not applicable

Table 2 The summary of the studies from 2010 to 2022 evaluating the prevalence of FS among people with intellectual disabilities

Author	Study group	The prevalence of FS (one-dimensional model)	FS characteristics (multi-dimensional model)
Brehmer, Weber (2010)	nP=190/ age;18-76/ ID; IQ (from 69 to <25)	Not applicable	FS = 27% (>50 years old) FS = 9% (two criteria) PFO = 12%
Evenhuis et al. (2012)	nP= 848/ age; >50/ ID; IQ (from 69 to <25)	FS= 13% (50-64 years old) FS =18% (>65 years old) FS =21% (>70 years old) PFO = 60%	Not applicable
Brehmer-Rinderer et al. (2013)	nP = 147/ age; 20-72/ ID; IQ (from 69 to <25)	Not applicable	FS= 17.7% PFO= 17.7%
Schoufour et al. (2013)	nP= 1050/ age; >50/ ID; IQ (from 69 to <25)	Not applicable	FI: 0.27±0.13
Evenhuis (2014)	nP = 1050/ age;50-94/ ID; IQ (from 69 to <25)	Not applicable	Not applicable
Schoufour et al. (2014)	nP=703/ age; 50>80/ ID; IQ (from 69 to <25)	Not applicable	FI=0.27 FI= 0.26 (3 years later) FI=0.32 (CG)
Schoufour et al. (2015a)	nP=632/ age;50>80 ID; IQ (from 69 to <25)	Not applicable	FI=0.27±0.13

Schoufour et al. (2015b)	nP=982 age;50>90/ ID; IQ (from 69 to <25)	Not applicable	FI=0.27±0.13
Schoufour et al. (2015c)	nP=982/ age; 50-93/ ID; IQ (from 69 to <25)	Not applicable	FI= ≥ 0.30 FS=38.5% PFO= 28.4%
McKenzie et al. (2015)	nP=7863 (participants with developmental disabilities)/ age; 18-99	Not applicable	FI =0.22±0,13 FS= 26.9% PFO = 21.3%
Schoufour et al. (2016)	nP=757/ age; >50/ ID; IQ (from 70 to <25)	Not applicable	FI=0.28±0.12
Schoufour et al. (2017)	nP=818/ age; >50/ ID; IQ (from 70 to <25)	FS= 13.3% PFO=59.7%	FI=(0.22±0.13) FS=25.2% PFO=38.8%
Martin et al. (2018)	nP=2893/(participants with developmental disabilities)/ age;18-99/ ID; IQ (from 70 to <25)	Not applicable	FS= 16.8% PFO =16.2%
Ouellette-Kuntz et al. (2018)	nP=5074 /(participants with developmental disabilities)/ age; 18-99	Not applicable	FI= 0.17±0.12
Lee et al. (2019)	nP=170/(participants with developmental disabilities)/ age; 19.8-86.4	Not applicable	FI=0-0,58 (The scores were derived only from these 13 items questionnaire)
O'Connell et al. (2020)	nP=570/ age; 44-60+/ ID; IQ (from 70 to <25)	FS=18.1% PFO=64.0%	Not applicable

Schoufour et al. (2022)	nP=982/ age; >50/ ID; IQ (from 69 to <25)	Not applicable	FS= 29.4% PFO=41.7%
Lin, Tseng (2022)	nP=85/ age; 40+ ID; IQ (from 69 to <25)	Not applicable	FS=23.5% FS=20.0% (9 months later) PFO=68.3% PFO=70.6% (9 months later)

nP – number of participants; *FS* – frailty syndrome; *PFO* – possible frailty onset, prefrail; *FI* - frailty Index *CG* – control group

Table 3 The summary of the studies from 2010 to 2022 evaluating the predictors of FS among people with intellectual disabilities based on the physical and functional status

Author	Research model & tool		Identified FS predictors	FS: the main findings	
	Phenotype model	Multivariant model		Phenotype model	Multivariant model
Brehmer, Weber (2010)	Not applicable	Vienna Frailty Questionnaire for Persons with ID	↑ pharmaceuticals intake, memory difficulties, nervous and/or anxiety behavior and/or anxiety, fear of failing ↓ general health status, muscular strength, joint mobility ↓ cognitive abilities, vision, disturbances in social relationships	Not applicable	No statistical significance between genders, FS and ID.
Evenhuis et al. (2012)	Physical activity (pedometer), conditional tests (grip strength - Jamar hand grip dynamometer, comfortable walking speed, poor endurance or exhaustion - "lacks energy" on the Anxiety, Depression and Mood Scale.	Psychiatric assessment of depression and IQ	↑ age, mobility impairment, Down syndrome, dementia, ID	FS correlated with dementia and physical disability	The high prevalence of frailty and motor disabilities in the group aged 50 to 64 suggests frailty before age 50.
Brehmer-Rinderer et al. (2013)	Not applicable	Vienna Frailty Questionnaire for Persons with ID (VFQ-ID)	↑ mobility impairment in activities of daily living	Not applicable	All four frailty domains (social, physical, psychological, and cognitive) of the VFQ-ID were a reliable measure of frailty and age-related changes in persons with ID.

Schoufour et al. (2013)	Not applicable	FI Questionnaire	↑ age, ID level, Down syndrome, residence in nursing homes	Not applicable	Older adults with ID aged 50 years and over already accumulate as many deficits as older adults without ID aged 70 and above (early aging).
Evenhuis (2014)	laboratory tests, pedometer, conditional tests, dynamometer	FI Questionnaire, nutrition assessment, psychological assessment (questionnaire) psychiatric interview, observation, sleep assessment,	↑ polypragmasia, ID level, Down syndrome, ↓ mobility impairment in activities of daily living, independence	↑ depression ↑ sleep disorders ↑ cardiovascular diseases (can lead to early weakness)	The correlation between ID and FS was ($r=0.94 \pm p < 0.001$)
Schoufour et al. (2014)	laboratory tests pedometer, conditional tests, observation,	FI Questionnaire, nutrition questionnaire, psychiatric questionnaire and interview, life quality questionnaire, IQ test, medical data assessment,	↑ mobility impairment in activities of daily living, ↓ joint mobility	FS was associated with physical disability and mortality.	In 84%, FI was not observed at the end of the study. FI at the beginning of the study correlated with the risk of deterioration and/or death (RR 1, 24, 95% CI 1.04-1.49).
Schoufour et al. (2015a)	Not applicable	FI Questionnaire	↑ pharmaceuticals intake, comorbidities	Not applicable	Frailty is related to decreased health status. Frailty has serious consequences in older adults with ID (mortality, increased care intensity, deterioration in independence and mobility).
Schoufour et al. (2015b)	Not applicable	FI Questionnaire	↑ mobility impairment in activities of daily living, pharmaceuticals intake, health care ↓ joint mobility -mortality	Not applicable	People with ID became weaker earlier than those in the general population.
Schoufour et al. (2015c)	Not applicable	FI Questionnaire	↑ age, ID level, Down syndrome, mobility impairment in activities of daily living, comorbidities	Not applicable	In 37.6% of participants, an improvement or deterioration of FI was observed. ID and comorbidities were the main predictors of changes of the FI.

McKenzie et al. (2015)	Not applicable	Resident Assessment Instrument – Home Care	↑ age, impairment, comorbidities	Not applicable	Premature aging has frequently been reported in adults with intellectual disabilities and Down syndrome.
Schoufour et al. (2016)	Not applicable	FI Questionnaire Blood samples tests	↑ age, ID level, residence in nursing homes, Alzheimer's disease, numbness, inflammation of the IL-6 and CRP, anemia, metabolic markers (glucose, cholesterol, albumin), and renal function	Not applicable	Frailty is associated with the current inflammation and nutritional status. Biochemical measurements can allow for the early identification of weak individuals with ID.
Schoufour et al. (2017)	physical activity (pedometer), laboratory tests (hand grip tester), conditional tests, exhaustion (the Anxiety, Depression, and Mood Scale)	FI Questionnaire, FP assessment, nutrition questionnaire, psychiatric questionnaire, health questionnaire	↑ bad health status, mostly females, loneliness, residence in nursing homes	Those who were weakened and frail were more likely to die, by 2.04 and 4.20 times, respectively.	Those who were weakened and frail were more likely to die, by 2.27 and 10.3 times, respectively.
Martin et al. (2018)	Not applicable	FI Questionnaire	↑ age, comorbidities, Down syndrome, mostly females, residence in nursing homes	Not applicable	Being pre-frail at baseline was associated with an increase in the risk of worsening or death (RR 1.24, 95% CI 1.04–1.49).
Ouellette-Kuntz et al. (2018)	Not applicable	Resident Assessment Instrument for Home Care	↑ age, Down syndrome, mostly females, residence in nursing homes, mobility impairment in activities of daily living, independence	Not applicable	Frailty should be monitored from the age of 40 years, those with Down syndrome, and those who live in group homes.
Lee et al. (2019)	Not applicable	The Home Care-IDD FI	↑ age, developmental disability level, residential conditions, hospitalization, comorbidities	Not applicable	Frailty predicts adverse outcomes and is more prevalent among adults with ID and IDD. Client charts should capture key information needed to measure frailty as knowledge of frailty status could improve care planning and facilitate personalized care.

O'Connell et al. (2020)	Modified Fried's Frailty Phenotype	Intellectual Disability Supplement to the Irish Longitudinal Study on Ageing (IDS-TILDA);	↑ age, ID level, residence in nursing homes, polypharmacy	Alzheimer's disease or dementia was found to be statistically significantly associated with frailty status	We identified an association between excessive polypharmacy and frailty status.
Schoufour et al. (2022)	Not applicable	ID-FI Short Form FI-Questionnaire	Not applicable	Not applicable	A good agreement between the full and short forms in dividing the participants into the frailty categories.
Lin, Tseng 2022	Not applicable	FI variables, Barthel rate, number of falls and hospitalizations, types of comorbidities	↑ ID level, comorbidities, mobility impairment in activities of daily living	Not applicable	Pre-frail condition is more commonly detected than frail condition in pre-maturely aging adults with ID. Adults with pre-frail or frail conditions possibly experience change over a short-term period and are associated with comorbidities and disabilities

FS – frailty syndrome; FI - Frailty Index; IDD - intellectual disabilities and Down syndrome; ↑ - increase; ↓ - decrease

5 DISCUSSIONS

Frailty syndrome has been an object of interest to researchers for many years, especially in terms of finding ways to identify this condition and estimating the strength and direction of change (Clegg et al., 2013; Di Ciaula, Portincasa, 2020; Mendiratta, Latif, 2021; Morley et al., 2013). Recent cohort, prospective, and longitudinal studies of the non-disabled population in middle and late adulthood have indicated several important predictors that identify frailty syndrome (Fried et al., 2001; Searle et al., 2008). Our study confirmed these predictors, especially with regard to the age of the subjects, comorbidities, and/or physical disabilities (Evenhuis et al., 2012; McKenzie et al., 2015; O'Connell et al., 2020; Schoufour et al., 2013; Schoufour et al., 2015a; Schoufour et al., 2015b). However, for people with ID, the predictive variable of age is indicated by most authors as a factor that manifests itself significantly earlier in explaining FS (Evenhuis et al., 2012; Schoufour et al., 2015a; Schoufour et al., 2015b).

In studies of the general population, according to the criteria of the Cardiovascular Health Study (CHS), FS has been diagnosed when the subject developed at least three of the following 5 criteria: weight loss, poor grip strength, low walking speed, low physical activity, poor endurance, and exhaustion. Such a one-dimensional (phenotypic) model was used in studies by Evenhuis et al. (2012), Schoufour et al. (2017), and O'Connell et al. (2020) and confirmed the effectiveness of FS identification in a group with ID. At the same time, they emphasized the importance of comorbid developmental, motor, and intellectual disabilities to the manifestation and aggravation of the syndrome's symptoms. On the other hand, when one or two of the above-mentioned criteria occurred, we observed that, as is the case in the general population, the subjects were classified as unstable individuals with possible frailty onset (PFO), which was found only in studies by Evenhuis et al. (2012), Schoufour et al. (2017); O'Connell et al. (2020). Such a one-dimensional (phenotypic) model is currently most commonly used as a reliable way to diagnose FS in the general population. However, in the available literature of the last decade, we failed to find more studies

using a phenotypic model in a population with ID, which is an important limitation for inferring from our study of phenotypic predictors that determine FS in this group.

Evenhuis (2014) also pointed out the importance of the age criterion in identifying FS, which is consistent with findings published in previous studies such as those by Schoufour et al. (2014), Schoufour et al. (2015b), while several authors indicated on gender criterion (female) (Martin et al., 2018; Ouellette-Kuntz et al., 2018; Schoufour et al., 2017). This conclusion was one of the most common findings in the manuscripts we analyzed regardless of the FS identification model used (McKenzie et al., 2015; Lee et al., 2019; Martin et al., 2018; O'Connell et al., 2020; Ouellette-Kuntz et al., 2018; Schoufour et al., 2013, 2015c, 2016, 2017).

The definition of FS includes both phenotypic and functional criteria, which have been described as a multidimensional way of identifying the syndrome. Researchers who created criteria for assessing FS in the general population relied on four domains (social, cognitive, psychological, and physical), recommending that a minimum of 30 to 40 assessed criteria should be met in order for the FS assessment index to be reliable (Searle et al., 2008). In the analyzed studies, this was the way which has been most popular among researchers who used psychological and social tests and interview questionnaires, without taking into account objective laboratory tests (Brehmer, Weber, 2010; Brehmer-Rinderer et al., 2013; Lee et al., 2019; Lin, Tseng 2022; Martin et al., 2018; McKenzie et al., 2015; Ouellette-Kuntz et al., 2018; Schoufour et al., 2013, 2015a, 2015b, 2015c, 2016, 2022). On the other hand, in general population studies, a complementary way of identifying FS using one-dimensional (phenotypic) and multivariate models has been more often employed to identify FS, which provides a predictive picture of the subject (Fried et al. 2001).

Therefore, the number of criteria is an important element of evaluation, since predictive accuracy is one of two types of criterion validation, the other being validation using a gold standard (Streiner, Norman, 2003). Given that there is no gold standard for assessing FS,

predictive validation is an important method in any approach to the operationalization of frailty syndrome (Searle et al., 2008). It was predictive validation that was also our goal of the systematic review of the available literature in the field of FS problems in the population of people with ID. At the same time, the systematic review using Prisma methodology is an indirect way of verifying the prediction of the prevalence of FS in the group of people with ID rather than developing criteria for assessing FS. Studies presented here (see Tab. 2) have mostly discussed a diagnosis of deficits and daily functional status of participants with ID, which made it possible to capture the occurrence of this status in significantly different (by ID, age, comorbid disabilities, social status (place of residence - nursing homes) groups of participants. However, with the lack of longitudinal studies on the populations with ID and, at the same time, its large internal variation in cross-sectional studies, it is impossible to clearly describe the predictors of FS.

6 CONCLUSIONS

1. The frailty syndrome in the population with ID occurs significantly earlier (from 10 to 25 years), and varies (9-27%) due to variables such as comorbid disabilities, and/or comorbid diseases, IQ, lifestyle including daily physical activity, and place of residence. Moreover, the frequency of the prevalence of FI varies from 0.17-0.58.

2. Limitations of the study include a large internal variation of the groups of participants (ID, developmental disabilities, age, and different methodological approaches of the researchers) and a small number of complementary studies using two models. Therefore, future research should focus on the standardization of methodologies and implementation of both one-dimensional and multidimensional models into research to infer FS.

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AUTHOR CONTRIBUTIONS

DC was the major contributor in writing and editing the original article. DC, EG and BR screened the databases, reviewed the list of the included studies and scanned the reference lists to find additional studies, contacted directly the corresponding author, if the crucial data were not available in the original articles and read and evaluated the methodological quality of the selected studies. AZ conceptualized the purpose and hypothesis of the study, wrote the discussion section, was designated to resolve all discrepancies that could occur among investigators during the risk of bias assessment and supervised during the study. The tables were prepared by DC and ZK. ZK was responsible for formatting, writing the review and editing. All authors read and approved the final version of the manuscript.

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LIFESTYLE OF PEOPLE CURRENTLY IN THEIR FORTIES IN TERMS OF THEIR RELATIONSHIP TO PHYSICAL ACTIVITIES

Pavel TILINGER

Abstract

The aim of our study was to analyse physical activities, wellness activities and other activities of people in their forties, i.e. people aged 40-49, who carry out in their daily lives. We also found out the physical fitness of this age group. To achieve our intention, we used a modified "Questionnaire to find out the physical activities and wellness activities of people in their forties", compiled especially for this occasion. The survey involved 75 women and the same number of men aged 40-49 years. The survey was conducted in 2020, just before the onset of the coronavirus epidemic. We used the statistical program Excel to process the results of the survey. The average age of the respondents was 45.2 years, BMI of men 26.4, women 23.7. Half of the respondents live in a city with more than 50,000 inhabitants, 47 % of women and 41 % of men have a university degree. 73 % of the interviewed men and 85 % of the interviewed women actively take care of their own condition. The most frequently mentioned physical activities realized in the last 12 months were walks (walking, trips, Nordic walking, hiking), followed by sports activities (most often sports games, cycling, swimming, skiing), activities in the fitness centre, group exercises (aerobics, yoga, Pilates etc.), own exercise, sauna and meditation. In the 12-minute running test men reached 1867 m and women 1613 m.

Keywords

fitness of forties; quality of life; healthy lifestyle; wellness

1 INTRODUCTION

A person's lifestyle represents a certain system of activities, relationships and habits that are characteristic of a particular individual. We can speak of a number of components that make a lifestyle. These include work style, personal, family and partner life, living conditions and way of living, nutrition, regeneration of physical and mental forces, leisure activities (Žaloudíková, 2009). In our work, we focused on the study of physical activities of forty-year-olds, i.e. citizens aged 40-49, on activities that represent just one of the components of lifestyle, intertwined into the other components. In the literature one can find a number of recommendations for the values of physical activities of this age category, e.g. WHO recommends for adults 30 minutes of moderate intensity 5 times a week, or 20 minutes of vigorous intensity 3 times a week, or a combination of moderate and vigorous intensity at least 2 times a week (in Bartůňková, 2013). The importance of physical activity for all ages has been substantiated and various

recommendations have been published by a number of experts (Daněk and Teplý, 1974; Dostál, 1978; Cooper, 1980, 1986; more recently, e.g. Hendl and Dobrý, 2011; Stackeová, 2014; Švamberk Šauerová et al., 2018; Bunc et al., 2013, Kučera et al., 2013 and others).

Movement is vital, a tool of life and one of the basic conditions of quality of life. Adequate movement is a prerequisite for physical fitness, which is determinant for health and the possibility of life satisfaction of a person (Krejčí, Hošek et al., 2016). It depends on one's discretion, emotional, social connections and habits whether and what kind of physical activity chooses, whether overcomes the comfort and incorporates it into one's own life.

The gradually increasing rate of decreasing physical activity in all age categories of the population strongly supports the fulfilment of the catastrophic forecasts published by the WHO for developed countries about the emerging obesity pandemic. This danger represents a great

warning for our society and forces physical education professionals to be proactive.

2 AIM OF THE STUDY

The aim of the present study was to analyse the lifestyle of contemporary 40-year-olds in terms of their relationship to physical activity. We were interested in the type and frequency of physical activities performed in the past and currently with the intention of taking care of fitness and leisure time during the day, week, month or year.

Sub-tasks

- What was the participation in sport and physical activity of the subjects when they were 20 years old?
- What is the current status of participation in physical activities among those in their 40s?
- How do forties take care of their fitness condition?
- What is the fitness level of those born in the 70s, last century?

3 METHODOLOGY

To accomplish our purpose, we used a modified "Questionnaire to Identify Physical Activity and Wellness Activities of People in their Forties" designed specifically for this occasion.

In addition to the identification questions, the questionnaire included a special section dedicated to questions aimed at fulfilling the above sub-tasks.

75 women and an equal number of men aged 40-49 participated in the survey. The survey was conducted in 2020, just before the onset of the coronavirus epidemic. The statistical program Excel was used to process the results of the survey.

The total numbers of respondents are based on the accuracy and the possibility of estimating the relative frequencies of the population. Even aggregate values above the level of two percent can be considered as estimates. All estimates based on the total number of probands are within a 95% confidence interval of no more than 4.9% either way.

For percentages divided by sex only, values above the 4 per cent level can then be taken as estimates of relative frequencies. All estimates divided by sex only have a 95 per cent probability of being within a maximum of 6.9 per cent either way.

The respondents in their forties mostly live in Prague and the Central Bohemia region, all of them belong to parents or friends of parents of students of VŠTVS Palestra, Ltd., who, after detailed instructions, carried out the survey practically in the form of structured questioning and testing, or interviews, and thus obtained fully completed materials.

Characteristics of the respondent population

Both genders were equally represented in the survey sample, 75 men and 75 women. The average age of men was 45.3; the average age of women was 45.1.

Somatic parameters are shown in Table 1. The mean values reported indicate that the population is composed of forty-year-olds (men) who are slightly overweight. In fact, we found a fairly wide range of representation of both very "thin" and very overweight individuals. On the basis of the calculations performed, it can be concluded that with a 95% probability, the average BMI of men aged 40-50 years is in the interval 24.1 to 28.7 and that of women in the interval 21.4 to 26.0.

Table 1 Somatic characteristics of forty-year-olds interviewed

Age category	Body height men (cm)	Body height women (cm)	Body weight men (kg)	Body weight women (kg)	BMI men	BMI women
40-49	178	169	88,5	67,7	26,4	23,7

Other characteristics related to partnership status were also of interest. Table 2 shows that

the majority of forties (74%) is married. The number of single men (16%) is interesting.

Table 2 Form of partnership status of people in their forties

	Total (n)	Total %	Men (n)	Men %	Women (n)	Women %
Married	111	74	53	71	58	77
Single	17	11	12	16	5	7
Divorced	22	15	10	13	12	16

Table 3 Size of the city where forty-year-olds live

	Total (n)	Total %	Men (n)	Men %	Women (n)	Women %
Up to 1000 inhabitants	17	11	9	12	8	11
Up to 10 000 inhabitants	29	19	14	19	15	20
Up to 50 000 inhabitants	35	23	15	20	20	27
Above 50 000 inhabitants	69	46	37	49	32	43

Almost half of the respondents (46%) live in a city with a population over 50,000 (Table 3), i.e. Prague. Municipalities under 50,000 and under 10,000 account for around 20%. Small municipalities under 1,000 are represented by only 11-12 percent.

The education of respondents also corresponds closely with living in a city (Table 4). The numbers of college- and secondary school-educated men and women far exceed the national average.

Table 4 Highest educational attainment of people in their forties

	Total (n)	Total %	Men (n)	Men %	Women (n)	Women %
Elementary	2	1	1	1	1	1
Vocational	13	9	10	13	3	4
Secondary with A levels exam	69	46	33	44	36	48
Higher education	66	44	31	41	35	47

4 RESULTS OF THE STUDY

4.1 Sports activities around the age of 20

Table 5 Numbers of men and women who report doing sports in their 20s

Age category	Men (n=75)	Men %	Women (n=75)	Women %
40-49	66	88	53	71

We found that 88% of male and 71% of female respondents reported playing sports in their 20s (Table 5). The majority (26 men and 26 women) played sport recreationally, with 19 men and 15 women competing at regional level, 9 men and 7 women achieving second-level performances

and 12 men and 5 women competing at first league level (Table 6). Out of any sport, 12% of men (9 individuals) and 29% of women (22 individuals) remained in their early 20s.

Table 6 Level at which forty-year-olds did sport in their 20s

Level of sportsmanship	Men (n=66)	Men %	Women (n=53)	Women %
Recreational	26	39	26	49
Regional	19	29	15	28
2. league	9	14	7	13
1. league	12	18	5	9

Table 7 shows which sports were most popular among the respondents in their forties at the age of 20. In the statements, 30 sports and sports activities were named. In the table, we have listed both activities common to men and

women and sports typical for men and sports typical for women. All activities encountered in more than one response were listed (at least 2 men or women had to name this sport).

Table 7 Most frequently reported sporting activities of the surveyed forties in their 20s (number of men and women doing sports, 119 persons in total, 66 men and 53 women)

Sports	Qty. of men	Qty. of women	%	Categories
Athletics	6	9	13	Men + women
Volleyball	4	6	8	Men + women
Handball	3	4	6	Men + women
Basketball	3	3	5	Men + women
Cycling	3	3	5	Men + women
Combat sports	5	1	5	Men + women
Tennis	2	3	4	Men + women
Gym, fitness	2	2	3	Men + women
Swimming	2	1	3	Men + women
Football	17		14	Men
Hockey	8		7	Men
Rowing	2		2	Men
Gymnastics		4	3	Women
Dance		2	2	Women
Aerobics		4	3	Women

4. 2 Current status of participation in physical activities

Participation in competitive sport

The interviewees' statements show that only one man is currently competing at the top

level in bodybuilding, one man and one woman are playing volleyball at the second league level and one is competing in cycling at a similar level. There are 5 other men (football, futsal, volleyball, tennis, paragliding) and two women tennis players playing at the

regional level. The frequency of training is indicated at 2-3 per week. The top bodybuilder trains practically every day. The number of competitive starts per year also corresponds

to the performance level and nature of the sport, ranging from a few starts in individual sports (3-10), to 10-30 matches in team sports (Table 8).

Table 8 Participation of 40-year-olds in competitive sport by level of performance (2-regional championship, 3-second league, 4-first league)

Sports	male representation by level of performance	female representation by level of performance
Tennis	2	2, 2
Volleyball	3, 2	3
Bodybuilding	4	
Paragliding	2	
Football, futsal	2, 2	
Cycling	3	

Participation in recreational sport

As Tables 9 and 10 show, 60% of 40-year-olds are involved in recreational sports. The most commonly reported sports are athletic running, cycling, skiing, swimming and tennis. The following sports represent a wide range

of interests of the respondents, but are not mentioned by more than one or two respondents (basketball, squash, fitness, dance, hockey, yoga, golf, etc.). Usually one to three training sessions per week are devoted to the sports mentioned. Only rarely do respondents report participation in competitions.

Table 9 Participation of 40-year-olds in recreational sport

	Yes (n)	Yes (%)	No (n)	No (%)
Men	45	60	30	40
Women	45	60	30	40

Table 10 Most frequently reported recreational sports

Sports	Qty. of men	Qty. of women	% (total)
Athletic run	3	13	11
Cycling	10	4	9
Skiing	6	7	9
Swimming	7	7	9
Tennis	3	6	4

Table 11 Participation of 40-year-olds in organised physical activities

	Yes (n)	Yes (%)	No (n)	No (%)
Men	20	27	55	73
Women	34	45	41	55

Organised physical activities

Relatively few forties admit to participating in organized physical activities (Table 11). If they do participate, it is in physical activities such as exercising in Sokol, kung Fu, dancing, spinning, bowling, aerobics, Pilates, kick yoga, with a frequency of 1-2 participations per week. These activities are reported no more than 1-2 times in the whole population, with the exception of participation in yoga, which is reported by a total of 12 women and one man.

Participation in unorganised physical activities

A very pleasant surprise came from the answers about the participation of the respondents in

unorganized physical activities, i.e. activities that the respondents prepare and implement themselves. 85% of men and 96% of women reported active participation in unorganised physical activities (Table 12). When asked to name specific physical activities, walking was the most frequently mentioned, followed by exercising at home, cycling (in summer), skiing (in winter) and swimming. Occasionally, respondents mentioned fitness running, dancing, exercising in the fitness centre, massages, etc. 48% of men and 41% of women go to the sauna at least once a month. These unorganised physical activities are practiced 2-4 times a week by forties, for a total of 10-11 hours per month (Table 13).

Table 12 Participation of 40-year-olds in unorganised physical activities

	Yes (n)	Yes (%)	No (n)	No (%)
Men	64	85	11	15
Women	72	96	3	4

Table 13 Most frequently reported unorganised physical activities (respondents had the option to indicate more than one activity)

Physical activity	Men qty./ %	Women qty./ %	% (total)	Hours per month
Walking	42 / 56	45 / 60	58	13
Own exercise	19 / 25	28 / 37	31	14
Sauna	36 / 48	31 / 41	45	3
Cycling (seasonal)	23 / 31	17 / 23	27	12
Skiing (seasonal)	13 / 17	9 / 12	15	18
Swimming	8 / 11	19 / 25	18	9

4. 3 Care of own fitness

The questionnaire included a specific question about how forty-year old ones take care of their own fitness. The results show that 27%

of men do not take care of their own fitness. For women, the percentage is lower, with 15% of women not taking care of their fitness (Table 14).

Table 14 Forty-year-olds' care for their own fitness

	Yes (n)	Yes (%)	No (n)	No (%)
Men	55	73	20	27
Women	64	85	11	15

Among the reported activities used for taking care of one's own fitness, walking and home exercises are predominant among women, while men most often mention various sports (volleyball, basketball, hockey, tennis, squash, bowling, etc.) and activities in fitness centres, especially in gyms (Table 15). Both men and women consistently report spending about

17-18 hours per month on fitness development. It is a question or a matter for discussion to list a rational diet as the most important means of fitness maintenance. When we think of fitness, we usually think of some kind of physical activity; a rational diet is then an important part of not only fitness but also of the overall health of the individual, wellbeing.

Table 15 Most commonly reported physical activities used by forties in care of their fitness condition

Physical activity	Men qty.	Men %	Women qty.	Women %
Sports	17	31	-	-
Own, home exercise	7	13	11	17
Fitness centre	10	18	4	6
Walking	4	7	14	22
Conditioning run	5	9	7	11
Yoga			7	11
Group exercise			6	9
Cycling	7	13	3	5
Sauna	3	5	3	5
Rational diet	1	2	7	11
Gardening	1	2	2	3
Total	55	100	64	100

4. 4 Testing the endurance and balance of forty-year-olds

We used a 12-minute run to assess the endurance of the 40-year-olds. The results and comparison of the values found with the norms reported by Cooper (1986) and Chytráčková

et al. (2002) are presented in Table 16. It is clear that the values achieved by our probands are (slightly) below average according to Unifittest, compared to the norms of Cooper (1986) the men's performance is "weak" and the women's performance is "acceptable".

Table 16 Evaluation of the endurance abilities of forty-year-olds using a 12-minute run

Rating according to Unifittest 6-60	Norms Men	Norms Women	Our performance men	Our performance women
Significantly below average	-1750	-1340		
Below average	1751-2130	1341-1690	1867	1613
Average	2131-2510	1691-2040		
Above average	2511-2890	2041-2390		
Significantly above average	2891+	2391+		

Rating by Cooper (1986)	Norms Men	Norms Women	Our performance men	Our performance women
Very weak	-1830	-1420		
Weak	1830-2000	1420-1580	1867	
Acceptable	2010-2240	1590-1790		1613
Good	2250-2460	1800-2000		
Very good	2480-2650	2010-2160		
Excellent	2680+	2170+		

To assess balance abilities, we applied a one-legged balance test consisting of standing on the right leg, then on the left leg, with and without visual control, i.e. four timed trials. If the subject lasted 40 seconds, the subtest ended. A summary of the average performances in the balance tests is given in Table 17. The performances in this test cannot be compared

with the general standard; in the past, we have tested seniors in this way (Tilinger et al., 2019) and the approximated values for 65-year-olds were at 103 s, the performances of 70-year-olds were 88s, and the performances of seniors aged 75 were at 73 s. From this point of view, the performances of 45-year-olds may appear to be an acceptable average.

Table 17 Assessment of balance abilities of forty-year-olds. Average values of the tested are given in seconds. In the last column is the total performance, the sum of all four times achieved

Standing on one leg	Right closed eyes	Right closed eyes	Left closed eyes	Left closed eyes	Performance in total (s)
Men	29,7	37,2	26,9	33,3	127,1
Women	29,0	38,7	25,0	34,1	126,5

5 CONCLUSIONS

The study is a small probe into the lifestyle studies of today's people in their forties, fellow citizens who were born in the 1970s. A look at their early adulthood (around their 20s) and an analysis of their current attitudes towards physical activity as an important part of taking care of one's own health and fitness shows that most of the respondents meet today's experts' ideas about the use of physical activity to promote a healthy lifestyle.

The results of the questionnaire analysis show that there is a part of the population that is obese (in our sample 5 women and 8 men with a BMI over 31). Men have an average BMI of 26.4, which shows a slight overweight of this population.

12% of men and 29% of women in their 20s did not do sport, even recreationally. Currently, 60% of people in their forties are involved in recreational sport.

There is very little participation by men (only 27%) in organised physical activities. For women, the proportion is higher, reaching 45%.

The participation of 40-year-olds in unorganised physical activities is significant, reaching 85% for men and 96% for women. This also scores strongly in the answers to the question on taking care of one's own fitness, which is consciously and purposefully taken care of by 73% of men and 85% of women.

The assessment of endurance skills shows some reserves and deficiencies in this component of fitness.

The overwhelmingly encouraging results of the study should be a further motivation for the uninvolved, inactive in the fight against the ageing process and the decline in performance, both physical and mental, as this population group, now very fit, faces another 20 years of working life in which physical activity as a health

promoter, compensation for work stress and an appropriate form of active rest will play a significant role.

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THE EFFECTS OF CREATINE SUPPLEMENTATION ON SINGLE AND INTERMITTENT ANAEROBIC EXERCISES AND BODY COMPOSITION DURING REDUCED TRAINING IN SOCCER PLAYERS

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Abstract

BACKGROUND: Several studies have examined the effects of creatine supplementation in adult athletes in season or pre-season preparation. However, few studies have examined the effects of creatine supplementation in adolescent soccer players during reduced training in an off-season. **OBJECTIVE:** The aim of the study was to examine the effects of short-term creatine monohydrate supplementation on the anaerobic performance and body composition in adolescent soccer players during reduced training in an off-season. **METHODS:** Using a double-blind experiment design, 16 soccer players (aged 18.0 ± 0.8 yr) were randomly assigned to 5 days of either $20 \text{ g} \cdot \text{day}^{-1}$ creatine monohydrate (Cr) or placebo supplementation. One day before and a day after the supplementation, participants completed squat and countermovement jumps (SJ, CMJ), 10-m running sprint, 6-s single cycling sprint (CST), an intermittent anaerobic test on a bicycle ergometer (10 x 6s, IAnTBE) and measurement of body composition. **RESULTS:** Cr supplementation had no significant effect ($p > .05$) on any performance test. However, effect size values indicated medium or small clinical significance in SJ ($d = 0.59$), CST (6-s power, $d = 0.50$; peak power, $d = 0.48$) and IAnTBE (best peak power, $d = 0.44$; post-exercise blood lactate concentration, $d = -0.59$; fatigue index, $d = -0.28$). Relative to the placebo, Cr supplementation resulted in a significant increase in body weight (BW) ($p = .015$). **CONCLUSIONS:** The results of the study suggest that short-term Cr supplementation administered to adolescent soccer players during their off-season significantly increase body weight and could have small/medium clinical significance effect on improve lower-body maximal anaerobic power output and power output recovery during maximal intermittent exercise. The study also confirms that Cr supplementation is safe and without side effects for adolescent athletes.

Keywords

muscle power output; bicycle ergometer; fatigue index; sprint; vertical jump

1 INTRODUCTION

The acute (short-term, loading) Cr supplementation, usually ingested in the form of creatine monohydrate in a dose of $20\text{-}25 \text{ g} \cdot \text{d}^{-1} / 0.3 \text{ g} \cdot \text{kg}^{-1}$ for 5-7 days, was shown to increase total intramuscular creatine (Cr) and phosphocreatine (PCr) (Greenhaff et al., 1994, Harris et al., 1992; Solis et al., 2017). Increased muscular PCr may lead to enhancement in maximal dynamic and isometric muscle force/strength, anaerobic power and intermittent anaerobic performance (Bemben & Lamont, 2005; Izquierdo et al., 2002; Urbanski et al., 1999). Soccer has been defined as an intermittent sport as a player's performance involves repeated explosive actions of the

lower limbs such as sprinting, turning, jumping, tackling, kicking and forceful contractions to maintain balance and control the ball executed over a prolonged period (Stølen et al., 2005). Thus, soccer players might benefit from two possible ways in which CrS is thought to improve physical performance. First, increased intramuscular PCr presents an increased energy pool, supports rephosphorylation of ADP, and enhances high energy phosphate diffusion between the mitochondria and myosin heads leading to better engagement in cross bridge cycling and tension maintenance (Bemben & Lamont, 2005; Greenhaff et al., 1994). Secondly, Cr supplementation can act to increase the rate of PCr resynthesis after intensive exercise and, as a consequence,

ameliorate metabolic recovery between successive bouts of very high intensity exercise (Yquel et al., 2002). In soccer players, both mentioned CrS benefits were confirmed by several studies (e.g. Claudino et al., 2014; Cox et al., 2002; Mujika et al., 2000; Ramírez-Campillo et al., 2016; Yañez-Siva et al., 2017), but not all (Williams et al., 2014).

The ambiguous effects of Cr supplementation on both single and repeated bouts of high intensity exercise might result not only from the biochemical and functional properties of muscle fibres of consumers (responders vs. non-responders) (Greenhaff et al., 1994; Syrotuik & Bell, 2004) and a Cr supplementation strategy (acute vs. maintaining) (Cooper et al., 2012), but also from different training regimes given by frequency and intensity of physical/muscle loading undergone during the Cr ingestion period. Typically, ergogenic effects of Cr supplementation have been investigated when players simultaneously underwent regular intensive training during a competitive season (Gouttebarga et al., 2012; Ramírez-Campillo et al., 2016) or pre-season or an intensive preparation period that involved strength/power training and conditioning, specific soccer exercises and game-like training (Claudino et al., 2014; Cox et al., 2002; Larson-Meyer et al., 2000). However, there is very limited knowledge on any possible effect of acute Cr supplementation during a period of significant reduction of training such as in the post-season (transient season) of soccer teams when only two studies have yet been published. In the first study (Yañez-Siva et al., 2017) elite adolescent soccer players who had 5 training sessions plus one match a week during their competitive season, ingested Cr ($0.03 \text{ g}\cdot\text{kg}^{-1}\cdot\text{d}^{-1}$) for 14 days during in the middle stage of the competitive season while physical loading was reduced to two training sessions a week. In spite of this reduction, Cr ingestion resulted in a significant increase in peak power output and total work in the 30-s Wingate cycling test while placebo did not.

In the second study (Mujika et al., 2000) highly trained adult soccer players underwent 6-day Cr supplementation ($20\text{g}\cdot\text{d}^{-1}$) that began three days after the last match of the competitive season. During the investigation the training load was reduced but no information is provided

on the extent of the reduction. As compared to the placebo, the Cr-induced improvement was reported for the 5-m times in two sprints of the repeated 6x 15 m sprint test and not for vertical jump and performance in an intermittent endurance test. As the Cr supplementation took place immediately after the last match of the competitive season in this study, the improvement of RSA might be rather attributed to a tapering effect. In addition, the first above-mentioned study (Yañez-Siva et al., 2017) reported an effect on anaerobic power and capacity of legs but information about how much time of reduced training preceded the Cr investigation is missing. Therefore the purpose of the study was to examine effects of acute Cr supplementation in the advanced stage of the post-season featured with reduced soccer training. According to training periodization in competitive sport (Bompa & Haff, 2009), the purpose of a post-season following the end of the competitive season is physical and mental regeneration but minimalizing decrease in the physical performance and sport-specific skills of players, while significantly reducing volume and/or training intensity. The study was focused on examining whether Cr supplementation applied in the advanced stage of the reduced post-season training might support maintenance of muscle strength and power in soccer players.

In addition, the efficacy of Cr supplementation on physical performance might be moderated by its effect on body composition, specifically, by the increase in body weight that is most likely contributed from increased total body water including intramuscular water, and/or an increase in body lean mass due to possible myofibrillar protein synthesis (Branch, 2003; Gutiérrez-Sancho et al., 2006). Therefore, the current study investigated the effects of CrS on the physical performance of soccer players with regard to possible changes in body composition.

2 MATERIALS AND METHODS

Participants

Sixteen male soccer players (age 18.0 ± 0.8 yr, range 17–19) from one team competing in a 3rd U19 league (regional league) were recruited as participants for the experiment. Over the last year, the players usually

underwent 3–4 training sessions a week, with a mean duration of 90 min, plus one official match a week. The total time of their regular soccer training was 9.1 ± 2.3 yr. The exclusion criteria for participation on the study was assessed verbally and included: i) the position of the goalkeeper, ii) chronic and acute physical and/or mental problems and iii) long-term or current ingestion of any medication. None of the participants was a vegetarian or ate unusually large quantities of meat.

Participants and their legal guardians (if <18.0 yr) received information about the study and the possible risks and discomforts associated with the experiment. Then, the legal guardians and/or players gave their written informed consent to participation. All of the experimental procedures done met the Code of Ethics of the World Medical Association (the Helsinki Declaration, 2000). The study was approved by the the University's institutional ethical committee, and the technical staff and the medical supervisor of the club.

Experimental design

The study was designed as a double-blind randomised placebo-controlled experiment, involving the creatine (Cr) group ($N = 8$) and the placebo (PI) group, ($N = 8$) (Table 1). An a priori power analysis showed that 12 participants would be sufficient to identify a significant effect of the two independent variables (time: pre, post, group: Cr, PI) with a within-subject design with a power ($1 - \beta$) of .80, effect size f of .50 and an α of .05 (Faul, Erdfelder, Lang, & Buchner, 2007).

One day before and one day after the 5-d supplementation, participants of both groups underwent the pre- and post-test session, respectively.

Training protocol

The experiment was carried out during the fourth week of the eight-week post-season (at the beginning of December). During the four weeks, participants underwent "maintenance" training that involved only two training sessions a week (75 min per session). Each training session involved warm-ups and

individual and group soccer skill drills (20-25 min), which were followed by games of small sides with different numbers of players, sizes of fields, goals and rules, focused on various aspects of defensive and offensive phases of a game (30-45 min) and finished with 10 min of cooling down and regeneration exercises. No exercises primarily focused on stimulation of muscle strength and power, anaerobic or aerobic conditioning were included in the post-season training. Thus, the total time of training load of a post-season course was reduced from 360-450 min in the competitive season to 150 min a week in the post-season.

Supplementation protocol

Participants were administered 20 small plastic bags, identical in appearance, size, texture, taste and colour, with each containing either 5 g of creatine monohydrate plus 15 g of maltodextrin (Myprotein, Northwich, UK) or 20 g of maltodextrin. They were instructed to mix the contents of a bag in 250 ml of lukewarm or warm water and drink at regular intervals four times per day (intervals of 4 hours) for 5 d, the best with food. This instruction to consume the supplementation with food was given because this ingestion increases body's Cr retention (Steenge et al., 2000). They were also asked to complete a written record of the time of supplementation each day. If they forgot to take a dose, participants were recommended to take it as early as possible after remembering or being reminded (see below) and then to modify the 3–4 hour interval supplementation schedule accordingly. Participants were encouraged to preserve their nutrition and physical activity habits that they usually maintain and not to combine the test supplement with other supplements.

Participants were also asked to report any adverse effects of supplementation such as changes in appetite, thirst, nausea, diarrhoea, frequent headaches, dizziness, muscle aches and cramping, decreased sensitivity of the neck, back or limbs, shivering, irritability and aggression. In addition, participants were contacted by one researcher by mobile phone once a day to check their health status, compliance with supplementation and regular

ingestion of the doses. The participants were also asked not to combine the test supplement with other supplements.

Pre- and post-tests

The pre- and post-test session involved the tests in the following order: i) basic anthropometric and body composition measurements, ii) a vertical squat jump and countermovement jump to assess the explosive strength of lower extremities, iii) a 10-m running sprint test to assess running sprint ability in the first acceleration phase, iv) an intermittent anaerobic test on a bicycle ergometer (IAnTBE) to assess repeated sprint ability. To perform all performance tests, participants wore shorts, T-shirts and indoor soccer shoes. All the tests were conducted under the same conditions such as time of day and place.

Anthropometric and body composition measurements

Body height was measured using the Tanita Leicester Height Measure device (Invicta Plastics Ltd, Leicester, England) with an accuracy of 0.1 cm. Body weight (BW) and body composition variables were assessed using a tetrapolar multi-frequency bioimpedance device InBody 230 (InBody Co., Ltd., Soul, South Korea).

Vertical jump tests

After a 10-min warm-up that consisted of static and dynamic stretching and low-intensity running, participants performed vertical squat jumps (SJ) and countermovement jumps (CMJ), both with arm fixation while keeping their hands on their iliac crests. SJs were executed from a position of 90° of knee flexion, stopping 1–2 s, and then jumping as high as possible, without knee and/or trunk countermovement. CMJs were executed from a standing position, legs moderately apart. For each jump test, participants were provided with one demonstration, followed by one practice trial and three test trials, separated by 30-s recovery. An optoelectronic instrument Optojump Next, version 1.3.20.0 (Microgate, Bolzano, Italy) was used to measure the jump height based on flight time.

Participants jumped between the light emitting and two parallel receiving bars of this device placed 1.5 m apart. The highest jump best of the three trials was always used as the dependent variable.

Single running sprint test

3 minutes after performing of the SJ and CMJ tests, each participant performed one practice trial and three test trials of the 10-m sprint test, with 90-s recovery after each sprint. Participants started from a standing position, with the toe of the preferred foot forward and 30 cm behind the position of a start photocell. Sprint times were measured with infrared electronic cells (Timing Brower Systems, Draper, USA) placed at the level of the participant's shoulder minus 10 cm. The shortest time achieved of the three trials was used as a dependent variable. The sprint and jump tests were performed in a sports hall on an artificial surface.

Single cycling sprint test (CST)

20 minutes after completing the running sprint test, each participant underwent the CST consisting two single 6-s cycling sprints on a bicycle ergometer, the Monark 894 Peak Bike (Vansbro, Sweden) in a lab to assess maximal anaerobic power. Prior to the test, a participant performed a 5-min warm-up while pedalling at a moderate rate against a resistance of 1.9% BW. 2 minutes after the warm-up, the participant executed two 6-s familiarisation cycling sprints of non-maximal intensity against a resistance of 1.9% BW with 2-min recovery between the sprints.

2 minutes after the familiarisation, a participant performed two single 6-s maximal sprints separated by 3 min passive recovery. Pedalling was executed in the sitting position, against a resistance of 7.5% BW by a mechanical belt brake. The weight brake resistance dropped the moment a pedalling frequency of 120 rpm was attained. The seat height was adjusted for each participant. The standard start position of the pedals before each sprint was kept with the dominant leg in the upper position. During the all-out test participants were encouraged to perform at their maximum. The higher 6-s power of two trials was used for the analysis.

Intermittent anaerobic test on bicycle ergometer (IAnTBE)

5 min after the cycling sprints, participants underwent the IAnTBE consisting of ten 6-s cycling sprints against a resistance of 7.5% BW. The rest interval between the two consecutive sprints was 30 s. Adjustment of the seat height, sitting position, pedalling frequency for dropping the weight brake resistance, the start position of the pedals before each work interval and encouragement of a participant were the same as for the single cycling sprint test. To assess post-exercise blood lactate concentration, a drop of blood was taken from the fingertip 3 minutes after finishing the IAnTBE (BLa_{3min} ; $mmol \cdot L^{-1}$) and analysed by LactateScout+ analyzer (EFK Diagnostics, Cardiff, Wales).

The mechanical power measures assessed are presented in Table 2. The fatigue index of 6-s power ($FI_{P_{6s}}$) was calculated by using the formula (Glaister et al., 2008):

$$FI_{P_{6s}} (\%) = 100 - [(P_{mean} / P_{6s \max} \times 100)]$$

where P_{mean} ($W \cdot kg^{-1}$) is the mean power across the whole test, and $P_{6s \max}$ ($W \cdot kg^{-1}$) is the highest 6-s power. Similarly, the fatigue index of peak power ($FI_{P_{peak}}$), i.e. highest power per revolution in each work interval, was calculated by using the same the formula⁽¹⁹⁾: $FI_{P_{peak}} (\%) = 100 - [(P_{peak \text{ mean}} - P_{peak \text{ max}}) \times 100]$, where $P_{peak \text{ mean}}$ ($W \cdot kg^{-1}$) is the mean peak power across all work intervals, and $P_{peak \text{ max}}$ ($W \cdot kg^{-1}$) is the highest peak power in the test.

Data analysis

All the values are reported as the means \pm standard deviations. To examine the effects of Cr supplementation on dependent variables, a

2 (Cr vs. placebo) \times 2 (pre vs. post) mixed-design analysis of variance with repeated measures (RM ANOVA) on the second factor was conducted. Bonferonni corrections were employed for post-hoc comparisons to reduce the probability of type I error. To assess the clinical significance, effect sizes (ES) were calculated according to the equation:

(mean pre-post difference of the Cr group – mean pre-post difference in the placebo)/pooled SD_{post}) and defined as trivial (≤ 0.2), small (< 0.5), medium (< 0.8) and large (≥ 0.8) (Cohen, 1992). The magnitude of the difference for each variable was expressed by 95% confidence limits.

3 RESULTS

The analysis of variance showed significant group \times time interaction for body weight (BW), $F(1.14) = 6.092$, $p = .027$, with a mean increase of BW by 0.8 ± 0.8 kg in the Cr group while the placebo led to a mean decrease of 0.1 ± 0.6 kg during the experiment (Table I). The time and group, as well as their interaction were not significant for other body composition measures but in some of them a small clinical effect was recorded (Table 1).

The effect of both the time and the group, and their interaction were not significant for performance in vertical jumps (SQ, CMJ), 10-m running sprint, CST (Table II) and IAnTBE (table III). However, the Cr supplementation led to the medium clinical significance in height of squat jump ($+ 2.44$ cm, $d = 0.59$), 6-s power in CST ($+0.65 \pm 0.79$ $W \cdot kg^{-1}$ BW, $d = 0.50$) and decrease of post-exercise BLA in IAnTBE ($- 3.5$ $mmol \cdot L^{-1}$, $d = - 0.59$). For other measures a small or trivial clinical effect was observed (Table 2, Table 3).

Table 1. Anthropometric and body composition measures in the creatine group and the placebo group in the pre- and post-test (mean ± SD).

	Baseline mean ± SD	Mean Diff ± SD	95%CI	d (ES)	p (interaction)
Weight (kg)					
Creatine	71.3 ± 8.5	0.77 ± 0.75	0.25; 1.19	0.14	0.027
Placebo	73.9 ± 5.4	-0.14 ± 0.62	-0.57; 0.29		
BMI					
Creatine	22.1 ± 1.8	0.26 ± 0.24	0.09; 0.43	0.15	0.024
Placebo	23.4 ± 2.6	-0.05 ± 2.27	-0.20; 0.10		
FFM (kg)					
Creatine	62.7 ± 7.0	0.74 ± 1.55	-0.33; 1.81	0.26	0.144
Placebo	65.5 ± 4.3	-0.68 ± 1.85	-1.96; 0.60		
PBF (%)					
Creatine	11.9 ± 3.8	-0.08 ± 1.64	-0.22; 1.06	-0.19	0.438
Placebo	11.3 ± 1.7	0.70 ± 1.98	-0.67; 2.07		
TBM (kg)					
Creatine	35.7 ± 4.1	0.51 ± 0.97	-0.16; 1.18	0.27	0.142
Placebo	37.4 ± 2.8	-0.39 ± 1.18	-1.21; 0.43		
TBW (kg)					
Creatine	45.9 ± 5.0	0.55 ± 1.11	-0.22; 1.32	0.28	0.118
Placebo	48.0 ± 3.1	-0.56 ± 1.38	-1.52; 0.40		
IntW (kg)					
Creatine	28.9 ± 3.2	0.40 ± 0.77	-0.13; 0.93	0.46	0.177
Placebo	29.7 ± 1.1	-0.83 ± 2.15	-2.32; 0.66		
ExtW (kg)					
Creatine	17.0 ± 1.9	0.15 ± 0.36	-0.10; 0.40	0.09	0.489
Placebo	17.8 ± 0.9	0.00 ± 0.43	-0.30; 0.30		

BMI – body mass index; FFM – fat free mass; TBF – total body fat; PBF – percentage of body fat; TBM – total body muscles; PBM – percentage of body muscles; TBW – total body water; PBW – percentage of body water; IntW, ExtW – percentage of intracellular and extracellular water, respectively; BCM – body cell mass; PRE – pre-test; POST – post-test; p – p-value (t-test); d – Cohen’s d effect size; * p<0.05.

Table 2. Performance in the 10-m running sprint, jump tests, and mechanical power measures at single 6-s cycling sprint in the creatine group and the placebo group in the pre- and post-test (mean \pm SD).

	Baseline mean \pm SD	Mean Diff \pm SD	95%CI	d (ES)	p (interaction)
Squat jump (cm)					
Creatine	33.5 \pm 2.6	2.44 \pm 3.69	-0.12; 5.00	0.59	0.182
Placebo	38.1 \pm 5.0	-0.05 \pm 2.88	-2.05; 1.95		
CM jump (cm)					
Creatine	37.7 \pm 4.2	0.28 \pm 3.49	-0.14; 0.70	0.21	0.463
Placebo	41.6 \pm 7.0	-0.84 \pm -0.84	-1.42; -0.26		
Sprint 10 m (s)					
Creatine	1.88 \pm 0.05	0.01 \pm 0.04	-0.02; 0.04	0.00	0.890
Placebo	1.86 \pm 0.05	0.01 \pm 0.06	-0.03; 0.05		
P_{6s} (W·kg⁻¹)					
Creatine	12.0 \pm 0.6	0.65 \pm 0.79	0.10; 1.20	0.50	0.244
Placebo	12.3 \pm 1.2	0.24 \pm 0.41	-0.04; 0.52		
P_{6s} (W·FFM⁻¹)					
Creatine	13.7 \pm 1.0	0.73 \pm 0.83	0.15; 1.31	0.43	0.324
Placebo	13.9 \pm 1.2	0.33 \pm 0.59	-0.08; 0.74		
P_{peak} (W·kg⁻¹)					
Creatine	13.8 \pm 1.1	0.82 \pm 0.83	-0.24; 1.40	0.48	0.131
Placebo	14.6 \pm 1.5	0.23 \pm 0.51	-0.12; 0.58		
P_{peak} (W·FFM⁻¹)					
Creatine	15.7 \pm 1.6	0.92 \pm 0.76	0.39; 1.47	0.42	0.14
Placebo	16.4 \pm 1.6	0.32 \pm 0.66	-0.14; 0.78		

SJ – squat jump; **CMJ** – countermovement jump; **P_{6s}** – the average mechanical power at the 6-s cycling sprint; **P_{peak}** – the peak power per one revolution at 6-s cycling sprint; **PRE** – pre-test; **POST** – post-test; **p** – p-value (t-test); **d** – Cohen's d effect size; * **p**<0.05.

Participants did not report medical problems, symptoms or their adverse effects during the Cr supplementation period. Also, no muscular

injury or cramping was observed during training and post-test sessions.

Table 3. Mechanical power measures and postexercise blood lactate concentration in the IAnTBE in the creatine group and the placebo group in the pre- and post-test (mean \pm SD).

	Baseline mean \pm SD	Mean Diff \pm SD	95%CI	d (ES)	p (interaction)
$P_{\text{peak max}}$ ($W \cdot \text{kg}^{-1}$)					
Creatine	14.0 \pm 0.9	0.35 \pm 0.60	0.07; 0.77	0.44	0.198
Placebo	14.4 \pm 1.6	-0.24 \pm 0.98	-0.92; 0.44		
$P_{\text{peak max}}$ ($W \cdot \text{FFM}^{-1}$)					
Creatine	15.9 \pm 1.4	0.38 \pm 0.47	0.05; 0.71	0.29	0.45
Placebo	16.2 \pm 1.7	-0.02 \pm 1.27	-0.90; 0.86		
$P_{6s \text{ max}}$ ($W \cdot \text{kg}^{-1}$)					
Creatine	12.1 \pm 0.6	0.11 \pm 0.37	-0.15; 0.37	-0.01	0.961
Placebo	12.3 \pm 1.2	0.13 \pm 0.63	-0.31; 0.57		
$P_{6s \text{ max}}$ ($W \cdot \text{FFM}^{-1}$)					
Creatine	14.1 \pm 1.1	-0.19 \pm 0.81	-0.75; 0.37	-0.40	0.37
Placebo	13.6 \pm 1.2	0.22 \pm 0.84	-0.36; 0.80		
P_{mean} ($W \cdot \text{kg}^{-1}$)					
Creatine	9.6 \pm 1.0	0.34 \pm 0.48	0.01; 0.67	0.17	0.458
Placebo	10.0 \pm 0.6	0.18 \pm 0.25	0.01; 0.35		
P_{mean} ($W \cdot \text{FFM}^{-1}$)					
Creatine	11.0 \pm 1.2	0.37 \pm 0.58	-0.03; 0.77	0.11	0.69
Placebo	11.2 \pm 0.7	0.25 \pm 0.48	-0.08; 0.58		
FI_{P6s} (%)					
Creatine	30.6 \pm 16.7	-0.61 \pm 5.15	-4.18; 2.96	-0.02	0.945
Placebo	26.6 \pm 9.2	-0.39 \pm 6.60	-4.96; 4.18		
$FI_{P\text{peak}}$ (%)					
Creatine	20.3 \pm 8.9	-1.96 \pm 3.96	-4.70; 0.78	-0.28	0.327
Placebo	17.4 \pm 6.8	0.12 \pm 3.71	-2.45; 2.69		
BLa ($\text{mmol} \cdot \text{l}^{-1}$)					
Creatine	19.6 \pm 5.6	-3.46 \pm 3.92	-6.18; -1.14	-0.59	0.373
Placebo	17.6 \pm 4.2	-1.32 \pm 4.75	-4.61; 1.97		

$P_{6s \text{ max}}$ – the highest mean 6-s mechanical power; $P_{\text{peak max}}$ – the highest peak power per one revolution, $P_{\text{peak mean}}$ – the mean of the peak powers per one revolution; P_{mean} – the mean power in the all test; BLa – post-exercise blood lactate concentration; PRE – pre-test; $POST$ – post-test; p – p -value (t -test); d – Cohen's d effect size; $p < 0.05$.

4 DISCUSSION

Our results showed that 5-day supplementation of 20g/d of creatine monohydrate mixed with maltodextrin in the ratio 1:3, divided into four equal doses and used in the middle of the post-season that was featured significantly reduced training of soccer players, led to a significant increase in body weight (BW), in contrast to the placebo. The mean change of BW in the Cr group 0.8 ± 0.8 kg was similar to that reported in other studies with soccer players who consumed Cr monohydrate over 5-6 days (Gouttebauge et al., 2012; Mujika et al., 2000). There is a suggestion that the early change in BW following Cr supplementation is mainly attributed to increased water retention in the intracellular compartments within muscle cells, probably due to the increased osmotic load caused by the increased intracellular Cr concentration (Bemben & Lamont; 2005; Deminice et al., 2016) The body water retention was also suggested in the current study. Although no significant change, the effect of the Cr supplementation on the change in intracellular water was close to medium effect ($d = .46$) with an obvious difference of mean individual change in the the Cr group as compared to the placebo group (table 1).

Our results also suggested a certain tendency towards increase in fat free mass (FFM) and total body muscles (TBM) following Cr ingestion as the positive small effect sizes were found ($d = 0.26$ and 0.27). These effects might partly contribute to the significant enhancement of BW. However, the increase in muscle size may be primarily due to intracellular water retention (Bemben & Lamont; 2005; Mesa et al., 2002). In addition, an increase in the cross-sectional area of muscle fibers as well as myogenic regulatory factors is achieved when a concurrent longer resistance training intervention is applied (Branch, 2003; Cribb et al., 2007; Deldicque et al., 2008). As participants in the current study underwent the reduced training regime throughout the post-season, based on soccer-skill and game practice, without muscle strength/power training, the increase in BW was most likely associated with increase in intracellular water.

Performance in SJ and CMJ are recognised as valid measures of explosive strength of lower limbs, mainly contributed from the knee

and hip extensors' moments (Ford et al., 2009). Furthermore, sprint acceleration has been reported to be strongly determined by lower limb strength, specifically by hip extensor and knee flexor muscle contractions, including eccentric hamstring capability (Morin et al., 2015; Schache et al., 2015). The benefit of Cr supplementation for the enhancement of explosive muscle strength of lower limbs seemed not be proved in movement actions (jumping, accelerated sprinting) that are specific for soccer.

In contrast to performance in both jumps and the accelerated sprinting, three measures of maximal anaerobic power assessed with the CST and one measure with repeated cycle sprints (IAnTBE) were enhanced following Cr supplementation (in 7 and 6 respectively of 8 participants). These measures of maximal mechanical power (see Methods and Results) are assumed to be the expression of the maximal rate of anaerobic ATP synthesis (Driss & Vandewalle, 2013). Specifically in the current study, maximal anaerobic power in the CST was indicated by the mean 6-s power output and the peak power determined by the highest power output per one crank revolution (both measures related to BW and FFM). Participants usually achieved peak power between 3-5 s during 6-s single cycling. It was proved that ATP resynthesis during a single all-out exercise lasting $\leq 5-6$ s is mainly provided from the breakdown of PCr (Bogdanis et al., 1998). Therefore, the results of the current study suggest that the 5-day Cr supplementation applied in soccer players might induce maintenance of ATP availability for repeated contractions of leg muscles during 6-s maximal intensity exercise, probably due to an increase in the PCr energy pool that helps to resynthesize ATP via hydrolysis of PCr (Ydfors et al., 2016).

The above-mentioned findings of the ergogenic effect of Cr supplementation for maximal anaerobic power might not influence jump performance and time of 10-m sprints when a vertical jump represents a single (one-off) muscle action of lower limbs and the duration of 10-m sprinting was 1.89 ± 0.05 s. It is possible that jumping and very short sprinting can be more limited by inter- and intra-neuromuscular coordination including motor

unit recruitment rather than changes in the high-energy phosphate metabolism. This suggestion is supported by the meta-analysis by Branch (2003) that revealed the lower effect size for field exercise including running and jumping compared to laboratory-based isometric, isokinetic and isotonic exercises performed against very high resistance.

No significant effect of Cr supplementation on vertical jumps and the acceleration phase of sprinting might also be associated with the increase in BW. Body water retention induced from Cr supplementation may concern other body parts, besides lower limbs. BW is the key factor of anaerobic power output when assessed by resistance cycling (Driss & Vandewalle, 2013) while jumping and running are bearing activities. A vertical jump depends on vertical force generated by the legs to overcome gravity that directly relates to BW

(Aragón-Vargas & Gross, 1997). Indeed, a change in body composition but not in BW was reported to be an important determinant of enhancement in performance of vertical jump (González-Ravé et al., 2011) and sprint running (Barbieri et al., 2017).

Recent research has provided somewhat controversial findings on the ergogenic value of Cr supplementation for the ability to maintain muscle power output and running performance during maximal or very high intensity intermittent exercises (see Introduction). Enhancement of mean mechanical power in the IAnTBE was found in both Cr and placebo conditions (Figure 1). This finding might show more on the familiarisation or learning effect. The participants did undergo short familiarization (one week before the experiment) consisting of three sprints, but not this entire intermittent cycle test.

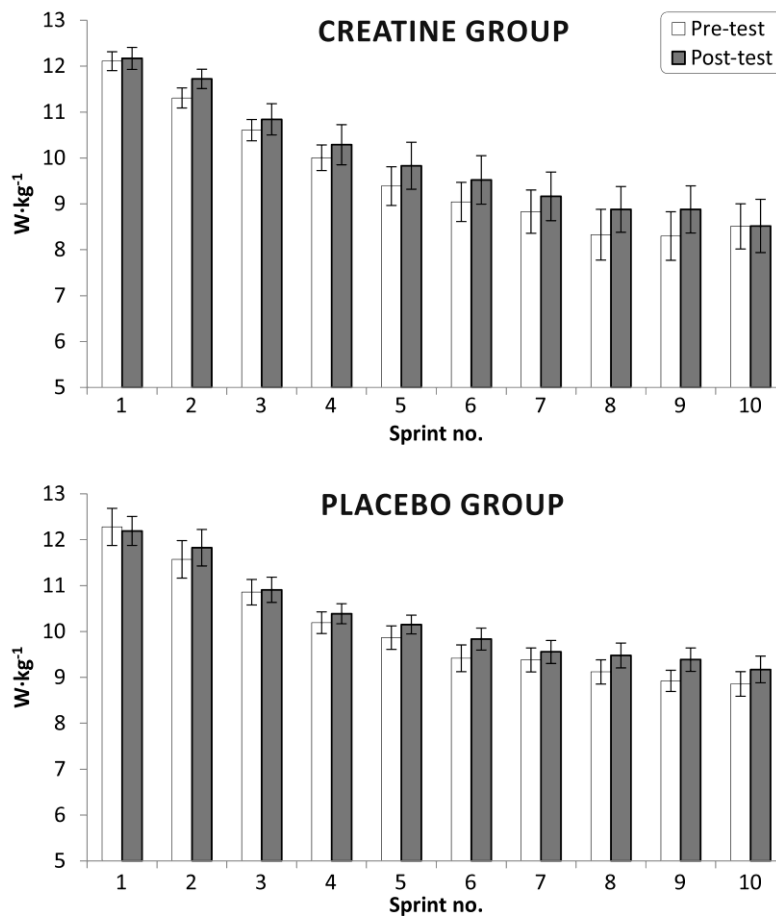


Figure 1. The mean 6-s mechanical power in consequent cycle sprints in the IAnTBE in the creatine group and placebo group.

However relative to the placebo condition, Cr ingestion led to an increase in mean peak power ($P_{\text{peak mean}}$; kg BW) by 4.4% during the IAnTBE (Figure 2). Furthermore, it is worth mentioning the relatively large, but not significant, decrease of FI_{6s} (by 9.7%) in comparison to increase in the placebo group (by 0.8%). These results could suggest increased PCr resynthesis during 30-s rest intervals. A strong relationship between PCr resynthesis and the recovery of power output during repeated very high intensity short duration bouts of exercise was reported (Bogdanis et al., 1996; Yquel et al., 2002). Higher PCr resynthesis and/or higher Cr availability is supported by

the larger significant decrease of the post-exercise BLa (by 16.6%) after the IAnTBE following Cr supplementation in the current study. It is known that PCr decreases stimulation of non-oxidative glycolysis, and Cr buffers pH changes caused by increased intramuscular acidosis by utilising the hydrogen ions during the Cr kinase reaction (Spriet, 1992). Following 6-day Cr supplementation applied within the training program for the Olympic games, significantly lower BLa was observed in elite female soccer players after first and second block of 11minutes of the soccer-match simulating exercise (Cox et al., 2002).

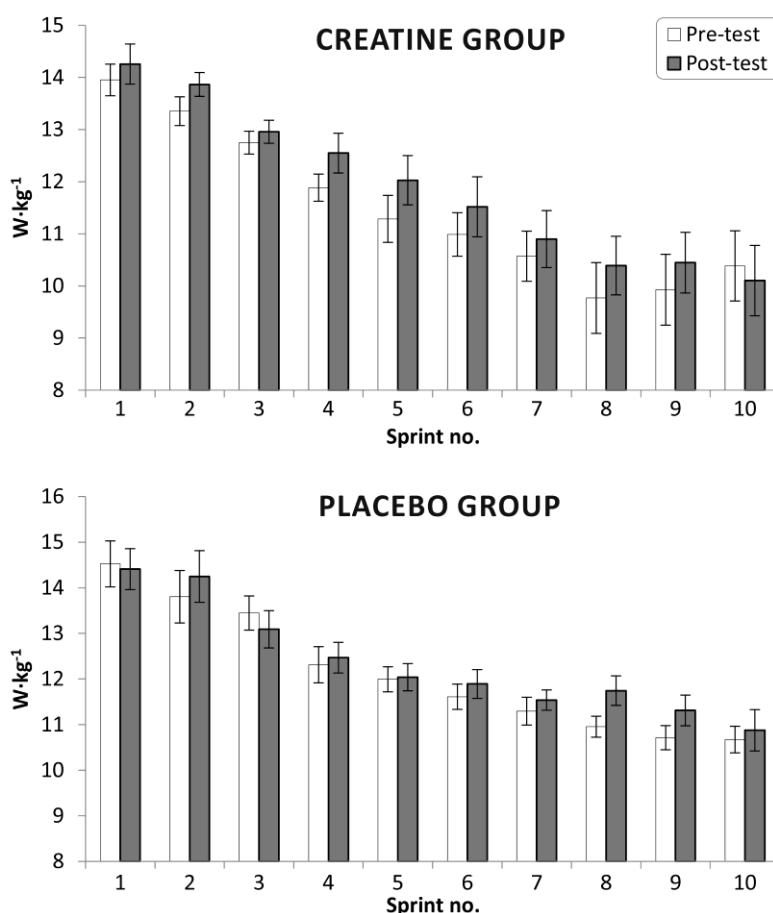


Figure 2. The mechanical peak power in consequent cycle sprints in the IAnTBE in the creatine group and placebo group.

A potential limit of the study is the smaller sample size. To better understand the effects of Cr supplementation, these effects should be

investigated with respect to the physiological profile of participants. The effect of Cr supplementation may be affected by initial levels

of Cr and PCr, the relative proportion of type II skeletal muscle fibres, preload muscle fibre CSA (Rawson & Persky, 2007) and coincidental ingestion of protein and/or carbohydrate (Steenge et al., 2000). However in the current study, 6 or 7 of the 8 participants were responders to Cr supplementation with an increase in the particular measures of maximal anaerobic power. This extent of inter-individual muscle strength/performance response to Cr supplementation corresponds to reported estimations on 20-30% of non-responders (Greenhaff et al., 1994; Rawson & Persky, 2007).

5 CONCLUSIONS

In summary, the study shows that 5-day Cr supplementation with a dosage of 20 g of creatine monohydrate per day applied in young soccer players during their off-season can improve body weight, lower-body maximal anaerobic performance and recovery during maximal intermittent exercise. The study also confirms that short-term Cr supplementation is safe and without side effects for adolescent athletes. From a practical perspective, short-term Cr ingestion might be useful in the event of reduced training due to an injury, fatigue and other reasons for training restrictions for players. The study supports the current hypothesis that Cr supplementation is beneficial for enhancement in lower limb performance for exercises with a duration of less than 3 minutes, independent on population characteristics and training protocol

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