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Monitoring of training activity as a determinant of people's health in the COVID-19 pandemic crisis

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Reliable determination of metabolic and physical activity parameters and influences of blood pressure indicators is relevant in the development of rehabilitation training programmes for people of all ages, especially in the context of the COVID-19 pandemic and the aging of the working population. The purpose of the study was to determine reliable parameters that were shaping general health during the COVID-19 pandemic crisis in the age-related aspect. This study used the results of comprehensive health monitoring data of 603 adults aged 20–89 from the Human Health Passport online tool (Ukraine) for the period of 2020–2022. Online health monitoring showed the consequences of mild forms of COVID-19 disease. The main indicators informing about this effect were the laboratory-method indicator for confirming a viral disease and the number of cases of mild forms of the disease. The indirect influence of this factor on various indicators of health, physical activity, metabolism, indicators of blood pressure compensation should also be considered. As for the age aspect, the state of health had a higher influence on the indicators of body mass index (BMI), blood pressure and its correction with drugs, the daily walking distance and exercises performed, and a dangerous loss of appetite. A noticeable drop in body weight and loss of appetite are reliable factors in the incidence of falls and decline in health. The leading factors shaping the health of the active population in mild forms of COVID-19 are physical activity (7.77%), metabolism (5.91%), and the blood pressure level (5.21%).

Keywords: lifestyle, physical activity, blood pressure, BMI, COVID-19

INTRODUCTION

Among other factors, bioeconomics evaluate the indirect effects of the COVID-19 aftermath (Dorn et al., 2022), and using bio-physiological or observational data measuring technology-induced stress in remote workplace is actually intended for coping with work-related technostress (Rohwer et al., 2022) in the COVID-19 pandemic crisis. Modern capability

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scales used in geriatrics make it possible to monitor the health and general working capacity of older people and workers and to carry out online selection of patients for initial health assessment by a physician. The algorithm for assessing the symptoms of the disease and online consultations for the implementation of proposed methods during the COVID-19 pandemic to limit contacts and minimize the risk of infection of older workers and pensioners are gaining relevance. The state of health is the basis of the general working capacity and functional age of employed and unemployed persons (Poliakov et al., 2020). Simplified scales have been proposed for the definition and assessment of senile infirmity, intrinsic capacity (Sadana et al., 2019), and assessment of cognitive abilities (de Souto Barreto et al., 2021). To monitor the Human Health Passport (Poliakov et al., 2022), the parameters of residual and general working capacity (Poliakov et al., 2022; McCallum et al., 2020), the rate of aging (Poliakov et al., 2020), the ICOPE (Integrated Care for Older People) mobile assessment recommended by the WHO (World Health Organization, 2019), and the assessment of age-related frailty SARC-F (**S**trength, **A**ssistance with walking, **R**ise from a chair, **C**limb stairs, and **F**alls) (Morley, 2016; Malmstrom et al., 2013; Malmstrom et al., 2013) and falls (World Health Organization, 2018; 2021; Stevens et al., 2015; Arosio et al., 2021) were used. Poliakov and Tomarevska developed the online monitoring tool 'Human Health Passport', which was launched on 22 May 2020 in the Occupational-Labour Rehabilitation Laboratory. The purpose of this tool is remote automatic evaluation of people's health to determine the prophylactic measures and to assess the need for consultation and medical assistance to improve their health.

The COVID-19 pandemic exacerbated absolutely all problems: both nosologically (when COVID-19 seemed to have overshadowed all other diseases) and in relation to concomitant diseases. The implementation of prevention methods for cardiovascular and other diseases underwent a modern challenge regarding the organisation of society in pandemic conditions. Studies into the professional profile of the hybrid workplace of an office worker or a teacher and online education of students during restrictive anti-epidemic measures revealed a reliable trend of the impact of hypodynamic syndrome on the state of people's health.

As a criterion of restriction of physical activity in the pandemic conditions, the total walking distance that pensioners, workers, students, the self-employed and the temporarily unemployed cover per day decreases. In connection with the restricted daily regime of work and rest, a need arose to pay more attention to daily breaks of physical activity and training in the conditions of a hybrid workplace. A meticulously organised schedule of work, rest, and physical activity has a significant effect on relieving fatigue and increasing the body's resistance to various diseases (Herrera et al., 2021). According to the WHO and the International Labour Organisation, overtime work leads to serious outcomes of cardiovascular attacks. According to scientific data, five hours of sitting at a desk leads to a hypodynamic lifestyle. That is, after two hours of sitting, blood coagulation and anticoagulation system is activated in the blood vessels with possible formation of blood microclots (Kivimäki et al., 2018). In connection with the change in the working regime, there was an urgent problem of overcoming this negative consequence at the workplace in particular.

In the early 1990s, 45 minutes of work in front of the computer monitor was the required standard; after those 45 minutes, they did exercises for the eyes, muscles of the upper shoulder girdle, neck and back, and lower limbs. But in the ecosystems of the acceleration of the pace of life, the expansion of professional duties, intensification of work, and the new scientific and digital era, this was forgotten and the workers began to neglect the time of workplace professional gymnastics and physical culture breaks. During the pandemic period, all these problems became actualised and came to the fore, especially in combination with chronic diseases for older workers. Today, a workout (physical exercise) in industry has receded into the

background: it is not given necessary attention in most workplaces. However, it is only physical activity at the workplace that facilitates both restoring and maintaining working capacity throughout the working hours. Using basic means of workout in industry, it is possible to combine care for health, maintenance of physical fitness, and high work capacity (Herrera, 2021). It is necessary to distinguish between the types of physical activity and prevention of the hypodynamic lifestyle. Physical workout of 5–6 minutes, a set of 6–7 physical exercises for different groups of muscles are performed, especially for those muscle groups that experience the hypodynamic effect. Warming up is the introductory part of the workout before more intensive exercise to prevent injuries. The workout is a set of hygienic gymnastics with 10–15 exercises for all muscle groups. Physical training activity is aimed at developing strength, endurance, flexibility, coordination, etc. The results of the online health screening by the Human Health Passport were analysed. The outbreak of COVID-19 forced all employees around the world to work in completely different conditions. COVID-19 prompted interventions such as social distancing, travel restrictions, and virtual or remote work, thereby changing the usual working routines (Narayanamurthy et al., 2021), the workplaces, and time management. Introduced by the outbreak of COVID-19, such measures brought about changes in the employee behaviour that came with numerous lockdowns ranging from temporary to long-term. Line managers, team leaders, and human resource professionals were genuinely concerned about such changes in behaviour because they could affect emotional, cognitive, and physical well-being of employees, which in their turn could affect their results and performance. Due to the COVID-19 pandemic, leading a physically active lifestyle in harmony with work and rest became difficult. Regular exercise at home can be helpful in keeping one active, preventing some of these problems, and helping to maintain one's fitness and health (Herrera et al., 2021). Sedentary life and work can cause various common occupational diseases affecting muscular, skeletal, cardio-vascular, or sensory systems, but they can be prevented by taking active breaks. Software can help reduce the risk of occupational diseases caused by sedentary work in the office; for this purpose, web and mobile applications have been developed for active control of the work break, which is a proven practice in reducing morbidity (Herrera et al., 2021; Shariat et al., 2020). The role that technology can play in increasing the existing professional knowledge of workers is remarkable. A promising and widely accepted strategy for achieving this goal is reduction of sedentary behaviour and increasing physical activity (Damen et al., 2020). Employees performing sedentary work do not compensate for it by increasing their physical activity or reducing their sitting time outside of work. Occupational measures should address sedentary behaviour both at the workplace and in leisure time (Clemes et al., 2014).

The aim of the study was to determine reliable parameters that were shaping general health of students, employees, and the retired during the COVID-19 pandemic crisis from the point of view of their age.

MATERIALS AND METHODS

The method of automatic preventive assessment using the online monitoring tool the Human Health Passport, accessed via QR code or the link https://forms.gle/Q5qUWZdmRyd9GDoQ7, was applied in this study. This sample-based, multicentred cohort study included the following parameters: age, working activity, social and demographic parameters, memory and attention, dynamics of weight changes, appetite, blood sugar levels, physical, cognitive, and social activities, hearing and vision, clarity of thought, functional capabilities, static balancing (e.g., standing on the left leg with eyes closed), breath test results, professional employment, skills, anthropometric data, blood pressure (and its medication corrections), hand grip muscle strength, vital lung capacity, anamnesis of disease and vaccination against COVID-19 between 2020

and 2022. The respondents' answers to all questions about their health were evaluated on the scale ranging from 0 to 21 points using Google Form; the set of values was assessed. The cloud platform instantly provided the result and guidance for actions according to the scale:

• Level 1: fewer than 6 points – a need for medical and social assistance, passive motor activity or passive movements;

• Level 2: 7–14 points – requires active rehabilitation and a more detailed diagnosis of one's state of health, light physical activity, breathing exercises to restore attention and clarity of thinking;

• Level 3: 15–16 points – requires consulting a doctor in detail, paying special attention to physical activity, breathing exercises to restore health, restore attentiveness, and clarity of thinking;

• Level 4: 17–19 points – a need to harmonise the balance of rest and work, physical training, performing breathing exercises to restore attention, clarity of thinking;

• Level 5: 20–21 points – the respondent is completely healthy, should not forget about active physical training and breathing exercises for excellent attention (Poliakov et al., 2022).

Both the potential patient and the physician received the results instantly via email. The study involved 602 people, and the results of 591 respondents were taken for detailed statistical analysis, due to correct answers. We studied the results of 103 males and 488 females aged 20 to 89 years during the pandemic crisis of 2020–2022. The data were analysed by standard statistical analysis methods (correlation analysis $p < 0.05$ considered reliable, cohort studies odds ratio with one-sided Fisher's exact test $p < 0.05$ considered reliable) (StataCorp, 2021; Skrondal, 2021; Cornfield, 1956; Woolf, 1955) using the Microsoft Office Data Analysis Suite add-in licensed version 2207 of Microsoft® Excel® for Microsoft 365 MSO and STATA ®17.0 SE–Standard Edition.

RESULTS AND DISCUSSION

The study covered people employed in main industry-related clusters, non-working respondents including students, and non-working pensioners, a total of 591 respondents included in the analysis. Respondents aged 25 to 89 years, 72.3% of whom were working and 27.7% non-working, were examined. Table 1 shows

Table 1. **Socio-demographic characteristics, employment, and health status of the respondents**

	Classification	N (%)
Sex	male	103 (17.4%)
	female	488 (82.6%)
Age range	<30 years old	199 (33.7%)
	31–44 years old	110 (18.6%)
	45–60 years old	198 (33.5%)
	61–70 years old	66 (11.2%)
	71 years old and above	18 (3.0 %)
Employment	employed	427 (72.3%)
	unemployed	164 (27.7%)
Health level (HL)	1 HL (≤6 points)	1 (0.17%)
	2 HL (14–7 points)	125 (21.15%)
	3 HL (16–15 points)	170 (28.76%)
	4 HL (19–17 points)	253 (42.81%)
	5 HL (21–20 points)	42 (7.11%)

the socio-demographic and professional characteristics of the sample.

Figure 1 presents a general picture of the distribution of the state of health according to the scale of the Human Health Passport and the history of COVID-19 disease and vaccination in the period of 2020–2022. The obtained trends of the impact of mild forms of COVID-19 disease and the protective effect of the introduction of active vaccination show an indirect impact on health indicators during the pandemic crisis.

Figure 2 shows significant correlations between various health indicators during the pandemic crisis. Significant association was obtained between laboratory confirmation of positive COVID-19 test and the parameters of the decrease in the health score ($r = -0.09755$; $p < 0.05$) and the level of health ($r = -0.1003$; $p < 0.05$), respectively.

There is a negative correlation between indicators of general health ($r = -0.114$; $p < 0.05$) and the scores with the number of cases of COVID-19 per person ($r = -0.109$; $p < 0.05$).

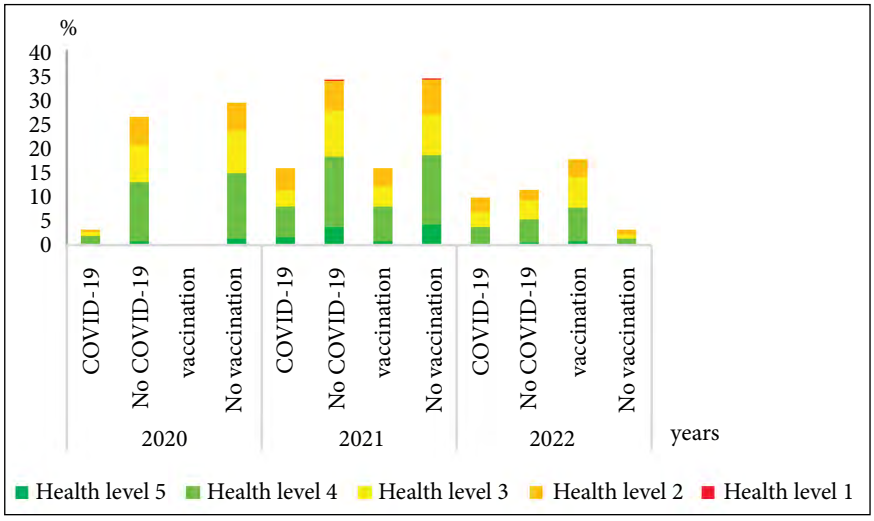

Fig. 1. The percentage of the parameters of COVID history and human health levels from the data of the Human Health Passport, 2020–2022

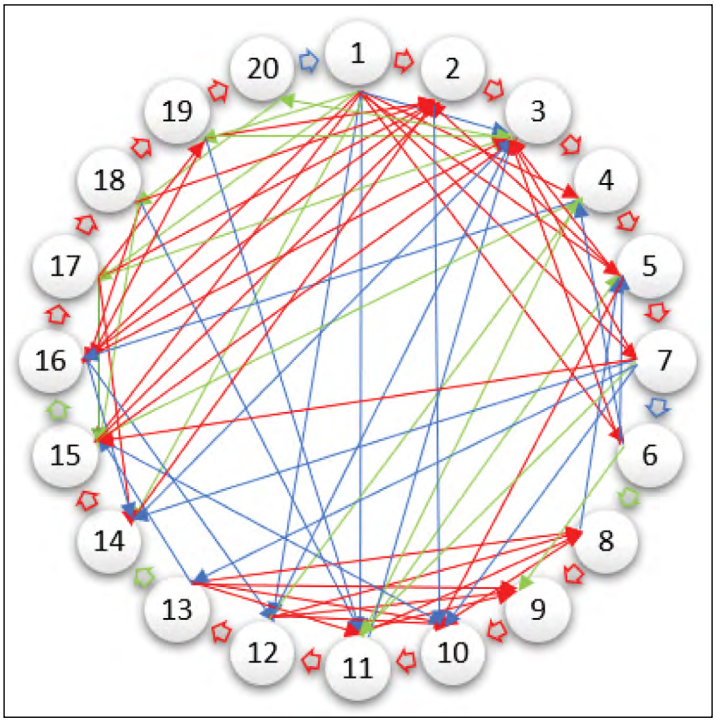

Fig. 2. Correlation galaxy model of the parameters obtained from general data of the Human Health Passport: 1 – scale in points; 2 – chronological age; 3 – health level; 4 – low activity; 5 – appetite loss ; 6 – fall; 7 – weight loss ; 8 – number of vaccinations; 9 – COVID-19 vaccination; 10 – date of the study; 11 – time of COVID-19 disease; 12 – COVID laboratory test; 13– COVID-19 positive; 14 – variety in workouts; 15 – distance in kilometres per day; 16– taking medicines for blood pressure control; 17 – BMI; 18 – systolic blood pressure; 19 – diastolic blood pressure; 20 – sex

→ $p < 0.05$; → $p < 0.01$; → $p < 0.001$

In Table 2, we demonstrated the reliable association of Health level 2 with such parameters as low activity during six months, appetite loss for three months, a shorter daily walking

Table 2. **Odds ratio of the activity and metabolism parameters with Health level (HL) from the data of the Human Health Passport (95% confidence interval)**

Definition		Males			Females		
	Classification	HL 2	HL3	HL4	HL 2	HL3	HL4
Low activity during six months	yes	4.97 (1.49–16.54)**	2.42 (0.91–6.47)	0.38 (0.16–0.94)*	5.22 (3.34–8.18)**	1.51 (0.99–2.28)*	0.21 (0.13–0.34)***
Appetite loss	yes	6.09 (1.80–20.57)**	1.31 (0.46–3.75)	0.51 (0.21–1.28)	3.60 (2.32–5.58)***	1.42 (0.94–2.14)	0.35 (0.22–0.54)***
Weight loss	yes	1.69 (0.44–6.56)	0.18 (0–1.134)	2.54 (0.86–7.44)	2.42 (1.52–3.87)***	1.31 (0.83–2.06)	0.48 (0.30–0.77)**
Fall (cases)	yes	2.34 (0.67–8.33)	1.79 (0.62–5.27)	0.63 (0.24–1.64)	3.60 (2.27–5.73)***	1.46 (0.93–2.29)	0.29 (0.17–0.48)***
Work out	Zero exercise	4.05 (1.10–15.22)	0.25 (0–1.60)	0.59 (0.19–1.76)	2.07 (1.04–4.11)*	1.21 (0.61–2.41)	0.50 (0.24–1.04)*
	1–2 exercises	0.52 (0.16–1.66)	4.46 (1.07–.)*	0.94 (0.39–2.24)	0.63 (0.35–1.13)	1.10 (0.62–1.96)	1.30 (0.75–2.26)
	3–4 exercises	0 (0–2.75)	0.38 (0.0–2.51)	0.63 (0.23–1.74)	0.77 (0.27–2.24)	0.53 (0.18–1.53)	1.66 (0.71–3.90)
	Five and more exercises	0 (0–10.24)	0 (0–4.79)	1.70 (0.21–.)	3.36 (0.59–19.29)	0.76 (0–5.40)	0.49 (0–3.45)
Walking distance km /day	Less than 1 km	5.07 (1.5–17.15)**	2.23 (0.79–6.36)	0.34 (0.13–0.9)*	2.46 (1.48–4.08)***	0.89 (0.53–1.51)	0.65 (0.39–1.08)
	1–2 km	0.5 (0–3.32)	1.41 (0.43–4.76)	0.5 (0.17–1.5)	1.14 (0.69–1.88)	1.29 (0.81–2.03)	0.62 (0.39–0.99)*
	3–4 km	0.63 (0–2.78)	1.31 (0.46–3.75)	0.99 (0.4–2.44)	0.82 (0.49–1.37)	1.06 (0.67–1.67)	1.2 (0.78–1.83)
	5–6 km	1.18 (0.32–4.49)	0.48 (0.14–1.7)	2.29 (0.87–6.0)	0.86 (0.51–1.44)	0.84 0.52–1.35)	1.21 (0.79–1.87)
	7–8 km	0(0–5.4)	0 (0–2.3)	(1.42–.)*	0.35 (0.13–0.95)*	1.12 (0.57–2.21)	1.53 (0.8–2.9)
	9 km and more	0 (0–1.85)	0.575 (0–2.52)	1.14 (0.38–3.41)	0.53 (0.22–1.26)	0.8 (0.396–1.62)	1.53 (0.8–2.9)
BMI	Low weight	. (.)	0 (0–1.71)	2.82 (0.61–.)	1.31 (0.55–3.15)	0.56 (0.21–1.47)	1.17 (0.53–2.59)
	Eutrophic	1.91 (0.61–6.0)	1.89 (0.74–4.80)	0.66 (0.30–1.43)	0.65 (0.43–0.99)*	1,16 (0.79 – 1.72)	1.01 (0.71–1.46)
	Overweight	0.93 (0.25–3.49)	0,56 (0.18–1.76)	1.61 (0.66–3.91)	1.24 (0.75–2.03)	0.56 (0.33–0.93)*	1.53 (0.99–2.36) *
	Obesity	0.87 (0–3.93)	1.4 (0.46–4.32)	0.7 (0.27–1.88)	30.88 (9.69–97.95)***	1.57 (0.98–2.52)*	0.56 (0.35–0.92)*

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

distance for people in our cohort study. This also corresponds to the correlation linking the health level and the score with the definitions (r = –0.411; p < 0.001), (r = –0.345, p < 0.001), (r = 0.207; p < 0.001) accordance with low activity during for six months, appetite loss for three months, a shorter daily walking distance for people (Fig. 2).

Health level 2 is associated with rising cases of falls among women (Table 2). In general, impact influence the characteristics of falls are formed the health level and score in points (r = –0.332; r = –0.294, p < 0.001), accordance (Fig. 2).

An excessive BMI made a significant contribution to the decline in health in women (Table 2). This association remains significant when analysing the characteristics in the overall sample since the correlation between the BMI and the health level (r = –0.129; p < 0.01) and score health assessment (r = –0.132; p < 0.01) also shows a significant relationship (Fig. 2). Shortening the distance in kilometres walked daily (r = –0.139; p < 0.01) and daily reduction in the variety of physical exercise (r = –0.185; p < 0.001) contributes to a high BMI, while the control of systolic (r = 0.437; p < 0.001) and diastolic pressure (r = 0.305; p < 0.001) worsens even with the use of medications (r = –0.469; p < 0.001) correlate very strongly. Table 3 shows the characteristics of the percentage distribution of blood pressure parameters of our cohort.

The study shows that a systolic blood pressure above 120 mmHg has a high correlation with a decrease in the number of kilometres walked daily (r = –0.121; p < 0.01). At the same time, a low systolic and diastolic blood pressure is associated with a high incidence of COVID-19 (r = –0.1082; r = –0.1075; p < 0.05), but these phenomena need verification with a more representative sample, of course. Association between hypertension and health level (r = –0.344; p < 0.001) is stronger than the relationship between the systolic blood pressure shown like hypotension and the health level (r = 0.160; p = 0.05).

Thus, the overall picture of the study demonstrates ample additional reserves for the use of digital assistants, original methods presented in existing video courses, knowledge of leading instructors, etc. in physical rehabilitation, kinesiotherapy, exercise therapy, training, and short daily physical activity breaks to improve health.

Figure 3 shows that the influences that determine health are physical activity (7.77%), blood pressure (5.21%), metabolic compensation (5.91%), with the contribution of age (2.9%) to the decline in health against the backdrop of the COVID-19 pandemic crisis (1.15%).

Table 3. **Analysis of the ranges of blood pressure and pharmacological control in respondents, *n* (%)**

	Males, blood pressure cases (%)	Males, use of medicines for blood pressure control	Females, blood pressure cases (%)	Females, use of medicines for blood pressure control
Systolic blood pressure <120	12 (11.7%)	2 (1.9%)	155 (31.8%)	29 (5.9%)
Systolic blood pressure =120	62 (60.2%)	11 (10.7%)	217 (44.5%)	64 (13.1%)
Systolic blood pressure >120	27 (26.2%)	15 (14.6%)	96 (19.7%)	84 (17.2%)
Diastolic blood pressure <80	14 (13.6%)	3 (2.9%)	185 (37.9%)	40 (8.2%)
Diastolic blood pressure =80	73 (70.9%)	15 (14.6%)	216 (44.3%)	76 (15.6%)
Diastolic blood pressure >80	15 (14.6%)	11 (10.7%)	66 (13.5%)	61 (12.5%)
Does not measure the blood pressure	2 (1.9%)	1 (0.97%)	20 (4.1%)	5 (1.02%)

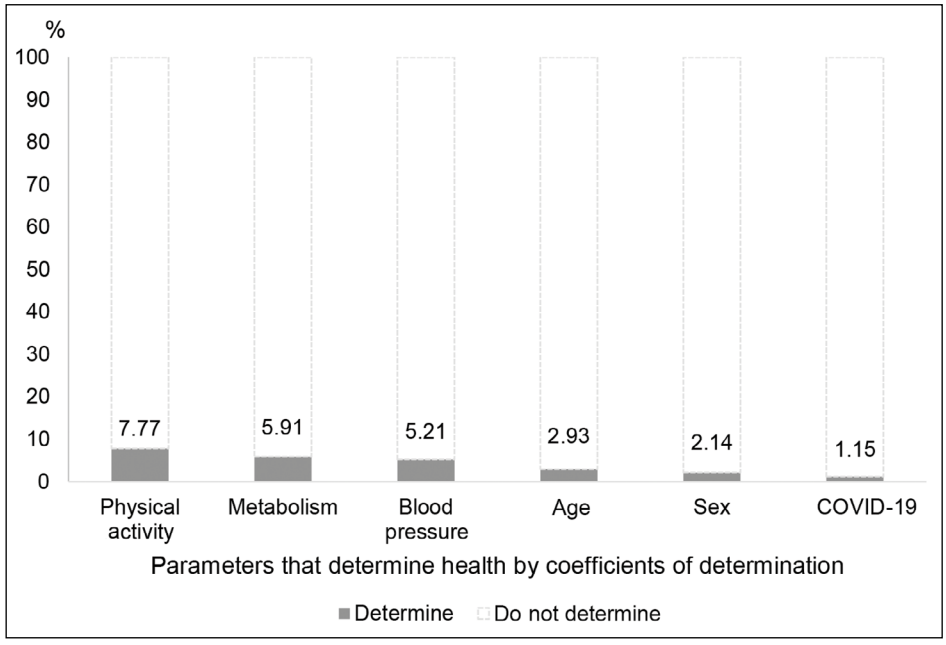

Fig. 3. The general trend means of R-squared for the relationship between parameters of physical activity, metabolism, blood pressure, age, sex, COVID and Health Level from the data of 2020–2022

CONCLUSIONS

This study showed reliable statistical coefficients of the relationships between characteristics of daily physical activity, blood pressure and metabolism, age aspects of health and performance during the pandemic crisis in males and females. Inclusion of this kind of data in rehabilitation programmes, training programmes for physical upgrade, and in the formation of simple breaks for physical workouts in the form of at least five exercises to improve health and increase people's working capacity is of vital importance.

Adequate physical activity, the presence of functional reserves in terms of blood pressure, BMI, maintenance of a healthy lifestyle and vaccination in compliance with anti-epidemic measures allows people to maintain their working capacity and quality life during the COVID-19 pandemic.

The prospect of the study is to monitor the health and performance status of the working population at both individual and community level over at least several years of observation against the background of improved objective indicators of physical activity such as daily walks, five or more different daily exercises for students, working pensioners and the non-working population as labour factors for smart ageing in the digital world. Online assessment of functional ability and health of people may improve physical rehabilitation in order to acquire the skill to perform easy and effortless physical exercises suitable for all health levels and to everybody.

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A – research concept and design, B – data collection and analysis, C – responsibility for statistical analysis, D – writing the article, E – critical review, F – final approval of the article

Competing interests

The authors declare no conflict of interest.

Consent for publication

All authors have given their consent for publication.

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Availability of data and material (data transparency)

Limited access to data granted by the authors upon reasonable request.

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FIZINIO AKTYVUMO ĮTAKA BENDRAI SVEIKATAI COVID-19 PANDEMINĖS KRIZĖS METU

Santrauka

Patikimas metabolinio fizinio aktyvumo parametrų ir kraujospūdžio rodiklių įtakos nustatymas aktualus rengiant reabilitacijos programas įvairaus amžiaus žmonėms, ypač COVID-19 pandemijos ir senstančios darbingos visuomenės sąlygomis. Tyrimo tikslas – nustatyti patikimus parametrus, formuojančius bendrą studentų, dirbančiųjų ir pensininkų sveikatos būklę COVID-19 pandemijos metu, pagrindinį dėmesį kreipiant į amžių. Šiame atsitiktinių imčių tyrime 2020–2022 m. išsamiai stebėta 20–89 metų amžiaus 603 suaugusiųjų sveikata naudojant internetinį „Žmogaus sveikatos pasą“. Duomenys analizuoti standartiniais statistinės analizės metodais. Internetinė dirbančiųjų, studentų ir pensininkų sveikatos stebėsena pagal funkcinius tyrimus ir įsivertinimą parodė galimas ligos pasekmes esant lengvai COVID-19 formai. Pagrindiniai rodikliai, informuojantys apie šį poveikį, yra koronaviruso patvirtinimas laboratoriniu metodu ir lengvos formos ligos atvejų skaičius. Reikėtų atsižvelgti į netiesioginį ligos poveikį įvairiems fizinio aktyvumo, medžiagų apykaitos ir kraujospūdžio rodikliams. Stebėjimai rodo, kad vyrų sveikatos būklė buvo geresnė nei moterų. Priklausomai nuo amžiaus grupės, sveikatos būklė turėjo didesnę įtaką kūno masės indeksui, kraujospūdžiui, per dieną nueitų kilometrų ir atliekamų fizinių pratimų skaičiui, pavojingam apetito praradimui. Įrodyta, kad svorio kritimas ir apetito praradimas yra patikimi pablogėjusios sveikatos ženklai. Esant lengvoms COVID-19 formoms, pagrindiniai gyventojų sveikatą formuojantys veiksniai yra fizinis aktyvumas (7,77 %), medžiagų apykaita (5,91 %) ir kraujospūdžio lygis (5,21 %).

Raktažodžiai: gyvenimo būdas, fizinis aktyvumas, kraujospūdis, kūno masės indeksas, COVID-19