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ORIGINAL RESEARCH PAPER

STUDY REGARDING THE INFLUENCE OF EXERCISE AND DIET ON THE IMPROVEMENT OF HEALTH DURING THE CORONAVIRUS PANDEMIC

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Abstract: The Covid 19 pandemic has troubled the entire world with its aggressive and fast way of spreading. The states of emergency and alert declared by multiple countries, including Romania, have determined major changes in all aspects of life. Banning free movement of any kind and the high number of cases of infection have created unrest and even panic. The people's general health was endangered. Exercise, among many other benefits, releases endorphins and that is why the authors thought that this could improve one's health during the pandemic. This study's objective was to investigate how *during the pandemic, exercising for 40 minutes four times per week together with a personalized nutritional plan, can contribute to the improvement of one's health, mainly one's cholesterol and triglycerides values.* The study has shown that the training sessions and personalized nutritional plan had a great effect to improve the health by reducing their cholesterol and triglycerides values and their body mass and from a motor point of view on the 56 year old subject, in the sense that there was a decrease in weight 7.14 % higher than in the 30-year-old subject.

Keywords: *coronavirus, exercise, biochemical markers, pandemic, running*

INTRODUCTION

A series of studies presented by the Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion show that under normal conditions, following a personalized nutritional and an exercise plan of moderate intensity, a person can lose between 1.8-3.6 kg·month^{-1} [1].

The psychological factors and lack of physical activity, in this case generated by the pandemic restrictions, can negatively affect one's health by modifying the biochemical markers - that is why a diet, corroborated with moderate physical activity can improve it considerably [2, 3].

An optimal diet (which include the consumption of whole grain foods, as well as fruits and vegetables) in combination with physical exercise can improve well-being, maintain good nutritional status to fight against viruses. An optimal diet, rich in vitamin C which is one of the best way to improve immune system, fibers, phytosterols, phenolic compounds, tocopherols, carotenoids, minerals, could reduce the risk of death associated with coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2, 4].

Physical training induces a biochemical adaptive response which might require an increase in the ingestion and/or the absorption of micronutrients [5]. Studies show that consumption every day of a small quantity of cinnamon for 40 days showed significant reductions in fasting serum glucose, triglycerides, LDL cholesterol and total cholesterol [6]. Also, sesame seeds, pumpkin, cashews, nuts contain bioactive compounds such as monounsaturated and polyunsaturated fatty acids, fibers, phytosterols, phenolic compounds, tocopherols, phospholipids, carotenoids, some minerals, and arginine which improve to lipid profile thus protecting against cardiovascular diseases [7 – 9].

The study was conducted on two volunteer female subjects, aged 30 (S1) and 56 (S2), performing a daily moderate physical activity. Once the state of emergency has been declared, this activity became almost nonexistent, which has led to this research, in the context that the blood tests indicated an increase of total cholesterol, LDL (low-density lipoprotein or "bad cholesterol") and triglycerides in both subjects. High levels of LDL cholesterol raise the risk for heart disease and stroke [10]. The body changes the extra calories into triglycerides, and stores them in fat cells. When your body needs energy, it releases the triglycerides. The cholesterol particles carry the triglycerides to the tissues.

Having a high level of triglycerides can raise the risk of heart diseases, such as coronary artery disease [11, 12].

A high LDL (bad) cholesterol and a low HDL (good) cholesterol connected with a high triglyceride level is related to accumulations of fat in the artery walls which increases the risk of heart attack and stroke [13 – 15].

The research had two independent variables - motor and nutritional. The results have confirmed the working hypothesis, in the sense that after three months the values of the three markers have entered normal parameters.

This study aimed to improve the health of two female subjects of different ages (30 and 56) by reducing their cholesterol and triglycerides values and their body mass, following a diet and exercise program of moderate intensity.

MATERIAL AND METHODS

The research was conducted over 3 months, between April 15 and July 15, 2020, on two female subjects aged 30 (S1) and 56 (S2), both overweight (S1 - 90 kg / 175 cm in height, S2 - 80 kg / 168 cm). Medically, both subjects were in relatively good health, but with high total cholesterol, LDL, and triglycerides values.

Considering the restrictions imposed by the pandemic, the subjects have agreed to participate in this experiment because, due to the lack of physical activity, their calorie burn has decreased immediately after the state of emergency.

The electric running band Body Fit F5000 and smartwatch HUAWEI Band 4 were used during the study. The working plan was to perform 4 km running on the treadmill and to follow a weekly diet consisting of one gram of cinnamon per day, vegetables / fruits, chicken, turkey and fish, walnut kernel, pumpkin seeds, sesame, lettuce, olive oil. Fried products, sweets and bread were completely excluded.

The study was based on two variables: **dietary** and **motor**, with initial and final measurements.

The nutritional variable consisted in a diet in which the weekly menus have changed every 30 days. This diet was created based on the initial blood test results, which showed in both subjects too high values for total cholesterol, LDL and triglycerides, and too low values for ionic Calcium in the 56-year-old subject.

The biochemical markers tested at the beginning and end of the experiment were: ESR, glycemia, ionic Calcium, cholesterol (total, LDL, HDL), triglycerides, Magnesium, GGT, creatinine, and uric acid. The blood tests analyses were performed at the medical laboratory of the Moinesti Emergency Hospital.

The motor variable was represented by 4 km running on treadmill, with no inclination, 4 times per week, at a treadmill speed that increased from one moth to another, from 4.5 $km \cdot h^{-1}$ initially to 5.5 $km \cdot h^{-1}$ in the second moth and to 6.4 $km \cdot h^{-1}$ in the last month.

Thus, the subjects performed 48 training sessions consisting of a total of 192 km. The recordings were made with the HUAWEI Band 4 smartwatch, which offered detailed information regarding the subjects' heart rate, number of paces, distance covered, speed, calories, transmitting the data to the Huawei S7 smartphone.

The recorded data were statistically analyzed with the SPSS 20 software. The data is presented as box plots and histograms. In order to determine the correlation degree between various parameters, the simple regression data was analyzed by testing the regression equation in SPSS. Thus, for a clearer representation of this variable's data the authors chose box plots and histograms for each recorded parameter, for each subject - work duration, average velocity, calories burned, average heart rate, number of steps and pace.

RESULTS AND DISCUSSIONS

Table 1 presents the initial and final values of the biochemical markers compared to the reference values, for both subjects. The final results of the biochemical markers with too high values show a progress, the final data being within the reference values. The only value that has maintained below the reference values and even accentuated its drop is Calcium, in the 56-year-old subject (Table 1). This can be explained by the poor

Calcium retention as a result of the menopause and the related hormonal changes, but also by the energy consumption caused by physical work.

Table 1. The biochemical marker values for the two subjects

Analyses	Reference values	S1		S2	
		Initial	Final	Initial	Final
VSH	2.00 - 20.00 mm·h^{-1}	15	14	12	11
Mg	1.80 - 2.40 mg·dL^{-1}	2.20	2.00	2.00	1.90
LDL cholesterol	**130 - 150 mg·dL^{-1}**	**193.8**	**145**	**221.0**	**148.00**
HDL cholesterol	35 - 60 mg·dL^{-1}	50	45	59	56
Total cholesterol	**110 - 220 mg·dL^{-1}**	**254**	**190.5**	**287**	**220.00**
Ca	8.6 - 10.0 mg·dL^{-1}	9.10	9.10	7.80	7.30
Uric acid	2.60 - 6.00 mg·dL^{-1}	5.70	5.00	5.00	5.10
GGT	5.00 - 55.00 Ul·L^{-1}	20	20	28	23
Triglycerides	**30 - 150 mg·dL^{-1}**	**159**	**101**	**309**	**148**
Creatinine	0.55-1.02 mg·dL^{-1}	0.92	0.82	0.75	0.62
Glycemia	70.00-115.00 mg·dL^{-1}	98	88	92.0	85

As one can see in Table 1, S1 recorded a drop in the LDL cholesterol values of 25.19 %, total cholesterol of 25 % and triglycerides of 36.48 %, while S2 recorded a drop in the LDL cholesterol values of 33.04 %, total cholesterol of 23.35 %, and triglycerides of 52.11 %.
The progress in regards to triglycerides and cholesterol for the two subjects is presented in Figure 1.

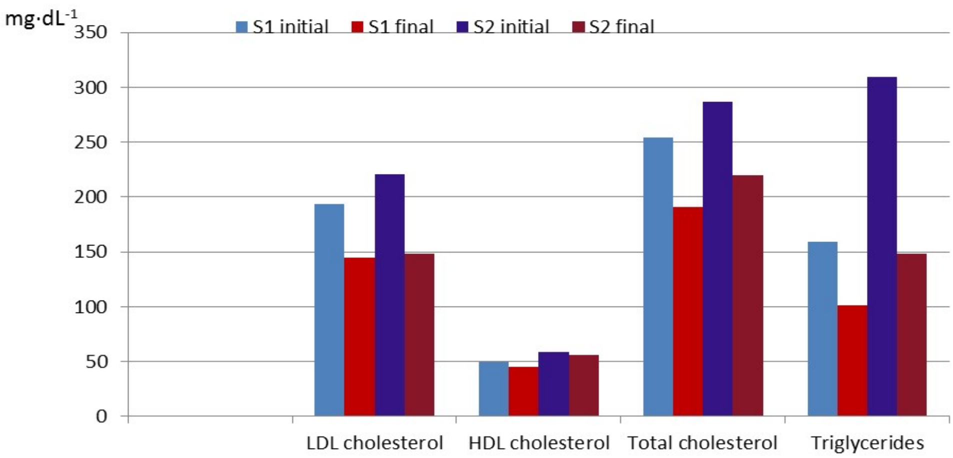


***Figure 1.** The progress of triglycerides and cholesterol in S1 and S2*

Good and very good triglyceride results were recorded by the 56-year-old subject - she initially had recorded double the reference value. Progress was recorded also in regards to cholesterol and LDL in both subjects. One can notice also the normal parameters of the other markers except for the Calcium in subject 2, where its numbers kept dropping below the reference values, by 6.4 % [16].
The final numbers moving within the reference values has generated a stable and balanced general state in the subjects.

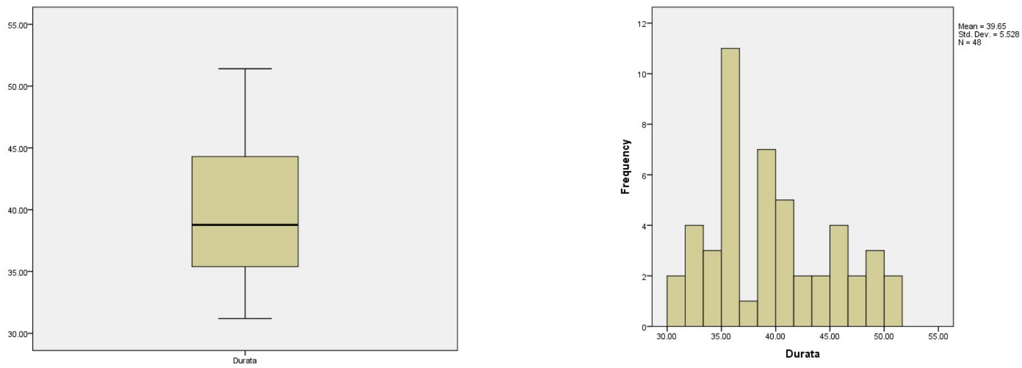
The cholesterol results must also be noted, in the case of which the literature speaks of two ways of decreasing it - diet and medicine therapy; in this case, there was a fortunate association of exercise and diet.

The subjects performed 48 training sessions consisting of a total of 192 km. Subject 1 (30 years old) covered this distance in a total of 1903.42 minutes, burning a total of 11917 calories and running a total of 234563 paces. Subject 2 (56 years old) covered this distance in a total of 2153.09 minutes, burning a total of 9773 calories and running a total of 246253 paces.

The statistical analysis of the recorded data for the **motor variable** was performed using the SPSS software. Thus, for a clearer representation of this variable's data the authors chose box plots and histograms for each recorded parameter, for each subject - work duration, average velocity, calories burned, average heart rate, number of steps and pace.

The results recorded by the 30 year-old subject are presented in Figures 2-7.

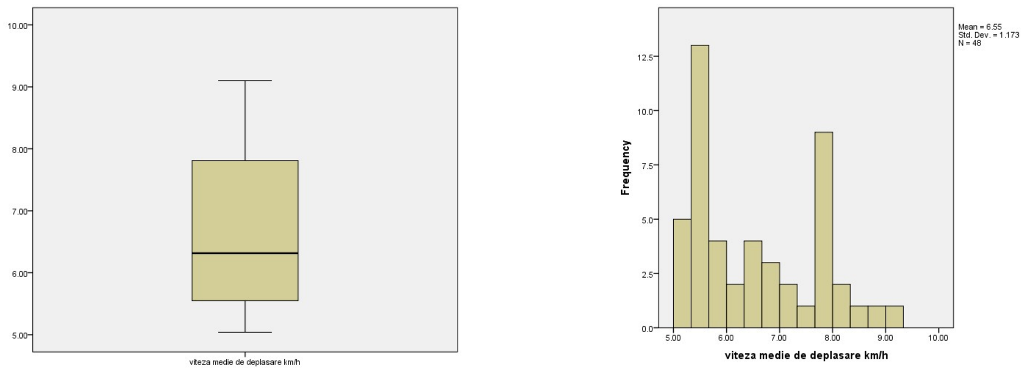
Work duration (Figure 2) for the 30-year-old subject was between 51.40 minutes and 31.20 minutes, with an average of 39.65 minutes.



a b

Figure 2. *Box plot (a) and histogram (b) for the motor variable work duration*

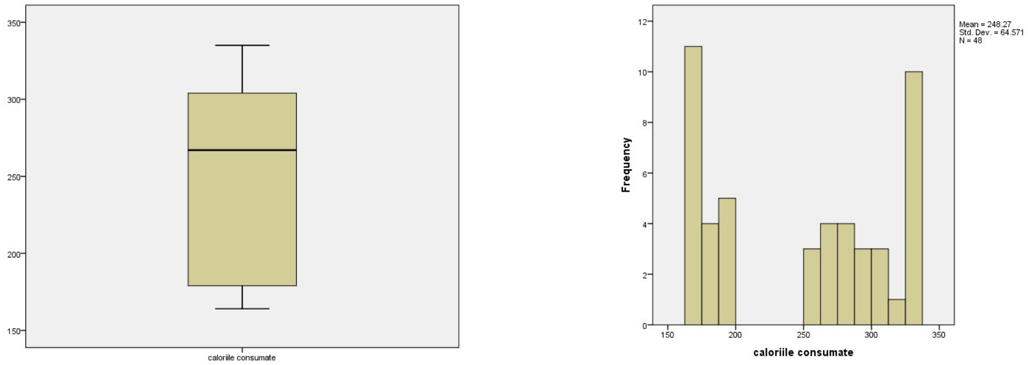
The average velocity represented in Figure 3 (a, b), recorded a minimum value of 5.14 km·h^{-1}, a maximum value of 9.14 km·h^{-1} and an average of 6.55 km·h^{-1}.



a b

Figure 3. *Box plot (a) and histogram (b) for the motor variable average velocity*

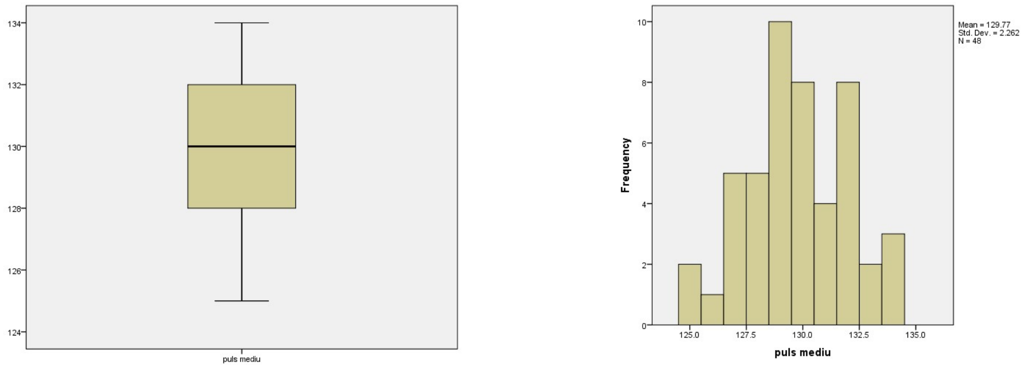
The calories burned during the 4 km of running were between 164 kcal in the first session and 332 kcal in session number 43. The average was 248.27 kcal (Figure 4).



a **b**

Figure 4. *Box plot (a) and histogram (b) for the motor variable calories burned*

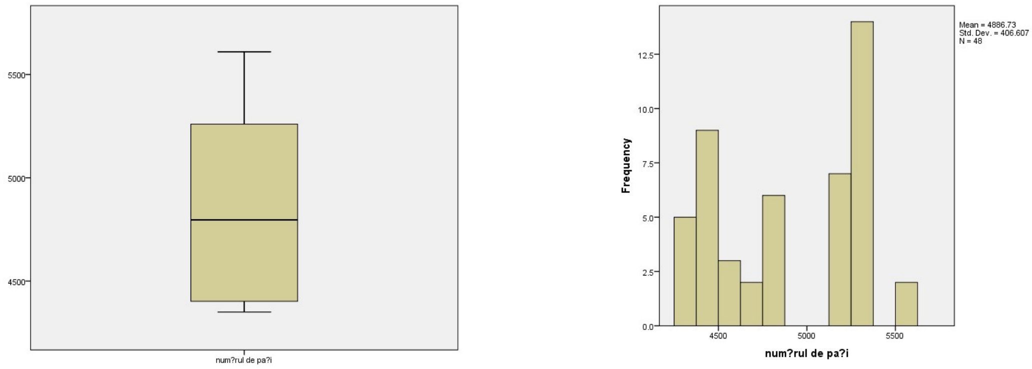
The heart rate varied between 125 beats·min^{-1} and 134 beats·min^{-1}, with an average of 129.77 beats·min^{-1} (Figure 5). One can see here a quicker adaptation of the body, in the sense that during session number 48, with the highest velocity, the heart rate reached only 129 beats·min^{-1}.



a **b**

Figure 5. *Box plot (a) and histogram (b) for the variable average heart rate*

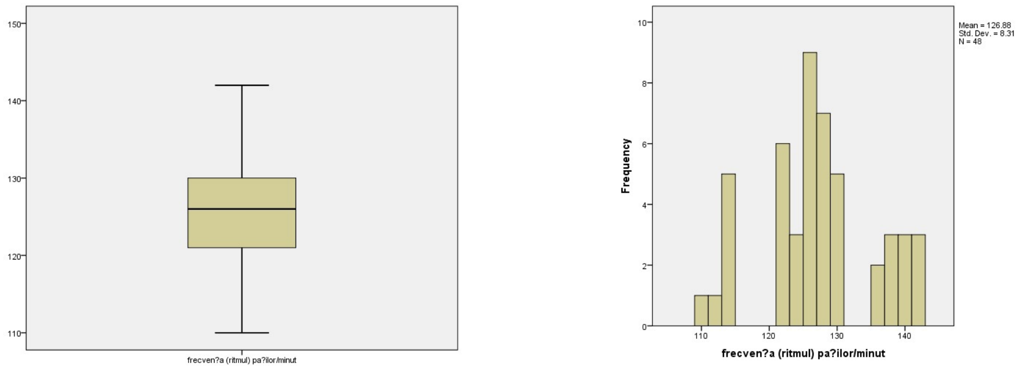
The number of steps was highest at the beginning of the sessions, of 5570, when the velocity was lower, determining shorter length of pace, and as a consequence, a higher number of steps (Figure 6). The lowest number of steps was recorded in session number 36, at an average velocity of 7.04 km·h^{-1}. Over the course of the study, this subject's average number of steps was 4886.73.



a b

Figure 6. *Box plot (a) and histogram (b) for the motor variable step count*

The pace had a minimum value of 110 steps·min^{-1}, a maximum one of 142 steps·min^{-1} at a velocity of 9.10 km·h^{-1} (Figure 7). The average was 126.88 steps·min^{-1}.



a b

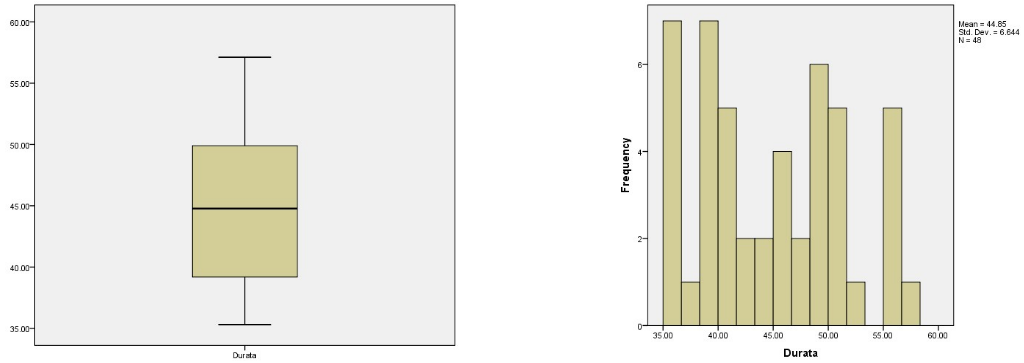
Figure 7. *Box plot (a) and histogram (b) for the motor variable pace*

Table 2. *Values recorded by the 30 year-old subject*

Case Summaries							
		Average velocity [km·h^{-1}]	**Duration [min]**	**Calories burned [kcal]**	**Average heart rate [bpm]**	**Step count**	**Pace· min^{-1}**
N	Valid	48	48	48	48	48	48
	Missing	1	1	1	1	1	1
Mean		6.5483	39.6546	248.27	129.77	4886.73	126.87
Std. Deviation		1.17260	5.52753	64.571	2.262	406.607	8.310
Variance		1.375	30.554	4169.393	5.117	165329.648	69.048
Skewness		.487	.479	-.042	-.037	-.064	.011
Std. Error of Skewness		.343	.343	.343	.343	.343	.343
Kurtosis		-1.108	-.809	-1.679	-.459	-1.597	-.488
Std. Error of Kurtosis		.674	.674	.674	.674	.674	.674

The results recorded by the 56-year-old subject are presented in Figures 8-13. Work duration for the 56-year-old subject was between 57.12 minutes and 35.39

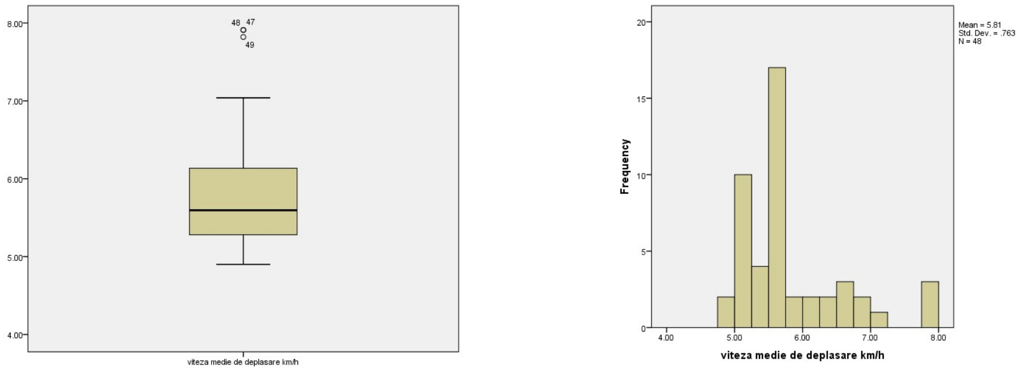
minutes, with an average if 44.85 minutes, 5.2 minutes higher than the one recorded by the 30-year-old subject (Figure 8).



a **b**

Figure 8. *Box plot (a) and histogram (b) for the motor variable work duration*

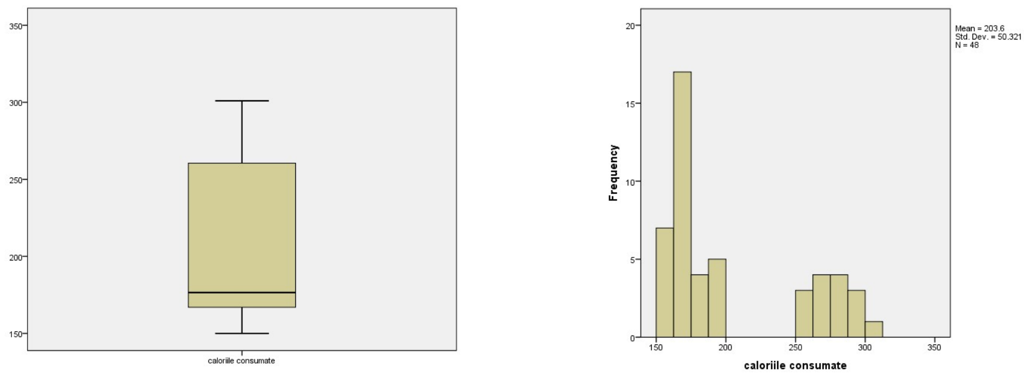
The average velocity in this case was between 4.90 km·h^{-1} and 7.91 km·h^{-1}, with an average of 5.81 km·h^{-1}, 0.69 km·h^{-1} lower than the previous subject (Figure 9).



a **b**

Figure 9. *Box plot (a) and histogram (b) for the motor variable average velocity*

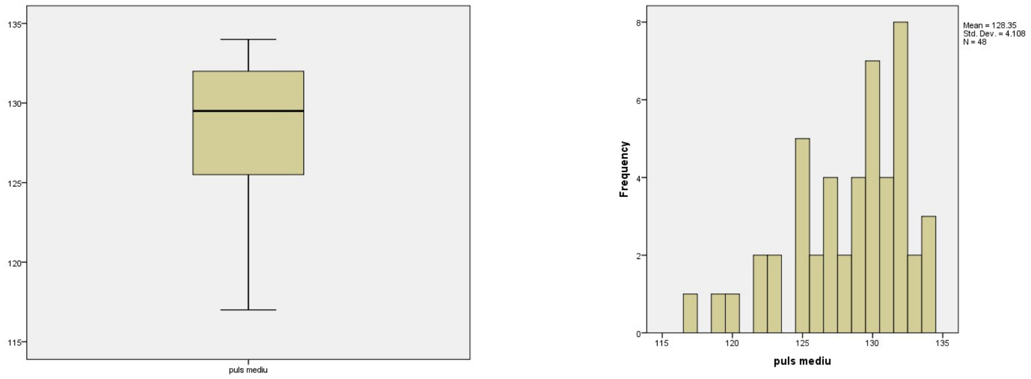
The calories burned were between 150 kcal and 301 kcal (Figure 10), with an average of 203.6 kcal, 44.67 kcal lower than the average recorded by the other subject.



a **b**

Figure 10. *Box plot (a) and histogram (b) for the motor variable calories burned*

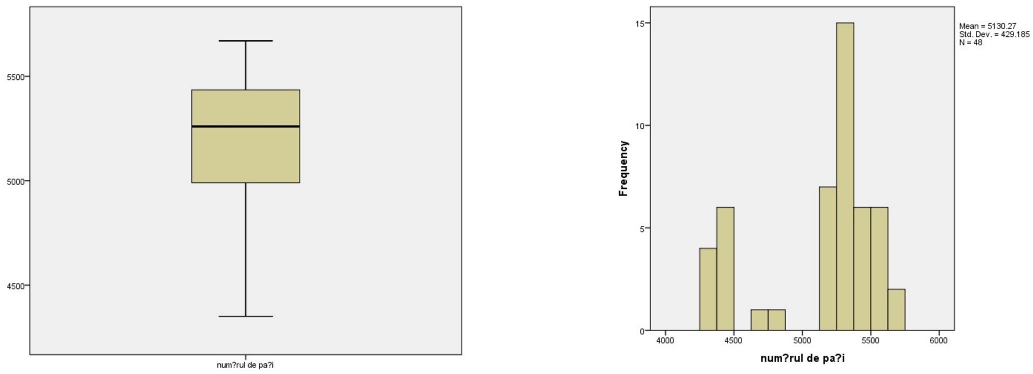
The heart rate had a minimum of 117 beats·min^{-1}, a maximum of 134 beats·min^{-1} and an average of 128.35 beats·min^{-1}, 0.65 beats·min^{-1} lower than the other subject (Figure 11).



a **b**

Figure 11. *Box plot (a) and histogram (b) for the variable average heart rate*

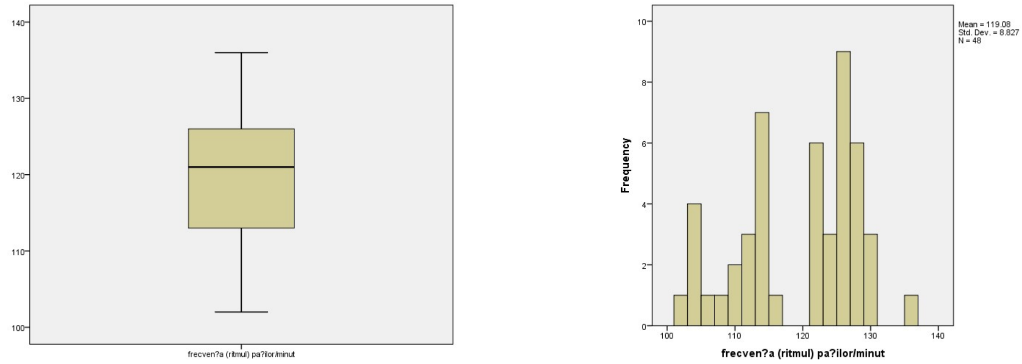
The number of steps had a minimum of 4350 steps and a maximum of 5650 steps (Figure 12). The average of 5130.27 is higher by 243.27 than the one recorded by the 30-year-old subject. This shows a shorter length of pace during running, which the authors believe to be normal considering the age difference and, implicitly, the development of leg muscles.



a **b**

Figure 12. *Box plot (a) and histogram (b) for the motor variable step count*

The pace had a minimum of 102 steps·min^{-1}and a maximum of 136 steps·min^{-1}. The average of 119.08 was lower by 7.8 steps·min^{-1}than the other subject (Figure 13).



a b

Figure 13. *Box plot (a) and histogram (b) for the motor variable pace*

Table 3. *Values recorded by the 56-year-old subject*

		Average velocity [km·h^{-1}]	**Duration [min]**	**Calories burned [kcal]**	**Average heart rate [bpm]**	**Step count**	**Pace·min^{-1}**
N	Valid	48	48	48	48	48	48
	Missing	1	1	1	1	1	1
Mean		5.8100	44.8544	203.60	128.35	5130.27	119.08
Std. Deviation		.76311	6.64391	50.321	4.108	429.185	8.827
Variance		.582	44.141	2532.159	16.872	184200.031	77.908
Skewness		1.367	.251	.799	-.857	-.913	-.425
Std. Error of Skewness		.343	.343	.343	.343	.343	.343
Kurtosis		1.435	-1.110	-1.138	.230	-.568	-.889
Std. Error of Kurtosis		.674	.674	.674	.674	.674	.674

In order to interpret the figures above as accurately as possible for both subjects, the authors chose the statistic descriptors: the average, square average, dispersion, skewness and kurtosis.

The indicator values of the cumulated data for both subjects are presented in Table 4.

In order to observe which markers have a higher correlation degree and had a greater contribution in regulating the body weight, cholesterol and triglycerides, the authors have analyzed the simple regression data, more precisely the influence of average velocity and pace on the heart rate and calories burned. This time the correlation degrees for the recorded markers were calculated using the cumulated data for the two subjects.

Table 4. *The indicator values of the cumulated data for both subjects*

Statistics							
		Average velocity [km·h^{-1}]	**Duration [min]**	**Calories burned [kcal]**	**Average heart rate [bpm]**	**Step count**	**Pace· min^{-1}**
N	Valid	96	96	96	96	96	96
	Missing	1	1	1	1	1	1
Mean		6.1792	42.2545	225.94	129.06	5008.50	122.98
Std. Deviation		1.05170	6.61702	61.802	3.374	433.485	9.383
Variance		1.106	43.785	3819.533	11.386	187909.432	88.042
Skewness		.961	.443	.420	-1.083	-.412	-.231
Std. Error of Skewness		.246	.246	.246	.246	.246	.246
Kurtosis		-.186	-.732	-1.442	1.576	-1.350	-.238
Std. Error of Kurtosis		.488	.488	.488	.488	.488	.488
Minimum		4.90	31.20	150	117	4350	102
Maximum		9.10	57.12	335	134	5670	142
Percentiles	25	5.4400	36.4800	170.00	127.00	4450.75	114.00
	50	5.6650	40.3500	190.00	130.00	5215.00	125.00
	75	6.7700	47.4000	281.00	132.00	5280.00	128.00

The authors did not get any positive correlations between work duration and number of steps and between work duration and calories burned. Table 5 and Figure 14 present the SPSS regression model for average velocity and heart rate, Table 6 and Figure 15 present the model for pace and heart rate, while Table 7 and Figure 16 present the SPSS linear regression model for average velocity and calories burned.

Table 5. *The SPSS linear regression model for average velocity and average heart rate*

Model Summary

R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
.285	.081	.072	1.013

The independent variable is average heart rate.

ANOVA

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Regression	8.548	1	8.548	8.324	.005
Residual	96.529	94	1.027		
Total	105.077	95			

The independent variable is average heart rate.

Coefficients

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
average heart rate	.089	.031	.285	2.885	.005
(Constant)	-5.294	3.978		-1.331	.186

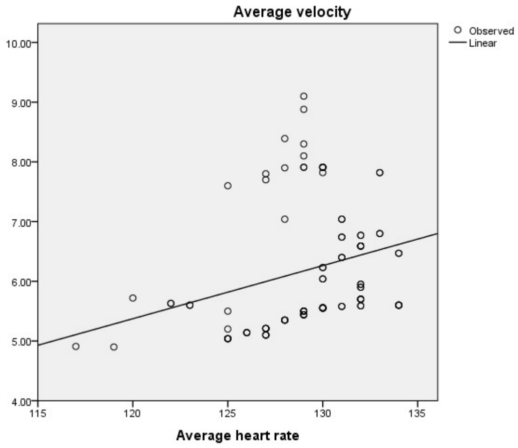


Figure 14. *The SPSS linear regression model for average velocity and average heart rate*

Table 6. *The SPSS linear regression model for pace and average heart rate*

Model Summary (a)

R	R Square	Adjusted R Square	Std. Error of the Estimate
.494	.244	.236	8.201

The independent variable is average heart rate.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	2041.898	1	2041.898	30.360	.000
Residual	6322.061	94	67.256		
Total	8363.958	95			

The independent variable is average heart rate.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
average heart rate	1.374	.249	.494	5.510	.000
(Constant)	-54.349	32.194		-1.688	.095

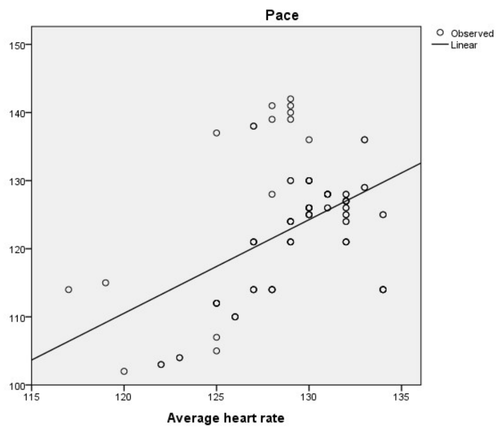


Figure 15. *The SPSS linear regression model for pace and average heart rate*

Table 7. *The SPSS linear regression model for average velocity and calories burned*

Model Summary (a)

R	R Square	Adjusted R Square	Std. Error of the Estimate
.931	.866	.865	.386

The independent variable is calories burned.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	91.045	1	91.045	609.923	.000
Residual	14.032	94	.149		
Total	105,077	95			

The independent variable is calories burned.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
calories burned	.016	.001	.931	24.697	.000
(Constant)	2.600	.150		17.314	.000

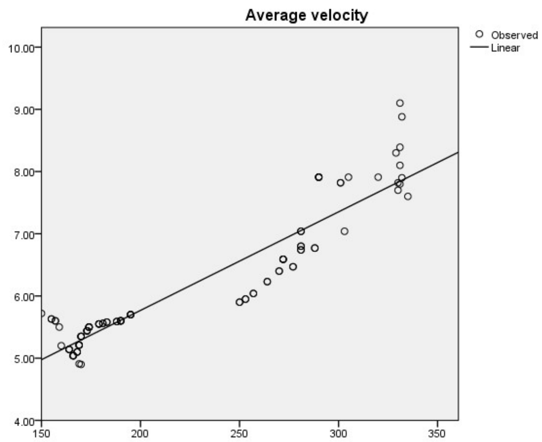


Figure 16. *The SPSS linear regression model for average velocity and calories burned*

One can see that the highest correlation degree was recorded between average velocity and calories burned, followed by the one between pace and average heart rate, then the correlation degree between average velocity and average heart rate.

CONCLUSIONS

The study has led to the following conclusions:
The final blood tests express the importance of systematic exercise and personalized diet in regulating certain metabolic markers. Out of these markers, the authors can mention cholesterol and triglycerides, which the latest studies show that can represent a potential, but controllable risk factor.

Blood tests show that both subjects at the end of the study had these markers within normal limits, while in regards to their body weight, it dropped by 7.14 % more in the 56 year-old than in the 30 year-old subject (5 kg in S1 vs. 7 kg in S2) - which proves that the stress factors caused by the pandemic have affected the normal functioning of the body. This aspect must be mentioned because in all other motor markers the 30-year-old subject recorded superior results compared to the other subject. The authors think that one of causes for that is the average value of the heart rate, of 129 beats·min^{-1}, which, related to age, was not considered an aerobic work, while the average heart rate of the 56-year-old subject corresponded entirely to her age. It is known that during training fatigue leads to progress and without getting out of one's comfort zone, one cannot achieve notable results. A second cause could be a deficient functioning of the thyroid - future investigations in this sense could be revealing.

The SPSS linear regression models that have shown how the recorded markers correlate with each other offer important information for establishing the type of work, its duration, but most importantly the heart rate that must be reached according to the work. Without a correct framing of the heart rate in the desired work regimen, the results will not be good, regardless of the work duration.

Even if the results obtained show an improvement of the biochemical indicators and a decrease of the weight, the pandemic stress acted on the organism. However, studies performed over a longer period under these stressful conditions are necessary to confirm the results obtained.

AUTHOR CONTRIBUTIONS

Every author had an equal contribution in this study.

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