Post Covid-19 Lockdown- An Eight-Week Physical Training Program's Impact on the Body Composition of Master's Students in Physical Education: A Bioelectrical Impedance Analysis Study

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ABSTRACT

Objective: To analyze the impact of 8 weeks of physical exercise on physical education students, focusing on body composition.
Introduction: A balanced diet, injury prevention, and regular medical check-ups are crucial for athletes. A well-designed fitness program is essential for optimal performance. Mental health professionals can help manage stress and anxiety. Health education and substance abuse prevention programs are necessary for children. A support network with peer support, safe training, and medical professionals is crucial. Quality health involves physical, physiological, and psychological factors.
Methods: This study collected data from selected individuals who are studying for a Master's in Physical education and used a professional body analysis scale to determine their weight management, fat management, muscle management, basal metabolic rate, total energy expenditure, obesity analysis, body fat percentage, visceral fat content, BMI, body shape analysis, muscle quality, waist-to-hip ratio, trunk fat mass, and overall health score. The process involved measuring weight and height, standing on the scale, and holding handles for reliable data collection. This process was repeated for statistical analysis.
Results: The eight weeks of training program significantly improved health and fitness variables, reducing body fat, visceral fat, trunk fat mass, and BMI and increasing Fat-Free Mass, protein mass, and overall health score.

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1. INTRODUCTION

The human body comprises roughly 60-70% water (1). Carbohydrates, proteins, and lipids are all significant sources of fuel. Furthermore, the body needs vitamins and minerals to stay healthy. Unused macronutrients are retained as fat, and excessive fat storage can contribute to noncommunicable diseases (NCDs) (2,4,5). The Body Mass Index (BMI) is a popular method for assessing human health. BMI is determined as weight in kilograms divided by height in meters squared (kg/m²) (6). The World Health Organization (WHO) categorizes persons based on their BMI as underweight (≤ 18.5), average weight (18.6-24.9), overweight (25-29.9), obese (30-39.9), or morbidly obese (≥ 40) (3, 7). After the COVID-19 lockdown restrictions were lifted, the researchers examined the impacts of an eight-week physical training program on the body composition of master's students enrolled in physical education. A significant portion of people's daily routine and manner of life has altered, including increased screen time (TV, mobile devices, tablets, laptops, desktop computers, video games, and so forth), improper meal timing, excessive rest, and partial social isolation (8,9). It causes weight gain and obesity, which increases the risk of developing hypokinetic disorders (NCD). Therefore, it is critical to develop feasible and effective interventions to improve both physical and mental health, since students are getting less and less active because of COVID-19 restrictions. At the same time, the only subject through which student can gain the necessary foundation to become physically active is physical education.

The spread of COVID-19 has transformed the nature of teaching physical education. The primary issue with physical re-education is the practical and experiential way of teaching and learning, which is addressed by a far more robust online component. Both teachers and students should have positive behavior and the appropriate training to prepare for this transformation as best they can. This new approach to learning will necessitate new strategies for student engagement. Health effects of a sedentary lifestyle during COVID-19: People who spend too much time on screens are unable to get enough natural vitamin resources, especially vitamin "D," which is gained through sunlight. Furthermore, melatonin secretion and quantity were changed as a result of the majority of people adopting a late-night sleep schedule throughout the day, which decreased the amount of restful sleep that people received (10,11,12,13).

Bioelectrical Impedance Analysis (BIA) is commonly used in the fitness and health clinic industry (14,15). BIA provides valuable data that is easy to use for statistical analysis, aiding in assessing body composition and health parameters. College and university students were notably impacted by the pandemic, experiencing significant changes in their daily routines. These disruptions affected them physically, socially, physiologically, and psychologically (16,17,18).

Regarding that, prior research has demonstrated the link between a poor diet, physical inactivity, and obesity. There is strong evidence that people who spend more time engaging in sedentary activities are more prone to alter their food-related purchase habits and to gain a significant amount of weight. Thus, overcoming interpersonal distance, worry, and a decrease in physical activity has become an essential necessity at a period in world history when people are required to respond crucial responsibilities and severe problems. In particular, the study used bioelectrical impedance analysis (BIA) to evaluate changes in body composition. Students engaged in a master's program in physical education made up the participants; they had been less active throughout the lockdown. The main goal was to determine how their body composition measures would change if they resumed structured physical training. This would light the possible advantages of physical activity during the post-lockdown phase.

2. LITERATURE REVIEW

Latino et al. [19] inspect the changes in learning and physical fitness outcomes during the pandemic and school closures in Italy by the second wave of COVID-19. Thirty high school students, ages 14 to 15, were randomized to either the experimental group (n = 15), which engaged in an at-home exercise program for about 60 minutes twice a week, or the control group (n = 15), which merely got a standard curriculum of theoretical teachings without any practice. The physical education teacher synchronized both groups in real time. A battery of standardized assessment motor tests (the Harvard step test, the standing long jump test, the sit and reach test, and the butt kicks test) and an academic achievement test (Amos 8–15) were given to students at baseline and after training to evaluate their starting level and notable progress made. At baseline and at the end of the program, the experimental group reported significant improvement in focus and motivation, a significant decrease in anxiety, and an increase in their ability to plan their studies and be more adaptable than the control group. The findings indicated that an online school-based fitness program could be an effective way to enhance students' physical fitness as well as their cognitive health and also achieve highest academic achievements.

Wang et al. [20] a thorough physical training experiment scheme is created employing a variety of techniques with the goal of investigating the effect of physical training on fat loss using a biomechanical approach. The study focuses on 184 university students who serve as the experimental subjects. Four times a week, the students in the experimental group receive training. In-depth understanding is obtained by carefully examining the students' morphology, body composition, body function, and physical quality indicators from a biomechanical perspective both before and after the experiment. The outcomes indicated that there is no significant difference between the experimental group and the control group prior to the experiment demonstrating homogeneity. Following the 12-week training, a number of biomechanical changes take place.

Hu et al. [21] examine the effects of a variety of dietary practices and digital technology-based exercise on the body composition of obese college students. The study's original sample consisted of 129 obese college students. The students participated in an 8-week weight loss strategy that combined activity with a variety of technologically supported food strategies. Muscle mass and fat mass, two measures of body composition, were measured both before and after the intervention. Three experimental groups were formed from the participants: time-restricted feeding (TRF), low-calorie diet (LCD), and twice-weekly fasting (TWF). A repeated-measures ANOVA was used for within-group comparisons, whereas a 1-way ANOVA is used for Between-group comparisons. The interaction effects between sex and group and between sex and time were investigated using linear mixed-effects models. This study showed that among obese college students, three diet-plus-exercise regimens resulted in sex-specific improvements in body composition.

Zuo et al. [22] explore the characteristics of inhibitory function in overweight female college students through two studies. Based on these findings, this study investigates how high-intensity interval training (HIIT) interventions affect these students' inhibitory function and test the mediating role of body composition. 34 overweight female college students and 38 normal-weight female college students were recruited for Study I. The participants' interference and response inhibition were assessed using the GO/NOGO task and the Flanker task. 64 overweight female college students were recruited for Study II, and they were split into two groups at random: an experimental group (n = 32) and a control group (n = 32). The experimental group participated in Tabata-based HIIT for eight weeks, whereas the control group did not exercise at all. A bioelectrical impedance body composition analyzer was used to determine the participants' body composition. The investigation was conducted using statistical methods such independent sample t-tests, Pearson correlation analysis, and mediation effect testing, which were based on the SPSS 21.0 program. 8 weeks of HIIT could significantly lower the reaction times of overweight female college students under the GO stimulus, consistent conditions, and inconsistent conditions, and effectively improve BMI, fat-free weight, fat content, muscle content, and basal metabolic rate. Fat content and reaction times under the GO stimulus, consistent conditions, and inconsistent conditions were significantly positively correlated, while the waist-hip ratio and reaction times under the GO stimulus were significantly negatively correlated. The study showed that HIIT has significant improvement to control the weight of overweight female college students and improve their inhibitory function.

Lan et al. [23] Examine how three different workout regimens affect college students' CRF and body composition metrics. 50 healthy, nonsmoking, and sedentary students were selected at random from a Beijing, China campus and divided into four groups: moderate-intensity continuous training, high-intensity interval training, low-intensity continuous training with blood flow restriction, and no exercise control. The intervention lasted for eight weeks. Prior to and following the intervention, measurements were made of aerobic capacity and body composition. In comparison to the control group, the exercise groups saw substantial improvements in their maximum oxygen uptake and a decrease in their body fat percentage. In the HIIT group, changes in muscle mass and fat were negligible. College students' CRF can be improved by all three exercise regimens, although MICT is better for improving body composition than the other two, and LICT-BFR has the most significant impacts.

3. METHODS

In this investigation, the subjects selected were individuals pursuing a Master of Physical Education at a reputable educational institute. The subjects' ages ranged from 24.9 ± 1.7 years. All subjects are from the northern region of India and largely follow a vegetarian diet consisting mainly of wheat-based dishes such as roti, Parantha, and chapati, complemented by dal or other gravies. Eggs and chicken, which are not vegetarian foods, were eaten quite seldom—roughly twice a week.

Every subject's daily schedule was carefully prepared and every day started with a 75–110-minute training session in the morning, followed by a two-hour respite. Following this, there were three hours of theoretical instruction, three hours of relaxation, and an additional 75–110-minute training session in the evening. The investigator noticed that the subjects' eating patterns were comparable. However, variations in rest periods and sleep patterns were not tracked and might have varied throughout subjects. Eight weeks of training were used, and the trial was carried out right after India's COVID-19 lockdown.

The fundamental physical activities used for this study focused on increasing exercise sets and repetitions. The duration of rest periods was modified by the subjects' capacity to increase training intensity since the participants resumed their physical activities following the COVID-19 lockdown. The training schedule was two sessions a day, Monday through Friday, for 10 weekly sessions. One evening session per week was devoted to range of motion (ROM) exercises for flexibility, and the other four evening sessions were dedicated to core training; before each session's cooling-down phase, these extra sessions were added to the already-existing training plan.

This experiment's training program started with a 50% to 60% intensity. Every two weeks during the ten weeks, except the final two, the intensity was raised by 10%. The last week saw a mere 5% increase in intensity. Based on the subjects' pulse rates, the investigator reached an 80% to 85% intensity by the program's conclusion. The intensity was controlled using the Karvonen formula, which considered the quantity of exercises, repetitions, sets, rest periods, and session durations training module attached to this chapter part end.

First two weeks Training Module

Time	Session	Exercises	Reps/ Sets	Rest between Sets
20 mins.	General Warming Up	The physical activity (PA) program started on the athletic track with slow jogging for about 800 meters, then moderate jogging for around 1200 meters. Every day, the participants ran a minimum of two kilometres overall. Energetic activities were also included for the warm-up portion of all five training days.		
30 mins.	Main Exercises	The leg front kick below the knee, side kick below the knee, leg front kick above the hip, side kick above the hip, high knee action, back kick, skipping movement, jump and twist, forward bending, sideward bending, squats, push-ups, partner exercises, and launching exercises are the bodyweight exercises that were chosen for this study as essential elements of the physical training regimen.	**Each- 20 rep** **5-8 sets** **Rest between sets was 40-75 seconds**	**Intensity** **50 - 85%**
10 mins	Core exercises Weekly 4 days Evening session	Core exercises were included in the training program four times a week. These were seated and laying workouts that comprised crunches, planks, bridges, double leg raises, flutter kicks, superman movements, and cycling and so on.		
15 mins.	Cooling Down	Active-based cooling down with jogging in slow phase various dynamic PA was done, after which the stretch & hold method of flexibility was adopted after all sessions were completed.		

4. RESULTS AND DISCUSSIONS

In this study, Descriptive statistics were calculated and evaluated for each body composition. Post hoc analyses were performed after the detection of major effects or significant interactions. These analyses identified significant differences between the intervention and control groups. Table 1 results show the descriptive statistics of all variables, measured before and after the eight weeks of training implementation from the selected individuals.

This investigation collected data from selected subjects before and after the experiment using a medical standard professional body composition analyzer scale (Body Impedance Analyser, Charder- 600). This method measures various factors from subjects, including intracellular water level, extracellular water level, protein, minerals, body fat mass, and body balance evaluation. The analysis provides insights into target weight control, fat control, muscle control, basal metabolic rate, total energy expenditure, obesity analysis, body fat percentage, visceral fat level, body mass index, body type analysis, muscle quality, waist-hip ratio, trunk fat mass, and overall health score.

All the chosen subjects were asked to assemble in a laboratory during the morning session. Each individual was instructed to remove their footwear and have their weight and height measured. Following this, each subject was requested to stand on the body composition analyzer, ensuring their feet were placed on the silver-coated area. They were also asked to hold two handles, positioning their palms on the silver-coated area, to obtain reliable data. The subjects remained in this position for the entire data collection process, which typically lasted between 30 and 90 seconds per individual. This procedure was repeated for all subjects before and after the implementation of the experiment to facilitate statistical analysis for this investigation, toanalyze the gathered data, OLS regression, Pearson's product movement correlation and measure of central tendency wereused as analytical tools.

Table 1. Characteristic features of all the variables

Name of Variables	**Pre-test**				**Post-test**			
	Mean	**S. D**	**Min**	**Max**	**Mean**	**S. D**	**Min**	**Max**
Weight	65.8	5.45	57.1	73.1	65.2	5.86	53.3	71.8
Height	169.8	5.27	161.5	176.5	170.2	5.57	161.5	176.5
Age	25	1.73	22.8	28.2	25	1.73	22.8	28.2
5kHz, Impedance(Z) of Whole Body	657.12	53.15	560.5	750.9	671.5	59.36	583.8	779
5kHz, Impedance(Z) of Trunk	29.1	1.87	27.2	32.7	29.6	1.82	26.8	31.9
50kHz, Impedance(Z) of Whole Body	571.9	46.3	488.5	642.1	582.7	51.2	505.4	667
50kHz, Impedance(Z) of Trunk	24.8	1.86	22.7	28.1	25	1.97	21.8	27.3
250kHz, Impedance(Z) of Whole Body	512	40.9	439.2	572.4	520	43.5	453.6	594.6
250kHz, Impedance(Z) of Trunk	21.3	1.77	19.4	24.5	21.3	1.73	18.5	23.2
Fat Free Mass	52.9	3.78	45.5	57.4	53.1	4.43	43.8	57.4
Fat Mass	12.9	2.86	8.4	18.5	12.15	2.57	8.2	16.2
Percentage Body Fat	19.5	3.22	13.7	25.7	18.5	3	13.4	22.5
Visceral Fat Area	56.5	14.6	33.4	85.2	52.7	13.25	32.2	73.3
Trunk Lean Mass	23.6	1.94	20.5	26.3	23.7	2.11	19.9	26
Trunk Fat Mass	7.11	1.69	4.5	10.4	6.7	1.52	4.4	9
Trunk Tissue Mass	29.4	2.99	25	33.2	28.9	3.12	22.9	32.8
Skeletal Muscle Mass	29.3	2.26	25	32.1	29.4	2.65	24	32
Waist-Hip Ratio	0.86	0.02	0.83	0.89	0.86	0.02	0.84	0.9
Protein Mass	10.7	0.85	9.1	11.8	10.7	0.96	8.8	11.7

Health Score	74.3	3.48	68.7	79.4	74.9	3.68	70.6	80.5
Fat Mass Index	4.47	0.88	3	6	4.2	0.88	2.90	5.7
Skeletal Muscle Mass Index	10.17	0.59	9.4	11	10.15	0.63	9.2	10.9
Basal Metabolic rate	1512.4	81.8	1352	1609	1515.6	95.9	1315	1609
Body Mass Index	22.8	1.35	21.2	25	22.5	1.55	20.4	25.2
Total Energy Expenditure	2148.5	116.4	1920	2286	2152.8	136.3	1868	2286
Hand Grip	39.2	1.95	35.8	41.4	39.2	2.07	34.9	41.52

Weight:

The sum of the weights before the test is 592.4 kg, and the sum after the test is 587 kg. This indicates a decrease in the total weight. The standard deviation has slightly increased from 5.46 kg (pre-test) to 5.86 kg (post-test). This means that the weight variation among participants has improved after the test. If there are no changes in the mean values, it suggests that the average weight of participants before and after the test is the same.

Fat-Free Mass (FFM)

Increased from 52.92 to 53.6. This suggests that, on average, participants gained FFM after the training. The standard deviation (SD) also increased from 3.79 to 4.43, which might indicate a slight increase in variability among the participants' FFM values. Positive Impact: The increase in the total sum and mean values of FFM signifies a positive effect of the training intervention on FFM. Increased Mean: An increase in the mean FFM indicates that, on average, participants gained muscle mass or lean tissue. Standard deviation: The rise in SD suggests that while the average FFM increased, there was a slight increase in the variability of the responses among participants. This could mean that while most participants gained FFM, the extent of gain varied more in the post-test compared to the pre-test.

Body Fat Percentage:

The pre-test data for body fat percentage was 175.5, with a mean of 19.5 ±3.22. Similarly, the post-test data aggregate is 166.9 with a mean of 18.54 ± 3.01. As a result, this finding indicates that physical exercise affects the variable of body fat %. However, this variable has no statistical significance when using paired 't' test results.

Fat Mass:

The pre-test data for the Fat Mass variable was 116.1 with a mean of 12.9 ± 2.87, while the post-test data was 109.4 with a mean of 12.15 ± 2.575. Training impacted the fat mass variable, but the paired 't' test results did not significantly improve. In Visceral Fat data, the test sum is 508.9, with a mean of 56.54 ± 14.68, and the post-test sum is 474.5, with a mean of 52.72 ± 13.25. The difference of 34.4 between the two aggregate values suggests that physical training had a favourable effect on visceral fat reduction for the subjects in this study.

The pre-test sum value for trunk fat mass is 64, indicating a mean of 7.1 ± 1.69; likewise, the post-test sum is 60.4, representing a mean of 6.71 ± 1.52. When taking into account the pre- and post-test data sets on the variable of trunk fat mass, it was shown that the given training positively influenced by reducing trunk fat mass to selected subjects.

The pre-test sum value of the skeletal muscle mass variable is 264.1, indicating a mean of 29.34 ± 2.26, whereas the post-test sum is 264.9, indicating a mean of 29.43 ± 2.65. According to the gathered data set on the variable of skeletal muscle mass, this suggests a marginally beneficial influence as a result of the training. Waist-hip ratio: a slight shift was observed in this measure; the pre-test total is 7.76, with a mean of 0.86 ± 0.022. The post-test mean is 0.86 ± 0.021, and the post-test sum is 7.75. It states that all physical education discipline subjects only marginally improved, as observed in the waist-hip ratio variable, after receiving a certain amount of physical training.

By physical training given to subjects, the Protein Mass variable also showed slight changes; the pre-test sum values are 96.3, with a mean of 10.7 ± 0.86, and the post-test sum values are 96.9, with a mean of 10.76 ± 0.96. These findings indicate that, compared to pre-and post-test data sets, the protein mass of the chosen subjects increased. Fat-Free Mass Index: Considering the table's results, there isn't much of a variation in this variable between the pre- and post-test data sets; In addition, the post-test total value was 164.8, mean 18.31 ± 1.04, while the pre-test total value was 165, mean 18.3 ± 0.987. The Basal Metabolic Rate (BMR) variable showed an increase in a subset of individuals following eight weeks of physical training. The pre-test total value is 13612, with a mean of 1512 ± 81.84, and the post-test total value is 13641, with a mean of 1515.67 ± 95.91. These values demonstrate statistical validity.

Body Mass Index: The pre-test total value for the BMI variable was 205.3, with a mean of 22.81 ± 1.357. Following the 202.3 total training value, the mean was 22.48 ± 1.55. This data set showed that the mean and total values decreased before and after training, demonstrating a substantial impact of the training the chosen participants received on the body mass index variable. When considering the total amount and the mean value, the results indicate that the Mineral% variable shows little change before and after training. The percentage of altered minerals was 48.2 for the pre-test, 5.35 ± 0.324 for the mean, 48.7 for the post-test, and 5.41 ± 0.314 for the mean. Comparing the pre-and post-test data sets for the aforementioned variables, there was a slight variation in the mineral percentage variable.

The Protein % variable had a pre-training total value of 146.6, with a mean of 16.29 ± 0.67, and a post-training total value of 148.6, with a mean of 16.51 ± 0.641. Comparing the total values of the pre-training and post-test data sets reveals that protein storage has risen, indicating that training causes certain subjects to trigger protein high. In the Fat Control variable, the physical exercise given significantly affected the subjects in this study; That way, before training, fat control demand was -27.3, mean -3.03, and after training, fat was -21.3, mean -2.37. These results indicate that adopted physical training controls fat in selected subjects.

Total Energy Expenditure (TEE)- before and after physical exercise, TEE improved dramatically in chosen subjects, which has been statistically confirmed. The pretraining sum value is 19337, the mean is 2148.55, and the σ is 116.47. The post-training sum value is 19376, the mean is 2152.89, and the σ is 136.291. It clearly shows that given training affects the TEE variable in this study. In this study, pre- and post-training data were compared to evaluate the impact of physical training on the subcutaneous fat area. The results show that the subcutaneous fat area shrank significantly after the physical training program. Before training, the subcutaneous fat region had a mean of 100.01 and 900.1. Following training, the subcutaneous fat area's total sum dropped to 829.6 with a mean of 92.178. A significant decrease in the subcutaneous fat area confirmed the success of the physical training program. The subcutaneous fat area's mean and total sum values decreased, indicating that frequent physical training benefits body composition.

Health Score- The provided training has altered a health score by having all positive impacts via other chosen factors with that impact. The health score has grown with a training total sum value of 669.5, a mean of 74.39, and a post-training sum score of 674.7, a mean of 74.97. The results show that the training positively impacted the health scores. The total sum and the mean of the health scores increased after the training. The increase in these values indicates that the participants' health scores improved due to the training. This suggests that the training effectively influenced the health score variable in this study.

Table 2. Pearson's product-moment correlation table of health score before and after the experiment

‘t’	**df**	**P**	**Confidence Interval** 95%		**Correlation Coefficient**
			Lower C. I	**Upper C. I**	
7.5508	7	0.00013	0.7491704	0.9883844	0.943

The correlation coefficient of 0.943 in the correlation table indicates a significant positive correlation between the health scores before and after the experiment. This implies that the experiment improved the participants' health scores. *The correlation coefficient (Table 2) between health scores obtained before and after training is 0.943, indicating a robust positive correlation. This substantial correlation implies a significant association between the health scores obtained at two different time points.

Specifically, this solid positive association indicates a significant difference in the data set acquired from the selected subjects before and during the execution of the physical training program. The significant improvement in health scores after training demonstrates the effectiveness of the training routine. It emphasizes the favourable influence of physical training on participants' health outcomes, verifying the intervention's success.

Figure 1. Box plot representing health score before and after training

The overall health score data for the chosen subjects before and after the experiment are shown in the box plot Figure 1 above. This graphic depiction unequivocally shows that the participants' health scores improved due to the training program. The results show that the implemented training regimen significantly improved the subjects' health outcomes, as demonstrated by the appreciable rise in their health scores following the trial.

Table 3. Highly Correlated variables

First Variable	Second Variable	Correlation
BMR1	TEE1	0.99999
F1	BMR1	0.99998
F1	TEE1	0.99997
FM1	VF1	0.99995
F1	SM1	0.99931
SM1	BMR1	0.99925
SM1	TEE1	0.99924
SM1	FM1	0.99923
VF1	TF1	0.99863
FM1	TF1	0.99858

** The above table represents the most highly correlated first ten variables.*

In Table 3, the following variables exhibit a highly positive correlation, with values exceeding 0.99. This indicates a strong correlation among the selected variables, which significantly influence the relationship with the health score. The post-test variables included are Basal Metabolic Rate (BMR), Fat-Free Mass Percentage (F1), Fat Mass (FM1), Trunk Fat Mass (TF), Visceral Fat (VF1), Total Energy Expenditure (TEE1), and Skeletal Muscle Mass (SM1).

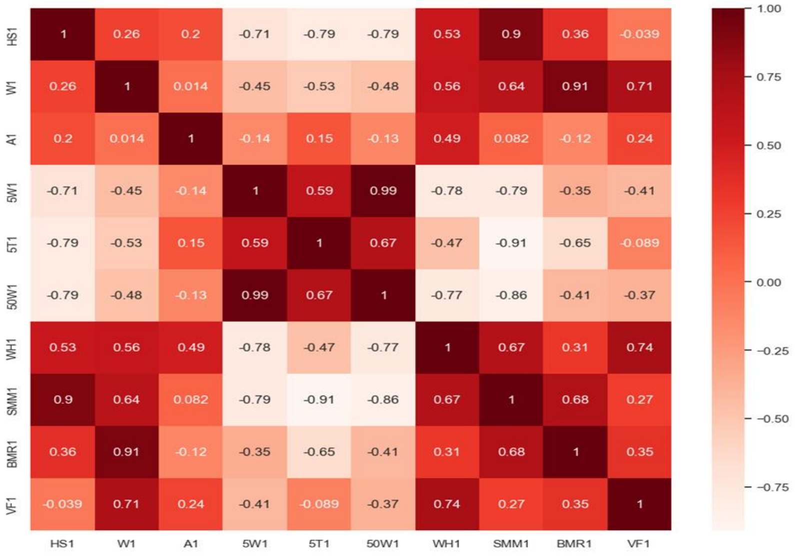

Figure 2. Correlation Matrix -Heat Map

Figure 2 presents a diagrammatic representation of the correlation matrix, visualized through a heatmap, for the students' post-training measurements. In this heatmap, the color intensity denotes the strength of the correlation between different variables. Specifically, lighter shades indicate a stronger or more positive correlation, whereas darker shades signify a weaker correlation. The predominance of lighter shades over darker ones in this diagram suggests generally strong correlations among the post-training measurements. This observation implies that the variables measured post-training are closely interrelated, reflecting consistent and significant improvements across the board. The relatively fewer dark shades indicate that weak correlations are less prevalent in this dataset, further emphasizing the overall positive impact of the training program on the students' health metrics, given the high-dimensional nature of the data, feature selection was employed to reduce dimensionality and enhance the model's performance. This study applied the forward variable selection method to identify the most informative features related to the health score. The features W1, A1, 5W1, 5T1, 50W1, WH1, and SMM1 were the most relevant, significantly impacting the health score. These selected variables were subsequently used for further model fitting. Multiple linear regression analysis demonstrated that the variables W1, 5T1, and SMM1 have p-values less than 0.05, indicating their statistical significance. Notably, W1 has a coefficient value of approximately –0.315, suggesting that an increase in the health score is associated with a decrease in W1 (Weight). Table 4 shows the coefficient values for the most significant features.

Table 4. Coefficient values for the most significant features

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                                 OLS Regression Results
=======================================================================================
Dep. Variable:                    HS1   R-squared (uncentered):                   1.000
Model:                            OLS   Adj. R-squared (uncentered):              1.000
Method:                 Least Squares   F-statistic:                          7.707e+04
Date:                Thu, 25 Jul 2024   Prob (F-statistic):                    1.30e-05
Time:                        16:28:51   Log-Likelihood:                          4.6401
No. Observations:                   9   AIC:                                      4.720
Df Residuals:                       2   BIC:                                      6.100
Df Model:                           7
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
W1            -0.3153      0.025    -12.481      0.006      -0.424      -0.207
A1             0.2332      0.083      2.812      0.107      -0.124       0.590
5W1            0.0231      0.030      0.765      0.524      -0.107       0.153
5T1            0.5485      0.122      4.491      0.046       0.023       1.074
50W1          -0.0247      0.038     -0.645      0.585      -0.190       0.140
WH1          -20.8251     12.668     -1.644      0.242     -75.329      33.679
SMM1           8.8931      0.725     12.265      0.007       5.773      12.013
==============================================================================
Omnibus:                        2.178   Durbin-Watson:                   2.002
Prob(Omnibus):                  0.337   Jarque-Bera (JB):                1.166
Skew:                           0.595   Prob(JB):                        0.558
Kurtosis:                       1.699   Cond. No.                     1.11e+05
==============================================================================
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Ellipses:

W1-Weight, H1-Height, A1-Age, 5W-5kHz, Impedance(Z) of Whole Body, 5T- 5kHz, Impedance(Z) of Trunk, 50W-50kHz, Impedance(Z) of Whole Body, 50T-50kHz, Impedance(Z) of Trunk, 250W-250kHz, Impedance(Z) of Whole Body, 250T-250kHz, Impedance(Z) of Trunk, F1- Fat-Free Mass, FM1- Fat Mass, BF1- Percentage Body Fat, VF1- Visceral Fat Area, TM1- Trunk Lean Mass, TF- Trunk Fat Mass, TT1- Trunk Tissue Mass, SM1- Skeletal Muscle Mass, WH1- Waist-Hip Ratio, PM1- Protein Mas, HS1- Health Score, FMI1- Fat Mass Index, SMM1- Skeletal Muscle Mass Index, BMR1- Basal Metabolic rate, BMI1- Body Mass Index, TEE1- Total Energy Expenditure, HG- Hand Grip.

5. CONCLUSION

Positive Impacts:

Body Fat Reduction: The adopted physical training (PT) program decreases body fat, which benefits overall health and aesthetics (19,20). Visceral Fat Reduction: Visceral fat accumulates around internal organs and decreases after PT (21). This is crucial because excess visceral fat is associated with health risks. Trunk Fat Mass Reduction: Targeting trunk fat can improve body composition and reduce the risk of metabolic disorders (22,23). BMI Decrease: A lower body mass index (BMI) indicates healthier weight management. Fat-Free Mass Increase: Gaining fat-free mass (muscle, bone, organs) contributes to strength and metabolic health. Protein Mass Increase: Adequate protein mass is essential for tissue repair and well-being. Overall, Health Score Improvement: The program positively impacted overall health, likely through multiple mechanisms.

Areas with Minimal Changes:

Waist-Hip Ratio: Although minimal changes were observed, maintaining a healthy waist-hip ratio is essential for cardiovascular health. Mineral Percentage: While less affected, monitoring mineral levels remains crucial for optimal bodily functions. Fat-Free Mass Index: The minimal change suggests that fat-free mass distribution remained relatively stable.

Considerations:

Individual Variation: Remember that responses to training can vary based on personal factors (genetics, adherence, baseline fitness). Long-Term Effects: Investigate whether these positive changes are sustained over time. In summary, the program has had significant positive effects on various health markers. Keep monitoring progress and adjust as needed to maintain a healthy active life (24).

Significance of Sports-Related Populations' Health

The COVID-19 pandemic has significantly disrupted sports-related populations, including college students, professional athletes, and those with active lifestyles. This has led to reduced physical activity, resulting in adverse health outcomes such as weight gain, changes in body composition, and a decline in overall health quality. The study aims to determine the effects of physical training on the health of sports-related populations, assess the effectiveness of structured exercise plans in improving health outcomes after inactivity, and provide recommendations for developing exercise plans for long breaks from physical activity. The findings may contribute to developing effective exercise plans to help individuals regain physical fitness and improve health after prolonged inactivity.

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