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BODY COMPOSITION ANALYSIS IN ADULTS WITH OSCIABLE BLOOD PRESSURE

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Abstract: Previous studies have suggested that physical activity in water can favorably influence body composition and blood pressure, having beneficial effects on cardiovascular health and reducing the risk of developing hypertension. Body composition and blood pressure are essential factors in assessing general health, having a significant impact on the risks of developing cardiovascular diseases. Hypothesis of the work: It is assumed that by practicing hydrokinetotherapy, the body composition of adults with oscillating blood pressure can be improved, and blood pressure oscillations can be reduced, thus contributing to improving general health. The purpose of this work is to analyze the impact of hydrokinetotherapy on body composition and blood pressure variability in adults, with the objective of highlighting the potential of this form of therapy in optimizing cardiovascular health and in effectively managing blood pressure fluctuations. Objectives of the work: Assessment of body composition before and after a hydrokinetotherapy program; Monitoring blood pressure during the program to observe changes in its oscillations. Determining the relationship between hydrokinetotherapy practice, body composition, and blood pressure stability. Further research is needed to validate the effectiveness of this hydrokinetotherapy program in different population groups and to investigate the mechanisms by which it affects physiological parameters.

Introduction: Body composition is an important factor in assessing health status and monitoring changes in body structure, such as fat percentage, muscle mass, and others. In the context of the pandemic, physical activities have undergone significant changes, such as the transition to online programs and the adaptation of exercises from the aquatic environment to the terrestrial one, considering the effects of gravity on the body and the neuromyoarthrokinetic system (NMAK) [2]. These changes are particularly relevant for adult women with fluctuating blood pressure, given that body composition parameters can significantly influence blood pressure values and cardiovascular health. Although total body mass is positively associated with blood pressure, it remains unclear whether this relationship is due to total body mass or a specific component, such as lean mass or fat mass [8]. Blood pressure refers to the pressure exerted by blood on the arterial walls during contraction and relaxation of the heart and is expressed by two values: systolic pressure (the pressure in the arteries when the heart contracts) and diastolic pressure (the pressure when the heart relaxes between contractions). Blood pressure measurement is essential in patient management, as it is influenced by the volume of blood pumped by the heart, the elasticity of the arterial walls, and the velocity of blood flow [7]. Normal blood pressure values are typically 120/80 mmHg, and higher levels are associated with significant risks of major clinical events, including death from cardiovascular disease and other causes [12]. Blood pressure fluctuations refer to significant variations in blood pressure values at different times of the day or due to factors such as stress, physical activity, diet, or pre-existing conditions, and may indicate problems with vascular regulation that require monitoring. Mean weight and BMI values increase with age and remain elevated across all age groups, highlighting the importance of weight management in preventing osteoporosis-related complications [3,4]. The present study aims to analyze body composition in adult women with oscillating blood pressure to explore possible correlations between changes in body structure and blood pressure oscillations. Another study [10] demonstrated that both fat mass and muscle mass had a significant impact on systolic (SBP) and diastolic (DBP) blood pressure in men and women. After full adjustment, trunk fat mass was positively associated with SBP and DBP, being the main contributor to blood pressure, while leg fat mass was negatively associated with SBP and DBP, suggesting a protective effect on blood pressure. Adiposity plays a key role in determining blood pressure, and this study aimed to examine the relationship between blood pressure and body composition indices over the lifespan in healthy adults [6].

Material and methods: The study was conducted on a sample of 10 adult women, who voluntarily agreed to participate. To evaluate body parameters, the BC 730 weight analyzer was used, an accurate and reliable device for body measurements. The study was conducted within the Reflexo Tox SRL medical rehabilitation clinic, for a period of 4 months, in 2024. Research methods: bibliographic study method, observation method, experimental method, statistical method, graphic method. Inclusion criteria: adult women, fluctuating blood pressure, participation in the hydrokinetotherapy program, agreement by signing the informed consent. The women participating in the study were evaluated periodically, according to the study protocol, to analyze the impact of the intervention on body composition, blood pressure and other relevant physiological parameters. The conditions of the study were optimized to ensure the standardization of measurements and interventions applied. The hypothesis of the study: it is assumed that by practicing hydrokinetotherapy, the body composition of adults with oscillating blood pressure can improve, and blood pressure oscillations can be reduced, thus contributing to the improvement of general health. The purpose of this work is to analyze the impact of hydrokinetotherapy on body composition and blood pressure variability in adults, with the objective of highlighting the potential of this form of therapy in optimizing cardiovascular health and in effectively managing blood pressure fluctuations. Objectives of the work: Assessment of body composition before and after a hydrokinetotherapy program; Monitoring blood pressure during the program to observe changes in its oscillations. Determining the relationship between the practice of hydrokinetotherapy, body composition and blood pressure stability.

Table 1 Blood pressure variation pattern - day without physical exertion-

Hour	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	Observations
Morning (after sleep)	13	8	Normal blood pressure, slightly elevated in the morning due to the body's natural activation
After lunch	14	9	Slight increase after meals due to digestion. Blood pressure remains within normal range
After relaxation (afternoon)	12	7	Slightly lowered tension as the body relaxes
Mid-afternoon	13	8	The blood pressure stabilizes to normal values after a period of rest
Before bed	12	8	Stable and normal blood pressure, slightly lower in the evening due to relaxation

Table 2 Blood pressure variation pattern - day with hydrokinetotherapy program-

Hour	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	Observations
Morning (after sleep)	13	8	Normal blood pressure, slightly elevated in the morning
After lunch	14	9	Slight increase in blood pressure after eating
Before hydrokinetotherapy (after a meal)	14	8	Higher tension before the hydrokinetotherapy session, possibly due to digestive activity
After 30-45 minutes of hydrokinetotherapy	12	7	After exertion in the water, blood pressure may decrease slightly, as hydrokinetotherapy helps relax blood vessels and increase peripheral circulation

Hour	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)	Observations
After post-program relaxation	13	8	Blood pressure returns to normal after the body relaxes post-therapy
Before bed	12	8	Stable, slightly lowered blood pressure due to body relaxation during the evening

Hydrokinetotherapy program for the target group

1. Weeks 1-4: Accommodating with water - adapting to light exertion; session duration: 30-40 minutes

Content: mobilization and flexibility exercises
• Warm-up exercises: easy walking in the water (10 minutes)
• Stretching exercises: easy stretching for the main muscles (10 minutes)
• Toning exercises: flexion and extension movements with the legs in the water (15-20 minutes)
Moderate effort is performed: no rapid or intense movements will be made, and the intensity will be adjusted according to the blood pressure response.
Monitoring: Measurement of blood pressure before and after each session to observe the evolution. Systolic pressure should not exceed 14 and diastolic pressure should remain below 8 to avoid overload.

2. Weeks 5-8: Gradually increase intensity; session duration: 40-50 minutes

Content: Toning exercises and light cardio
• Warm-up exercises: Moderate intensity water walking (10 minutes)
• Toning exercises: Light weight or bodyweight exercises (e.g., push-ups and push-ups in water) (20 minutes)
• Light cardio exercises: Twists and quick movements for legs and arms (10-15 minutes)
Monitoring: Blood pressure before and after each session. If blood pressure exceeds normal values (e.g. systolic greater than 14 and diastolic greater than 8), intensity will be reduced.

3. Weeks 9-12: Increase intensity and improve endurance; session duration: 50-60 minutes

Content: Resistance exercises and moderate cardio
• Warm-up exercises: vigorous water walking and arm rotations (10-15 minutes)
• Toning exercises: water resistance exercises, using equipment (e.g. balls and water devices) (20-25 minutes)
• Cardio exercises: series of short sprints in the water to stimulate the cardiovascular system (15-20 minutes)
Monitoring: Continue to measure blood pressure before and after hydrokinetotherapy sessions. If systolic pressure reaches 14 and diastolic pressure

remains at 8 or higher, the intensity should be reduced and a longer recovery period should be given.

4. Weeks 13-16: Moderate intensity, consolidation and recovery; session duration: 50-60 minutes

Content: intense toning exercises, mobility improvement and recovery exercises

• Warm-up exercises: 10-15 minutes of brisk walking in the water and stretching

• Toning exercises: muscle strengthening (20-25 minutes)

• Active recovery: relaxation and stretching exercises (15-20 minutes)

Monitoring: Continue measuring blood pressure before and after hydrokinetotherapy sessions. If blood pressure remains constant or lower than baseline values (e.g. systolic below 14 and diastolic below 8), the intensity can be maintained at a higher level.

Results: Changes in anthropometric parameters and the relationships between them were analyzed, considering the impact of the hydrokinetotherapy program on the body composition of the women subject to the research.

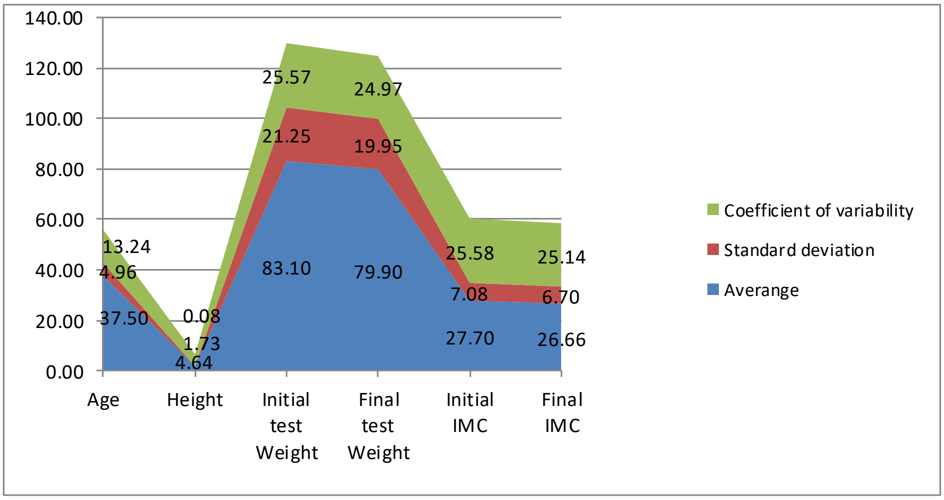

Fig.1 Evolution of weight and BMI in the target group after the program

Analysis of the group, with a mean age of 37.5 years and a mean height of 1.729 m, shows a mean weight loss of 3.2 kg, from 83.1 kg to 79.9 kg, and a reduction in BMI from 27.7 to 26.6. These changes indicate an overall improvement in weight status. The moderate standard deviations of 6.7 for final BMI and 19.95 kg for final weight and the high coefficient of variation >25% suggest significant differences between participants in response to the program.

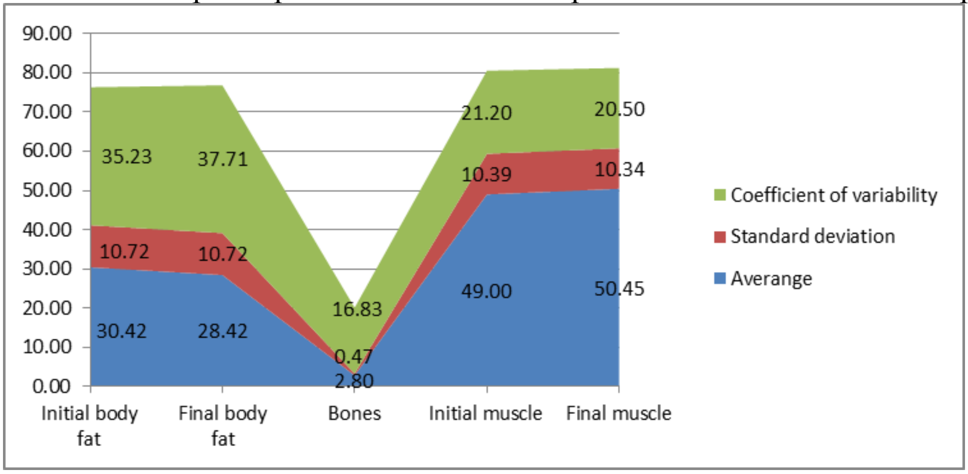

Fig.2 Changes in body fat and muscle mass after the program

The analysis shows a mean decrease in body fat from 30.42% to 28.42% and an increase in muscle mass from 49 kg to 50.45 kg, reflecting an improvement in body composition. Bone mass remained constant at 2.8 kg. The high coefficient of variation for body fat of 35.23% suggests significant differences between participants, while the increase in muscle mass shows a lower variability of 21.20%.

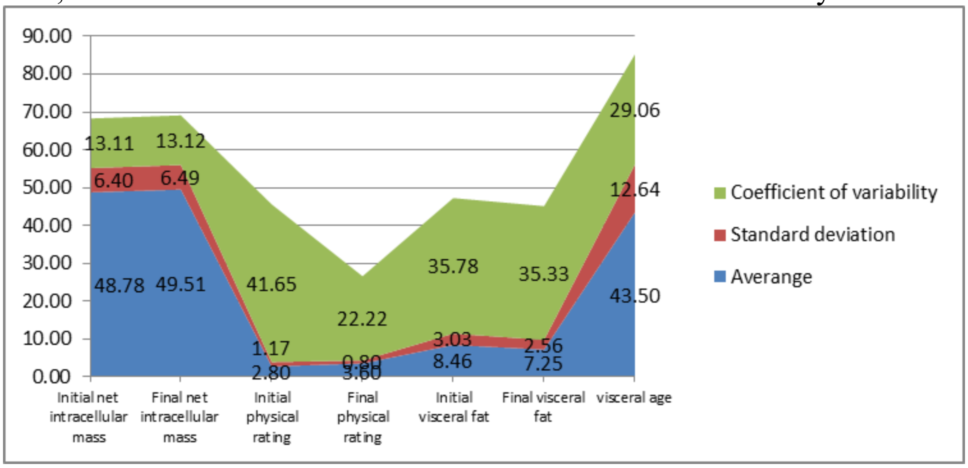

Fig.3 Evolution of intramuscular mass, visceral fat and metabolic health after the program

Data interpretation reveals a slight increase in net intramuscular mass, from 48.78 kg to 49.51 kg, with a moderate variability of 13.12%. Physical retention improved from 2.8 to 3.6 points on average, indicating an enhancement of physical performance. Visceral fat decreased from 8.46 to 7.25 units, reflecting a reduction in cardiovascular risk, and the mean visceral age decreased from 43.5 years to 43.3 years, suggesting overall improvements in metabolic health.

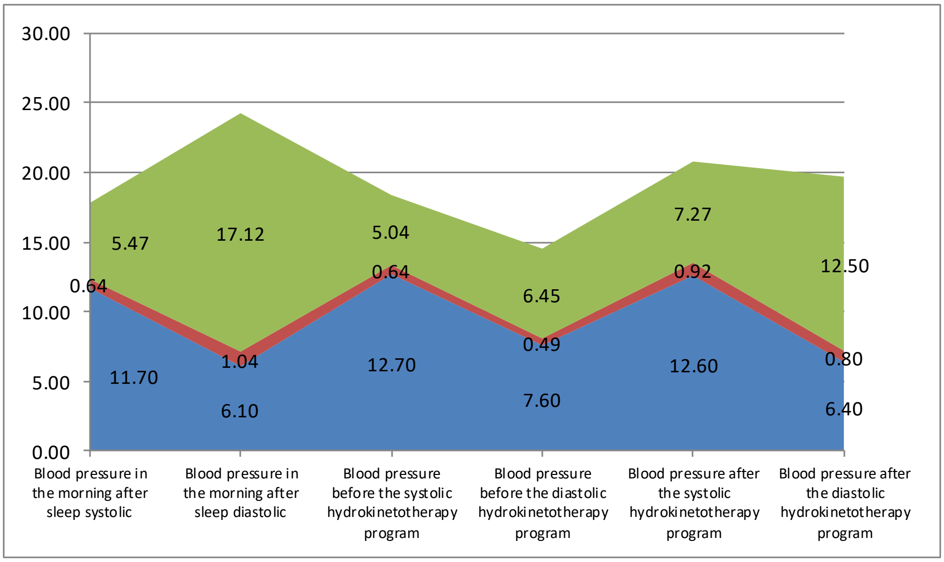

Fig.4 Evolution of blood pressure of participants before and after the hydrokinetotherapy program

The participants' blood pressure showed average values within normal limits, with moderate variations. In the morning, the systolic pressure had an average of 11.7, and the diastolic pressure 6.1, indicating relative stability for systolic and greater variability for diastolic. Before the hydrokinetotherapy program, the average values were 12.7 for systolic and 7.6 for diastolic, with a slight increase compared to the morning values. After the program, the systolic pressure decreased to 12.6, and the diastolic to 6.4, highlighting a moderate relaxation effect on blood pressure.

	Age	Height	Intial test Weight	Final test Weight	Initial IMC	Final IMC	Intial body fat
Age	1.00						
Height	-0.22	1.00					
Intial test Weight	-0.01	0.42	1.00				
Final test Weight	0.01	0.40	1.00	1.00			
Initial IMC	0.08	0.05	0.93	0.93	1.00		
Final IMC	0.09	0.02	0.91	0.92	1.00	1.00	
Intial body fat	0.05	0.08	0.82	0.81	0.85	0.85	1.00
Fianl Bady fat	0.05	0.08	0.82	0.81	0.85	0.85	1.00

Fig. 5 Correlations between body parameters- examples of correlations

Correlation between initial weight vs. initial body fat (r = 0.81, strong), women with higher weight at the beginning of the program have a higher percentage of body fat. The correlation is strong, showing that weight is an important estimator of initial body fat. Final BMI vs. final body fat (r = 0.84, strong), final BMI directly reflects the final body fat level. Within the program, changes in body weight (BMI) are closely related to body fat. Visceral age vs. visceral fat (r = 0.63, moderate), women with higher visceral age tend to have higher visceral fat. The relationship indicates that visceral fat contributes significantly to the increase in visceral age, an important indicator of metabolic health. Final weight vs. final net intramuscular mass (r = 0.45, moderate), higher final weight is associated with higher intramuscular mass. The program helped women maintain or increase muscle mass during weight loss. Morning systolic blood pressure vs. pre-program systolic blood pressure (r = 1, strong), morning systolic blood pressure values closely reflect blood pressure values measured before the program began. The almost perfect correlation shows the stability of this indicator over time. Final net intramuscular mass vs. final BMI (r = 0.41, moderate), women with a higher final BMI had higher muscle mass. The moderate correlation indicates that muscle mass contributes a significant portion of BMI, but does not explain all of the variation. Baseline weight vs. baseline BMI (r = 0.97, strong), baseline weight is very closely related to baseline BMI, which is expected since BMI is derived from weight and height. Weight is a nearly perfect predictor of BMI. Baseline BMI vs. baseline body fat (r = 0.79, strong), baseline BMI is a good indicator of percent body fat at baseline. The relationship is significant, but body fat does not fully explain the value of BMI, which also includes muscle mass. Visceral age vs. initial BMI (r ≈ 0.68, moderate), women with a higher initial BMI tend to have a higher visceral age. The relationship emphasizes the link between excess weight and metabolic aging. Final weight vs. final body fat (r = 0.76, strong), final weight shows a strong correlation with final body fat, showing that weight loss was mainly reflected in the reduction of body fat. Most of the strong positive correlations ($r \geq 0.7$) involve body weight, BMI, and body fat, which is expected, as these variables are directly correlated naturally. Moderate correlations ($0.3 \leq r < 0.7$) involve visceral age and muscle mass, indicating important but more complex relationships that may also be influenced by other factors (e.g., physical activity, genetics). Net intramuscular mass at baseline vs. net intramuscular mass at end (r = 1.00, strong), the perfect relationship between the two variables shows that intramuscular mass did not vary significantly during the program. Women who had high muscle mass at baseline maintained this level.

	Initial net intracellular mass	Final net intracellular mass	Initial physical rating	Final physical rating	Initial visceral fat	Final visceral fat	Visceral age
Initial Net intracellular mass	1.00						
Final Net intracellular mass	1.00	1.00					
Initial physical	0.27	0.29	1.00				
Final physical	0.15	0.18	0.99	1.00			
Initial visceral fat	-0.52	-0.53	-0.20	-0.11	1.00		
Final visceral fat	-0.52	-0.53	-0.25	-0.17	0.99	1.00	
Visceral age	-0.78	-0.78	-0.20	-0.11	0.63	0.67	1.00

Fig.6 Correlations between body parameters- examples of correlations

Initial fitness rating vs. final fitness rating (r = 0.99, strong) there was a near perfect correlation suggesting that the overall fitness level of the women included did not undergo major changes, although there was a slight improvement. Initial visceral fat vs. final visceral fat (r = 0.99, strong), women who had high levels of visceral fat at the beginning maintained it after the program, indicating stability in this parameter or limited effects of the program on visceral fat. Morning blood pressure (systolic) vs. pre-program blood pressure (systolic) (r = 1.00, strong), systolic blood pressure values measured in the morning are identical to those measured before the program, indicating a consistency between these two data sets. Post-program blood pressure (systolic) vs. pre-program blood pressure (systolic) (r = 0.48, moderate), there is a moderate relationship between pre- and post-program systolic blood pressure, suggesting a moderate reduction in blood pressure after the program. Regarding post-program blood pressure (diastolic) vs. pre-program blood pressure (diastolic) (r = 0.15, weak), there is a weak correlation indicating a greater change in diastolic blood pressure after the program. Baseline net intramuscular mass vs. baseline visceral fat (r = -0.52, weak), women with higher baseline intramuscular mass tend to have lower visceral fat. The moderate relationship suggests a protective effect of muscle mass against visceral fat accumulation. Baseline net intramuscular mass vs. visceral age (r = -0.78, weak), women with higher muscle mass have a lower visceral age, indicating a healthier metabolic state. The strong correlation suggests that muscle mass is a key indicator of metabolic health. Baseline physical assessment vs. baseline visceral fat (r = -0.20, weak), people with better fitness levels tend to have less visceral fat, but the relationship is weak. Post-program (diastolic) blood pressure vs. baseline net intramuscular mass (r = -0.34, weak), women with high muscle mass had a greater reduction in diastolic blood pressure after the program. We can specify another correlation baseline visceral fat vs. pre-program (diastolic) blood pressure (r = -0.55, weak), women with more visceral fat tend to have lower pre-program diastolic blood pressure, but this relationship may reflect complex metabolic factors, and the correlation between visceral age vs. pre-program (diastolic) blood pressure (r = -0.27, weak), higher visceral age tends to be associated with lower pre-program diastolic blood pressure.

Discussions: A study showed that various indices of TSM, especially arm LBM, are positively associated with elevated blood pressure, prehypertension, and hypertension in Chinese adults, after controlling for confounding factors such as body fat and its distribution [11]. A study examined the relationship between body composition and blood pressure (BP) in Bahraini adolescents. In a sample of 504 students, it was found that BP was higher in boys and that weight and BMI were associated with elevated BP in both boys and girls. Central obesity (WHR, WC) was also correlated with elevated BP. The results suggest that obesity influences BP in adolescents and that simple measurements can help identify the risk of hypertension [1]. The study shows that boys were fitter and had a lower percentage of body fat than girls. Multiple regression analysis showed that weight and age significantly explained the variations in SBP and DBP. In girls, fat percentage influences SBP, and in boys, weight and age explain the variations in DBP. In girls, age and BMI are significant factors for the variations in DBP. However, the independent variables explain less than 50% of the total variation in blood pressure [9]. The study reported significant increases in body weight (0.78±0.1 kg, P <0.001), body fat percentage (0.5±0.2%, P = 0.007), systolic (2.3±1.2 mm Hg, P = 0.048) and diastolic (1.8±0.8 mm Hg, P = 0.028) blood pressure among participants. Obese individuals (35.2±0.8 kg/m^2) had a greater increase in BF% compared to normal weight individuals (21.7±0.2 kg/m^2, P <0.05). Exercise (4.8±0.6 h/week) also did not prevent holiday weight gain and did not significantly influence changes in BW or BF%[5].

Conclusions: Body weight and BMI are very good estimators of body and visceral fat, and these relationships are relevant both at the beginning and at the end of the program. Muscle mass shows a moderate positive correlation with body weight and BMI, indicating the importance of maintaining muscle mass during weight loss. Visceral age is closely related to visceral fat and BMI, highlighting the link between metabolic health and excess weight. The strong negative correlations between intramuscular mass and visceral fat or visceral age highlight the importance of muscle mass for metabolic health. Body composition ratings and visceral fat are strongly correlated between baseline and endpoint, indicating stability but smaller improvements following the program. Systolic and diastolic blood pressure show moderate correlations before and after the program, suggesting a moderate positive effect on blood pressure reduction. Individuals with more visceral fat have a higher visceral age, and these correlations are strong and significant, highlighting the link between excess fat and metabolic aging.

References:

1. A.M., Al-Sendi, P., Shetty, A.O., Musaiger, Myatt M. (2003). Relationship between body composition and blood pressure in Bahraini adolescents. British Journal of Nutrition;90(4):837-844. doi:10.1079/BJN2003963
2. E. Vizitiu, Constantinescu M. (2023). Impact of physical activities on overweight people during the COVID-19 pandemic, Chapter 27 , Biomedical Engineering Applications for People with Disabilities and the Elderly in the COVID-19 Pandemic and Beyond, Academic Press, 2022, pp. 313-324, ISBN 9780323851749, https://doi.org/10.1016/B978-0-323-85174-9.00020-0, https://www.sciencedirect.com/science/article/pii/B9780323851749000200
3. E. Vizitiu, A.I., Costea, Silişteanu, S.C. (2023). Prevalence of osteoporosis and risk factors in differentage categories in adult women. Balneo and PRM Research Journal 2023, 14(4).
4. E. Vizitiu, T. Dobrescu, Slusar, A. (2022). Research on optimizing the morphological status in a category of adult population by means of therapeutic swimming. Gymnasium: Scientific Journal of Education, Sports, and Health 2022, 23(2).
5. J. Stevenson, S., Krishnan, Stoner, M. et al. (2013). Effects of exercise during the holiday season on changes in body weight, body composition and blood pressure. Eur J Clin Nutr 67, 944–949 (2013). https://doi.org/10.1038/ejcn.2013.98
6. Li, W., He, Y., Xia, L., Yang, X., Liu, F., Ma, J., ... & Li, C. (2018). Association of age-related trends in blood pressure and body composition indices in healthy adults. Frontiers in physiology, 9, 1574, https://doi.org/10.3389/fphys.2018.01574
7. Magder, S. (2018). The meaning of blood pressure. Critical Care, 22(1), 257.
8. R. M., Siervogel, A. F., Roche, W. C., Chumlea, J. G., Morris, P., Webb, Knittle, J. L. (1982). Blood pressure, body composition, and fat tissue cellularity in adults. Hypertension, 4(3), 382-386.
9. S. Guerra, J. C., Ribeiro, R., Costa, J., Duarte, Mota, J. (2002). Relationship between cardiorespiratory fitness body composition and blood pressure in school children. Journal of Sports Medicine and Physical Fitness, 42(2), 207-13. Retrieved from https://www.proquest.com/scholarly-journals/relationship-between-cardiorespiratory-fitness/docview/202715672/se-2
10. S. Zhao, J., Tang, Y., Zhao, C., Xu, Y., Xu, S., Yu, Zhang, Y. (2022). The impact of body composition and fat distribution on blood pressure in young and middle-aged adults. Frontiers in Nutrition, 9, 979042, https://doi.org/10.3389/fnut.2022.979042

11. S., Ye, C., Zhu, C., Wei, M., Yang, W., Zheng, D., Gan, Zhu, S. (2018). Associations of body composition with blood pressure and hypertension. Obesity, 26(10), 1644-1650, https://doi.org/10.1002/oby.22291
12. Stamler, J. (1991). Blood pressure and high blood pressure. Aspects of risk. Hypertension, 18(3_supplement), I95