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Original Article

Effects of Circuit Exercise Training Intervention on Health-Related Physical Fitness and Biomarkers for the Elderly People with Cardiovascular Diseases

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Abstract

This study aimed to investigate the effects of a 12-week circuit exercise intervention on the health-related physical fitness and biomarkers of elderly with cardiovascular diseases. Sixty-seven subjects participated in the study, included stretching, aerobic, and resistance training. Pre- and post-examination blood testing and fitness testing. Paired samples t-tests, and correlation analysis were used to analyse the data. Results showed that subjects were overweight and had medium risk levels of infection for cardiovascular diseases. Cardiovascular and strength performance improved, but sit-up performance was lower than the norm. Total cholesterol and systolic blood pressure improved, but systolic blood pressure remained at a pre-hypertension level. The intervention had a significant positive effect on health-related physical fitness and biomarkers with medium risk cluster of cardiovascular diseases, and there was a high correlation between the two. BMI had a positive correlation with biomarker index and cardiovascular fitness, while agility and flexibility had a negative correlation.

1. Introduction

In recent years, due to the improvement of medical science, health education and economic ability, the average life expectancy of Algerian people has gradually increased, and the population structure has gradually transformed into an aging society. In Algeria, people aged 60 and above represent 8.71% of the total

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population in 2015 (Tiliouine, 2015), which is in line with the World Health Organization (W H O). the proportion of the population over the age of 65 exceeds 7% is an aging society (He, Goodkind, & Kowal, 2016).This phenomenon is common in developing and developed countries. After Algeria has entered an aging society, the impact is that aging is accompanied by the occurrence of diseases and the decline of body functions, which greatly increases the medical expenses and the burden of various family care. Therefore, delaying the aging phenomenon of the elderly and improving physical fitness has become one of the important issues facing now (Youcef, Mokhtar, & Adel, 2022).

Physical fitness decreases with age, with rapid declines in muscle mass and strength, It leads to the decline of related functions, which in turn causes various problems (Fragala et al., 2019). previous research on the elderly has also pointed out that the aging phenomenon formed by increasing age, the performance of physical fitness will also decline relatively with age (Booth, Roberts, & Laye, 2012). In addition, related literature points out that after human beings grow up, their physiological functions will decrease with age (Braidy et al., 2019), which will lead to the reduction of body functions and metabolism, and the degeneration of daily life functions (Shigenaga, Hagen, & Ames, 1994; Wallace, 2005).

According to a national wide web survey conducted by the Algerian National Health ministry on the amount of physical activity in different age groups in 2004, only 24.7% of the elderly people between the ages of 55 and 69 exercised for 20 minutes three times a week. And the proportion decreases with age (Lalia, Ali, Adel, Asli, & Othman, 2019; Sibai et al., 2010) . Due to the decline in mobility, The relative physical function also gradually declines due to the lack of physical activity, which will affect various activities of daily life (Adel, Mokhtar, Abdelkader, Mohamed, & Othman, 2019; Mohamed, Mohamed, Mohammed, Mokrani, & Belkadi, 2019).

According to statistics, the population rate of the elderly over 65 years old among the number of deaths has increased year by year, reaching 68.5% in 1999. Among them, the ten major causes of death among the elderly are malignant tumour, heart disease, pneumonia, cerebrovascular disease , and diabetes, chronic lower respiratory tract disease, hypertensive disease, renal syndrome and nephropathy, sepsis, accident injury (van de Vijver et al., 2014). In particular, cardiovascular disease-related diseases account for the majority, and the proportion of mortality and disease has shown an increasing trend compared with the past few years (Beboucha, Belkadi, Benchehida, & Bengoua, 2021; Khachfe & Refaat, 2019; Mokhtar et al., 2019).

Exercise improves physical function and reduces medical care resources in older adults (Benchehida et al., 2021; Gleeson, Sherrington, & Keay, 2014). However, a comprehensive study on sports behaviour found that domestic people generally have insufficient physical activity. Only 30-45% of them are engaged in regular exercise, and the rest are no or irregular physical activities (Eggermont & Scherder, 2006). In fact, as long as regular exercise habits are maintained, no matter the age, one can maintain a healthy body through exercise training (Swift et

al., 2018; Yacine et al., 2020), or can strengthen the function of muscles and joints, enhance balance ability, and at the same time have the effect of preventing diseases (Hess & Woollacott, 2005).

There are many national studies on improving physical fitness and cardiovascular disease (Almahmeed et al., 2012; Belahsen & Rguibi, 2006; Houti et al., 2016; Nejjari et al., 2013), but for middle-aged and elderly people, exercise During intervention, the safety, individuality, regularity and effectiveness of training must be given priority to achieve the benefits of sports training (Mohammed, Bachir, Eddine, & Adel, 2018; Taylor et al., 2004; Yung et al., 2009). For most elderly people, the fatigue caused by poor physical fitness and the general lack of motor skills during exercise will momentously limit the motivation of the elderly to continue to exercise (Adel, Alia, & Mohammed, 2020; Pedersen & Saltin, 2015), and form a bad circle that is not easy to maintain exercise habits.

At present, there is no standardized exercise prescription for circuit training exercises, which combines aerobic exercise, soft activities and water resistance training suitable for the elderly with the assistance of professional instructors (Belkadi et al., 2015). And get the benefits of these sports at the same time. Therefore, this study chose circuit training exercises as a training prescription for middle-aged and elderly people (Adel et al., 2019). In addition to explore the impact of circuit training exercises on healthy physical fitness and blood biomarkers, it is also necessary to establish a standardized process to facilitate the use of this exercise. Promotion and application of safe and effective exercise training prescriptions (Benbernou, Bennama, Belkadi, Boukchiche, & Koutchouk, 2022).

The main purpose of this study is to investigate the effect of circuit exercise training on healthy physical fitness and blood biomarkers in the elderly at risk of cardiovascular disease. And explore the relationship between healthy physical fitness and blood biology after the intervention of circuit exercise training in middle-aged and elderly risk groups of cardiovascular disease.

2. Material and methods

Participants

The subjects of the study were out patients from hospital in Mostaganem, who were referred by doctors to the sports medicine center to participate in sports, and who were judged by medical staff and who agreed to be involved in circuit exercise training for this study and high-sensitivity C-reactive protein according to the recommendations of the Centers for Disease Control and Prevention and the American Heart Association (High sensitivity C-reactive Protein (Hs-CRP)) were screened according to the criteria of moderate risk of cardiovascular disease. As shown in Table 1, the age range was 40 to 75 years old. After screening, there were 69 subjects, including (25 men, 44 women).

The basic information of the subjects included age, height, weight, demographic background variables, and lifestyle variables. Subject age range 40-

75. The average age was 59.65±9.51 years old; the average height was 159.19±7.47 cm; the average weight was 66.37±9.86 , as shown in Table 1.

Table 1. *Basic information of the subjects included age, height, weight, demographic background variables*

	Tests	N	Mean ± SD
Anthropometric	age (years)	69	59.65±9.51
	Height (cm)	69	159.19±7.47
	Weight (kg)	69	66.37±9.86
Body composition	body mass index(kg/m²)	69	26.12±2.85

Experimental design

Initially, the subjects were randomly assigned to an experimental group and a control group. The experimental group underwent a 12-week circumferential exercise training intervention, and their health fitness and blood biomarker data were measured before and after the training. In contrast, the control group did not receive the intervention and only had their health fitness and blood biomarker data measured before and after the study.

However, during the study period, it was discovered that the control group faced issues with randomization due to negligence in the work process. As a result, intentional sampling was employed instead of randomization. Although this method did not involve the division of participants into experimental and control groups, it did not impact the primary objective of the study. The study aimed to investigate the effects of a 12-week circular exercise training intervention on the energy levels and changes in blood biomarkers of middle-aged and elderly individuals who are at risk of developing cardiovascular disease.

Intervention of circuit training exercise

The circuit training exercise intervention consists of a 60-minute workout session, during which participants are required to wear a heart rate monitor to track their heartbeats before starting. Each training activity is supervised by a professional instructor (Abdelkader, Madani, Adel, & Bouabdellah, 2018; Saddek et al., 2020). In addition to using resistance training equipment for resistance exercises, the training also includes aerobic exercises and stretching. The principle of increasing load is employed during the training, and all activities can be adjusted based on individual abilities and needs.

The training sequence begins with stretching activities. Participants are then guided through a series of resistance exercises, which can be adjusted according to their individual fitness levels. Finally, the session concludes with aerobic exercises, which can include running, cycling, or any other activity that elevates heart rate and promotes cardiovascular health. Overall, the circuit training exercise intervention is designed to improve participants' overall fitness levels and promote a healthy lifestyle(Boudehri, Belkadi, Dahoune, & Atallah, 2023) .

The circuit exercise training program consists of three main components: resistance exercise, aerobic exercise, and stretching exercise.

1. During the resistance exercise portion of the program, participants use hydraulic resistance fitness equipment to train their core muscle group, upper body muscle group, and lower body muscle group. The trainer initially tests the maximum muscle strength (repetitions), and then the training intensity is set at 60~80%, with two sets per exercise. The resistance intensity increases with movement speed and decreases vice versa, which is different from the commonly used barbell-type fitness equipment.

2. The aerobic exercise component of the program includes stationary bicycles, elliptical machines, treadmills, and stair climbing machines. The intensity is set at 60~80% of the participant's maximum heart rate, and the duration of each session is 10 minutes, with two sessions per training session.

3. The stretching exercise component of the program involves yoga mats, resistance balls, elastic (rope) belts, and stretching machines, which are assisted by professional sports instructors. Each stretch lasts for 20 seconds, and each exercise is repeated six times, with a total of three sets per exercise.

Statistical analysis

Statistical analysis was performed using the using SPSS software (version 22) and Significance levels were set at $p \leq 0.05$. Shapiro- Wilk test was used to evaluate normal distribution of the conformity of continuous variables. The reliability of differences in the results of the mean values in two unrelated samples was determined using Student's t-test.

3. Results and Discussion

The body mass index of the middle-aged risk group of cardiovascular disease in healthy physical fitness is 26.12±2.85kg/m²; 72.13±12.68 for climbing in three minutes; 5.72± for sit-ups 5.57 times; back muscle strength 71.58±29.99 kg; grip Force 28.23±11.12 kg; vertical jump 18.04±6.96 cm; side step 18.27±6.34 times; reaction time 525.91±185.23 milliseconds; eye-closed monopod balance 11.66±23.48 Seconds; sitting forward bend 3.65±11.51 cm; Trunk extension 27.41±.10.84 cm, as shown in Table 2 below shown.

Table 2. *The data of each index of healthy physical fitness of the subjects*

Variable	Tests	N	Mean ± SD
cardiorespiratory fitness	Climb in three minutes	53	72.13±12.68
	Sit-ups (Second-rate)	69	5.72±5.57
muscle fitness	back muscles force (Kilogram)	66	71.58±29.99
	Grip Strength (Kilogram)	69	28.23±11.12
explosive force	vertical jump(cm)	69	18.04±6.96
agility	side by side (Second-rate)	67	18.27±6.34
reaction ability	Reaction time(millisecond)	67	525.91±185.23
balance ability	Balance on one foot with eyes closed (Second)	67	11.66±23.48
softness	Sitting forward bend(cm)	69	3.65±11.51
	Trunk stretch (cm)	68	27.41±10.84

Analysis of the current status of blood biomarkers in the elderly at risk of cardiovascular disease:

C - reactive protein in the blood biomarkers of the elderly at risk of cardiovascular disease was 2.31±3.11 mg/L; fasting blood glucose was 107.48±23.10 mg/dl; total cholesterol 193.14±44.24mg/dl; triglycerides 149.75±76.57 mg/dl; high density lipoprotein 48.07±10.92mg/dl; low density lipoprotein 112.16±33.48mg/dl; systolic blood pressure 135.38±15.27mm-Hg; diastolic blood pressure 76.23±10.45mm-Hg, as shown in the following Table 3.

Table 3. *Data of blood biomarkers of subjects*

Variable	Tests	N	Mean ±SD
inflammatory biomarkers blood	High sensitivity C- reactive protein (mg/L)	67	2.31±3.11
	Fasting blood glucose (mg/dl)	69	107.48±23.10
	Total cholesterol (mg/dl)	69	193.14±44.24
liquid biochemical	Triglycerides (mg/dl)	69	149.75±76.57
	High-density lipoprotein (mg/dl)	69	48.07±10.92
	Low density lipoprotein (mg/dl)	69	112.16±33.48
value blood pressure	Systolic blood pressure (mm-Hg)	69	135.38±15.27
	Diastolic blood pressure (mm-Hg)	69	76.23±10.45

Table 4. *Changes in physical fitness before and after circuit training intervention of circuit exercise training*

variable	Tests	N	Before training	After 12 weeks of training	Change ratio	*t* value
body composition	body mass index (kg/m²)	65	26.20±2.90	25.81±2.83	-1%	4.05*
cardiopulmonary fitness	The 3-Minute Step Test	52	72.35±13.72	88.44±22.28	22%	-6.17*
muscle fitness	sit-up test (Crunches)	68	5.72±5.61	7.84±6.00	37%	-6.89*
	muscle strength (kg)	64	70.91±29.89	79.14±30.96	12%	-5.02*
	Grip Strength (kg)	68	28.32±11.18	29.78±11.53	5%	-4.56*
explosive force	Explosive vertical jump (cm)	67	18.21±6.99	20.19±7.45	11%	-4.11*
agility	Side step (times)	66	18.18±6.35	22.64±6.71	25%	-8.02*
reaction ability	Response time (Ms)	67	525.91±185.23	463.93±195.80	12%	2.46*
balance ability	Balance on one foot with eyes closed	66	11.80±23.63	16.42±26.09	39%	-3.83*
softness	Sitting forward bend	68	3.56±11.57	7.65±10.78	115%	-5.88*
	Trunk stretch (cm)	67	27.35±10.91	32.54±10.95	19%	-6.15*

Note: 1 Significant difference between before and after sports training intervention, p < ..05;*
2. Change ratio = [(Post-Test - Pre-Test) / Pre-Test] ×100%.

Difference analysis of circuit exercise training intervention in healthy physical fitness:

Statistically dependent sample t- test found that the measured values before and after 12-week circuit exercise training were significantly different in all items of healthy physical fitness ($p < .05$), cardiorespiratory fitness ($t = - 6.17$)), sit-ups ($t = - 6.89$), back muscle strength ($t = - 5.02$), grip strength ($t = - 4.56$), vertical jump ($t = - 4.11$), side step ($t = - 8.02$), eyes closed One foot balance ($t = - 3.83$), sitting forward bend ($t = - 5.88$), trunk extension ($t = - 6.15$) and other items have all been significantly improved through exercise training, while the body Composition ($t = 4.05$) and reaction time ($t = 2.46$) decreased significantly, as shown in Table 4.

Healthy Physical Fitness After Intervention of Circuit Exercise Training in Middle-aged Risk Groups of Cardiovascular Diseases Relationship to blood biomarkers:

The relationship between healthy physical fitness and blood biomarkers after the intervention of circuit exercise training. Because there are more than two variables in each of the two variables of healthy physical fitness and blood biomarkers, the canonical correlation in statistics is used to find the relationship between the two sets of variables to see whether there is a correlation between the two sets of variables. In the canonical correlation, in order to understand the relationship between healthy physical fitness and blood biomarkers after the intervention of circuit exercise training, the eight orientations of healthy physical fitness are used as the X variable group (control variable), and the blood biomarker is Y The variable group (the criterion variable) was used for correlation analysis.

From Table 5 below that among the three groups of correlation patterns, only one group reaches a significant level of difference. therefore, X The variable group extracts the first group of canonical correlation factors χ 1, Y The variable group extracts the first group of correlation factors η 1. The first group of correlation factors χ 1 with n 1 The correlation coefficient of 0.507 ($p < .05$).

Table 5. *Correlation analysis of various factors of healthy physical fitness and blood biomarkers*

Typical variable	explained variance Eigenvalues (%)		correlation coefficient ρ	coefficient of determination ρ^2	degrees of freedom *df*	Wilk' s λ
1	0.345	74.616	0.507*	0.257	24	**0.663**
2	0.083	17.822	0.276	0.076	14	**0.892**
3	**0.035**	**7.561**	**0.184**	**0.034**	**6**	**0.966**

**p <.05*

Correlation between healthy physical fitness and blood biomarkers after the intervention of circuit exercise training:

The coefficient of determination was 0.257 and the canonical correlation coefficient was 0.507. X The factor structure coefficients of the variables (control variables) are X 1 =-0.648, X 2 =0.337, X 3 =-0.244, X 4 =-0.296, X 5 =0.378, X 6

=-0.241, X 7 =0.134, X 8 =0.468, the percentage of extracted variation is 13.989, and the percentage of repetition coefficient is 3.592. By The typical factor structure coefficients of the variables (the standard variables) are Y 1 =-0.465, Y 2 =-0.816, Y 3 =-0.429, The percentage of variation extracted is 35.502 and the percentage of repetition coefficient is 9.115.

Table 6. *Correlation Analysis of Health Physical Fitness and Blood Biomarkers*

Health fitness		**Blood biochemical markers**		**correlation**
Dependent variables	χ 1	Dependent variables		η**1**
body composition	-0.648	(Y 1)	Inflammatory Biomarkers	**-0.465**
cardiorespiratory fitness	0.337	(Y 2)	blood biochemical value	**-0.816**
muscle fitness	-0.244	(Y 3)	blood pressure value	**-0.429**
explosive force	-0.296			
Agility	0.378			
Response capability	-0.241			
balance ability	0.134			
softness	0.468			
Extraction Variation %	13.989	Extraction Variation %		**35.502**
Overlap factor %	3.592	Overlap factor %		**9.115**
		Typical correlation coefficient (ρ)		**0.507***
		Coefficient of Determination (ρ²)		**0.257**

Note: * $p < .05$

Discussions

This study took the middle-aged and elderly people at risk of cardiovascular disease in Chiayi area as the research scope. The purpose of this study was to investigate the differences in physical fitness and blood biomarkers among the elderly at risk of cardiovascular disease in different background variables and to analyse interrelationship between the two.

From the table 2. It was noted that the body mass index of healthy physical fitness is 26.12±2.85kg/m², according to the evaluation standard of Algerian body mass index of the Department of Health of Mostaganem (Houti et al., 2016) Defined as overweight (24 ≦ BMI < 27); the three - minute climbing index was 67.50±11.14 for men and 75.90±14.50 for women. National physical fitness norm, male 9.56±5.27, the judgment level is not good, female 3.49±4.52; back muscle strength 71.58±29.99 Kilogram (Hess & Woollacott, 2005). Compared with the research, the performance is better; the grip strength comparison (Pedersen & Saltin, 2015) during the research on the physical fitness score of the elderly in the community, male 38.74±10.44 kg and female 22.26±5.90 Kilograms can be judged as good; vertical jumps are compared to (Swift et al., 2018) criteria, male 24.16±7.21 cm and female 14.67±3.70 cm, all judged as bad; side by side 18.27±6.34 times and (Zhao, Huang, & Gu, 2022), the performance was poor; the reaction time was 525.91±185.23. Compared with past studies by (Hess & Woollacott, 2005; Nakagaichi, Anan, Hikiji, & Uratani, 2018; Yung et al., 2009; Zhao et al., 2022), the performance of middle-aged and elderly people was poor; balance on one foot with eyes closed 11.66±23.48. Compared with the previous

studies by (Fragala et al., 2019; Gleeson et al., 2014; Sibai et al., 2010), the balance ability of the subjects in this study was average; the starting point of the sitting forward bend test was 20 cm, the national physical fitness norm was compared, and the male was 20.08±11.99 cm and female 25.58±10.96 cm, the judgment level is all ordinary; the trunk is stretched 27.41±.10.84. Compared with the previous studies (Sillanpää et al., 2009), the performance is better.

Overview of blood biomarkers in the elderly at risk of cardiovascular disease From Table 3. It was noted that the high-sensitivity C-reactive protein is 2.31±3.11mg/L, which is in accordance with the recommendations of the Heart Association (Schaumberg et al., 2007), judged to be at moderate risk of cardiovascular disease (1.0-3.0mg/L); blood biochemical values are determined according to the standards of the National Health Administration's Manual for the Prevention and Treatment of Hyperlipidaemia and Hypertension (Pande, Perlstein, Beckman, & Creager, 2011; van de Vijver et al., 2014), fasting blood glucose 107.48 ± 23.10 mg/dl in the normal value (<126 mg/dl) range; total cholesterol 193.14±44.24 mg/dl is normal (120-200 mg/dl); triglycerides 149.75±76.57 mg/dl is normal (<200 mg/dl); high density lipoprotein 48.07±10.92 mg/dl is normal (40-60 mg/dl); low density lipoprotein 112.16±33.48 mg/dl is normal (<160mg/dl); systolic blood pressure 135.38±15.27 mm-Hg ,was determined as prehypertension (120-139 mm-Hg); diastolic blood pressure 76.23±10.45 mm-Hg is normal (<90 mm-Hg).

Differences in the health related to physical fitness of circuit exercise training interventions, Table 4. It was noted that after 12 weeks of circuit exercise training, the middle-aged and elderly risk groups of cardiovascular disease All health fitness items have improved, body composition (body mass index) and reaction ability (reaction time) have been significantly reduced, cardiorespiratory fitness (three-minute steps), muscle fitness (sit-ups, back muscle strength, grip strength), explosive power (vertical jump), agility (side-by-side step), balance ability (eye-closed balance on one foot) and flexibility (sitting forward bending, trunk extension) were significantly improved. recent study with an average of 69.1±4.9 The middle-aged and elderly people were the subjects for a period of 12 week, 3 per week times, 90 each time Minutes of exercise intervention (stretching + aerobic exercise + muscle strength training), through training, can significantly improve cardiorespiratory fitness, upper and lower body muscle strength and balance ability (Olivares, Gusi, Prieto, & Hernandez-Mocholi, 2011). Another study with an average of 72.5±7.4 years old as subjects, a period of 12 week, 3 per week times, 80 each time Minutes of exercise intervention (stretching exercise + aerobic exercise + muscle strength training + leisure activities) (Marcos-Pardo et al., 2020), This research results show that through exercise training the elderly have significant improvement in cardiorespiratory fitness, upper and lower limb muscle strength and balance ability (Marcos-Pardo et al., 2020). Compared with previous studies (Miyamoto-Mikami et al., 2015; Nemoto, Gen-No, Masuki, Okazaki, & Nose, 2007; Olivares et al., 2011; Pearson et al., 2013), the results of this study are similar, and circuit exercise training can improve the health and fitness of middle-

aged and elderly people.

The third part study of circuit exercise training intervenes in the differential situation of blood biomarkers in the elderly risk groups in cardiovascular disease, differences in the blood biomarkers involved in circuit exercise training.

From Table 3. Only total cholesterol and systolic blood pressure were significantly improved in the blood biomarkers of the 12-week circuit exercise training intervention. However, by observing the numerical changes before and after training, it can be seen that there is a trend of improvement, which is similar to the results of training intervention (aerobic exercise + resistance exercise + stretching exercise) (Marcos-Pardo et al., 2020; Nemoto et al., 2007).

According to the past Takeshima et al. (2004) research aimed at 35 Bit average 53 The elderly over the age of 51 were randomly divided into exercise group and control group. week, 3 per week times, for 50 Minutes of circuit exercise training (intensity: 70% of maximum heart rate) were involved; no exercise was involved in the control group. The results found that the intervention of exercise can improve the blood biochemical value, which is also similar to the results of circuit exercise training intervention in this study (Adel et al., 2019; Belkadi, Benchehida, Benbernou, & Sebbane, 2019; Takeshima et al., 2004).

From Table 6, It was noted that there is a typical correlation between healthy physical fitness and blood biomarkers in the elderly at risk of cardiovascular disease, and a set of typical correlation patterns are obtained, with a typical correlation coefficient $\rho = 0.507$ reached a significant level ($p < .05$). the control variable (χ 1) can account for 25.7% of the total variance of the principle variable (η 1)(ρ^2=0.257), and the typical variable (η 1) of the standard variable can explain 35.502% of the variance of the standard variable, and the overlap between the control variable and the standard variable is 9.115% , which means that the control variable terms through the first set of variables (χ 1 and η 1) can explain 9.115% of the total variance of the principle variable.

The overlapping part of the control variable and the standard variable, a total of 9.115%. In other words, the control variables of body composition, cardiorespiratory fitness, muscular fitness, explosive power, agility, reaction ability, balance ability and flexibility can be used to explain the inflammatory biomarkers, blood biochemical values of the elderly at risk of cardiovascular disease through typical variables. The total variation of blood pressure was 9.115%; and this typical factor could directly explain 35.502% of the total variation of blood biomarkers in the elderly risk group of cardiovascular disease.

In the case of correlation, if the absolute value of the structure coefficient is higher than 0.30, it is considered to have a correlation with a moderate or low degree. The Observed variables with structure coefficients above 0.30 are discussed. The control variables to be observed were body composition (structural factor = - 0.648), cardiorespiratory fitness (structural factor = 0.337), agility (structural factor = 0.378), flexibility (structural factor = 0.468), However, the absolute value of all relevant factors of the principal variable is higher than 0.30. the control variables in cardiorespiratory fitness, agility and flexibility, and the

inflammatory biomarkers , blood biochemical values and blood pressure values have a positive and negative structure coefficient, which is represented by It was known that higher levels of cardiorespiratory fitness, agility and flexibility resulted in lower levels of inflammatory biomarkers, blood biochemical values and blood pressure values; In the control variable, the body composition with the highest structure coefficient is the blood biochemical value that mainly affects the middle-aged risk group of cardiovascular disease. Since its structure coefficients are all negative, which was observed in the lower value of body composition of the middle-aged and older risk of cardiovascular disease Groups, also blood markers with lower inflammatory biomarkers, blood biochemical values and blood pressure values.

4. Conclusions

Current status of health fitness and blood biomarkers in elderly at-risk groups with cardiovascular disease:

The mean value of the body mass index of all subjects in this study was too high, according to the National Body Mass Index (NBMI) standard of the Department of Health of the Executive Yuan. The subjects were found to be overweight or obese. The participants' performance in the three-minute ascent test was better than the national and international fitness norms. The male and female participants performed better on the cardiopulmonary fitness test, grip strength test and back strength test. However, their performance on the sit-up test was below the norm for males, and the balance, flexibility, explosive strength, reaction time and agility tests needed improvement.

The values of inflammatory biomarkers "hypersensitive C-reactive protein" measured by the subjects in this study reached the level of "cardiovascular disease" as defined by the American Heart Association. The subjects were found to be at a moderate risk level for developing cardiovascular disease. The fasting blood glucose, total cholesterol, and total bile tests were performed in accordance with the NHLBI's manual for the prevention and control of hyperlipidaemia and hypertension.

In conclusion, this study highlights the importance of circuit exercise training interventions in improving health fitness and reducing the risk of cardiovascular disease in elderly populations at risk. The findings of this study provide valuable information for healthcare professionals and policymakers to develop effective intervention strategies to promote healthy aging.

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