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EVALUATION OF STRENGTH, FLEXIBILITY AND BALANCE IN OLDER ADULTS THROUGH FUNCTIONAL TESTS AND APPLICATION OF A PROGRAM OFPHYSICAL AND RECREATIONAL ACTIVITIES

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Abstract

Aging diminishes the freedom and independence of older adults. Muscle strength, flexibility, and balance are improved with physical and recreational activity. This research aims to demonstrate the impact of the stimulation of these capacities through a program of physical and recreational activities in older adults in the city of Quito, the population of this study was made up of 50 people, of whom 39 are female and 11 males, aged between 65 and 81 years old, the methods applied to assess their physical capacity were five

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tests functional. Subsequently, the program of physical and recreational activities was applied, finally a final assessment test was carried out on the study group, to know what was the effect of the applied program, functional tests that projected significant results both in strength, flexibility and balance of older adults, Through the statistical analysis in the T Student and Wilcoxon tests, which evidenced a significance value of p <0.05, concluding witha confidence level of the research study greater than 95%. It is suggestedthat the intensity of physical activity should be systematized and monitored so that it is possible to achieve the results and benefits of an active life.

INTRODUCTION

Knowing that aging is related to a decrease in muscle strength and power and, therefore,with a decrease in functional capacity. This reduction in muscle strength with age, it is mainly due to the loss and reduction of the size of type II muscle fibers and the decreasein the maximum voluntary neural activation of the muscles (Peterson, Rhea & Gordon, 2010; Reid & Fielding, 2012).

Likewise, other important changes occur with aging, the decrease in cardiorespiratory capacity (since maximum cardiac output decreases due to the reduction in maximum volume and heart rate) and the process of sarcopenia (which compromises the use of oxygen captured by reducing aerobic and functional capacity). Some studies suggest a decrease of 0.5 ml. (kg.min.year) -1 (Romero-Arenas, Martínez-Pascual & Alcaraz, 2013) of maximum oxygen consumption (VO2 max) in healthy older adults.

These alterations generate some functional modifications such as a decrease in stability and muscle strength, mainly in the lower limbs (Maki, 1997; Reid & Fielding, 2012). It is known that physical activity during adulthood and in particular in older adults contributes to improving muscle strength, stability, cardiorespiratory endurance, postureand to maintain stable some physical conditions such as flexibility, coordination and agility, which helps to maintain the independence and autonomy of the person (Reid & Fielding, 2012). Physical activity in older adults is one of the concrete alternatives to maintain physical well-being and, even more, mental well-being (Albala, et al., 2005).

The changes that older adults present are undeniable, ranging from biological, physical, psychological and social changes, presenting deterioration in some capacities at all levels, it is essential to assess the special needs for comprehensive care and support at this important stage of life.

Within the aging process, changes occur both in the organic sphere and in the mental and social sphere. The general physiological tendency that occurs during the aging process leads to sarcopenia and a decrease in functional efficiency. The changes that predispose to falls in the aging process are associated with several factors, among whichwe can name: the decrease in muscle strength, increased body instability.

Previous studies show that older adults have a lot of variability in gait pattern mainly due to a decrease in stride length and increased frequency as well as increased instability during gait. (Davies, Greig, Jordan, Grieve & Lipkin, 1992). These alterations raise VO2 (Davies et al., 1992) and the energy consumed per unit of distancetraveled (C) (Schmidt-Nielsen, 1972).

Physical activity refers to all movement, even during leisure time, to move to and from certain places, or as part of a person's job. Physical activity, both moderate and intense, improves health (WHO, 2020).

As an older adult, one of the most important things you should do for your health is tobe physically active on a regular basis. It can help prevent many of the health problems that seem to come over the years. It also helps strengthen your muscles so that you can continue to do your daily living tasks without having to depend on others (CDC, 2020).

There is conclusive scientific evidence, based on well-conducted studies, that physicallyactive adults 65 years of age and older have better cardiorespiratory function, a lower risk profile for disabling diseases, and lower rates of chronic noncommunicable diseasesthan inactive people. On the whole, the benefits of the physical activity recommended here outweigh the possible harms. Certain setbacks, such as musculoskeletal injuries,are common, although generally mild, especially when the exercise is of moderate intensity (eg, walking). The inherent risk of adverse events can be greatly reduced by progressively increasing activity level, especially among older sedentary adults. A progressive increase in physical activity, interspersed with periods of adaptation, appears associated with lower rates of musculoskeletal injury than in cases of abrupt increase in activity (WHO, 2020).

Physical activity is considered to be one of the strategies for the elderly to reduce risk factors and optimize lifestyles. The positive effects of physical activity in the elderly areshown below.

The main scientifically proven benefits are: decrease in body fat, increase in muscle strength, flexibility, prevention of falls; There is also an improvement in self-esteem, a decrease in anxiety, insomnia, an increase in cognitive functions and socialization(Bautista, 2008).

There is no doubt that exercise can be used to improve people's health, it should be considered that physical activity should be progressive where it includes aerobic activities and muscle strengthening training (José Alberto Ávila-Funes, 2004).

Physical and recreational activities planned for this population, which promote improvement in muscle strength, flexibility and balance, increased cardiorespiratory capacity and stability contribute to the better performance of all their daily tasks, even the most basic, such as walking. Independence in your tasks and the increase in walkingduring your walks help prevent and / or reduce the effects of various cardiovascular diseases, type II diabetes mellitus, obesity, high blood pressure, depression amongothers (Manson, Skerrett, Greeland and Vanlallie, 2004).

METHODOLOGY

This study had an observational and cross-sectional design. The study sample consisted of 50 participants between the ages of 65 and 81, living in the city of Quito and attending a gerontological center. The total number of participants was divided into two groups of 25 people each, according to their level of physical activity. The active group was defined as the one made up of the participants who reported performing at least 150minutes of moderate weekly physical activity (the physical activities performed by the participants were: hydro-gymnastics, yoga and walking); and sedentary group to participants who reported performing less than 150 minutes of moderate weekly physical activity and did not perform intense physical activity.

Initially they were invited to participate, then the proposal was presented to them and they were explained how they should carry out the different tests. Finally, with the people who decided to participate in the study, the place, day and time where the measurements will be carried out were agreed, taking into account the availability of theparticipant and the team of researchers. The exclusion criteria were: Heart failure; Mellitus diabetes; history of recent respiratory infection; chronic obstructive pulmonary disease; recent myocardial infarction or cardiovascular surgery (in the last 3 months); recent neuromuscular disease (in the last 3 months); previous history of lung diseaseand / or smoking (in the last 12 months), transplantation of any organ, serious osteoarticular injuries.

The evaluations were carried out in a single day, first some measurements of theparticipants were taken and then the functional and walking tests were carried out. The study followed the ethical standards of the Declaration of Helsinki (1975), The sequence was as follows: signing of the informed consent, anamnesis, measurements of mass, height, length of the lower limb, blood pressure, heart rate, strength of the lower extremities, flexibility of the lower extremities, agility or getting up tests walking test of6 minutes and VAS in a random way with the use of a card to record all the data.

The following was used for physical measurements: weight measurement obtained with a balance (Beurer BF480); height obtained with a tape measure attached to the wall; blood pressure through the Premium BPLP200 blood pressure meter; abdominal circumference measured with an inextensible tape measure at the level of the umbilicus,midway between the costal margin and the iliac crest (anterior superior iliac spine) in standing and expiration; Circumference of the hips measured with an inextensible tape measure at the level of the gluteal prominence, the waist-hip ratio was calculated as the ratio between the waist and hip circumference; the length of the lower limb for the estimation of the Vóptima was measured with a tape measure from the level of the greater trochanter to the ground (Alexander, 1989).

For the evaluation of the functional tests, the materials used were: 43 cm high chair, stopwatch (CASIO HS-70W-1); meter or tape measure and cones.

Functional tests performed

a) Strength test for the lower extremities:

Tests of getting up and sitting in the chair (sit-to-stand test). Test is performed toquantify the performance of the muscles of the lower limb. The participant began sittingin the middle of a chair of standard size (43-44 cm in height), with his back straight and leaning against the back while keeping his arms crossed at the wrists and leaning against his chest. The researcher gave the order to start the test. At the “go” signal, the participant had to reach the full standing position, sitting down again afterwards and repeating this action at the highest possible speed. The maximum number of repetitions performed in 30 seconds that the participant managed to achieve was considered as the result of the test (Csuka and McCarty 1985; Guralnik et al., 1994; Guralnik et al., 2000).

b) Lower extremity flexibility test (sit and reach test):

It is commonly used to assess spinal flexibility and hamstring length. The participant stood on the edge of a standard size chair (43-44 cm high). One leg had to be kept bent with the sole of the foot resting on the ground while the other was stretched as far as possible along the hip line. The heel of the leg that was stretched should always be in contact with the ground, and the foot flexed at approximately 90o. At the "go" signal, the participant gradually had to try to reach the tip of the foot with his arms, stretching both with his hands placed one on top of the other (index fingers one on top of the other)trying to get as far as possible to reach or exceed the big toe. The distance that was taken into account for the test was the one that the participant could reach and maintain for at least 2 seconds. It was made for both sides (right and left). The result could have positive or negative values depending on whether or not the participant was able to reach the tip of the foot with both hands (Jones, Rikli, Max, & Noffal, 1998).

c) Flexibility test of the upper extremities (back scratch test):

The participant, standing, placed one of his hands over his shoulder, with the elbow pointing upwards, the fingers extended with the palm of the hand parallel to the back and trying to slide it as far as possible along his back. At the same time, the other handis placed around the back and the other hand should be reached or passed. It was made for both sides (right and left). The final result was the distance that exists between the heart fingers of both hands or the overlapping distance between them (Bautmans, Van Hees, Lemper, & Mets, 2005).

d) Balance test: Test of getting up, walking (2.44 m) and sitting again (Time Up & Go).

The test is used to measure the ability of participants to perform sequential locomotive tasks including walking and turning. The participant had to remain seated in the middle of a standard chair, with your back straight and your hands on your thighs. The dominant leg slightly forward over the other. At the "go" signal, the participant had to get up from the chair, walk as fast as possible towards a cone that was placed 2.44 m from the chair, go around it on either side and sit back in the chair. The final result of this test was the time required from the start signal until the moment when the participant returned to sitting in the chair (Furness, et al., 2014).

e) Single-leg stance test:

It is used to quantify the ability to maintain static equilibrium. The participant had to stay as long as possible supported on one leg with the arms at the sides of the trunk. Thetime in which this position could be maintained until one of the following situations occurred was measured:

a) that the supporting foot changed position,

b) that the raised foot touches the ground, c) that the arms were detached fromthe trunk, and/or.

d) that the raised leg touched the supporting limb (Harrison, Duenkel, Dunlop, &Russell, 1994).

Protocol of the gait tests carried out

a) Walking endurance test:

Called Test of the 6 minutes (six minutes' walk test). The 6-minute test is a submaximaltest used to assess aerobic capacity and endurance. This is a test adapted for older people in order to assess their aerobic endurance (important for walking distances, climbing stairs, shopping, etc.). It consists of determining the number of meters that a person can travel around a circuit in 6 minutes (Enright, 2003). To compare the estimated measures of the distance traveled in the 6-minute test, three different equations were used from those that have been proposed for this purpose in otherstudies (Enright and Sherrill, 1998; Troosters, Gosselink and Decramer, 1999; Enright, 2003). No equations were found for the elderly population of Quito, for this reason this study proposes intra-group measurements and comparisons through these three equations.

b) Self-select walking speed:

Through the VAS it is possible to estimate the running economy. Speeds close to 4-4.5 km.h-1 result in lower energy consumption while driving, which is the optimal V (Cavagna et al., 1977). To carry out this measurement, the participant was asked to walkat a speed that is comfortable for him in a 15 m corridor. He had to repeat the tour three times, beginning with a verbal order from one of the investigators. The researcher measured the time in which the participant completed the 15 m. The initial and final two meters were discarded, to ensure that the walking speed was measured in a stable phase without acceleration and / or deceleration. Thus, it was possible to know the participant's VAS (Bona, et al., 2017a).

VOptimal estimated by the Froude equation: It is an estimative measure of the VOptimal of gait through the length of the lower limb. For this we use the equation of the Froud number (nFr - Alexander, 1989):

v = velocity g = gravity L = Length of lower limb

nFr = v^2 / gL

nFr = 0.25 (dimensionless number) for the VOptimal of gait, it is possible to estimatethe VOptimal for each subject.

Statistics: The values are presented with descriptive statistics, mean and standard deviation. Normality was tested through the Shapiro-Wilk test for all variables. To compare the differences between the two groups (active and sedentary), the student's t- test was used for independent samples. For intra-group comparisons, the student's t test was used for dependent variables. The statistical package used was PSPP 1.01, free software with a p <0.05.

Results and Discussion

Table 1. *Characteristics of the elderly (participants)*

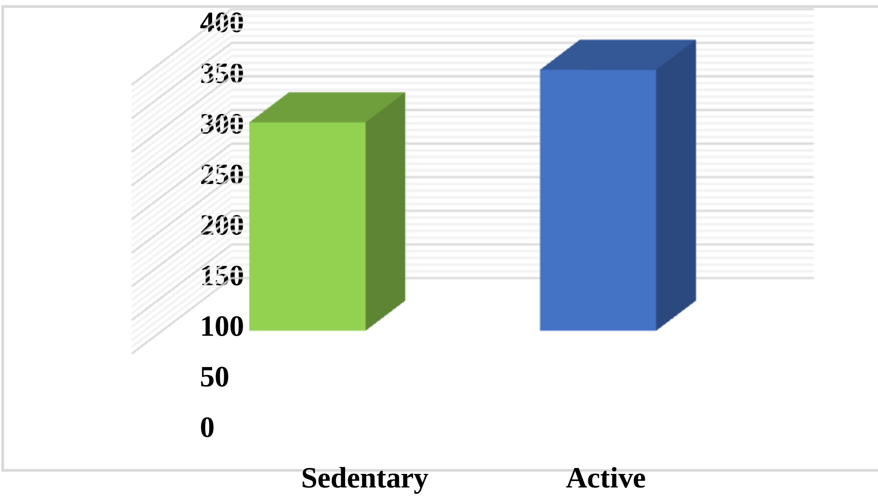
	Sedentary lifestyle	Active	P value
Individuals (N)	25	25	-
Age (years ± SD)	75.8 ± 6.1	65.7 ± 9.7	0.24
Weight (kg ± SD)	69.0 ± 7.24	70.2 ± 11.11	0.31
Height (m ± SD)	1.6 ± 0.04	1.60 ± 0.08	0.95
Sex	9H/16M	14H/11M	-
Systolic BP (mmHg)	124.7 ± 11.60	127.1 ± 16.40	0.67
Diastolic BP (mmHg)	80.1 ± 12.11	74.6 ± 12.43	0.27
Abdominal Circumference (cm)	92.3 ± 5.7	100.3 ± 6.15	0.05
Hips circumference (cm)	92.9 ± 6.3	100.3 ± 8.6	0.48

Waist- Hips Index (a dimensional)	0.9 ± 0.05	1.0 ± 0.06	0.01
Length MI (cm)	0.91 ± 0.03	0.91 ± 0.09	0.95
Estimated VOptimal nFr (m.s^{-1})	1.31 ± 0.02	1.31 ± 0.08	0.99

Source: BP syst is systolic blood pressure; PA dist. is the diastolic blood pressure; Long MI is the length of the lowerlimb; VOptimal estimated by nFr is the optimum velocity estimated by the Froude equation (nFr - Alexander, 1989).

The comparison of the evaluation of the walking test in the two groups evaluated, the sedentary and the active, is presented below.

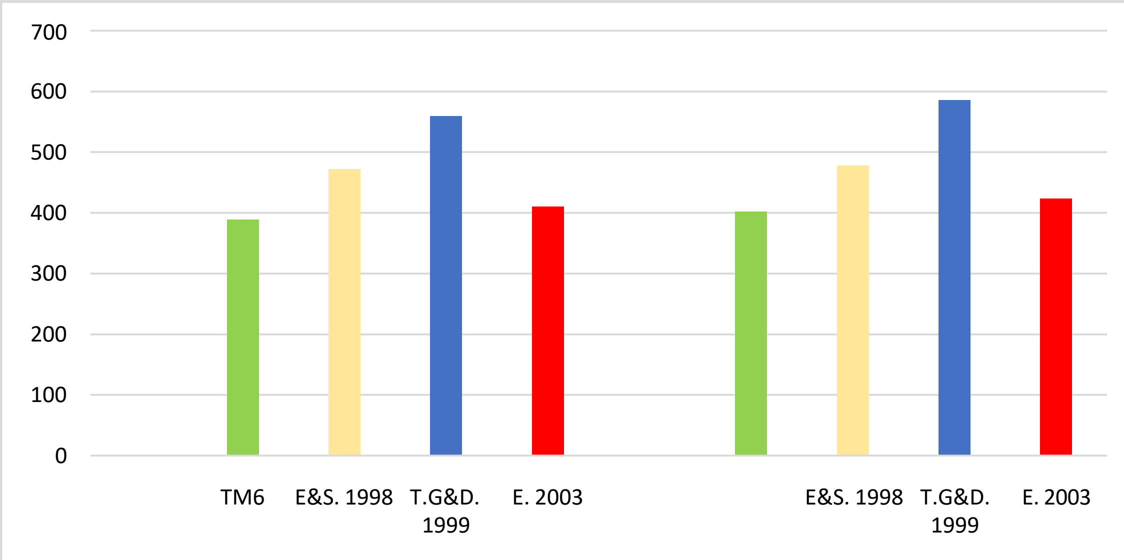
Figure 1. *Results of the walk test*



Source: distance in meters for the two groups evaluated: sedentary group (green) and active group (blue).

Figure 1 shows the average with standard deviation for each group evaluated. The difference in meters found was only 16.02 m. between one group and the other. Which does not represent a statistically representative difference.

Figure 2. *Intra-group comparison through three different equations for the six-minute walktest.*



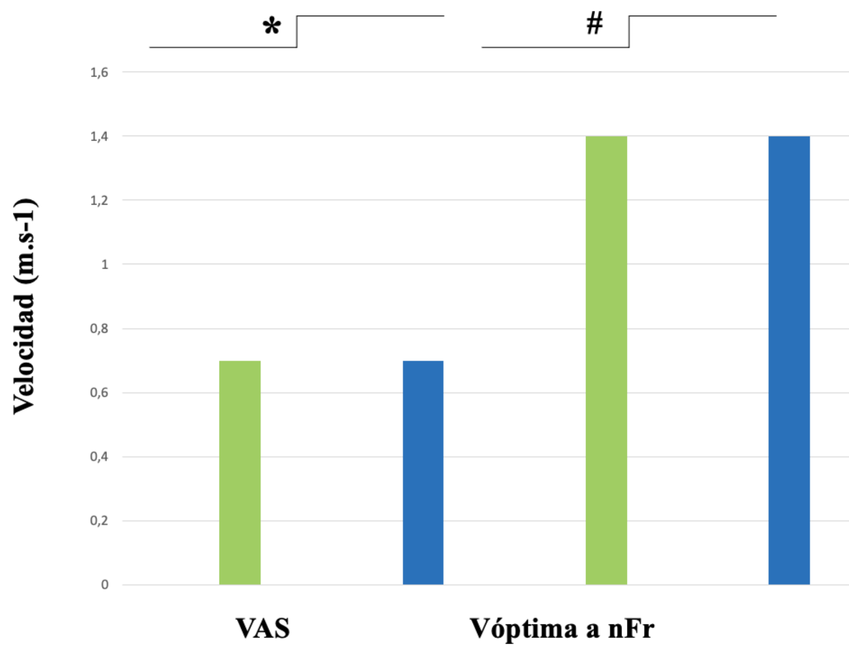
Source: Walk Test, different equations made and differentiated by colors.

Differences were found in the intragroup evaluation with three different equations. The colors represent the differences between the six-minute test measure measured in the present study and the different equations. The difference with the equation of Enright & Sherrill, 1998 for the sedentary group is (P <0.001), and for the same situation for the active group (P = 0.001); The difference with the Troosters equation, et al., 1999 for thesedentary group is (P <0.001), and the same situation for the active group (P <0.001); while the difference with the equation of Enright, 2003 for the sedentary group is (P = 0.002).

TM6 is the average of the six-minute walk test; E and S, 1998 is the average of the equation of Enright and Sherrill, 1998; T, G and D, 1999 is the average of the equation of Troosters, et al., 1999; E, 2003 is the average of the equation of Enright, 2003. average of the equation of Enright, 2003;the green column is the measure of the six- minute walk test of the present study for the sedentary group, the yellow column is the estimated measure of the walk test of six minutes through the equation of Enright and Sherrill, 1998, the blue column is the estimated measurement of the six-minute walktest through the equation of Troosters, et al., 1999, and the red column is the estimated measurement of the six-minute walk test through the Enright equation , 2003; The gray column is the measure of the six-minute walk test of the present study for the active group, the purple column is the estimated measure of the six-minute walk test through the equation of Enright and Sherrill, 1998, the turquoise column is the estimated measurement of the six-minute walk test through the equation of Troosters, et al., 1999, and the black column is the estimated measurement of the six-minute walk test through the Enright equation , 2003.

Figure 3 shows the VAS and Vóptima estimated for the two groups.

Figure 3: *VAS and Vóptima estimated for the two groups.*



Source: Gait speed test, speed results in meters per second.

As you can see the sedentary group (green) and the active group (blue), VAS is the autoselected speed; VOptimal is the optimal velocity estimated by the Froude equation. (*) represents difference between VAS and VOptimal for the sedentary group ($P \leq 0.001$); represents the difference between the VAS and the VOptimal for the group of assets (P
≤ 0.001).

Table 2. *Results of functional tests*

	Sedentary lifestyle	Active	P Value
Flexibility MsIs (cm)			
Right	3.6 ± 11.2		0.55
Left	3.2 ± 13.2		0,.83
Strength MsSs (cm)			
Right	0.8 ± 9.5	3.6 ± 7.25	0.49

Left	5.6 ± 11.3	4.2 ± 8.06	0.84
Strength MsIs (repetitions)	14.8 ± 4.7	15.64 ±4.52	0.75
balance (s)	7.2 ± 2.3	6.78 ± 2.0	0.60
Right	19.8 ± 19.4	19.6 ± 15.09	0.53
Left	26.3 ± 25.8	19.6 ± 19.78	0.67
6 minutes' walk test	386.9 ± 62.8	405.95 ± 47.80	0.43
Enright & Sherrill, 1998	460.6 ± 52.6	470 ± 44.50	0.92
Troosters et al. 1999	560.5 ± 59.8	580.78 ± 41.09	0.45
Enright, 2003	425.8 ± 47.8	445.08 ± 35.45	0.43
VAS (m. s^{-1})	0.8 ± 0.3	0.85 ± 0.22	0.98

Source: Data are presented in Mean SD, for difference: $p <0.05$. Flexibility MsIs is the flexibility measured in the lower limbs; flexibility MsSs is the flexibility measured in the upper limbs; force MsIs is the force measured in thelower limbs; VAS is the auto selected speed.

As stated, (Newman, et al., 2006) The group of active older adults was expected to havebetter results for the different variables analyzed. The application of the tests in closer time spans, in a study with training follow-up, allow a better tracking (follow-up) of the results in order to efficiently compare the physical activity / sedentary lifestyle relationship. We improve the intensity of physical activity for the active and sedentary group by applying a program of recreational physical activities in the population investigated.

PROPOSAL

Physical and Recreational Activities Program.

Our main objective of the proposal is to determine the stimulation of strength, flexibilityand balance through a Program of Physical and Recreational Activities in older adults ofa gerontological center in the city of Quito.

Through the results obtained in the previously described tests, we have implemented a program applied in three fundamental areas which are: recreational, recreational and artistic.

These activities were applied for 3 months, uninterruptedly and three days a week, witha duration of 60 minutes for each session, which are divided as follows:

Parts of the class: what does the initial part, which is the warm-up, the main part, the proposed exercises and the return to calm, which would be the stretching, the name of the activities to be carried out each session, the resources to be used and the evaluation that It will be applied to participants at the end of each activity.

Table 3. *Monthly Physical and Recreational Activities*

Monday	Wednesday	Friday
Yoga	Playful games	Tai Chi
Pilates	Dance	Gymnastics
Yoga	Playful games	Tai Chi
Pilates	Danza	Gymnastics

Source: Elva Katherine Aguilar Morocho

All these activities were executed and 100% fulfilled.

Table 4. *Daily work plan*

Class parts	**Activity**	**description of theactivity**	**Resources**	**Time**	**Evaluation**
Icebreaker Activity	Jesus told Lazarus	"Get up, get up" and Lazaro gives him an activity (sing) with theword sing the song. Execution of movementsor postures "healthy" conscious, generating a connection with the breath, natural movement and the environment. Repetition of conscious breaths	Human Resources	15"	Motivation and active participation in the entrusted activities
Main Activity	Yoga		Mats	35"	
Final Part	Meditation		Music for relaxation	10"	

Source: Elva Katherine Aguilar Morocho

This is a model planning of all classes implemented with older adults who improved strength, flexibility, and balance through all of the quarterly planning.

CONCLUSIONS

The physical capacities of the elderly were evaluated by means of the functional and walking tests applied in the sedentary participants, when performing the initial test, we realized that in the two groups there was little difference than what we could expect, in addition to not having differences in the tests, the active group presented two greater physical measures than the sedentary ones.

The applied program demonstrated the benefits of recreation through the use of sports, recreational and artistic physical activities, strategically planned areas that allowed the achievement of the objective during the three months, promoting other possibilities that lead to the improvement of the integral health of the entire population of older adults.

When carrying out the evaluation of the improvement in capacities we can realize that the strength increased by 0.75% in the active population, in flexibility we have 0.94% and in terms of balance we have 0.60% which indicates that our program impact of mildway to older adults. A weakness of this work is that the sample that participated did a self-report of the intensity and amount in minutes of their weekly physical and recreational exercise routines.

For future studies, it is suggested to carry out an intervention through planned and structured physical activity, with routines established by coaches, it is essential tomonitor the heart rate and scale of perceived exertion during sessions of physical and recreational activities applied in older adults.

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