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Can recreational physical activity improve trunk and hamstring flexibility in older adults in the Covid-19 pandemic?

Iris Malka[1,2], Iacob Hanțiu[1]
[1] *Physical Education and Sports Faculty, Babes-Bolyai University, Cluj-Napoca, Romania*
[2] *Movement, Posture and coordination studio for children and adults, Tel Aviv, Israel*

Abstract

Background. It is well-known that flexibility is related to the range of motion of the muscles and joints. Trunk and hamstring flexibility was found to be related to low back pain and falls, health and well-being.

Aims. This study aimed to investigate the impact of two recreational physical activity (RPA) programs, Harmonic Gymnastics and Fitness exercise, on the flexibility of the trunk and hamstring muscles in adults aged 50+. A secondary aim was to analyze the relationships between flexibility, BMI and gender.

Methods. Flexibility was measured in 32 subjects, mean age 61.40, from Tel Aviv, Israel, by the Back Saver Sit and Reach test. They were divided into two groups (16 subjects in each group).

Results. The paired samples t-test revealed significant differences after the program only in the Harmonic Gymnastics group ($p = 0.00$; $d = 1.34$). The correlation analysis indicated that after the program, flexibility scores were negatively related to higher BMI in women ($r = -0.508$, $p = 0.031$), and women had higher flexibility scores than men before and after the intervention program.

Conclusions. This research shows that the Harmonic Gymnastics recreational physical activity program had a significant influence on the flexibility of older adults, even in pandemic conditions of Covid-19. Regarding the relationships between flexibility, BMI and gender of the subjects, women revealed higher flexibility scores than men, and higher BMI was related to lower flexibility scores in women.

Keywords: flexibility, hamstring muscles, harmonic gymnastics, fitness, older adults

Introduction

Recreational physical activity (RPA) is related to various physical activities, practiced at different levels of metabolic equivalent of task (METS) energy expenditure and in different types of exercise activities practiced during leisure time such as: walking, jogging, cycling, aerobic, Yoga exercises, Pilates, dancing, etc. (Ainsworth et al., 2011). Studies have shown great benefits of RPA in healthy adults, older adults and also people with higher genetic risk of illnesses and people with chronic diseases (Kehm et al., 2020; García-Esquinas et al., 2021; Wang et al., 2017). On the other edge, sedentary behavior was found to be one of the main factors asociated with everyday basic activities functioning declines in older age. Flexibility of the lower limbs was found to be one of the indirect mediating factors of the association between sedentary behavior and functioning abilities (Garcia Meneguci et al., 2021). It appears that this association also occurs in young adults, as was found by Fatima et al. (2017), in 200 university students. Long hours without physical activity significantly resulted in tightened hamstring muscles.

Flexibility refers to the range of motion of a joint or series of joints, and to the length of the muscles that cross the joints to induce movement. It has been found to be related to a more efficient movement, and to the ability to move the joints smoothly and without pain (Alter, 2004). Iyengar (1979) defined flexibility as the ability to direct and focus awareness and attention, and to control oneself. Additionally, flexibility decreases unnecessary and uncoordinated movements, preventing injuries and musculoskeletal pain. Flexibility was found to be beneficial to the quality of life, by reducing pain, stress, and tension and by improving body and mind relaxation, posture and body symmetry, self-regulation, quality of sleep and sex life (Alter, 2004; Álvarez-Yates & García-García, 2020; da Silva et al., 2017). In addition, flexibility was found to contribute to muscle activation and growth, especially in older adults and people with physical disabilities (Wang et al., 2021).

Clinical studies indicated that flexibility decreases

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Address for correspondence: Faculty of Physical Education and Sport, Babeș-Bolyai University, Cluj-Napoca, Pandurilor Str. 7, PC 400376, Cluj-Napoca, Romania
E-mail: irismalka4@gmail.com
Corresponding author: Iris Malka: irismalka4@gmail.com
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steadily during lifespan as the child grows up, and as adults and older adults age (McKay et al., 2017), especially in older ages (Kulkarni & Fernande, 2017). The decrease in flexibility in older ages is also related to the general decline in the physical body systems and specifically to the structural and biomechanical changes expressed in the tenocytes and collagen mollecules in the joints, tendons and ligaments (Ueda et al., 2019). Age related decline in flexibility was also found to increase the risk of falls (Turusheva et al., 2020), and the risk of cardiovascular diseases and death following the decrease in elasticity of connective tissues and the artery stiffness process (Chen et al., 2020; Yamamoto, 2017). Furthermore, Komatsu et al. (2017) showed that older adults who had high trunk flexibility scores had lower systolic blood pressure and central pulse pressure.

There are two main types of flexibility training: *static* flexibility practice and *dynamic* flexibility. The static way of practicing flexibility is performed through passive stretching exercises that are intended to reach up to the point which is uncomfortable but can be held for 15-20 seconds. In contrast, dynamic flexibility is related to functional movements and is performed while moving. Dynamic flexibility is used mainly in track and field warm-up and other dynamic sports. It is characterized by exercising transitions from one position to another such as: "The lunge walk", "The walking leg swing to opposite hand", etc. (Hedrick, 2000). In most fitness exercise programs, subjects exercise *static flexibility*, but there are also other types of physical activities, in which flexibility is practiced in the dynamic way such as: Pilates, Feldenkrais method, Tai-Chi, etc.

Hamstring muscles include three main posterior thigh muscles: biceps femoris, semitendinosus and semimembranosus. All three of them are attached to the ischial tuberosity in their origin and clutch at the fibula and tibia edges. These are biarticular tendon-muscles, who cross two joints: the hip and the knee. Crossing these two joints may double the need of flexibility of these muscles in order to provide flexion ability of the trunk and extension in the lower limbs (Napolitano & Gupta, 2021). This may be the reason why hamstring muscles have a great impact on lower back pain, and therefore on quality of life. A meta-analysis by Sadleret al. (2017) of 5,459 subjects revealed that low back pain increased when the range of motion of the hamstring and trunk muscles was restricted. Moreover, Radwan et al. (2015) found that the tighter the hamstring muscles, the greater the severity of low back pain.

Objectives

The main purpose of this research was to investigate the impact of Harmonic Gymnastics (HG) and Fitness (F) RPA programs on the flexibility of hamstring and trunk muscles of older adults. Another goal was to investigate whether there is any relationship between flexibility and the BMI of the subjects, and whether there are any gender differences.

Hypotheses

In this research we started from the following hypotheses:

- The participation of older people (aged 50+) in recreational physical activities can have the effect of improving flexibility.
- The degree of flexibility will be dependent on the type of physical activity exercise, BMI and gender of the subjects.

Material and methods

Research protocol

a) Period and place of the research

The research study was approved by the Babes-Bolyai University (U.B.B.) Ethics Commission, Cluj-Napoca, as part of a research in the Physical Education and Sports Doctoral Studies Faculty of the U.B.B. The actual research study was conducted in Tel Aviv, Israel, in February 2020, three weeks before the Covid-19 pandemic imposed social restrictions. The program continued for three months under the new conditions of Covid-19, outdoors and by digital channels.

b) Subjects and groups

A total of 47 subjects agreed to participate in the study voluntarily and signed a consent form. They were divided into two groups, depending on the type of recreational physical activity program in which they wanted to participate: the Fitness (F) RPA or Harmonic Gymnastics (HG) recreational PA. The subjects began the program in the studio and the fitness club, but, after three weeks, had to deviate from the original program and participate through web application (Zoom) and in outdoor facilities, following Covid-19 pandemic restrictions. During participation in the intervention programs, one subject was excluded because of illness and 14 subjects did not come for the final measurements because of the fear from gathering together in Covid-19 pandemic conditions. Some of the subjects did not adjust to the changes in the program and did not agree to participate through web applications or practice by themselves. Therefore, only 32 subjects (16 in each group) remained in the program and came for the measurements after three months. The subjects' total mean age was 61.40 (9.48). The mean age of the F group was 63.44 (8.25), while in the HG group it was 59.37 (10.71) years old. Each group consisted of 9 women and 7 men. Most of the subjects of both groups had academic education (68.7% in the F group and 81.2% in HG). Most of the subjects of both groups were married (68.7% in both).

The participants in the F group practiced muscle strengthening, endurance and aerobics. When they trained together at the gym club, before the Covid-19 restrictions, they started with a warm-up that included static stretching exercises, aerobic running or walking on a treadmill, cycle ergometer or stepper, and after the cyclic training of muscle strengthening on the machines, they practiced static flexibility exercises to complete the session. Following Covid-19 restrictions, some of the participants trained through web applications at home and some trained in outdoor RPA facilities, walking, jogging, outdoor cycling, etc., 2 times a week, for 50 minutes in each practice for three months. They performed simple static flexibility stretching exercises as practiced in the gym club.

The Harmonic Gymnastics type of practice is a low intensive RPA, which is focused on strengthening

and flexing the muscles and joints in the most efficient qualitative way. In HG, flexibility is practiced in a dynamic way, while moving. Each exercise combined a series of several movements that are performed in a sequence. The trainees exercised transitions from one position to another and expanded their movement possibilities, range of motion and muscle power, at a slow pace through attention and body awareness. In addition, the trainees also practiced coordination, proprioceptive and vestibular ability (Mullan, 2016; Stebbins, 1892). They exercised 2 times a week, for 50 minutes in each practice for three months. At the beginning, the practices were performed on matts at the studio, but in Covid-19 conditions the practices were conducted through the Zoom application from home.

c) Applied tests

In this research, the flexibility of the hamstring muscles was measured by the Back Saver Sit and Reach test (BSSR). This is a very well-known and practical tool for hamstring and low back flexibility measurement. It was found to be more suitable for the spine than the classical Sit and Reach test, because in BSSR one leg is bent and this way imposes less load on the spine vertebrae (Hui &Yuen, 2000). In fact, BSSR had the strongest correlation with hamstring flexibility (Dhayal et al., 2019; Hajdarević, 2019).

Following the BSSR Protocol, the subject sat on the mattress, with the tested leg straight forward while the other leg was bent with the foot at the level of the tested leg's knee. The subject held the sliding bar of the box's ruler and moved it forward as far as he/she could in this position in a flowing and continuous motion, as shown in Figure 1.

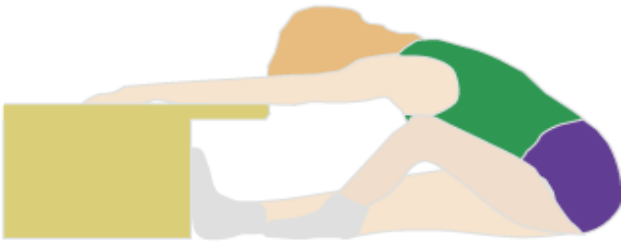

Fig. 1 – Back Saver Sit and Reach (Retrieved from topendsports.com).

d) Statistical processing

The statistical plan included a report of sociodemographic data such as: age, gender, marital status, education and BMI. The comparisons of the BSSR scores before and after the three month program of all participants and the mean scores by the groups were conducted following distribution analysis by the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. The paired t-tests were conducted for the comparisons of the data before and after the program in the normal distributions and the Wilcoxon tests for the non-normal distributions. Descriptive analysis and comparisons of the mean scores of males and females and BMI scores in each group were conducted by the independent sample tests and paired t-tests before and after the program, in addition to Pearson correlation for the relationship between flexibility and gender, flexibility and BMI.

Results

According to the Shapiro Wilk test, data for the variables BMI and BSSR were normally distributed in the HG and in the F group ($p > 0.05$). The independent sample t-test presented in Table I shows that there were no differences between the groups before the program in the BMI and the BSSR measurements of both groups.

The comparison of the means of the variables analyzed in all subjects, as a result of the scores recorded at the beginning and at the end of the intervention program, using the t-test for paired samples (Table II), shows that there were no significant differences in BMI scores, but significant differences in BSSR scores after the program ($t = -3.44$, $df = 31$, $p = 0.002$, $d = 0.6$).

Table III indicates the comparisons of the BMI and the BSSR scores between before and after the program in each group, according to the type of PA program. Data show that there were no differences within the Fitness group between before and after the program in the BMI ($t = -1.25$, $df = 15$, $p = 0.232$), or in the BSSR scores ($t = 0.34$, $df = 15$, $p = 0.737$). In the HG group, the difference between the mean BMI scores was not significant ($t=1.77$, $df=15$, $p=.097$), while in the BSSR variable, the difference between the means recorded at the beginning and at the end of the intervention program was significant ($t=7.62$, $df=15$, $p=.000$, $d=-1.34$).

In the comparisons of the means of the subjects ($N = 32$) by gender, the t-test for independent samples (sig 2 tailed), shown in Table IV, revealed no differences in

Table I

Comparisons of mean BMI and BSSR scores in the HG and the Fitness group before (1) and after (2) the program (N = 32).

Variable	RPA group	Descriptive statistics				Independent Samples Test			
		N	Mean	Std. Dev.	Std. Error Mean	t	df	Sig. (2-tailed)	Size effect
BMI 1 kg/m^2	F	16	27.63	4.443	1.110	0.157	30	0.877	0.027
	HG	16	27.42	2.918.	0.729				
BMI 2 kg/m^2	F	16	27.79	4.500	1.125	0.438	30	0.665	0.077
	HG	16	27.18	3.218	0.804				
BSSR 1 (cm)	F	16	20.58	7.755	1.938	-0.034	30	0.973	0.006
	HG	16	20.67	6.266	1.566				
BSSR 2 (cm)	F	16	20.35	8.303	2.075	-1.742	30	0.092	0.307
	HG	16	24.96	6.567	1.641				

Table II
Comparisons of mean BMI and BSSR scores before and after the program (N = 32)

Paired Samples Statistics						Paired Samples Test			
Pair	**Variable**	**Mean**	**N**	**Std. deviation**	**Std. error mean**	**t**	**df**	**Sig. (2-tailed)**	**Size effect**
Pair 1	BMI 1 kg/m^2	27.5322	32	3.69953	.65399	0.406	31	.687	.071
	BMI 2 kg/m^2	27.4924	32	3.86082	.68250				
Pair 2	BSSR 1 (cm)	20.6297	32	6.93623	1.22616	-3.440	31	.002	-.601
	BSSR 2 (cm)	22.6641	32	7.72736	1.36602				

Table III
Comparisons of the mean BMI and BSSR according to the group, before (1) and after (2) the program.

Group	Pair	Mean	Std. deviation	Std. error mean	t	df	Sig (2-tailed)	Size effect
F (N=16)	BMI 1 kg/m^2	27.6363	4.44347	1.11087	-1.25	15	0.232	-.311
	BMI 2 kg/m^2	27.7950	4.50048	1.12512				
	BSSR 1 (cm)	20.5875	7.75587	1.93897	0.34	15	0.737	.085
	BSSR 2 (cm)	20.3594	8.30310	2.07577				
HG (N=16)	BMI 1 kg/m^2	27.4281	2.91853	.72963	1.77	15	0.097	.441
	BMI 2 kg/m^2	27.1898	3.21807	.80452				
	BSSR 1 (cm)	20.6719	6.26679	1.56670	-7.62	15	0.000	-1.34
	BSSR 2 (cm)	24.9688	6.56752	1.64188				

Table IV
Paired Samples t-test for the BSSR scores of male and female subjects in the Fitness and HG group.

Paired Samples Statistics			Paired Samples Test			
Program (N)	**BSSR-1 Mean (STD)**	**BSSR-2 Mean (STD)**	**t**	**df**	**Sig (2-tailed)**	**Size effect**
Fitness Female (9)	24.26 (7.84)	24.08 (8.53)	0.186	8	0.857	0.043
Fitness Male (7)	15.86 (4.68)	15.57 (5.25)	0.298	6	0.776	0.079
HG Female (9)	21.13 (6.70)	26.25 (7.13)	-6.38	8	0.000	-1.504
HG Male (7)	20.07 (6.11)	23.32 (5.85)	-5.166	6	0.002	1.93

Table V
Pearson correlation analysis of BMI and BSSR scores in men and women before and after the program (N = 32).

Gender	Variable		BMI 1 (kg/m^2)	BMI 2 (kg/m^2)	BSSR 1 (cm)	BSSR 2 (cm)
Male (14)	BMI 1 (kg/m^2)	Pearson Correlation	1	0.990**	0.163	0.080
		Sig. (2-tailed)		0.000	0.579	0.786
	BMI 2 (kg/m^2)	Pearson Correlation	0.990**	1	0.156	0.045
		Sig. (2-tailed)	0.000		0.595	0.880
Female (18)	BMI 1 (kg/m^2)	Pearson Correlation	1	0.991**	-0.426	-0.511*
		Sig. (2-tailed)		0.000	0.078	0.030
	BMI 2 (kg/m^2)	Pearson Correlation	0.991**	1	-0.402	-0.508*
		Sig. (2-tailed)	0.000		0.098	0.031

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

BMI between men and women before (t = 0.066, df =30, p = 0.948) and after the program (t =-.030, df = 30, p = 0.976), but significant differences in the BSSR scores before (t =-2.00, df =30, p = 0.05, d = -0.353) and after the program (t =-2.20, df =30, p = 0.035, d = 0.388). Women had higher flexibility scores than men before [22.70 (7.26) cm. vs 19.44 (6.68) cm.] and after the program [25.16 (7.71) vs 19.44 (6.68)]. The paired samples t-tests in Table IV indicated there were no significant differences after the program in men (p = 0.776) and women (p = 0.857) in the Fitness group, while in the HG group, men and women had significantly increased BSSR scores after the program, from 20.07 (6.11) to 23.32 (5.85), p = 0.002, d = 1.93 in men and from 21.13 (6.70) to 26.25 (7.13) p = 0.000, d = -1.50 in women.

The Pearson correlation presented in Table V indicates there were no significant correlations between the mean BMI and BSSR scores in men before or after the program, while in women there were significant correlations between the BMI and BSSR scores after the program, indicating that a higher BMI was correlated with lower flexibility scores in women after the program (r = -0.508, p = 0.031).

By examining the scatter plot of the relationship between BMI and BSSR, Figure 2 shows that there is no evidence of a curvilinear relationship or the negative influence of outliers.

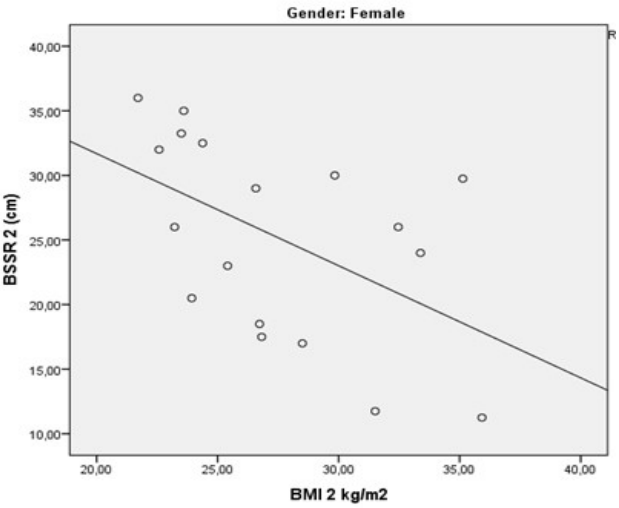

Fig. 2 – Dispersion diagram illustrating the relationship between BMI and BSSR in female subjects.

Discussions

Studies show that RPA is considered beneficial for many parameters, especially in older adults (Bruce et al., 2002; García-Esquinas et al., 2021); however, it was not clear whether the Fitness or the HG type of exercise would gain any changes in flexibility measures. In this research study, statistical analysis did not reveal significant changes in the Fitness group, in contrast to the HG group, which significantly improved the trunk and hamstring flexibility after the program in men and in women. Although the Fitness group practiced mainly muscle strength and aerobic ability, part of the practice included static flexibility exercises in the warm-up before the practice and at the end of the practice. These results follow many studies showing that regular PA intervention programs which included flexibility did not always gain differences in flexibility (Stathokostas et al., 2012). Takeshima et al. (2007) investigated the impact of different training programs such as: aerobic, resistance training, balance practice, Tai-Chi and flexibility training on functional fitness. They found improvements in cardiovascular ability, upper and lower body strength, balance and agility, but flexibility was not improved by these practices. Furthermore, flexibility workout in some cases was found to reduce muscle ability, power and performance (Lima et al., 2019). Nikolaidis et al. (2018) found that in women who practice recreational marathon running, the group who scored highest in flexibility measured by the sit and reach revealed the slowest running time. Finally, Nuzzo (2020) suggested to delete this component from the physical fitness major capabilities, because of its small impact on performance, as was seen by the fitness programs.

Flexibility of hamstring muscles significantly improved in our study only in the HG group ($p = 0.00$), which exercised flexibility thoroughly and in a dynamic way. This may be related to the dynamic way of practice which is included in the HG program, in contrast to the static type of training practiced in the Fitness program. In HG practice, every exercise comprises a sequence of several movements so that the muscles and joints are flexed and strengthened simultaneously. Many studies have shown that the dynamic flexibility way of practice produces better results than other modes of training, and improved the range of motion along with muscle power, agility and balance (Chatzopoulos et al., 2014; Opplert & Babault, 2018). Moreover, Herzog (2014), explained the mechanism of dynamic stretching, based on experimental observations on active stretching. He found that in contrast to the concentric and isometric contractions in passive stretching, the active flexibility practice is more likely to be related to the ability of titin stiffness activation. These proteins are engaged in muscle contractions and contribute to the elasticity of the muscle fibers, but also to their stiffness ability and the reduction of the free spring length. In active stretching, titins are able to bind to calcium and to actin, a process which enables them to gain resistance ability. This way, the muscles are lengthened without losing force, and are also protected from injuries at times when the isometric and concentric mechanisms are unstable.

Harmonic Gymnastics also involves the practice of coordination, proprioceptive and vestibular ability in addition to attention and body awareness. These components were also proven to be important in improving flexibility. Flexibility improvements along with functional basic physical performances were seen in various PA programs which involved dynamic flexibility and the practice of coordination, proprioceptive and vestibular abilities such as: Feldenkrais, Pilates and Tai-Chi, which in many ways resemble Harmonic Gymnastics (Bueno de Souza et al., 2018; Ghram et al., 2020; Zou et al., 2019). For example, in HG, as is usually performed in these PA programs, exercises that are related to the pelvic movement ability such as: anterior-posterior and medial-lateral pelvic tilt are practiced. These exercises were found important in improving trunk endurance and hamstring muscle flexibility along with better gait movement, knee and hip flexion and extension (Mendiguchia et al., 2020).

The fact that part of the time, some of the Fitness group participants continued practicing outdoors by themselves following Covid-19 restrictions in preventing the practice in gyms, sports clubs and any gatherings of any kind probably influenced this research outcomes (Grabowski & Maddox, 2020). Regardless of the Covid-19 pandemic, researchers have found that in general, social conditions contributed to the PA level of people more than other components such as physical environment or other facilitations (Chaudhury et al., 2016; Kleppang et al., 2018). In fact, Atad & Yanuv (2020) indicated that practicing in a group and practicing with a trainer revealed higher health and well-being scores in older adults. The HG group, although isolated in their homes, met by the Zoom application and sort of practiced together. Researchers have shown that digital behavior promoted PA levels and health among older adults in the Covid-19 period of time (Stockwell et al., 2019; Swechya et al., 2020). Nevertheless, the HG group may have had an advantage over the Fitness group because the participants still practiced together through a shared application.

Interestingly, McKay et al. (2017), have found that waist cirumference was a significant predictor of flexibility changes in adolescents, adults and older adults. A greater waist circumference was related to lower flexibility. In this study, a significant negative corelation was also found between flexibility and BMI scores after the program in women ($r = -0.508$, $p = 0.031$), indicating that a higher BMI was related to lower flexibility scores in women of this research sample. These results also follow the study of Jeong et al. (2018), where significant decreases in joint flexibility was found in 22 movements, among people who were defined as obese or pre-obese compared to people with a normal BMI. The same trend was found in overweight boys and girls compared to normal weight peers. It appears that obesity has a negative impact on the joints' ability to move eficiently, and fatty particles in the joint area create a blockage of the range of motion (Martínez-López et al., 2019).

In this research study, although in a small sample, women revealed higher flexibility scores than men, before and after a three months program. These results are in contrast to the findings of McKay et al. (2017) after screening 1000 children, adults and older adults, which showed no differences in flexibility scores by gender. On the other hand, Lopes et al. (2021) showed in 545 men and women that men achieved higher scores in power and strength measures, but women scored better in flexibility. The same trend was found in 10,036 adolescents (Martínez-López et al., 2019).

Conclusions

1. This research highlights the possibility of flexibility improvements following recreational physical activity in adults aged 50 years and older, even in pandemic Covid-19 conditions.
2. Flexibility was improved following the dynamic type of flexibility training as was practiced by the Harmonic Gymnastics PA program.
3. Women revealed higher flexibility scores than men, and a higher BMI was related to lower flexibility scores in women.

Limitations

The research program was conducted in Covid-19 pandemic conditions, which restricted practice in studios and gym clubs, therefore the program changed during the research practice time. Also, limitations of this study are caused by the small number of subjects participating in the study.

Conflicts of interests

The authors declare no conflict of interests.

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