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THE INFLUENCE OF HARMONIC GYMNASTICS ON FLEXIBILITY, DYNAMIC BALANCE, HEALTH AND WELL-BEING OF OLDER ADULTS: A PILOT RESEARCH

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ABSTRACT. Background. Physical activity (PA) is highly recommended for older adults in order to improve physical functioning, health and well-being. **Aims.** The purposes of this pilot research were: to investigate the influence of Harmonic Gymnastics (HG) on flexibility, dynamic balance, health and well-being of older adults, and to verify the feasibility of the research tools. **Methods.** In this pilot research 15 healthy men and women, mean age 58.7 (6.5), from Tel Aviv, Israel, volunteered to participate in the research program, which included 50 min. of HG practice, three times a week, for six weeks. Three questionnaires – SF-36 Health and quality of life questionnaire, The Global Physical Activity Questionnaire (GPAQ) and the Mindfulness Awareness Assessment Scale (MAAS) – and two physical skills testing equipment – Y Balance Test (YBT) and the Back Saver Sit and Reach test (BSSR) – were used to assess the subjects. **Results.** Post-test results showed significant improvements of total score of health and well-being by SF-36 ($p < 0.05$) and body awareness by MAAS ($p < 0.0001$), but no significant results for SF-36 (0.0629) subscales nor for the global PA measured by GPAQ ($p = 0.391$). Participants improved hamstring flexibility ($p < 0.05$) and dynamic balance of right leg ($p < 0.001$) and left leg ($p = 0.00001$). C**onclusions.** This pilot research indicates the feasibility of YBT, BSSR, MAAS and SF-36. HG was found to be tailored for older adults. Older adults improved functioning capabilities, body awareness, health and well-being after the program.

Keywords: *harmonic gymnastics, older adults, flexibility, dynamic balance, health and well-being.*

REZUMAT. ***Influența gimnasticii armonice asupra mobilității, echilibrului dinamic, sănătății și stării de bine a persoanelor în vârstă: o cercetare pilot.*** **Introducere.** Activitatea fizică (AP) este recomandată adulților în vârstă pentru

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a-şi îmbunătăţi funcţionarea fizică, sănătatea şi starea de bine. **Obiective**. Scopurile acestei cercetări pilot au fost: investigarea influenţei gimnasticii armonice (HG) asupra flexibilităţii, echilibrului dinamic, sănătăţii şi stării de bine a vârstnicilor şi verificarea fezabilităţii instrumentelor de cercetare. **Metode.** În această cercetare pilot, 15 bărbaţi şi femei sănătoşi, cu vârsta medie 58,7 (6,5), din Tel Aviv, Israel, s-au oferit voluntari să participe la programul de cercetare, care a inclus 50 de minute. de practică HG, de trei ori pe săptămână, timp de şase săptămâni. Trei chestionare – SF-36 Chestionar privind sănătatea şi calitatea vieţii, Chestionarul global de activitate fizică (GPAQ) şi Scala de evaluare a conştientizării atenţiei (MAAS) – şi două echipamente de testare a abilităţilor fizice – Testul de echilibru Y (YBT) şi Back Saver Sit and Reach Test (BSSR) – au fost utilizate pentru a evalua subiecţii. **Rezultate.** Rezultatele post-test au arătat îmbunătăţiri semnificative ale scorului total de sănătate şi stare de bine ($p < 0,05$) şi conştientizarea corpului de către MAAS ($p < 0,0001$), dar nu s-au obţinut rezultate semnificative pentru subscalele SF-36 (0.0629) şi nici pentru PA globală măsurată prin GPAQ ($p = 0,391$). Participanţii şi-au îmbunătăţit flexibilitatea hamstring ($p < 0,05$) şi echilibrul dinamic al piciorului drept ($p < 0,001$) şi piciorului stâng ($p = 0,00001$). **Concluzii**. Această cercetare pilot indică fezabilitatea YBT, BSSR, MAAS şi SF-36. S-a constatat că HG este adaptat pentru adulţii în vârstă. Adulţii mai în vârstă au îmbunătăţit capacităţile de funcţionare, conştientizarea corpului, sănătatea şi bunăstarea după program.

***Cuvinte cheie**: gimnastică armonică, adulţi în vârstă, flexibilitate, echilibru dinamic, sănătate şi bunăstare.*

Introduction

In addition to utility, abundance, physical health and meaningful life, it appears that all approaches agree on functional capability as a key component of the quality of life (Nussbaum & Sen, 1993). Steptoe, Deaton & Stone (2015) have found that a happy person with a positive life also succeeds in life and has better health components. They have found that the predictors of low levels of well-being were: male sex, single males, low income, obesity, diseases such as stroke, smoking, and physical activity (PA). Of all components of life style, PA had the strongest relationship with well-being and quality of life (Steptoe, Demakakos, de Oliveira, & Wardle, 2012; Steptoe, Deaton & Stone, 2015).

Many researchers of recent years have shown that, the decline in physiological, cognitive, and mental abilities in older age and the tendency to a sedentary lifestyle may cause a decline in physical functioning, well-being and quality of life in the elderly. PA was found to improve physiological, social,

cognitive and mental health components. Additionally, it was found also to reduce the risk of chronical and neurological diseases (Adlard, Perreau, Pop, Cotman & Neurosci, 2005; Bangsbo et al., 2019; Schmidt et al., 2015; Reiner, Nierman, Jekauc & Woll, 2013; Ross, Hudson, Stotz & Miu Lam., 2015; Stodden et al., 2008).

Therefore, it would be interesting to better understand the type of physical activity that would benefit older adults, and the specific skills older adults should practice for better health and well-being. Balance was found to be a crucial capability for independent functioning, since older adults tend to have lower postural control and are at higher risk of falls (Cohen, Nutt & Horak, 2011; Hasegawa et al., 2016; Hsiao et al., 2018). Flexibility was also found to be connected to reduced pain, stress and tension, and increased posture control, body symmetry, self-regulation and sleep quality (Alter, 2004; Sadler, Spink, Ho, de Jonge & Chuter, 2017; Tekur, Singphow, Nagendra & Raghuram, 2008). Researchers have also emphasized the need for a tailored PA for older adults and recommended to work on coordination and the quality of movement (Schwickert et al., 2016; Skelton & Dinan, 1999). This pilot research is conducted in order to investigate the influence of HG on posture control, balance, flexibility, health and well-being and to verify the feasibility of back saver sit and reach (BSSR), Y balance test (YBT), SF-36 questionnaire, mindfulness attention awareness scale (MAAS) and the global PA questionnaire (GPAQ) for older adult's population.

Material and methods

In this pilot research fifteen healthy adults, three men and twelve women from Tel Aviv, Israel, ages 47-71 volunteered to participate in the research program and signed a consent form of ethical approval. Participants had not practiced any organized physical training for at least one year prior to the program. The intervention program included 50 minutes' sessions of HG, three times a week for six weeks in total.

Harmonic Gymnastics intervention program contained a low intense physical activity that is focused on strengthening the body muscles and joints, postural alignment, posture transitions, coordination, proprioceptive and vestibular ability in addition to attention and body awareness.

Participants answered three questionnaires: SF-36 Health and quality of life questionnaire, The Global Physical Activity Questionnaire (GPAQ) and the Mindfulness Awareness Assessment Scale (MAAS). They were also assessed by two physical ability tests: dynamic balance by Y Balance Test (YBT) and low back and hamstrings flexibility by the Back Saver Sit and Reach test (BSSR).

Pilot research tools

SF-36 Health and quality of life questionnaire (Version 1.0) USA.

The MOS 36-item short-form health survey by Ware and Sherbourne (1992), is a valid and reliable questionnaire, that focuses on physical functioning and role limitation due to physical health, vitality (energy/fatigue), pain and general health, social and emotional well-being (Ware & Sherbourne, 1992; Ware & Gandeka, 1998).

Global Physical Activity Questionnaire (GPAQ)

The Global Physical Activity Questionnaire measures the amount of physical activity of people in different countries. It collects information on physical activity participation at work, in everyday traveling from place to place and in recreational activities. It was developed by WHO and comprises 16 questions (P1-P16). This questionnaire considers the daily energy expenditure measured by METs (Metabolic Equivalents) in sedentary activity (is equivalent to 1 MET), moderate PA (4METS), and 8 Mets for intensive PA (WHO, 2019).

Mindfulness Awareness Attention Scale (MAAS)

The 15-item MAAS was designed to assess a core characteristic of dispositional mindfulness, namely, open or receptive awareness of and attention to what is taking place in the present.

Back Saver Sit and Reach test (BSSR)

This is a practical, valid and reliable physical test that is mostly assigned to measure hamstrings muscle's flexibility capability. In Back Saver Sit and Reach test the subject has to place one leg standing on a mat with bended knee while the other leg remains straight.

Y Balance Test (YBT)

The YBT is a valid and reliable tool to measure dynamic balance and the neuromuscular ability to maintain equilibrium of the body and coordination. It measures the anterior/ posterior direction (AP), the posterior -medial direction (PM) and the posterior lateral direction (PL) while standing on one leg and pushing the cube with the other leg (Neves, 2017).

Results

Table 1. Sample Characteristics

Variable	Overall
N	15
Gender N (%)	F 12 (80.0) / M 3 (20.0)
Education N (%)	Academic 11 (73.3) / High School 4 (26.7)
Age – years (mean (SD))	59.2 (6.4)
BMI – kg/m^2 (mean (SD))	28.5 (5.4)

The characteristics of the subjects are presented in Table 1: 15 subjects were included in this study – twelve women (80%) and three men (20%) – 11 of them (73.3%) with academic education and 4 (26.7%) with high school education, from Tel Aviv, Israel; subjects' mean age was 59.2 (6.4) and BMI mean value was 28.5 (5.4), value that indicates a situation of overweight (WHO, 2000).

Table 2. Mean comparison of pre-test and post-test of questionnaires (N=15)

Questionnaire	Pre-test Mean (SD)	Post-tests Mean (SD)	SMD	p	Size Effect
MASS	67.41 (10.84)	76.69 (20.10)	-9.28	<0.0001	2.3
GPAQ	582.65 (776.79)	736.67(767.83)	-154.02	0.3081	0.89
SF36 Total	66.42 (16.73)	74.70 (9.91)	-8.28	0.0353	2.39
SF36 PF	74.33 (17.20)	81.67 (8.80)	-7.33	0.0629	2.01
SF36 EWB	63.11 (14.77)	65.67 (15.43)	-2.56	0.3793	0.66
SF36 sf	75.00 (27.14)	79.50 (20.49)	-4.5	0.5515	0.72

*Note: SF36 subscales are: PF-Physical functioning, EWB-Emotional Well Being, sf is Social Functioning. p is p-value based on Paired Wilcoxon test.

In Table 2 we can see statistical analysis of three questionnaires. Significant improvements were observed in attention and body awareness measured by MAAS (P < 0.0001), and in the total score of health and well-being measured by SF- 36 (p = 0.0353). Borderline significance for physical functioning (0.0629) subscale of health and well-being SF-36 questionnaire, and no significant differences for emotional and social well-being (p = 0.3793/0.5515). No significant changes for the global PA measured by GPAQ (p=0.3081) were observed. The highest size effect was seen in SF36 total (2.39) and physical functioning (2.01) scores and in MAAS (2.3) whereas in GPAQ and SF36 emotional and social health scores insignificant size effect.

Table 3. Mean comparison of pre-test and post-test of BSSR (N=15)

	Pre-test	Post-test	SMD[a]	P[b]
BSSR	Mean (SD)	Mean (SD)		
	11.02 (5.73)	18.82 (7.20)	-8.2	0.0013

*Note: a. SMD is the Standardized Mean Difference. b. P is p-value based on Paired t-test

Table 3. shows significant improvements in hamstrings' flexibility and lower back muscles from 11.02 (5.73) cm. to mean value of 18.82 (7.20) cm. after program (p= 0.0013), as was measured by BSSR.

Regarding dynamic balance and the neuromuscular ability to maintain equilibrium of the body and coordination, measured by Y Balance Test (YBT), Table 4 presents significant improvements in right leg scores in all directions (AP/PM/PL) and significant improvements by composite scores (p =0.001). Significant improvements in left leg scores in all directions and also by composite score (p =0.00001). The differences between legs (Delta) were smaller in all directions. Significant improvements were found only on PM (p = 0.042) and borderline on PL (0.068).

Table 4. Mean comparison of pre-test and post-test of YBT (N=9) [a]

YBT	Pre-test Mean (SD)	Post-test Mean (SD)	SMD[b]	P[c]
Right leg AP	36.30 (13.76)	60.72 (9.31)	-23	0.000781
Right leg PM	51.98 (21.39)	86.84 (10.08)	-30.9	0.0019
Right leg PL	47.75 (21.42)	85.88 (11.16)	-35.6	0.00082
Right leg composite	45.34 (18.58)	77.82 (9.07)	-29.8	0.00102
Left leg AP	32.12 (14.20)	59.08 (9.23)	-26.9	0.00127
Left leg PM	44.00 (19.65)	86.18 (11.90)	-43.9	0.00027
Left leg PL	46.06 (24.22)	82.38 (13.11)	-38.9	0.000273
Left leg composite	40.72 (18.32)	75.88 (10.43)	-36.6	0.00001
Delta AP	8.54 (8.00)	5.31 (6.33)	1.7	0.63891
Delta PM	14.59 (11.36)	4.72 (3.59)	8.5	0.04202
Delta PL	17.76 (13.78)	5.75 (4.51)	9.5	0.06842
Delta composite	12.14 (11.06)	3.64 (3.83)	6.2	0.14898

*Note a. six subjects who failed the pretest were excluded b. SMD is the Standardized Mean Difference. b. P value is based on paired t-test. AP is anterior- posterior direction; PM is posterior - medial direction; PL is posterior - lateral direction; Delta indicates the difference between legs Right-Left legs.

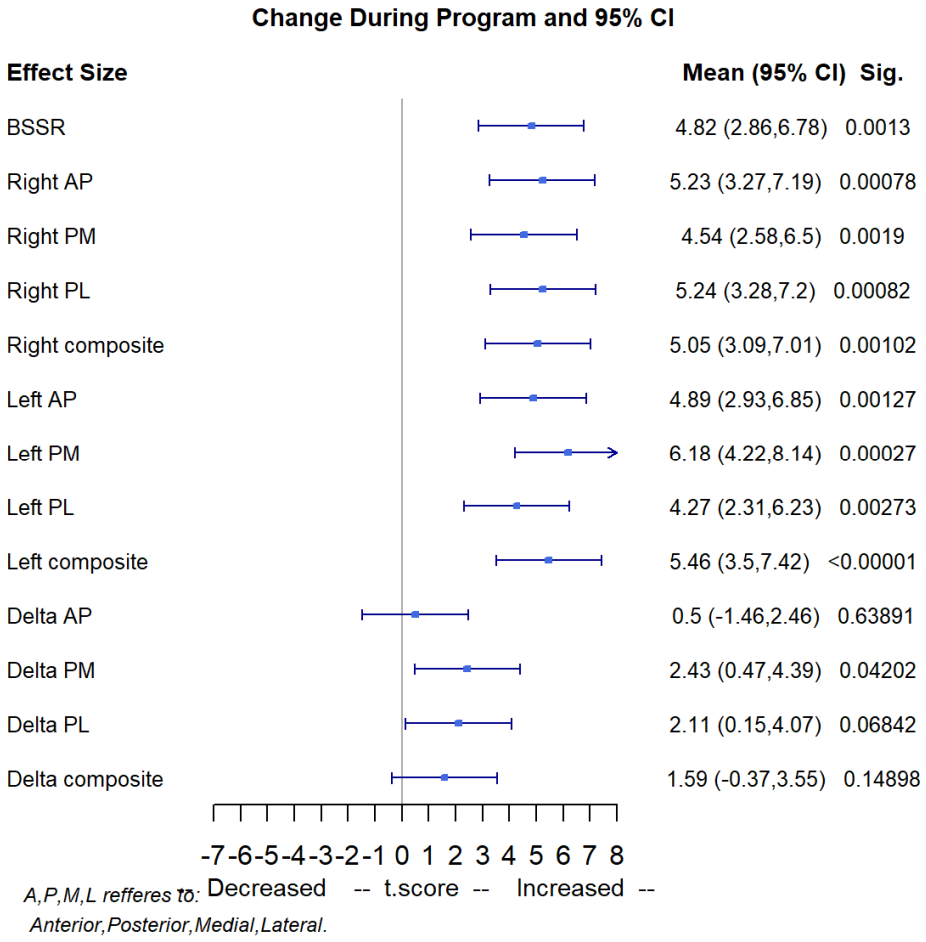

Fig. 1. Forest plot of BSSR and YBT size effect

Fig. 1 shows the forest plot of size effect of HG on capability variables. The forest plot shows positive size effect on flexibility (4.82), left leg of dynamic balance test in PM direction (with highest score effect of 6.18), in AP (4.89) and PL (4.27) directions as well. In right leg the highest size effect was in AP (5.23) and PL (5.24), while in PM 4.54. In composite scores size effect was 5.05 in right leg and 5.46 in left leg. Size effect of the difference between legs (Delta), was positive but generally the smallest of all: 2.43 in PM, 2.11 in PL, and only 0.5 in AP. Size effect of composite Delta score was 1.59.

Discussion

The results of this pilot research revealed significant improvements in health and capabilities measured: dynamic balance, hamstrings flexibility, body awareness, and total score of health and well-being. HG was found to be a tailored and beneficial PA program for older adults.

Flexibility of hamstrings muscles significantly improved ($p = 0.0013$) in addition to health and well-being especially in physical functioning ($p < 0.05$).

These results are in line with Alter (2004), Sadler, Spink, Ho, de Jonge & Chuter (2017) and many researchers who have found that tightened hamstrings muscles restrictions and lumbar lordosis movement are related to low back pain and restricted functioning. These results are also in line with other low intensive intervention programs such as Yoga, breathing and meditation practice and proprioceptive exercises, which improved flexibility, dynamic balance and health components (Kellis & Kofotolis, 2006; Tekur, Singphow, Nagendra & Raghuram, 2008).

The results of this pilot research indicate that flexibility exercises didn't come at the expense of muscle's strength. Dynamic balance ability test which is supported among other abilities by muscle strength, was also improved ($p =/< 0.01$). Lee, Kang, Lee & Oh (2015), who investigated older women (ages 45-80), have found that YBT is significantly and positively related to lower limb strength. Moreover, it is well known that athletes who tend to be injured are characterized by tightened and weaker muscles (Jonhagen, Nemeth & Eriksson, 1994), and recommendations are to flex and strengthen the muscles in order to prevent injuries and increase muscles' ability (Worrell & Perrin, 1992).

Baseline scores of YBT in this pilot study are relatively low and averaged 45.34 (18.58) for right leg and 40.72 (18.32) for left leg, and the differences revealed composite score of 12.14 (11.06) cm. Six subjects failed the test before the intervention program. These findings are in line of other researcher's findings. Older adults revealed poorer results in YBT and other similar balance and coordination tests (Cosio-Lima et al., 2016; Smith, Chimera & Warren, 2015; Gorman, Butler, Kiesel, Underwood & Elkins, 2009; Teyhen et al., 2014). In fact, Plisky et al. (2009) have found that composite scores below 94% and difference between legs of more than 4 cm. indicate instability of the ankle, deficit in dorsi-flexion in the sagittal plane and lower musculoskeletal control of lower limbs.

In addition, there is a large scale of variance within group. This test is usually applied to athletes or younger population. Older adults in this pilot although healthy did not reach good results at baseline test (Gupta, Yangdon, Gupta & Kumari, 2016), but after intervention program, subjects significantly improved YBT scores in all directions ($p =/< 0.001$). Only two subjects failed

after program compared to six subjects before program, and the difference between the two legs was reduced from 12.14 (11.06) to 3.64 (3.83), which is less than four cm. and as was indicated above, this result is related to lower risk of falling and injuries.

The pilot research shows us that dynamic balance improved as well as total score of health and well-being ($p < 0.05$). these results are in line with Tsigkanos, Gaskell, Smirniotou & Tsigkanos (2016), who have found that people with low back pain had greater postural sways. They concluded in their study that dynamic and static balance are strongly connected to low back pain whereas dynamic balance ability had greater impact on low back pain.

Health and well-being measured in this research by the SF-36 revealed high mean score of 67.6 (16.8) which is best health (60. +). Subjects of this pilot study were highly educated. Eleven of them (73.3%) were academically educated and four of them (26.7%) finished high school. They are from neighbourhoods in north Tel Aviv Israel, characterized by well-educated people with high- income. These results are in line with Kahneman & Deaton (2010) who showed that higher educational levels increased the subjective well- being and quality of life, and low income was associated with lower life evaluation and lower emotional well-being.

Subjects of this pilot study improved total health and quality of life questionnaire's score from 66.42 (16.73) total mean score to 74.70 (9.91) after program ($p < 0.05$), but no significant improvements on separate health sections especially in emotional well-being (EWB) and social functioning (SF). Lins & Carvalho (2016), indicated that it would be inappropriate to determine one single score that would reflect a person's entire health score. Since this questionnaire includes physical, mental and social components, these should be calculated separately (Lin & Woollacott, 2002). Sectional components of health and well-being improved after program, but not significantly. The fact that it was not significant may have been related to the relatively high baseline scores, or to the fact that the sample was rather small.

Mindfulness Attention Awareness Scale significantly improved after the program ($p <0.0001$). HG program included mindfulness practice. Trainees were requested to pay attention to their bodily reactions and leaning positions, while moving and while resting and after the exercises. Attention is directed to the rhythm, the power and weight, the course and the direction of the movement. In HG there is also considerable reference to the breathing process and to the "here and now" space, as practiced in mindfulness training.

These results are in line with recent findings of mindfulness practice. Mindfulness has been discovered to act as a stress protector for older adults (de Frias & Whyne, 2015), and pain redactor (Banth & Ardebi, 2015). Poulin et al.

(2016), have found that acting in awareness had a great impact on pain reduction, mental health and quality of life. Results of this pilot research encourage to combine mindfulness practice in physical activity training and emphasize its importance, especially in older ages (Poulin et al., 2016).

GPAQ was not been changed in the light of HG intervention program. This is a low intensive program. Most exercises are practiced in a supine position, some in sitting position and some standing. This training is not intended to improve cardiovascular endurance. It is directed at improving posture and coordination skill that may affect the quality of movement rather than the quantity of physical activity. Its positive influence on physical capabilities and health may encourage older adults to participate in various activities, including moderate and intensive type of PA in the long term.

Conclusions

Harmonic Gymnastics program has been found to be tailored for older adults. Subjects in this pilot research participated successfully in the program and improved their flexibility, dynamic balance, body awareness and total score of health and well-being. No significant changes for health and well-being were found in questionnaire's subscales. Emotional and social health were not significantly improved and physical health was border line ($p= 0.064$). In addition, HG did not change the global physical activity (GPAQ) of older adults. This pilot research indicates the feasibility of measuring dynamic balance by YBT, flexibility by BSSR, body awareness by MAAS and health and well-being by SF-36 for older adults.

Recommendations

Following this pilot research, it would be recommended to implement a long-term research program consisting of 6-12 months of HG intervention program for older adults, with a larger sample that could be divided by age groups and with original tools. It is recommended to compare HG program with other physical activity programs such as a regular gym intervention program of muscles' strengthening or aerobic physical intervention program as a control group. GPAQ should be measured at least 6 months after HG long-term intervention program in order to investigate whether older adults will participate in more physical activities in their everyday life following the practice of HG.

Limitations

This is a pilot research with a small sample (n=15). The range of ages varied from 47 years old to 71 years old. Because of small sample size it was impossible to divide them by age groups. The duration of this research was too short for solid conclusions.

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