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The Impact of Harmonic Gymnastics on Physical Functioning, Health and Well-Being of Older Adults

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List of Acronyms

PA – Physical activity
HG – Harmonic Gymnastics
METS – Metabolic equivalents
BSSR – Back saver sit and reach
YBT – Y balance test
WBB – Wii balance board
mCTSIB – sensory interaction on balance
SF-36 – Short form 36 questionnaire
MAAS – Mindfulness awareness and attention scale
GPAQ – Global physical activity questionnaire
AP – Anterior Posterior direction
ML – Medial Lateral direction
MP – Medial Posterior direction
Bp – Bodily pain
GH – General Health
Rp – Role physical
RE – Role Emotional
EWB – Emotional well-being
SWB – Social well-being
SWB- Subjective well-being
E/F – Energy Fatigue
q-2 – question number 2
Covid-19 – Corona virus disease 2019
ROS – Reactive oxygen species
CoP – Center of pressure

INTRODUCTION

In light of the rapid growth of the elderly population over the last decades (Roberts, Ogunwole, Blakeslee and Rabe, 2018), it has become urgent to seek treatments and resolutions of degenerative and chronic diseases, that are related to age and are detrimental to the physiological cognitive and mental functioning, health and well-being (Halter, 2014). Health and well-being in old age, is one of the greatest challenges in the modern world. Finally, this thesis deals with the question: How to age physically and mentally in a better way? Because in order to gain freedom, happiness and meaningful goals, humans need to create optimal physical, cognitive and mental conditions. As a matter of fact, recent studies have shown that better physical capabilities and bodily functioning may act as the key factor that can propel the positive wheel, which may lead to a sense of control, independence and freedom. These are important elements for health and quality of life of people, especially in old age (Cooper, Strand, Hardy, Patel & Kuh, 2014). Unfortunately, researchers found that older adults tend to prefer sedentary behavior, which aggravates the decreases in functioning abilities (Dunlop, Song, Arntson et, al, 2015). On the other hand, PA may be risky for older adults. In some cases, PA was found to increase injuries, falls and lowered health components and mood, especially in cases where the PA was too intense, and where the trainees had previous injuries or were unskilled (Chachula, Cameron and Svoboda , 2016). These conditions might occur especially when people begin physical training during older ages. Nevertheless, trained older adults may also suffer from symptoms of old age such as: low back or joints stiffness and pain, vertigo, sarcopenia, osteoporosis, etc. (Alsubaie et al., 2021). For that reason, it is important to seek a tailored PA, which could improve the main physical skills that older adults should master and also would fit their state and abilities (Schwickert et al., 2016). Hence, the questions which are relevant today regarding the PA of older adults are: 1- what would be the most important physical abilities older adults should practice in order to improve their health and well-being? 2- What kind of physical activity program would improve posture, balance and flexibility of older adults? 3- What kind of physical activity program would be the most adjusted for this population?

Harmonic Gymnastics is a unique somatic body-mind intervention program that combines the practice of physical capabilities such as: posture control, balance, muscle strength, flexibility, coordination, vestibular and proprioceptor ability along with body awareness, breathing techniques and challenging motor learning processes. Harmonic Gymnastics is practiced at a slow pace involving consciousness of the way the movement is performed, by learning new movement combinations and by paying attention to the movement and breathing patterns. In Harmonic Gymnastics PA program, participants activate according to their understanding and abilities without imitating the teacher or anyone else. It is characterized with the practice of gaining elegant and coordinated movement, which expresses the harmonious, intelligent, qualitative way of performance, so that posture and balance are improved along with muscle strength and flexibility and the capabilities mentioned above such as: coordination, vestibular and proprioceptive ability which also contribute to the physical and mental health and well-being of the individual (Stebbins, 1892; Lowell, 1895; Mullan, 2016). Research studies showed that

moderate to low intensity is beneficial to the older adult population, sometimes in preference to high intensity (Skelton, 2001). Moreover, Games, Winkelmann, and Eberman (2020), found that exercising at higher levels of intensity may lower dynamic balance and posture control. Another important issue which this thesis explores is: the specific physical capabilities which are important to practice in older ages. Although WHO (2021) recommends muscles' strengthening and endurance practices, studies showed the importance of the practice of flexibility, dynamic balance, posture alignment and attention and body awareness, especially in older ages.

Eventually, this thesis study seeks to examine if the HG type of exercise will improve physical abilities, body awareness, health and well-being of adults aged 50 years and older, and if Harmonic Gymnastics PA program will be more tailored and effective for the older adults' population than the regular more popular gym club Fitness program, in which the practice is more focused on building and strengthening the muscles, and developing endurance ability by gym equipment such as: weight lifting machineries, stationary bike, stepper, treadmill, etc.

The thesis main question is:

Will HG type of PA improve physical functioning, health and well-being of people aged 50 years and older?

The research hypothesis:

- Harmonic Gymnastics physical activity intervention program will improve physical functioning such as: posture, balance and flexibility, of older adults.
- Harmonic Gymnastics physical activity intervention program will improve body awareness, health and well-being of older adults.

Key concepts: Older adults; Posture; Balance; flexibility; Body awareness; Well-being.

Dependent variables: Posture; Balance; Flexibility; Body awareness; Health and well-being.

Independent Variable: Harmonic Gymnastics intervention program; Fitness program; No physical activity program.

The tools, with which this investigation was actually practiced, were chosen very carefully, with scientific validity and reliability. Flexibility was measured by the back saver sit and reach (BSSR) original box, dynamic balance was measured by the Y balance test (YBT) and posture control by the Wii balance board (WBB). All three devices are considered valid and reliable in the scientific physical education community in the world. In addition, these are well-known and practical devices for measuring these specific physical abilities. Health and well-being were measured by the short form survey- I , which consists of 36 questions (SF-36). Attention and body awareness were measured by the mindfulness attention and awareness scale (MAAS).

These questionnaires are popular and reliable, and are considered as valid scientific tools for these measurements.

Part I. Literature review

Chapter 1. Health and Well-being

1.1. Health and well-being, definition and approach

The basic approach of health and well-being is related to the freedom the individual has in the basic aspects of his life: the freedom of the physical, mental and social functioning ability. To be healthy is not to be restricted and have many options from which a person can choose to act and to be, as has been described by Martha Nussbaum and Amartya Sen (1993). They have described the quality of life as: "… the capability of a person to the various alternative combination of functioning anyone of which (any combination that is) the person can choose to have…" (Nussbaum and Sen, 1993, p.3). The freedom of choice is a spiritual and physical desire of humans. Many methods and techniques have been designed to expand human's abilities and skills in order to fulfil their purposes in life. Conventional and unconventional routines such as: medical solutions, physiotherapy, psychological therapies and also spiritual therapies are intended to provide the freedom of functioning. In fact, PA is one of the many ways to allow people to achieve a greater functioning ability by muscles strengthening and aerobic endurance practices (Fielding et al., 2017; Sivaramakrishnan et al., 2019). Various recreational exercises such as: Yoga, Tai-Chi, Pilates, Feldenkrais method, the Alexander technique, dance therapies and so on, also suggest different paths and ways to enhance health and well-being and bring new possibilities to cases of body and mind disabilities (Bueno de Souza, Marcon, Arruda, Pontes Junior and Melo, 2018; Sinvani, 2020; Ahmadi , Adib, Selk-Ghaffari, et al., 2020).

In the last decades health concepts and definitions are expanding from seeking to heal illness towards finding ways to promote the physical, mental, cognitive and social well-being. There is an understanding that health is not just the absence of illness, it contains within it a whole range of abilities and it is associated with various domains of life (Hernandez, et al., 2018). At the end of the last century subjective well-being (SWB), was defined mostly as the happy times of life, the pleasurable moments and the satisfaction from life (Kahneman, Diener and Schwarz, 1999). Deci and Ryan, (2008) contributed to the well-being definition the idea that the focus is on the eudaimonic well-being, that is concerned with the meaning a person has in his life, his mission and goals in life, the way he experiences self growth. The eudaimonic well-being is not about being always comfortable and happy. People may have to overcome challenges and sometimes go through unpleasant states which will gain at the end of the process the sense of fulfiling the desired purpose. The SWB also contains the person's evaluation of his mental, emotional and social components. Studies showed that the person's ability to be independent, to gain his goals, have meaning and control over his life, in addition to moments of joy and happiness, are major factors of his health and well-being. Depression and stress were found

connected to lower health components and lower SWB, on the other hand positive evaluation, happy moments and sense of meaning in life increased health and were found protective factors of mortality, diseases and lower SWB (Steptoe, Demakakos, de Oliveira and Wardle, 2012).

Diener et al. (2017) indicate that although researchers found that 40% of the SWB is influenced by hereditary components, 60% are not. They emphasized the micro and macro environmental components that consist of circumstances in life such as: the marital or employment status, the weather, taxation, the country state etc. After many years of research he indicated that these factors and life style factors such as: smoking, low income, being male, being single, chronic diseases and PA, had also great impact on SWB. Interestingly, PA had greater impact on SWB than the other lifestyle factors (Steptoe., Deaton and Stone., 2015; Diener et al., 2017). Moreover, Ryu and Heo (2018) found that after controlling covariant, PA was positively related to life satisfaction and indicated the positive outcomes of outdoor activities, social and cultural interactions and volunteering activities to the quality of life, health perception and optimism.

Health and well-being measurements and body - mind approaches

As seen by researchers who were interested in understanding people's well-being, measuring a person's well-being is a very complicated issue that comprises some key notes that must be taken into account. Velleman (1991), argues that classifying physical, social and mental well-being may be a false assumption, because researchers cannot compute the margin value of every state to comparable units, and the interactions between physical, social and mental states, have not been clarified yet. Kashdan and Biswas-Diener (2014) show that people who are able to connect with their "whole being", which contains the whole range of emotions: the positive and the negative ones, and can use them according to the situation, are found to be proactive, with greater personal, social and mental agility. The body-mind approach may emphasize the importance of looking and treating the human as a 'whole' creature. Recent studies revealed strong relations between physical, mental and social health and how positive well-being is connected to health outcomes. It appears that these bidirectional relationships of physical and mental well-being also have great impact on actual and practical health outcomes such as: the gene's expressions in the body inflammatory genes and increased activation of antiviral genes (Fredrickson, et al, 2013; Hernandez et al, 2018).

Chapter 2. Aging, Physical Capabilities and Physical Activity

Beyond claims, such as the biologic clock and the erosion of body systems, researchers have found that inflammation processes actually are deeply responsible for body aging. Understanding these mechanisms would probably help us increase longevity and most importantly improve the quality of life. Ghazanfar et al. (2017), have investigated the various paths of aging. They have indicated the main theories that explain aging and death of a living body, and have mentioned the reactive oxygen species (ROS), that are related to internal and

external factors that cause oxidative stress. These oxidative radicals and non-radical molecules that seek for a missing electron that is missing in their structure, cause imbalances which drags to problematic chain reactions of cellular and organ damages, which at their turn cause aging, diseases and death.

In addition to internal and external factors that cause oxidative stress, biological factors such as the Telomers are also involved in cellular damage, aging and death. Telomers are the edges of eukaryotic chromosomes that balance metabolic stress and define the biological aging. The telomers get shorter with age, and are badly influenced by higher BMI, visceral fat and general obesity. These small structures are designed to protect the cells but are related to age and genetic state, and are also very much affected by inflammation and stress situations. In fact, all aging processes are related to inflammation. Ghazanfar et al. (2017) indicated that in some cases it was shown that aging can be moderated to some extent, by consuming antioxidant nutrients, decrease obesity, and lowering inflammatory processes and stress. In their conclusion, obesity was found to be the greatest cause of oxygen stress, telomeres' shortening process and inflammation, the three main mechanisms of aging, diseases and death. Adipose tissues that are related to obesity are largely responsible for metabolic damage that leads to lower insulin resistance, diabetes mellitus, inflammation, rapid aging, diseases and death.

Nevertheless, aging naturally produces decline in many aspects, but the process of deterioration happens differently from person to person. Some will age rapidly and some very slowly, and will keep a higher functioning ability. In fact, the human body can keep good functioning for 80 to 100 years and in some special cases even older. Beyond genetic and biological causes, lifestyle encompassing nutrition, smoking and alcohol drinking, mental stress, physical activity or sedentary behavior, is a major factor in the way a person will get old. Researchers who followed people who participated in PA or were athletes in their youth, found that in adulthood and old age they had health benefits over people who had not engaged in PA and sports (Chakravarty et al, 2008). According to Altavilla, (2016), inactivity increased the risk of mortality in 20 to 30% compared to people who followed recommendations of at least 30 minutes of moderate PA per day for three or more days a week.

2.2. Physical capabilities and aging

The WHO Physical activity recommendations and other worldwide health organizations' recommendations mostly focused on the aerobic, muscles' strength and endurance practice. Research studies noticed that coordination, core strengthening and balance exercises were neglected and less covered by the guidelines and the health departments, although these abilities were found extremely important especially for adults and older adults, facing the risk of falls, and deficits in the physical functioning (Milton et al., 2018).

Posture Control

Posture control usually refers to the body physical equilibrium ability, which is related to the ability of the body to cope with the gravity and perform all basic physical capabilities effectively in the space. Eventually this is the most important skill in preventing falls. Static balance is the ability of the body to maintain its center of mass above the center of the feet, which are the body's base of support. The ability of the body to equilibrate facing gravity, also refers to the dynamics of several components of the individual such as: the body's structure and morphology, muscle's activation ability, power and speed in addition to environmental conditions such as: space and surface (Anson et al., 2017). Good posture is characterized by minimal sway, while avoiding the point of "no return" which might lead to falling. At the same time, it is characterized by minimal effort and good distribution of body weight on the body organs so that it does not create overload on body's muscles, bones and joints and enables effective mechanical and physiological organization of the internal organs, soft tissues and skeletal muscles (Bronstein, Brandt, Woolacott and Nutt, 2004). The body's alignment deformations were found to reduce functioning ability and cause unnecessary muscular tension, bone and joint erosion and pain especially in older age (Migliarese and White, 2019).

Contrary to what has been thought in the past, in recent decades posture control has been known to be associated not only with reflexive responses but also with multiple sources which are related to physiological and neurological body systems such as: the visual, proprioceptive, vestibular and somatosensory senses (Nashner, 2014). In older age, the decline in several physiological and neurological systems, lead to the decline in the ability to gain posture control. The decline in voluntary muscles and reflex's ability, coordination and the somatosensory integration loss, interfere with the mechanisms which create and support the ability of postural control (Rath and Wade, 2017; Anson et al., 2017).

Dynamic balance

Dynamic balance is one of the most required skills in the simple everyday activities and surely in the skilled sports performances. Dynamic balance requires the transition of the center of gravity of the body from one point to another in the space (Winter, Patla and Frank, 1990). Pollock, Durward, Rowe and Paul (2000) indicated in their article that balance ability encompasses three main strategies: 'maintaining 'which is when a person wants to stay in one position such as: standing, sitting or lying, 'achieving' when someone wants to move the body or one organ from one position to another and 'restoring' when someone needs the body's response to environmental disturbances. These strategies may be performed in fixed positions and variable positions. In order to define the body's posture stability, it is necessary to assess dynamic balance in addition to the static postural sway assessment. The static and dynamic posture control are two different skills independent from each other (Dunsky, Zeev and Netz, 2017). Similar to static posture control, in dynamic balance the proprioceptive and vestibular abilities also play important factors in gaining body's equilibrium, especially in older ages where the visual and neurological abilities decrease (Goble, et al., 2011). The age-related deterioration

of the peripheral and central neurological nervous system leads to decreases in important motor abilities such as coordination, postural and balance control. The direct results of these decreases lead to postural control disorders such as in step production, balance control, reaction time and inhibition ability compared to young individuals (Papegaaij, Taub, Baudry, Otten and Hortobagyi, 2014).

Coordination and motor learning

Postural control and dynamic balance were found to be very much related to the coordination ability. Shunway-Cook and Horak (1986), indicated that posture control and balance involve coordination between trunk and leg muscles, in order to gain equilibrium at the base of support. Researchers of recent years showed the strong relations between coordination ability and balance. In some cases, programs involving coordination and motor learning may reveal higher outcomes (Dunsky, 2019). McGinnis, Brickhouse, Pascual and Dickerson (2011) indicated that these results would bring some directions towards interventions and therapies that may inhibit the neural deteriorations in older ages. Motor learning for example, was found to enhance motor and prefrontal areas of the brain (Ostry et al., 2010).

Flexibility

Flexibility is related primary to the range of motion of the skeletal muscles and one or more joints, in addition to the length of the muscles which crosse the joints to induce a bending movement or motion. Finally, flexibility refers to expanding the movement, and encompasses the ability to move the joints smoothly and without pain. The ability of the muscle to lengthen is related to the organization of the sarcomeres of the muscles' fibers and the quantity of elastin fibers, which produce the ability of the muscles, tendons, ligaments and connective tissues to comply for a change in the formation or range of motion. Flexibility varies between individuals, particularly in terms of differences in muscle length of multi-joint muscles. Women for example tend to be more flexible than men, and there are specific areas in the body which are more flexible than others (Gleim and McHugh, 1997; Knudson, Magnusson and McHugh, 2000). Studies' researchers point out the classification of static and dynamic flexibility in addition to the ballistic type of flexibility training and the proprioceptive neuromuscular facilitation (PNF).

Iyengar (1979) emphasized the relationship between flexibility and self-control, focus, attention and body awareness. He indicated that the word Yoga in Sanskrit contains the terms: to bend, to pay attention, to communicate and to unite. Flexibility training positively affected many health-related components such as: stress and tension, body and mind relaxation, postural alignment and body symmetry, movement efficacy, falls, pain relief, self-regulation, quality of sleep and sex life (Alter, 2004). Moreover, Wang, Ikeda and Ikoma (2021), have found that passive stretching exercises in aging gastrocnemius muscle, increased the muscle's growth, its weight and cross- sectional area, myogenic and AKT-mTOR signals which are related to protein

synthesis after the protein breakdown process. These results suggests that older adults who are not active or paralyzed individuals may gain muscles' hypertrophy through stretching exercises.

The link between the flexibility of the spine and the hamstrings muscles, to back pain is well known and shown by many studies (Kroll and Raya, 1997; Kato, et al, 2021). Yamamoto (2017) found that decrease of flexibility of the trunk and hamstrings was related to the artery stiffness and imbalanced blood and heart pressure. She indicated in her review that Yoga practice lowered blood pressure in subjects with high blood pressure. Older adults who were more flexible had better blood pressure (Komatsu, et al, 2017).

Flexibility was found to be negatively influenced by age (Kulkarni and Fernande, 2017), but practicing flexibility in older adults would keep upper and lower torso with rather good range of motion, and would contribute to functioning health and well-being also in older age (Napolitano and Gupta, 2021).

The proprioceptive ability

Proprioceptive ability which comes from the Latin root – percepio, which means perception. It is the ability of the brain to perceive the environment by the body senses. The sensory components deliver information to the brain (e.g., the light waves which are captured by the retina of the eye, the sounds that are absorbed through the ears, or the position information coming from the muscles' spindles and Golgi cells of the joints) so that it is able to translate them to electrical input and respond accordingly. The proprioceptive receptors mainly determine the position of the limbs or the whole body in the space (Proske and Gandevia, 2012). This ability is somewhat similar to the relationship between hardware and software, although in humans it is not only a passive absorption of signals but it is an ability which is also related to memory and learning since in humans it can be trained. The proprioceptive ability is necessary in everyday activities and in high skilled sports performances. It contains the motor learning and body perception, the muscles functioning, limb and joints coordination. Researchers have found that aging has a negative influence on the proprioceptive ability and one of the troubling consequences is that it is related to poor balance control and the increase of the risk of falls in older adults (Proske and Gandevia, 2012). Older and sedentary individuals moved slower and less smoothly than younger active people. Proprioceptive exercises especially in the ankle and the knee joint have been recommended by researchers to gain higher postural control (Ree and Hwang, 2020).

The vestibular ability

The vestibular ability is one of the sensory systems. Its organs equilibrate and balance the body against gravitational forces, and allow the body to move to different directions freely. The vestibular system consists of the inner ear cochlea characterized with fluid filled basilar membrane, hair cells, the Saccule, Utricle, Oval window and the posterior, superior and horizontal semicircular canals. These organs react to the gravity forces and to the head passive

movements (Khan and Chang, 2013). The vestibular organs also react to the muscles' spindles and Golgi cells in the joints as the muscles stretch or contract and the body moves in the space. The vestibular system is related to the proprioceptive and kinesthetic systems as well as to the posture and balance control (Proske and Gandevia, 2012). Attention and body awareness were found connected to the vestibular system. Shum and Pang (2009) have shown that children with attention deficit hyperactivity disorder (ADAH) had significant vestibular impairments compared with typically developed children. Finally, the vestibular mechanisms play a role in integrating the kinesthetic and proprioceptive signals through the spinal column to the cerebellum and other central neurological systems. Therefore, the vestibular mechanisms contribute to various functions in many ways, starting from the simple reflexes to complex motoric coordination. The central neurological system uses the vestibular signals topline motoric reactions (Angelaki and Cullen, 2008). In aging, in the face of neurologic deteriorations, the vestibular ability decreases and older adults reveal lower scores and suffer more from vestibular deficits (Yeo, Kwon and Cho, 2020). Normally, people are not aware to these vestibular processes but when there is a vestibular deficit, people complain about unpleasant symptoms such as: dizziness, vertigo, instability, balance, posture and movement difficulties and fatigue. These symptoms caused tension in the neck and shoulders, headaches, fatigue and often led to a decrease in general muscles' strength, range of motion posture and balance control, fear of falls and actual falls, which in general decrease the well-being and quality of life (Anson and Jeka, 2016).

Chapter 3. Types of Physical Activity Programs

3.1. The Fitness physical activity

The Fitness PA as was practiced in this study includes muscles' strengthening, endurance and aerobic training. In contrast to the Fitness practice, the HG intervention program is related to the somatic, low impact, body-mind type of PA.

Muscles strengthening

Muscular strength is an important ability to gain an optimal physical performance, especially in situations such as lifting, carrying or moving weights over long distances (Suchomel, Nimphius, Bellon and Stone, 2018). Researchers have found that normal aging is associated with motor stiffness and with a decrease in the number of motor units of the muscles that compose the muscle's structure and are in charge of muscle strength (McNeil, Doherty, Stashuk and Rice, 2005). Sarcopenia was first defined by I.H Rosenberg, in 1989 and referred to the loss of muscle's mass in older ages. Fielding, Vellas, Evans et al. (2011) indicated that Sarcopenia has high prevalence among older adults and was found related to disability, sedentary behavior, deficiencies in the endocrine system, insulin resistance, nutrition, and also to inflammation and diseases. Unlike cachexia, sarcopenia is involved with functioning deficiencies such as: rising up from a chair, walking very slowly etc. Li et al. (2018), have found in 4,449 older adults in the U.S. that muscle strength was significantly associated with health and all

causes-mortality. In fact, they have found that lower muscle strength was associated with lower health outcomes and mortality more than muscle mass, considering sedentary time, leisure and PA behaviors. Muscles' strengthening and aerobic practices were found beneficial also for mental health as was found in 17,839 American adults ages 18-85. Aerobic practice such as: walking, cycling, running combined with muscle's strengthening practice such as: resistance training, were associated with lower rate of depression (Bennie, Teychenne, De Cocker and Biddle, 2019).

Aerobic ability

The pulmonary functioning, which exchanges the oxygen into the capillaries, the heart beat that drives the oxygen in the blood stream (the stroke volume), the hemoglobin- oxygen binding capacity as the hemoglobin leads the oxygen to the cells, the mitochondrial biogenesis that are activated in the presence of the reactive oxygen species (ROS), the number and volume of the mitochondria, the antioxidant enzymes, proliferator-activator receptors (Y coactivator 1 @, PGC-1@), mitogen activator protein-kinase and SIRI-1 in addition to endogenic antioxidants (glutathione and thioredoxin), which modulate ROS activation in high VO2 consumption and also satellite cells that are important to the muscle's growth process, all these complex processes indicate the importance of the oxygen consumption to the human health and homeostasis. This long list of physiological systems and biological components emphasize the variation potential between individuals. Better VO2max will lead to better health components, and better major physiological systems functioning (Strasser and Burtscher, 2018).

Vo2max decrease every 10 years in 10% starting from 30 years of age (Ogawa et al., 1992). The aerobic exercise ameliorated the older adults' VO2max 3.5 times higher than untrained subjects, and in general, reduced ageing declines, hospitalizations, diseases and death (Burtscher, 2013). Park and Kim (2021), have shown in meta-analysis of 1,110 subjects that aerobic exercise was associated with a decrease in waist circumference and the blood glucose and increased the Vo2max and metabolism efficiency. Aerobic exercise was found beneficial for subjects who suffered from irritable bowel symptoms by improving antioxidant and anti - inflammatory processes (Tartibian et al., 2018), It also can improve the insulin sensitivity by increasing the insulin carriers in the cell membranes, improving the insulin signals transmissions and by decreasing the adipokines that are related to oxygen and inflammatory stress (Yaribeygi, Atkin, Simental-Mendía and Sahebkar, 2019).

3.2. The somatic physical activity programs

The somatic practice involves the psycho-physical domain and the holistic view of the human experience. The somatic, or in other words, the holistic approach suggests that the mind and the body have mutual relation-ships. The mind and spirit have a great impact on the body and the body, actions and movements can also have a great impact on the mind. Unlike the fitness

type of exercise, the somatic approach is related to the movement quality awareness and attention and less to the intensity, frequency and force achievements (Eddy M., 2009).

Recent studies showed that these somatic physical mind-body practices contributed to adults and older adults' physical and mental abilities health and well-being (Walter, Van Puymbroeck, Bosch and Schmid, 2020). In this part of the somatic body-mind types of PA programs, three types which resemble in some ways to the HG approach. Although these practices are not exactly the same, they share many basic principles, main focus and way of teaching with the HG approach.

Chapter 4. Harmonic Gymnastics

4.1. The roots of Harmonic Gymnastics

Harmonic Gymnastics intervention program of this research, is a physical educational activity for adults and older adults, influenced by the HG approach led by Genevieve Stebbins (1857-1934), who emphasized the body-mind practice and the idea of the connection between the physical action and the bodily senses that were grounded by Delsarte (Stebbins, 1892). Delsarte (1811-1871) seems to have been a very charismatic teacher of theatre and stage performing arts (Ruyter, 1996). As was explained before, he emphasized the somatic consciousness in movement, in posture, in the art of speech and in every movement of the individual and influenced many somatic movement teachers, stages arts and dance.

The teachers who introduced the HG approach in Tel-Aviv, Israel, were: Judith Binetter and Lotte Kristeller. They founded the Physical Education and Movement faculty, in the Kibbutzim College of Education, Tel-Aviv, Israel, 1944'. They were physical education, movement and dance teachers from Germany, students of Elsa Gindler (1895-1961) who brought the modern natural approach to Germany at the beginning of the 20th century. The Physical Education and Movement Faculty in the Kibbutzim College of Education in Tel-Aviv, Israel was rather a unique institute which educated students and teachers through the HG approach and emphasized the important role of the physical education in the development of the personality and spirituality of the individual through physical attention and body awareness and through practicing physical skills such as: posture control, coordination, proprioceptive and vestibular capabilities, strength and flexibility (Kosh-Zohar, 2016; Mullan, 2016; Heyman and Shkedi, 1998). However, HG is not a method or technique, but an approach, a principle of action in which the means and goals are to enhance the quality of the movement. The main goal is to develop, understand and explore movement ability and self in a soft, considerate and sensitive way. The trainee discovers his /her precise way of movement, the amount of effort and rhythm he/ she uses. It is practicing movement through body consciousness, attention and awareness (Binneter, 1972; Kosh-Zohar, 2016).

4.2. The Principles of Harmonic Gymnastics in practice

In HG the focus is on the quality of one's movement: its sequence, smoothness, directions, weight, muscles' tonus, rhythm, etc. The principles of the HG, which Lowell (1895) described the three important elements of the movements: the ease of the movement, the precision and the harmonious way of performing the movement. He also indicates the two types of movements which are practiced in HG: the movement of unity he named *'Recomposing Motion'* and the movement of separation he termed *'Decomposing Motion'*. In HG, there are the movements which gather together the parts of the body and the movements which separate them to different directions. As is known in the HG approach, the movement cannot be qualitative if the body is not relaxed. Harmonic Gymnastics of this intervention program, consists of chain of movements which are more like "movement processes". Unlike short repetitive exercises, each "movement process" contains number of movements that are designed as one "long exercise". In every lesson or practice there are 6-8 "long movement processes" and they all refer to the theme of the lesson. Every lesson concentrates mostly on certain physical purpose or certain part of the body. Examples of practice themes: 'Expanding the movement of the shoulder blade and shoulder belt' / Knee joints movement/ 'Extension and flexion of the feet', etc. Usually, the practice takes about 50 minutes and is practiced twice a week. The following principles of the HG demonstrate the way of teaching and the important emphases of the HG approach in the actual practice:

Translating words to movements

The way of teaching is verbal. The HG teacher describes the movement processes by words only. Usually, the HG teacher do not show the exercises as in the Feldenkrais method. By doing so, the trainee develops the body awareness and self- consciousness. He learns his own abilities and limits and does not make efforts to imitate the teacher or anyone else.

Transitions

In HG movement lessons the HG teacher leads the trainees to move from one position to another in several ways. The HG practices consist of moving from lying on the mat to sitting position, from sitting position to standing position, from lying on the back to lying on the stomach, and also moving to the left/right side, etc.

Gradation

The movement processes or exercises are given in a graduate level. First the easy simple processes and then the more complicated and more difficult. First lying down on the mattress than sitting and then standing up. Harmonic Gymnastics program consists exercises mostly on lying position whereas sitting and standing usually are practiced at the end of the practice. First beginning in the easiest position such as: lying on the mat, then to the more challenging ones such as: sitting or standing up.

Rhythm

The rhythm of the movements is not dictated. It is personal and is controlled by the individual in accordance to his/her cognitive and mental ability. There is a constant reference to the aspects of the volume and ways of performance. In order to test the right pace to every individual and create challenging situations it's important to experience different speeds. Usually, the rhythm is slow and with control and is connected to the breathing rhythm. The practitioners find the breathing rhythm and match it to the movement process by themselves.

Effort

The purpose is to strengthen the muscles of the body, but not in the manner as "body builders" do. It's not about getting a certain shape of the body but about being strong in a functional way, so that the body is able to produce movements in an elegant way without unnecessary effort. The actual purpose is to teach the body how to use the least effort to every movement so that it is most efficient, and easily performed. In this practice, every practitioner follows the instructions only as much as he/she can perform and is convenient for him. In HG it is very important and the responsibility will be on them to know and discover their own limits.

Rest between exercises

As in Feldenkrais method we take a few minutes between exercises to stop, to listen to the breathing, pay attention to our body's sensations and reaction after the exercise (sometimes some parts of the body react positively and lean more comfortably on the floor and sometimes they react negatively and maybe raise discomfort). We dedicate the small brake lying down on our back after every exercise to see how our body leans on the floor, how far the low back, for example, is lifted from the floor, what impact the exercise had on our breathing, on the spinal column and the other parts of the body. The rest and the reflections are as important as the movement and exercise.

4.4. The basic theories related to the Harmonic Gymnastics

The theories that may explain the HG approach are the three main theories brought in this chapter: the dynamic systems theory, the mindfulness theory and the Top-Down and Bottom-Up theory. These theories may explain how the body-mind practice may improve the physical and mental functioning, health and well-being components of adults. These theories will show the mechanisms in which health and well-being can be improved also in old age, and what are the main principles which would allow this positive process.

Part Ⅱ

Chapter 6. The Impact of Harmonic Gymnastics on Flexibility, Dynamic Balance, Health and Well-Being of Older Adults: A Pilot Research

6.1. The pilot study: aim and hypothesizes

The pilot study program was intended to be small research which investigated the Harmonic Gymnastics PA program, the methodology, tools and materials' feasibility, before conducting the main research. The pilot research program was the first time the program and tools were used. The pilot program was conducted between July and August 2019, whereas the research was conducted after understanding the pilot research outcomes, and after reorganizing the program and subjects' samples. The aim of this pilot research was to explore the influence of Harmonic Gymnastics PA program on three specific physical capabilities which were found to be important for physical functioning, independent living, quality of life, health and well-being. The physical capabilities measured in this pilot research were: flexibility, posture control and dynamic balance. These measurements were found to be preventing falls and increasing movement abilities as was shown in the literature review. These basic capabilities may encorage older adults to participate in various activities, including activities of higher intensity and complexity such as: cycling, running, surfing, ball games, etc. also into older age. In addition to physical measurements, the pilot study investigated the attention and body awareness, the global physical activity practice, health and well-being of adults older than 50 years old using three questionnaires. Nevertheless, besides the subjects' achievements, the pilot research was conducted to verify the back saver sit and reach (BSSR) tool for measuring older adults' flexibility, the Y balance test (YBT) for measuring dynamic balance ability, and the three questionnaires that were found to be valid and reliable: the mindfulness attention awareness scale (MAAS) for measuring the body attention and awareness, the short form of 36 health and well-being questionnaire (SF-36), and the global PA (GPAQ) to measure the amount of PA that is practiced by the subjects. Besides investigating the tools' practicability, it was important to assess if all tools and program are relevant and adjusted to the pilot research subjects.

Key concepts: Older adults; Posture; Balance; Hamstring's flexibility; Body awareness; Health; Well-being

The literature search yields physical activity intervention programs that improve health, well- being and various of physical abilities. The questions that are relevant today are: what kind of physical activity program would be the most adjusted for older adults to improve physical functioning, health and well-being? In this pilot study, the questions are: 1 - Will the subjects who practice the HG physical activity program improve their flexibility, balance, attention and body awareness, health and well-being? 2- Will the Harmonic Gymnastics PA program, the

materials and tools used for all the physical measurements and subjective questionnaires, be feasible, clear and relevant for this study population?

The pilot research hypothesizes:

1. Harmonic Gymnastics physical activity program will improve the flexibility of hamstrings muscles and the dynamic balance of older adults.
2. Harmonic Gymnastics physical activity program will improve the attention and awareness, health and well-being of older adults.

6.2. The pilot study methods and materials

The study participants

In this pilot research 16 healthy men (3) and women (13) from Tel Aviv, Israel, ages 47-78 (mean age - 58.7(6.5)), volunteered to participate in the research program and filled a consent form which explained the research procedure, the measurements and general program. The consent form indicated that the participants could exclude themselves from the program whenever they wished to do so. Ethics approval were conducted by the Babeș-Bolyai University, Cluj-Napoca, Romania. The research participants did not practice any organized physical training for at least one year before the program began. The intervention program included 50 minutes' sessions of Harmonic Gymnastics low intensive physical activity program, three times a week for six weeks in total. Before and after the program, they answered three questionnaires: SF-36 Health and quality of life questionnaire, The Global Physical Activity Questionnaire (GPAQ), and the Mindfulness Awareness Assessment Scale (MAAS), in addition to two functional ability tests: dynamic balance by Y Balance Test (YBT) and low back and hamstrings flexibility by the Back Saver Sit and Reach Test (BSSR).

Harmonic Gymnastics intervention program

Harmonic Gymnastics program included three movement lessons a week, 50 minutes each for six weeks. Every exercise takes about 4 - 5 minutes and rest is 1 - 2 minutes. Although every movement lesson had a specific theme, all of the body's joints and muscles were exercised each time. Overall, 18 different HG movement lessons were included in the pilot.

Tools, materials and questionnaires

Health and well-being were measured by the SF- 36 is the short-form health survey which was retrieved from the Medical Outcome Study (MOS) by the RAND Corporation and Health and Aging, School of Nursing, University of California, Santa Monica, U.S.A. This valid and reliable questionnaire (all Alphas > 0.91) investigates physical and mental health functioning and well-being in eight different scales: physical functioning, role limitation due to physical health, vitality

which is described as energy / fatigue, emotional well-being, role limitations due to emotional functioning, social well-being, pain and general health (Ware and Sherbourne, 1992).

The Global Physical Activity Questionnaire (GPAQ)

The Global Physical Activity Questionnaire measures the amount of physical activity of people by countries. It collects information on physical activity participation at work, in everyday traveling from place to place, and at recreational activities. It was developed by WHO and comprises 16 questions (P1-P16). Analysis is measured by METs (Metabolic Equivalents) for expressing the intensity of the physical activities. The energy expenditure of sedentary activity is 1 MET and is equivalent to a caloric consumption of 1 kcal/kg/hour. The energy expenditure for moderate physical activity is 4 METS (four times as high as sedentary behavior) and the energy expenditure for intensive physical activity is 8 METS (eight times as high).

Mindfulness Awareness Attention Scale (MAAS)

The 15-item Mindfulness Attention Awareness Scale (MAAS) was designed to assess a core characteristic of mindful behavior, in the sense of being aware and attended to what is taking place in the present (Brown and Ryan, 2003). The scale shows strong psychometric properties and has been validated with different types of samples such as: college students, community members and cancer patients. Clinical studies showed that the MAAS taps a unique quality of consciousness that is related to, and predictive of, a variety of self-regulation and well-being constructs. The MAAS is also a well-known and acceptable questionnaire, which includes 15 questions on body awareness and general attention in every day behavior. Each question contains 6 scales about how often a statement is usually practiced in life from – "almost always" to "almost never".

The Back Saver Sit and Reach (BSSR)

This is a practical, valid and reliable test that is mostly assigned to measure hamstrings muscle's flexibility capability. In the BSSR test, the subject has to place one leg bended/ bent knee, while the other leg remains straight. The subject places his hands together one on top the other straight ahead and slide them on the ruler forward and back without bending his straight leg knee three times. At the third time, he has to stay as far as he can for one second. The examiner records the score he reached at the third forward reach. The subject repeats this process two times for each leg and the best score of each leg is taken. The composite score is made by the sum of the two best scores (of each leg) and divided by 2.

The Y Balance Test

The YBT is a valid and reliable tool to measure dynamic balance and the neuromuscular ability to maintain equilibrium of the body (Smith, Chimera and Warren, 2015). This test derives

from the Star Excursion Balance Test (SEBT) and measures three out of eight directions of the SEBT. It measures the anterior/ posterior direction (AP), the posterior -medial direction (PM), and the posterior lateral direction (PL). Like in the SEBT, the subject stands on one leg while the other leg tries to reach the furthest distance on each direction without landing on the ground. Unlike the SEBT, in the YBT the subject stands on a three-sided interface point that is connected to three tracks: one in AP direction, one on PM and the third on PL direction. Every track has a dice that the subject must move to the longest distance he can in a smooth continuous movement. Data was calculated by dividing the average of the distance one leg has achieved in every direction by the length of the leg *(multiplied by) 100.

The Statistical Methods of the Pilot Study

Data was cleaned and entered to Excel database. Preliminary analysis included evaluation of demographics and all baseline characteristics by age and gender. Evaluation of variables fit to normal distribution was carried out using the Shapiro Wilk test. The analyses in the pilot study were conducted using R version 3.6.0 and compiled with R markdown. P-value ≤ 0.05 was considered statistically significant. Normal distributions have been calculated by t-test, but because of the small sample, the Wilcoxon test has been mostly used. No corrections for multiple comparisons have been performed as this is a pilot study and the results are preliminary.

6.3. The pilot research findings

The pilot subjects

Fifteen subjects were included in this study. 12 women (80%) and 3 men (20%) participated the program. The subjects were residents of Tel Aviv, Israel. Eleven of them (73.3%) with academic education and 4 (26.7%) with high school education. The subjects' mean age was (59.2 (6.4)) ranging between 47 years old and 71 years old, BMI mean value of 28.5 (5.4). This value is considered overweight according to WHO (2021).

Table 2.

Descriptive statistics and mean comparisons of the questionnaires SF36 before and after the pilot program (N = 15)

Variable	Mean (STD) Before the program	Mean (STD) After the program	SMD	P*
MASS	67.41 (10.84)	76.69 (20.10)	-9.28	<0.0001
GPAQ	582.65 (776.79)	736.67 (767.83)	-154.02	0.3081
SF36 CS	66.42 (16.73)	74.70 (9.91)	-8.28	0.0353
SF36 PF	74.33 (17.20)	81.67 (8.80)	-7.33	0.0629
SF36 EWB	63.11 (14.77)	65.67 (15.43)	-2.56	0.3793
SF36 SF	75.00 (27.14)	79.50 (20.49)	-4.5	0.5515

Note: * Wilcoxon test / CS – composite score/ PF- physical functioning/ EWB – emotional well-being/ SF- social functioning

Table 3.

Descriptive analysis and mean comparisons of the BSSR and YBT data before and after the pilot program (N=15)

	Mean (STD) before program [f]	Mean (STD) after program [f]	SMD[a]	P[b]
BSSR	11.02 (5.73)	18.82 (7.20)	-8.2	0.00391
Right [c] AP	36.30 (13.76)	60.72 (9.37)	-23	0.00781
Right [c] PM	51.98 (21.39)	86.84 (10.08)	-30.9	0.00781
Right [c] PL	47.75 (21.42)	85.88 (11.16)	-35.6	0.00391
Right [c] composite	45.34 (18.58)	77.82 (9.07)	-29.8	0.00391
Left [c] AP	32.12 (14.20)	59.08 (9.23)	-26.9	0.00391
Left [c] PM	44.00 (19.65)	86.18 (11.90)	-43.9	0.00391
Left [c] PL	46.06 (24.22)	82.38 (13.11)	-38.9	0.00781
Left [c] composite	40.72 (18.32)	75.88 (10.43)	-36.6	0.00391
Delta AP [e]	8.54 (8.00)	5.31 (6.33)	1.7	0.82031
Delta PM [e]	14.59 (11.36)	4.72 (3.59)	8.5	0.05469
Delta PL [e]	17.76 (13.78)	5.75 (4.51)	9.5	0.05469
Delta [e] composite	12.14 (11.06)	3.64 (3.83)	6.2	0.16406

Note: **a.** SMD is the Standardized Mean Difference. **b.** P2 is p-value based on Paired Wilcoxon test **c.** Right/Left indicates Right/Left leg **d.** Delta indicates the Delta change between legs Right-Left legs **e.** A/P/M/L is Anterior/ Posterior / Medial / Lateral directions **f.** Subjects 2,4,6,8,11,14,15 missed the pre- or post- measurement of YBT and were excluded from analysis.

6.5. Discussion, conclusions and recommendations after the pilot research

The BSSR was found to be a practical tool for measuring flexibility. The subjects in this pilot study had some difficulties in following the instruction not to bend the knee of the straight leg attached to the measuring box. Therefore, a specific warm-up for the low back and posterior thigh muscles was performed before the test in the measurements before and after the program. Flexibility of the hamstring muscles significantly improved ($p = 0.0013$) after the six -weeks program. These results were expected, because in HG as in Yoga, Pilates and Feldenkrais method, flexibility is practiced thoroughly (Tekur, Singphow, Nagendra and Raghuram, 2008; Connors, Galea and Said, 2009; Parthiban, CB, JohnBosco, and Ramesh, 2021). Moreover, the improvements in flexibility along with physical, general health and quality of life ($p < 0.05$) are in line with studies in the literature, which show that flexibility is related to the quality of life.

Dynamic balance

The YBT instrument was close-fitting for this research because it measured important basic skills such as: proprioceptive and coordination and defined the dynamic balance ability, which is extremely important for older adults' physical functioning. The subjects found it difficult to follow the instruction to stand on one leg for as long as the other leg pushes the cube to the three-directions. The warm-up before the test helped them to be ready for the tasks. In addition, the YBT was placed near a wall so that the subjects would not fall, although they failed the test if they touched the wall.

In HG intervention program, muscle flexing and strengthening with body weight were exercised among other movement quality workout such as: coordination, proprioceptive and vestibular ability. Programs which were focused on these capabilities increased the dynamic balance and decreased the risk and the fear of falling. Lee D-K. et al. (2015) who investigated older women (ages 45-80), found that YBT is positively related to lower limbs strength. Yong and Lee (2016) showed that proprioceptive exercises on the ankle movement mainly improved the dynamic balance ability. Karmeli, Rey, Clark, Wang and Merfeld (2017) showed that vestibular ability was significantly related to dynamic balance. Stoffregen, Pagulayan, Bardy and Hettinger (2000) showed that posture control was greater when there was a cognitive challenge which is performed in the HG program. The findings regarding the improvements in the dynamic balance skill along with health and well-being, are also in line with Tsigkanos et al. (2016) who have found that dynamic and static balance abilities are strongly connected to low back pain whereas dynamic balance ability has the greater impact.

Attention and body awareness

Mindfulness Attention Awareness Scale scores were significantly improved after the program ($p < 0.0001$). These results are in line with recent findings of mindfulness practice. Mindfulness is discovered as stress protector for older adults (de Frias and Whyne, 2015), and pain redactor as was seen in older women (Banth and Ardebi, 2015). Poulin et al. (2016) have also found that acting in awareness had a great impact on pain reduction, mental health and quality of life. The mindfulness combination in somatic body-mind practices such as: the Feldenkrais method or Alexander technique, revealed significant improvements in attention and body awareness (Sanjiv, Janssen and DeCelle, 2004).

Health and well-being

The SF-36 health and well-being questionnaire was generally practical and clear except for some questions such as: questions 33-36 or questions about emotional and social health, which were not quite clear and subjects needed help in filling the questionnaire. The composite score of the SF-36 questionnaire significantly improved after the pilot program ($p = 0.035$), but the subscales scores of the SF-36 questionnaire which measured the physical functioning (PF), emotional wellbeing (EWB) and the Social Functioning (SF) improved, but did not reveal significant changes. These findings are in line with Lins and Carvalho (2016) who explored data of SF-36 scoring technics and found that researchers used nine different ways of scoring the SF-36 health and quality of life questionnaire. They indicated that it would be inappropriate to determine a one single score that would reflect a person's health state since this questionnaire included physical, mental and social components, which should be calculated separately. The fact that the subjects in this pilot research revealed higher results in the physical and general health may be related to the fact that the HG program is mainly a physical exercise program which may

have a certain positive impact on mental and social health, but not as much as the physical and general health.

Global physical activity

In the GPAQ there were no differences between before and after the six-weeks pilot research program ($p = 0.391$). The subjects who practiced the HG program did not increase the amount or intensity of the PA in daily life. The WHO'S global physical activity questionnaire (GPAQ), which measures the amount of PA, included questions about daily physical activities. The subjects found it difficult to evaluate the time they spent in physical activities regarding work, moving from place to place, leisure and sports activities. Nevertheless, since this program is a low intensive PA and most exercises were practiced in supine, sitting and standing positions, it did not change the quantity of the PA as expressed by the GPAQ in METS (metabolic equivalents). Following the improvements in basic physical skills such as: posture, balance and coordination, the subjects of this pilot may participate in various activities in the future and drive the "positive wheel" of health and well-being over time.

In addition, the subjects' references about the program were rather positive. Most of them indicated they have enjoyed the program. It was adjusted to their abilities, and some of them indicated it restored faith in their self-capability.

Conclusions of the pilot research

- In general, this pilot research indicates the feasibility of measuring dynamic balance by the YBT, flexibility by the BSSR, body awareness by MAAS and health and well-being by the SF-36.
- This pilot study emphasizes the benefits of Harmonic Gymnastics program, which has been found tailored for older adults. the statistical analysis showed that subjects who participated in the Harmonic gymnastics PA program three times a week for six weeks, significantly improved their hamstrings flexibility, dynamic balance of the right and left leg, attention and body awareness and the composite score of health and well-being.
- In health and well-being, the composite score improved ($p = 0.035$), but the separated health and well-being scales did not reveal significant changes. Physical functioning was close to significance ($p = 0.063$), while emotional and social well-being were smaller ($p = 0.38$; $p = 0.55$, respectively).
- The subjects of Harmonic Gymnastics did not reveal changes in the global physical activity (GPAQ). These findings indicate that the HG program, which is a low impact PA had positive effect on the quality of the movement but did not affect the quantity of the daily PA at this stage.
- Although the questionnaires were found adjusted and practical to use, the MAAS was found to be confusing for the subjects, following the negative and positive statements. The SF-36 was found to be confusing following the questions about emotional and social well-being.
- Although the devices used for the physical measurements were found to be practical and adjusted, the subjects had difficulties in keeping the straight leg without bending the knee in the

BSSR test and they had difficulty in standing on one leg while the other leg pushes the dices to all three directions.

Recommendations from the pilot research

- ❖ The first recommendation following the pilot study is to practice a long program research of 10-12 months of HG intervention program for older adults, with a larger sample that can be divided by age groups and with original tools.
- ❖ Second, to measure the GPAQ questionnaire at least six months after the HG long intervention program, in order to investigate whether older adults who participated in HG would practice more physical activities in their everyday life.
- ❖ It would be recommended to compare the HG program with other physical activity programs, such as regular gym intervention program, muscle strengthening work-out or aerobic exercise program and a control group, consisting of subjects who do not participate in any PA.
- ❖ To add Posturography measurements for posture control examination, using the Wii Balance Board, and by applying contact with the software's company.
- ❖ Regarding the use of the tools, it would be recommended to perform a suitable warm-up before the measurement process.
- ❖ It would be advisable to place the YBT device next to a wall, so that they have something to lean on when they momentarily lose their balance.
- ❖ It would be necessary to explain and answer to questions which may rise while filling the MAAS and SF-36 questionnaires.

Part Ⅲ

Chapter 7. Personal Research: The Effect of Harmonic Gymnastics on Older Adults' Physical Functioning, Health and Well-being

Methodology, materials and tools of the research program

The personal main research was focused on two different types of recreational physical activities: the HG somatic type of PA and the Fitness gym muscle strengthening and endurance practice. The Covid-19 had a great impact on this research, and changed its plan in unexpected ways. It interfered with the subjects' recruitment in the first stage and in the next stage, it was not possible to conduct the training meetings in the studio for the HG program, nor in the gym club for the fitness program as it had been planned. Some subjects decided not to participate in the program after the first measurements session, because of changes in the program. However, the third group which consisted of people who did not do any PA, the No PA group, was created with the people who agreed to arrive for the measurements but did not want to participate in the

program. Considering the new conditions following the Covid-19 pandemic, after about 20 days from the beginning of the program, the HG program moved from a studio meetings to a Zoom application twice a week for 50 minutes for every practice, and the Fitness group moved from the gym practice to various ways of practice: some practiced through different fitness PA applications that conducted muscle strengthening and aerobic practice, some practiced brisk walking, outdoor bicycling, jogging and muscle strengthening through outdoor gym facilities in their neighborhoods, for at least 50 minutes twice a week. People who did not choose to engage in any of the programs because of the new conditions were gathered into the third group, which was the No PA group.

The research aim, questions and hypothesizes

The aim of this research is to investigate whether Harmonic Gymnastics type of PA program would improve functioning ability such as: flexibility, dynamic balance and posture control, attention and body awareness, health and well-being in adults aged 50 years and older. In this stage of the study, the measurements involved three different groups: the No PA group, which consisted of people who did not participate in any PA, the Fitness group, with people who practiced fitness PA and the Harmonic Gymnastics group, who participated in the HG intervention program. The research questions for these conditions were: 1-Will Harmonic Gymnastics PA group improve the physical capabilities: flexibility, dynamic and static balance, health and well-being and body awareness of older adults during the period of Covid-19? 2- Will the Fitness group improve the physical capabilities, health and well-being and body awareness of older adults during the period of Covid-19? 3- Will Harmonic Gymnastics improve the physical capabilities, he alth and well-being and body awareness of older adults more than the Fitness PA group and more than the No PA group?

The research hypotheses were: 1- The participation of older adults in the Fitness and Harmonic Gymnastics PA programs will improve their physical capabilities, health and well-being and body awareness. 2- The influence of the HG program on the physical capabilities, health and well-being and body awareness will be greater than that of those who did not participate in any PA and also that of the Fitness programs.

Materials and methods

Overall, fifty-eight older adults from Tel Aviv, Israel, volunteered and signed the informed consent form (sample found in the appendices) of the study approved by the Ethics Committee of Babeș-Bolyai University in Cluj-Napoca, Romania. They conducted the measurements before the program and were divided into three groups: Group 1 - the Harmonic Gymnastics PA program group, Group 2 - the Fitness PA group, and Group 3 - the No PA group. After three months, 19 subjects were excluded from the statistical analysis: one subject because of illness, 6 subjects did not show up for the second measurements, and 12 subjects stopped participating in the research program. After three months, 39 subjects participated in the research: 16 subjects participated in

the HG group, 16 subjects participated in the Fitness group, and 7 subjects participated in the No PA group. After 6 months of the program, only 4 subjects of the No PA group, 5 subjects of the Fitness group and 10 subjects of the Harmonic Gymnastics PA group came to most but not all of the final measurements. Figure 2 below represents the flow chart and enrollment of the research subjects.

During the first 20 days of the research program, the Fitness group practiced aerobic, endurance and strengthening exercises in a gym fitness club in Tel Aviv with a skilled and experienced trainer. The Covid-19 which busted into the world and imposed restrictions, prevented people from practicing together in the gyms and fitness clubs. Therefore, most of the Fitness subjects practiced outdoor walking, jogging, cycling or muscle strengthening in the outdoor facilities in their neighborhoods, while some of them, practiced fitness exercises through the different available applications.

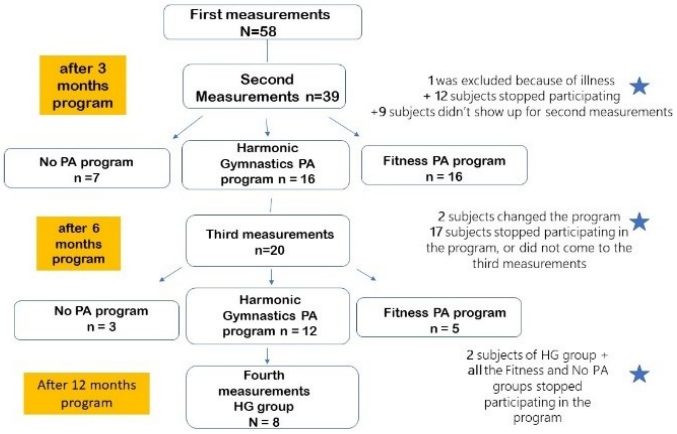

Figure 1. The participants flowchart of the research

The Harmonic Gymnastics physical activity program

The HG group practices contained varied and creative exercises on a matt, in lying down, sitting, and a few exercises also in standing positions, mostly without any equipment and sometimes with a stick, a soft ball, a bean bag, etc. These practices were delivered by a HG skilled and experienced trainer. The HG practices focused on specific physical capabilities, such as: extension and flexion of the feet/ the knee joints movement/ the shoulder blades movement ability/ sideway sitting ability / extending and flexing the quadriceps/ strengthening core muscles/ hands and wrist movements, etc. At first, before the Covid-19, the HG subjects practiced together in a studio but when Covid-19 restrictions were conducted, the HG practices were performed by an application through smart phones, tablets or computers.

Measurements, materials and methods

Following the pilot research, the physical measurements which were conducted in the main research program were: anthropometric measurements, two questionnaires and three physical measurements. The anthropometric measurements were: weight, height, right and left leg length,

age, gender, residence, education. The questionnaires the subjects answered were also used following the pilot research, but this time only two questionnaires were included: the SF-36 health and well-being and the MAAS questionnaire for attention and body awareness. The physical capabilities included: flexibility by the BSSR for the hamstrings' flexibility and the YBT for the dynamic balance ability (see the pilot study methods in Chapter 2). In addition, unlike the pilot program, in the main research program posture control was additionally measured by the Wii Balance Board (WBB). Measurements were conducted before and after three months, and six months for all groups. Measurements after 12 months were conducted only in the HG group and only for the flexibility, dynamic balance in addition to the health and well-being, attention and body awareness measurements.

The statistical analysis was performed through an SPSS version 23. 0 software. The final comparisons between groups and between different points of time were conducted after presenting the descriptive statistics, including means and standard deviations (STD) and after analyzing the distributions of the data. Normal distributed data were analyzed by parametric tests, while the non-normal distributed data were analyzed by non-parametric tests. Correlations between variables were conducted in addition to the means comparisons between groups and between time points.

Posturography measurements

Posturography test measures the reaction of the standing or moving body on the surface in relation to the body center of pressure (CoP). When examining static posture, the subject stands on a board with sensors which interpret the force moments of the smallest sways of the body in quiet stance. The deviation from the CoP expresses the degree of stability of the body. These sways are measured in real time through a connected software which calculates the sway from the center of gravity which is expressed by the CoP. The Wii Balance Board (WBB) is a practical, inexpensive tool for Posturography tests. It has high reliability and is valid for clinical practice. In this research, the focus is on the mCTSIB in four conditions for 30 seconds each: quiet standing on the Wii board with eyes open / quiet standing on the board with eyes closed / quiet standing on foam with eyes open / quiet standing on the foam with eyes closed. Data of WBB express the vertical moments from four sensors and calculates the deviation from the CoP in the horizontal axis (x) and vertical axis (y) through a specific formula (Llorens, Latorre, No´e and Keshner, 2016).

7.3 Results after 3 months program

Most of the participants were characterized with academic education, most of them were married and from good neighborhood in Tel-Aviv, Israel. The mean age in this group was 63,44 (8,25). The mean BMI of the whole group was 27.13 (3.97) and after the 3 months program, it was 27.27 (0.26). None of the groups revealed changes in BMI after three months program.

In the final comparisons of flexibility scores measured by the BSSR in Table 19, the statistical analysis indicates that in the No PA group, the subjects slightly increased their flexibility scores, in the Fitness group subjects slightly decreased their flexibility scores while in the HG group the participants significantly increased their flexibility scores ($p = 0.000$, $d = 0.62$).

The results of health and well-being scores after three months of the main research showed that the No PA group decreased the Pf ($p = 0.009$, $d = 0.4$), Bp ($p = 0.013$, $d = 0.25$), RE ($p = 0.02$, $d = 0.3$), SWB ($p = 0.021$, $d = 0.3$), E/F ($p = 0.037$, $d = 0.3$) and the composite score ($p = 0.009$, $d = 0.4$). The Fitness group increase the mean scores of the RP ($p = 0.017$, $d = 0.2$), Bp ($p = 0.000$, $d = 0.4$), RE ($p = 0.054$, $d = 0.3$), E/F ($p = 0.036$, $d = 0.3$), q-2 ($p = 0.56$, $d = 0.25$) subscales and the composite scores of the SF-36 questionnaire ($p = 0.015$, $d = 0.35$), but they decreased the SWB ($p = 0.038$, $d = 0.3$). The HG group increased the Pf ($p = 0.002$, $d = 0.5$), RP ($p = 0.065$), Bp (0.004, $d = 0.4$), q-2 ($p = 0.001$, $d = 0.5$) and composite score of the SF-36 questionnaire ($p = 0.001$, $d = 0.5$).

Table 19.

Comparisons of the BSSR scores between the groups before and after 3 months program

Physical activity (N)	Variable	Mean (SD)Time 1	Mean (SD) Time 2	Sig p*	Size effect
No PA (N=7)	BSSR (cm)	26.07 (8.56)	26.35 (7.77)	0.865	
Fitness (N= 16)	BSSR (cm)	20.58 (7.75)	20.35 (8.30)	0.698	
HG (N= 16)	BSSR (cm)	20.67 (6.26)	24.96 (6.56)	0.000	0.62

* Wilcoxon Signed Ranks Test 1 = before program 2 = after program

Table 23.

Comparisons of the YBT scores before and after 3 months program by groups (N = 39)

	Variable	Mean (SD) Time 1	Mean (SD Time 2	Sig. p*	Size effect
No PA (7)	Right leg	36.87 (30.10)	26.22 (24.77)	0.225	
	Left leg	44.13 (31.4)	27.22 (20.72)	0.043	
	Difference	7.26 (11.68)	10.71 (15.07)	0.686	
	No of Falls	2.57 (2.5)	2.71(2.62)	0.655	
Fitness (16)	Right leg	34.77 (29.71)	41.31(26.64)	0.096	
	Left leg	33.76 (30.16)	49.93 (25.93)	0.069	
	Difference	1.01 (20.09)	8.62 (19.76)	0.233	
	No of Falls	3.00 (2.28)	1.62 (1.96)	0.017	0.42
HG (16)	Right leg	43.99 (26.10)	64.17 (23.23)	0.001	0.59
	Left leg	48.84 (26.81)	67.82 (20.65)	0.001	0.60
	Difference	4.83 (16.470)	3.65 (11.48)	0.394	
	No. of Falls	1.75 (2.17)	0.5 (1.54)	0.017	0.42

Table 24.

Spearman correlation between the BSSR and YBT scores before and after 3 months program

	CSRL before program	CSLL before program	CSRL after 3 months	CSLL after 3 months
Flexibility (BSSR)	0.27	0.28	0.150	0.31

CSRL- composite score of the right leg CSLL- composite score of the left leg

Table 26.

Comparisons of the Posturography data by group before and after 3 months

Condition and direction of WBB Posturography measures	Physical activity/N	Mean 1	Mean 2	Sig p value non-norm Wilcoxon
EYES OPEN AP	No PA (5)	1.1025(0.61)	1.9300(0.63)	0.068
	Fitness (16)	1.458(0.650)	1.4644(0.95)	0.776
	HG (16)	1.695(0.762)	1.4450(0.569)	0.352
EYES OPEN ML (WILCOXON)	No PA (4)	0 negatives	4 positives	0.068
	Fitness (16)	6 negatives	10 positives	0.301
	HG (16)	7 negatives	9 positives	0.979
EYESOPEN VELOCITY	No PA (5)	0.470(0.094)	0.5425(0.110)	0.144
	Fitness (16)	0.465(0.110)	0.4625(0.109)	0.897
	HG (16)	0.476(0.151)	0.4494(0.127)	0.325
EYES CLOSED AP	No PA (5)	1.360(1.139)	2.0800(0.688)	0.068
	Fitness (16)	1.806(1.270)	1.7350(0.96)	1.000
	HG (16)	1.561(0.822)	1.7625(0.816)	0.756
EYES CLOSED ML	No PA (2)	2 negatives	0 positive	0.180
	Fitness (16)	1 negative	1positive	0.599
	HG (10)	5 negatives	5positives	0.838
EYESCLOSED VELOCITY	No PA (5)	0.487(0.129)	0.5075(0.099)	0.854
	Fitness (16)	0.539(0.169)	0.5094(0.083)	0.820
	HG (16)	0.523(0.150)	0.5256(0.161)	0.864
EYES OPEN ON FOAM AP	No PA (5)	1.407(1.203)	2.4525(0.749)	0.068
	Fitness (16)	1.883(0.706)	1.7806(0.487)	0.535
	HG (16)	2.049(1.031)	1.5700(0.676)	0.205
EYES OPEN ON FOAM ML	No PA (4)	0 negatives	4 positives	0.068
	Fitness (16)	8 negatives	8 positives	0.266
	HG (16)	12 negatives	4 positives	0.148
EYES OPEN ON FOAM VELOCITY	No PA (5)	0.510(0.093)	0.6200(0.170)	0.068
	Fitness (16)	0.531(0.089)	0.5019(0.093)	0.087
	HG (16)	0.533(0.171)	0.4563(0.112)	0.127
EYES CLOSED ON FOAM AP	No PA (5)	3.310(1.990)	3.6675(1.166)	0.715
	Fitness (16)	2.644(0.882)	1.8688(1.088)	0.006
	HG (16)	3.123(1.296)	2.8281(1.070)	0.234
EYES CLOSED ON FOAM ML	No PA (5)	1.982(0.584)	1.9225(0.565)	0.715
	Fitness (16)	1.451(0.523)	1.4306(0.928)	0.501
	HG (16)	2.161(1.391)	2.0619(1.195)	0.877

EYES CLOSED ON FOAM VELOCITY	No PA (5)	0.750(0.159)	0.7600(0.29)	1.000
	Fitness (16)	0.731(0.161)	0.6300(0.102)	0.023
	HG (16)	0.758(0.220)	0.7044(0.198)	0.352

AP = anterior – posterior direction/ ML = medial=lateral direction

Table 30.
Paired t-tests of the MAAS scores before and after 3 months program

			Descriptive Statistics		Test Statistics		
Group	Pair	**Variable**	Mean	Std. Deviation	t	df	Sig.
No PA	Pair 1	MAAS 1	76.958	15.1135	0.767	6	0.472
		MAAS 2	74.317	13.9471			
Fitness	Pair 1	MAAS 1	74.619	15.1944	0.260	15	0.799
		MAAS 2	74.164	11.8043			
HG	Pair 1	MAAS 1	76.651	11.1916	-0.243	15	0.811
		MAAS 2	77.009	11.4123			

Note: 1 = before program 2 = after program

7.3.1 Discussion after three months program

Hamstring's flexibility

In this research, the results showed that the HG program significantly increased the subjects' flexibility scores ($p < 0.001$) while, the Fitness and the No PA group, slightly decreased the flexibility scores and finally revealed no significant differences ($p = 0.865$; 0.698 respectively). Regarding the No PA group, it is known that sedentary behavior decreases the flexibility especially in older adults. Fatima, Qamar, Hassan and Basharat (2017), have found significant association between sitting hours and range of motion of the knees and most of the sample (87% of 200 college students) had tightened hamstrings.

The Fitness group did not reveal positive changes in flexibility. These findings contradict some studies which did show that fitness training programs significantly improve flexibility (Virág, Harkányi, Karóczi, Vass and Kovács, 2018). However, other studies do show that flexibility was one of the exceptional fitness components, which have not necessarily been improved by fitness type of practice training (Stathokostas, Little, Vandervoort and Paterson, 2012).

Dynamic balance

The No PA group was not expected to improve their dynamic balance ability, it was surprising that within three months, they did not remain the same and their scores decreased in both legs and with significance in the left leg ($p = 0.043$). This may be explained by the impact of

the quarantine and Covid-19 pandemic attack, which occurred immediately after the first measures of this research.

The question if a somatic type of PA can improve dynamic balance was positively answered in this research. In fact, the subjects who trained in Harmonic Gymnastics RPA improved the dynamic balance more than the fitness group. As was explained after the pilot program, it may be related to the fact that the practice of basic physical abilities such as: coordination, proprioceptive and vestibular ability, were found to be beneficial to the dynamic balance ability especially in older age (Nashner, 2014). Voelcker-Rehage, Godde and Staudinger (2011), examined the effect of aerobic exercise and coordination training and found that coordination practice was more beneficial than aerobic exercise in improving accuracy and speed of perception and attention in movement.

Posturography measurements of the static balance

The first hypothesis of this research was that the Fitness and HG practice will have positive impact on the posture control of older adults. The results of this research show that in the Fitness and the HG groups subjects generally decreased the sway from the CoP and therefore, improved their posture ability, in contrast to the No PA group who increased the sway and lowered posture control. Although the results were not always significant, significant changes were obtained only in the Fitness group, in the more challenged conditions such as: standing on foam in eyesclosed in AP direction ($p = 0.006$) and the mean velocity ($p = 0.023$). Studies showed that the differences between groups are not easily expressed in Posturography measurements. The conditions in which eyes are closed and subjects are on unstable surface are more likely to differ between groups (Anson, Bigelow, Studenski, Deshpande and Agrawal, 2020). Many studies found better results of active groups compared to subjects who did not participate in any PA (Brustio, Rainoldi, Petrigna, Rabaglietti and Pizzigalli, 2021). Moreover, studies showed that PA which involved strength and endurance capabilities improved postural control, therefore fitness practice is highly recommended (Fragala, et al., 2019). Paillard (2017) pointed out that muscle strengthening practice may reduce the loss of muscle fibers type Ⅱ, which were found to be related to better reaction time and balance control in young and older adults.

Attention and body awareness

In contrast to this study's findings, after three months program, Zhu, et al. (2021), revealed significant emotional improvements following three weeks mindfulness intervention program during the pandemic. People who participated in the program had lower stress, anxiety and depression symptoms, compared to subjects who did not practice the mindfulness program in China. The findings of our study may be consistent with MacKillop and Anderson (2007) study. They indicated that the MAAS questionnaire was found valid but was not necessarily associated with meditation practice. Moreover, Van Dama, Earleywine and Borders (2010), found in 414

university students that some declarations in this questionnaire had greater statistical adjustments than others. Negative declarations which required the subjects to admit for being less mindful were in lower validity than the positive same declarations. Vitale (2021), found that the MAAS scores were not related to emotional regulation. Moreover, Jacobs, Gurevitch, Catlin, and Bamonty (2019), indicated in their analyzed literature review that MAAS was one of the most popular mindfulness surveys but mindfulness attention awareness skills were not examined properly in population aged 50-year-old and older. But, in general, programs which resemble the HG practice improved the body awareness, the physical and psychological functioning. However, in this particular research, the Covid-19 conditions may have had an intervening influence, since the pandemic was found to increase confusion, stress, fear and anxiety in addition to reducing attention and awareness as was found by Baiano, Zappullo, LabNPEE Group and Conson (2020), who investigated MAAS scores along with mental agility before and during the pandemic in Italy.

Health and well-being

In this research we can see a difference between the active groups and the No PA group also the in health and well-being scores. The composite scores and most of the subscales' scores show the significant benefits of PA on health and well-being and the risks of sedentary behavior. These findings are in line with many studies from the last two decades, which emphasize the great positive profits of the RPA to physical and general health and the dangers of sedentary behavior (Bangsbo, et al., 2019). Nevertheless, in the emotional and social well-being the improvements of the PA groups were not significant, moreover, the Fitness group decreased in social well-being. These findings may be related to the fact that this research was conducted under Covid-19 pandemic conditions. This pandemic requested social distancing, which imposed a conflicted situation. Mills, Kaye and Mody (2020), stressed that although physical distancing and isolation is necessary to avoid infection, older adults may be adversely affected by these instructions and increase their solitude and rather reduce their quality of life and well-being. Social networks and social involvements were found connected to the mental health, especially the diverse social connections (Windsor, Rioseco, Fiori, Curtis and Booth, 2016).

The fact that the HG group did not decrease the social well-being scores, may be related to practicing together as a group using the digital Zoom application two times a week for the three months. Using digital channels to practice PA improved health and well-being in older adults before and during the pandemic (Van Tilburg, Steinmetz, Stolte, van der Roest and de Vries, 2021). Practicing in a group with a skilled trainer was also found to be more beneficial and may have caused the advantage of the HG group (Delle et al, 2018).

7.3.2 Conclusions and recommendations after three months program

- After three months program, it is possible to indicate that there are some significant differences between the group who did not participate in any PA and the two groups who

participated in the Fitness and Harmonic Gymnastics RPA. The people who did not participate in any PA, reduced the functioning capabilities, health and well-being, measured in this research. The mean scores of the flexibility, dynamic and static balance capabilities, in addition to the mean scores of health and well-being decreased in the No PA group. Both, the Fitness and HG groups increased the physical functioning, each type of PA had significant changes in specific domains. The Fitness group increased the postural control measured by the Posturography measurements in the eyes closed on foam in the AP direction ($p = 0.006$) and mean velocity ($p = 0.023$), while the HG group increased the flexibility ($p < 0.001$) and dynamic balance ($p = 0.001$). Both groups increased the health and well-being composite scores. In addition, The Fitness group increased the role physical, bodily pain, role emotional and energy-fatigue subscales and decreased the social well-being. The HG group increased the physical functioning, bodily pain, general health and health compared to last year subscales.

- This study emphasizes the importance of practicing RPA in older age. It demonstrates the benefits of RPA on important physical capabilities and health and well-being components. The differences between the types of PA were seen in flexibility, posture control and specific physical and mental domains of health and well-being, therefore it is recommended to combine the practice of fitness and somatic type of RPA such as: Harmonic Gymnastics, to gain best outcomes in physical functioning, health and well-being in older age.
- Additional investigation is needed to be performed with a larger sample and under normal conditions. The Covid-19 restrictions obligated to change the original plan and to find new ways to conduct the research program.

7.4 The results after 6 months program

Performing under new conditions following Covid-19 restrictions, caused drop outs of subjects mainly in the No PA and Fitness group. Statistical comparisons were performed although the sample was rather small. After six months program, overall, only 20 subjects agreed to come for measurements.

Table 48.

The descriptive statistics and comparisons of the BMI BSSR and YBT scores in the Fitness group before and after 6 months program

Measurement	N	Minimum	Maximum	Mean	Std. Deviation	Z	Sig
BMI1 kg/m^2	3	22.89	27.77	27.63	2.65		
BMI3 kg/m^2	3	23.58	27.59	25.63	2.00	-0.53	0.59
BSSR1 (cm)	3	14.25	9.50	20.58	5.11		
BSSR3 (cm)	3	9.50	20.00	16.33	3.41	-1.60	0.10
RL/Comp1	3	0.00	43.41	35.93	13.22		
RL Comp 3	3	22.28	53.70	40.43	9.39	-1.60	0.10
LL/Comp 1	3	0.00	20.94	33.76	6.98		
LL/Comp 3 (cm)	3	0.00	52.38	34.35	17.18	1.34	0.18

F1 Number of falls	3	3.00	6.00	3.00	0.88		
F3: Number of Falls	3	2.00	5.00	3.00	1.00	1.63	0.10
Valid N (listwise)	3						

Table 49.

The descriptive statistics and comparisons of the BSSR and YBT mean scores in the HG group before and after 6 months program

Descriptive Statistics [a]

	N	Min.	Max.	Mean	Std. Deviation	Z	Sig
BMI1 kg/m^2	12	23.65	32.74	28.14	2.98		
BMI3 kg/m^2	12	22.40	32.74	27.48	3.26	-2.93	0.01
BSSR 1(cm)	12	11.00	28.75	20.20	1.76		
BSSR3(cm)	12	17.00	32.50	25.93	1.51	-3.05	0.00
RL [b] /Comp1	12	0.00	82.10	49.00	7.48		
RL [b] / Comp 3	12	0.00	87.55	68.32	6.74	-2.93	0.00
LL [c] /Comp 1	12	0.00	85.84	50.24	8.35		
LL [c]/ Comp 3	12	0.00	88.26	68.42	6.69	-2.93	0.00
F1 [d]	12	0.00	6.00	1.50	2.23		
F3 [d]	12	0.00	6.00	0.50	1.73	-1.82	0.07
Valid N (listwise)	12						

a. PA 2 = HG / b. Right Leg / c. Left Leg / d. Number of falls

Table 50 in the thesis presents the differences in the Posturography scores of the three subjects of the No PA group, 5 subjects of the Fitness group and 10 subjects of the HG group, between before and after six months program. Although some of the statistical distributions were shown as normal, the Wilcoxon tests were performed because of the small sample. Table 50 shows that after six months the No PA group slightly increased the sway mainly in eyes opened on board conditions and decreased the sway in eyes closed on board and on foam conditions, but none of these results were significant. The HG subjects significantly decreased the sway in eyes opened AP and ML directions ($p = 0.047$) and in eyes opened on foam AP and ML directions ($p= 0.005$; 0.032), whereas the Fitness group significantly decreased the sway in eyes closed on foam AP and mean velocity ($p= 0.043$; 0.043, respectively).

Table 51.

The statistical comparisons of the MAAS and SF-36 scores in the 2 active groups before and after 6 months program

Descriptive Statistics

Group	Variable	N	Minimum	Maximum	Mean	Std. Deviation	Z	Sig
	MAAS1		77.70	87.70	84.00	5.48		
Fitness	MAAS3	3	71.11	82.22	77.40	5.70	-1.60	0.10
	SF36/1		75.83	91.66	81.89	8.54		
	SF36/3	3	80.27	93.88	85.68	7.21	-1.60	0.10

	MAAS1		53.30	93.33	75.81	12.10	-0.04	0.96
HG	MAAS3	12	56.66	95.55	75.48	12.09		
	SF36/1		47.77	92.63	74.57	14.14		
	SF36/3	10	53.05	90.41	79.21	12.39	-1.27	0.20

7.5 The results after one year

The sample of the HG group included 4 men and 4 women. Most of them had an academic education (62.5%) and most of them were married (87.5%). The average age of the sample was approximately 60 (9.68) years and the average BMI was 27.99 (2.69).

7.5.1 Statistical analysis of all measurements during 12 months program

Table 55.
Mean scores of the BSSR in the HG group during 12 months program

	Before program M (SD)	After 3 months M (SD)	After 6 months M (SD)	After 12 months M (SD) P value
BSSR	19.75 (4.98)	23.53 (4.67)	24.60 (3.97)	25.00 (4.31)

The year repeated measures ANOVA analysis showed there were significant differences in BSSR among the HG group over the year (F (3, 18) = 9.08, p = 0.001). The BSSR level was significantly higher after one year. Additionally, a paired sample t-test analysis indicated that there were no significant differences in BSSR between the final measurement and - after 6 months (t (6) = 0.36, p = 0.73), or - after 3 months (t (7) = 1.27, p = 0.24). However, there were significant differences in BSSR between the final measurement in comparison to before the program (t (7) = 4.06, p = 0.005).

The repeated measures by the ANOVA analysis showed significant differences in CSRL among the HG group over the year (F (3, 15) = 7.40, p = 0.003). CSRL level was significantly higher after one year. Additionally, a paired sample t-test analysis indicated that there were no significant differences in CSRL between the final measurement and - after 6 months (t (5) = 1.28, p = 0.25), or - after 3 months (t (7) = 1.43, p = 0.19). However, there were significant differences in CSRL between the final measurement and before the program (t (7) = 3.56, p = 0.01). The ANOVA analysis showed there were significant differences in CSLL among the HG group over the year (F (3, 15) = 5.91, p = 0.007). CSLL level was significantly higher after one year. There were no significant differences in CSLL between the final measurement - after 6 months (t (5) = 1.78, p =0.13), or after 3 months (t (7) = 1.13, p = 0.29). However, there were significant differences in CSLL between the final measurement and before the program (t (7) = 2.91, p = 0.02).

Table 56.
Mean scores of the CSRL and CSLL scores in the HG group during 12 months program

	Before program M (SD)	After 3 months M (SD)	After 6 months M (SD)	After 12 months M (SD)
CSRL	34.28 (26.81)	57.40 (28.96)	58.31 (29.52)	61.64 (30.56)
CSLL	31.08 (28.61)	57.56 (28.49)	55.99 (27.48)	60.80 (30.50)

CSRL – composite score of the right leg CSLL – composite score of the left leg

The health and well-being scores measured by the SF-36 questionnaire presented in Table 57, revealed significant differences in health and well-being, after one year program ($F = 9.91$, $df = 1,9$, $p = 0.000$). There was an increase in the SF-36 scores between before the program and after 3 months, and after six months and after 12 months ($p = 0.000$), No differences between after three months and after six months.

Table 57.

Mean scores of the SF-36 composite scores in the HG group during 12 months program

	Before program M (SD)	After 3 months M (SD)	After 6 months M (SD)	After 12 months M (SD)
SF-36		79.98 (13.44)	79.22 (12.39)	82.97 (5.27)

Table 58.
Mean scores of MAAS in HG group during 12 months program (N = 8)

	Before program M (SD)	After 3 months M (SD)	After 6 months M (SD)	After 12 months M (SD)
MAAS	73.16 (13.18)	73.48 (8.80)	73.05 (7.26)	86.09 (8.91)

The repeated measures of ANOVA analysis showed there were significant differences in MAAS among the HG group over the year ($F (3, 18) = 5.74$, $p = 0.006$). MAAS level was significantly higher after one year in comparison to all time points. Additionally, a paired sample t-test analysis indicated that the differences in the MAAS mean scores presented in Table 58, between the final measurement and - after 6 months ($t (6) = 3.55$, $p = 0.01$), - after 3 months ($t (7) = 3.15$, $p = 0.01$), and between the final measurements and before the program ($t (7) = 3.01$, $p = 0.02$), were all significant.

Chapter 8. General discussion of all phases of the research

8.1 General discussion

In Flexibility, the statistical comparisons along the program show that the HG program, consistently improved the flexibility measured by the BSSR after three months and six-months program, while the Fitness subjects and the people who did not participate in any PA did not reveal

any changes. We can also see that during the whole year, these improvements remained and were significant. The main argument given about the flexibility progress following the HG program, was focused on the dynamic type of flexibility exercises, the subjects of the HG program practiced (Herzog, 2014; Opplert and Babault, 2018) and the fact that flexibility is thoroughly practiced in the HG program. These results seem to follow studies which practiced types of PA programs, which are similar to HG in many ways and from similar origins such as: Pilates, Feldenkrais method, and other somatic types of practices as was seen earlier in this thesis (Parthiban, CB, JohnBosco and Ramesh, 2021).

The two active groups, in contrast to the No PA group, inceased their mean dynamic balance scores of the groups after three and six months program. Many studies showed that fitness and somatic, alternative types of PA improved dynamic balance, decreased falls and the fear of falls in older adults (Papalia, et al., 2020; Ullman, Williams, Hussey, Durstine and McClenghan, 2010). This study showed that the HG increased the dynamic balance more than the Fitness group. These findings reinforce the argument that the practice of coordination, flexibility, proprioceptive and vestibular abilities, are essential to the dynamic balance capability of older adults, as was shown in the literature following clinical studies (Karmeli, Clark, Wang and Merfeld, 2017; Henry and Baudry, 2019; Pollock, Durward, Rowe and Paul, 2000).

In the Posturography measurements, the HG group improved the posture control in eyes opened on board and on foam, only after 6 months program, while the Fitness improved posture control in eyes closed on foam after the 3- and 6-months program. It may have taken 6 months for the HG group because in HG program the focus was on improving the postural alignment such as: the spine curves, the movement of the neck, etc. These components which were thoroughly established over the years and created sorts of erroneous patterns of body organization and movement, may have been created as compensations or due to physiological, genetical or behavioral factors and may be very difficult to change, especially in older adults (Kuo, Tully, and Galea, 2009). many studies which investigated low intensive PA programs and which resemble the HG program, revealed positive improvements in static postural control in healthy subjects and in people with deficits (Patti, et al., 2021). The positive results of the HG in eyes opened on board and on foam after six months, may reinforce the study of Inukai, et al. (2018), who showed that galvanic vestibular stimulation improved the postural control in older adults, in quiet standing in the eyes opened condition. Goble, et al. (2011) showed in FMRI that the activated locations of posture control, were related to proprioceptive signals mainly to the right side of the brain where attention and body awareness are performed. The findings of our investigation here are also in line with many studies which also showed best results in posture control when the practice combined various types of practice (Thomas et al, 2019).

The findings of the development of attention and the body awareness of the HG subjects along the year, are in line with the studies which showed that body-mind somatic practices improved attention and body awareness (Fonow, Cook, Goldsand and Burke-Miller, 2016). The findings are also in line with Ginzburg, et al., (2015) and van der Maas (2016), who found that higher body awareness decreased pain sensation, as was found in our study. Bodily pain

significantly improved in the HG group ($p = 0.027$) after three months program. The fact that only after one year of practice there were significant improvements is in line with the study of Wong, Coles, Chambers, Wu and Hassed (2017), who found in their longitudinal mixed method research, that there was a large effect after one year follow-up, in people who continued practicing, compared with people who practiced for shorter period of time.

The HG subjects improved their health and well-being scores measured by the SF-36 questionnaire. These findings are in line with many studies which showed that somatic physical activity contributed to health and well-being and indicated that body-mind workout is related to mutual relationships of the physical and emotional reactions as was seen in the studies of Pascoe et al. (2021) who performed a systematic review and meta-analysis of 22 empirical studies with Yoga-based intervention programs and Herndon (2008), who found in 142 subjects that higher mindfulness levels were related to higher cognitive ability and higher emotional well-being. Haywantee (2021) demonstrated that these mutual relationships between the physical and mental aspects, are important and can be used especially when facing the Covid-19 pandemic conditions.

Nevertheless, in a broad view of the thesis and all phases of the study, we can also see that the HG group did not reveal improvements in the emotional and social well-being in any stage of the study. Although the main research program was conducted under Covid-19 conditions during the whole year, the subjects in the pilot study also had the same trend, and revealed no changes in emotional and social well-being, although they participated in normal conditions. It is possible that beyond the influence of the Covid-19, it would be beneficial to add to the program's components items that will strengthen mental and social well-being, such as music or physical interactions between the participants. These components were found to increase emotional and social well-being, and may improve these components in addition to the physical and general health (Sandstrom and Dunn, 2014; Welch, Biasutti, MacRitchie, McPherson and Himonides, 2020).

8.2 General conclusions of the thesis study

- The Harmonic Gymnastics somatic PA program improves functioning abilities, attention and body awareness, health and well-being in adults aged 50 years and older. Flexibility was the capability which revealed the highest improvements during the year. In the HG program, flexibility is practiced thoroughly in a dynamic way. Flexibility was significantly improved after the pilot research ($p = 0.000$), after three months in the main research ($p = 0.000$, $d = 0.6$), after six months (0.000, $d = 0.6$) and after 12 months ($p < 0.005$). It was improved more than in people who did not participate in any PA after the three months program ($p = 0.865$) and more than in people who practiced the Fitness type of PA (0.698). Flexibility was found to be higher among participants with lower BMI and among women. It had positive and close to significant correlation with dynamic balance in the left leg's scores ($r = 0.31$, $p = 0.05$).

- Harmonic Gymnastics program revealed significant improvements in the dynamic balance of the practitioners in the right leg, left leg and in the number of falls after the pilot program, after the three–months, six-months and 12- months program (($p = < 0.01$ in all cases, $d = 0.6$). The

Fitness subjects also improved their dynamic balance after the three-months program in the right leg ($p = 0.096$), left leg ($p = 0.069$) and the number of falls ($p = 0.017$), but the HG subjects revealed higher results.

- Posture control measured by Posturography tests revealed significant improvements in the eyes opened condition on board in the AP and ML directions ($p = 0.047$ in both) and in eyes opened on foam in AP ($p = 0.005$) and ML ($p = 0.032$) directions only after six months, while after three months, the HG subjects revealed no significant differences. In contrast, the Fitness group revealed significant improvements in eyes closed on foam in AP direction after three months ($p = 0.006$) and after six months ($p = 0.047$), and also improved the mean velocity in eyes closed on foam after three months ($p = 0.032$) and after six months program ($p = 0.043$). These results may suggest the importance of the two types of PA to the postural control. The Fitness group had higher scores after three months while the HG improved the static posture control scores only after six months. Each program improved some other aspects of the postural control after the six-month program. These results may indicate that in order to improve the postural control in various conditions, it appears that it would be best to combine the Fitness type of exercise along with somatic type of practice such as: HG. Nevertheless, this research also emphasizes that the practice of flexibility, proprioceptive and vestibular ability along with coordination and motor learning are very important in improving dynamic and static balance, and may contribute in preventing falls among older adults.

- The HG subjects improved the attention and body awareness measured by the MAAS questionnaire after the pilot program. But after the three-months and six months program during Covid-19 conditions, there were no changes in attention and body awareness among the HG group, nor among the No PA or the Fitness group. But after 12 months program, the HG subjects finally revealed significant improvements in attention and body awareness ($p = 0.006$). These results may emphasize the negative impact of the Covid-19 pandemic on peoples' attention and body awareness. It may also highlight the notion that that it may take longer periods of time and practice to achieve improvements in attention and awareness capabilities.

- The mean composite score of health and well-being were improved by the HG in the pilot study ($p = 0.031$), while no significance was obtained in the separated components of health and well-being such as in the physical ($p = 0.062$), mental ($p = 0.379$) and social ($p = 0.551$) scores. In the main research, the HG increased the composite health and well-being score ($p = 0.001$, $d = 0.5$) as did the Fitness group ($p = 0.015$, $d = 0.35$).

- This research shows that people who did not participate in any PA significantly decreased most of the physical capability scores measured in this research program, and significantly decreased health and well-being composite score and most of its subscales' scores, while the people who practiced fitness and people who practiced the HG somatic type of PA, revealed improvements in physical capabilities, health and well-being. These findings demonstrate the benefits of physical activity and the great risks and declines of sedentary behavior.

- The findings of this thesis in general, highlight the potential of a low impact, somatic, body-mind type of physical practice to prevent falls, and improve important capabilities, health and well-being in older adults' population.

8.4 The research limitations

- The pandemic was unexpected, and caused great worldwide upheaval. It was present during all 12 months of the research program, and affected all human populations, especially older adults.

- The second limitation which is very important to consider, is the small sample, especially after the six- and 12-months program.

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