Cognitive and physical factors influencing quality of life of older adults. Exploring the effects of Bingocize® in Poland

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ABBREVIATIONS

BMI	Body mass index
CG	Control group
CTT 1	Color Trails Test part 1
CTT 2	Color Trails Test part 2
COWAT 1	Controlled Oral Word Association test part 1
COWAT 2	Controlled Oral Word Association test part 2
COWAT 3	Controlled Oral Word Association test part 3
EG	Experimental group
FESI	Fall Efficacy Scale International
IADL	Lawton and Brody Instrumental Activities of Daily Living
LC – all	Lifetime cognition questions including all questions
LC – cur	Lifetime cognition questions in the current moment
LC – 6	Lifetime cognition questions leading up to the age of 6
LC – 12	Lifetime cognition questions leading up to the age of 12
LC – 18	Lifetime cognition questions leading up to the age of 18
LC – 40	Lifetime cognition questions leading up to the age of 40
WHOQL	World Health Organization Quality of Life Brief Version
WHOQL – D1	World Health Organization Quality of Life, Domain 1: physical
WHOQL – D2	World Health Organization Quality of Life, Domain 2: psychological
WHOQL – D3	World Health Organization Quality of Life, Domain 3: environmental
WHOQL – D4	World Health Organization Quality of Life, Domain 4: environmental
WHOQL – Q1	World Health Organization Quality of Life, Question 1
WHOQL – Q2	World Health Organization Quality of Life, Question 2

1. INTRODUCTION

1.1 Demographics and changes in the world

The number of people aged 60 or older will rise from 900 million to 2 billion between 2015 and 2050 (moving from 12% to 22% of the global population) (WHO, 2018). Population aging is inevitable and with advances being made on all fronts it is happening at a much quicker rate than in the past. The Administration on Aging (U.S. Department of Health & Human Services, 2012) projects that by 2040, older adults (persons 65 and older) will represent 21% of the population in America. GUS (2021), stated that the growing rate of the elderly 60+ population in Poland increased 1% from the year before, at the end of 2020 the number of individuals aged 60+ was more than 9,8 million. The percentage of elderly people aged 60+ amounted to 25,6% (GUS, 2021). Poland is projected to be the 11th oldest country in the world by 2050 (U.S Census Bureau 2014). In figure 1 we can observe the percentage of individual's over the age of 60 in Poland from 2005–2020 (GUS, 2020). In comparison Korea is the fastest growing aging population as of 2017 it had 14% of their population over the age of 65, by 2025 it is expected that 20% of their total population will be over the age of 65 (Kim, 2022). In the United States the number of Americans aged 65 and older are projected to nearly doubl**e** from 52 million in 2018 to 95 million by 2060, and the 65-and-older age group's share of the total population will rise from 16 percent to 23 percent (US Census Bureau, 2019).

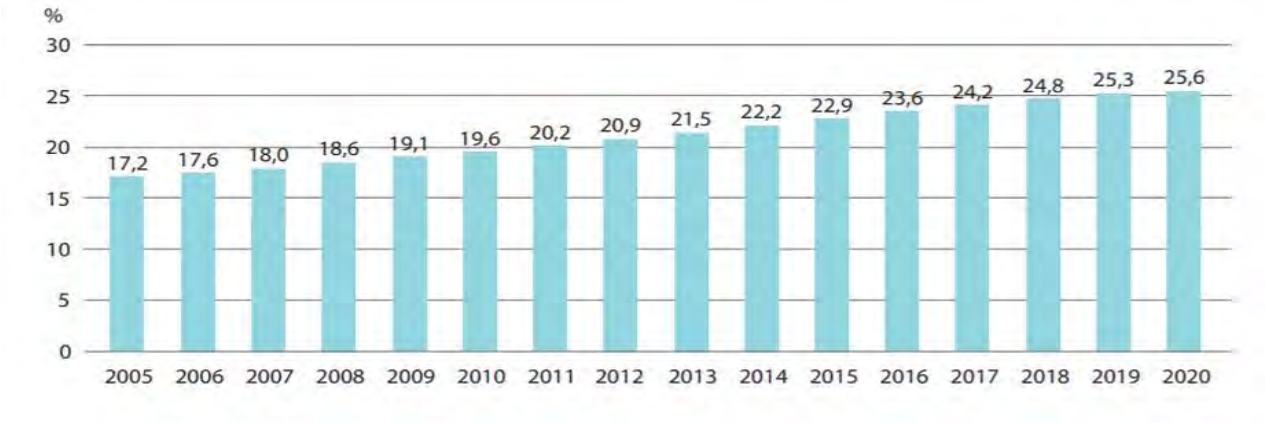


Figure 1: Individuals over the age of 60+ in Poland from years 2005–2020 measured on December 31 (GUS, 2020).

Recent gerontological studies indicate, health and social care services required by disabled older persons will be a growing burden and a major societal concern for the next century (Stuck et al., 1999). An intervention plan in response to this situation is to devise and implement strategies for preventing or delaying the onset of disability (Fries et al., 1980; Katz et al., 1983).

To put population growth into perspective it took more than 50,000 years for the world's population to reach 1 billion people (Bloom et al., 2022). Starting in 1960 the world population was already at 3 billion meaning that between acquiring the 1st billion there was a billion in population growth every one to two decades. In 2000 there were 6 billion people and the United Nations projects it will surpass 9 billion by 2037 (United Nations, 1999). Although population growth has been observed to be slowing, from peak annual rates in excess of 2 percent in the late 1960s, to about 1 percent currently, to half that by 2050 (United Nations, 1999). It has been shown that a life expectancy has also increased by 16 years (Bloom et al. 2022). Not only is the population growth in the world rapid, but this growth far exceeds the level of production and improvement of people's social needs (Sadigov et al., 2022).

COVID-19 has had a large impact on the population as a whole. COVID-19 was initially reported to WHO on December 31, 2019 and then on January 30, 2020, WHO declared the COVID-19 outbreak as a global health emergency (WHO, 2020). Globally, as of 9:19am CEST, 29 March 2023, there have been 761,402,282 confirmed cases of COVID-19, including 6,887,000 deaths, reported (WHO, 2023). In Europe reported cases of COVID-19 as of March 2023 by WHO are 274,567,136 and confirmed deaths are 2,206,630. In the United States the reported cases of COVID-19 of March 2023 are 102,697,566 and 152,968 deaths (WHO, 2023). In 2020, 84,9 % of all deaths of residents in the EU occurred among people aged 65 years and over at this time the third most common cause of death in among elderly people was COVID-19, accounting for nearly one tenth (9,1 %) of deaths of elderly people (Eurostat, 2023). In the U.S., about 81% of deaths from COVID-19 have been in people age 65 and older (Tejada-Vera et al., 2020).

Majorly in part by COVID-19, Poland had the highest excess death rate in the European Union in 2020; over 20% more people died in Poland's than recent annual average. Eurostat (2020) mentions that the closest to Poland's excess death rate is Spain with 19,91%, followed by Italy and Slovenia both having 19,49%, and the Czech Republic with 18,31%. According to Eurostat in 2020, Poland's 80,000 or so excess deaths amounted to 28,500 to be Covid-related. In the report

of “ Informacja o zgonach w Polsce w 2020 roku” by Ministerstwo Zdrowia published in February of 2021 claimed that the increase of deaths was a direct result of COVID-19. Poland in 2020 is EU’s 13th highest Covid death rate in relation to population (Eurostat, 2020). The lowest rates were recorded in Latvia (1,82%), Finland (2,49%) and Denmark (3,08%) (Eurostat, 2020). Even though all these factors played a role in the general population the trend of an aging population continued as the birth rate also fell by 5,2% last year relative to 2019, or by 19,700 births to 355,300 (Eurostat, 2020). The Organization for Economic Co-operation and Development determined that Poland has one of the lowest life expectancies at birth among European Union countries; the average life expectancy in 2014 was 77 years of age (73 years old for men and 81 for women).

Vaccinations have been shown to be effective for preventing morbidity and mortality associated with certain infectious diseases in the aging community this is important as older adults are at increased risk of severe outcomes (Chen et al., 2009: Lee et al., 2018). According to WHO (2023), Vaccines have saved more human lives than any other medical invention in history. In Poland it is estimated that the rollout of COVID-19 vaccination in Poland prevented about 61,000 deaths in 202; the most people saved from death by COVID-19 are mostly above 60 years of age, approximately 95% of all patients saved (Lewandowski et al., 2022).

Another important factor when talking about population demographics is migration. The current global estimate is that there were around 281 million international migrants in the world in 2020, which equates to 3,6 percent of the global population (UN DESA, 2021). When international migrant populations are examined by United Nations region, Europe is currently the largest destination for international migrants, with 87 million migrants (30,9% of the international migrant population), followed closely by the 86 million international migrants living in Asia (30,5%), (UN DESA, 2021). As has been the case for the past 50 years, the United States of America remains the primary destination for migrants, at over 51 million international migrants. Germany has become the second most prominent destination, with nearly 16 million international migrants, while Saudi Arabia is the third largest destination country for international migrants, at 13 million (UN DESA, 2021). In figure 2 we can observe the trends mentioned and for the top 20 countries where migration occurs (UN DESA, 2020).

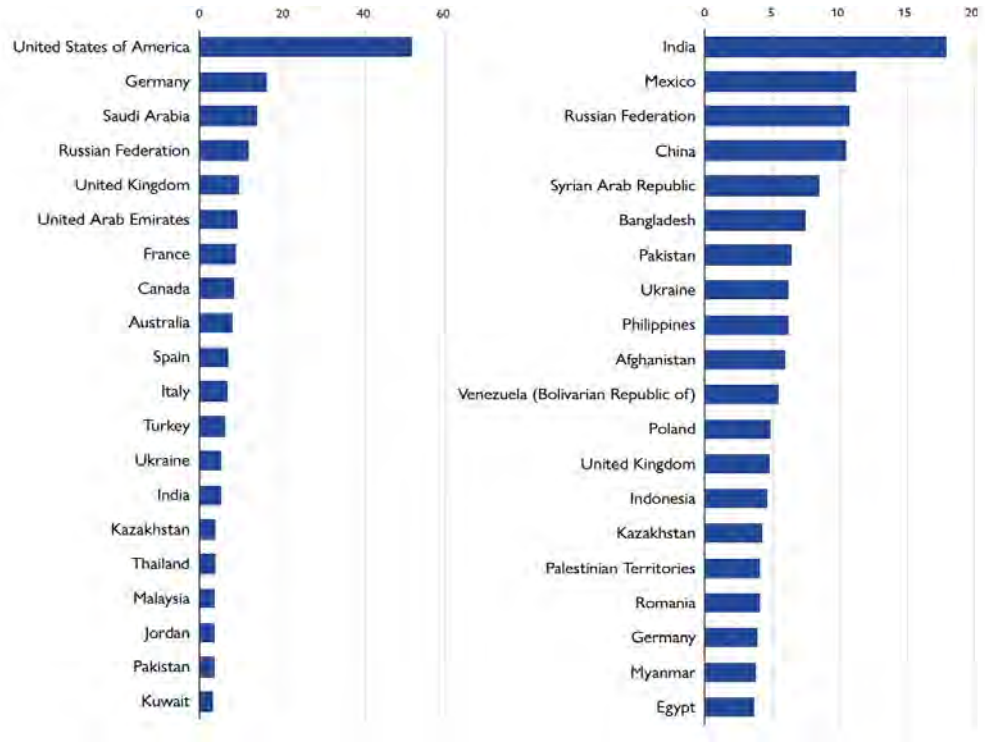


Figure 2: Top 20 destinations (left) and origins (right) of international migrants in 2020 (millions) (UN DESA, 2020).

Most international migrants (around 78%) were of working age (between 15 and 64 years of age). Since 1990, the share of international migrants age 19 and younger has dropped from 18,9 percent to 14,6 percent, while international migrants older than 64 have remained steady at around 12,2 percent (UN DESA, 2020).

More than 7,4 million refugees from Ukraine have been recorded across Europe since the escalation of hostilities in February 2022 (Sas, 2023). Since February 24, 2022 more than 10,8 million refugees from Ukraine have crossed the Polish border, with the largest number on March 6 – more than 142 thousand people (OCHA, 2023). On July 25, 2022, the economic publication Dziennik Gazeta Prawna published the results of a study commissioned by the Union of Polish Metropolises, which unites the country's 12 largest cities. Analysts found that the total number of Ukrainians who lived in Poland before the war and arrived in the country as refugees after February 24, 2022 is 3,37 million people. The U.N. High Commissioner for Refugees, Filippo Grandi, has previously called it "the fastest-growing refugee crisis in Europe since World War II."

With all this information provided we can determine that while Poland is not the fastest aging Population, Poland still has an aging country. Poland's population in summary has an increase in life expectancy and a decreasing fertility rate. What can be done to help with increase in population healthy aging? The human population as a whole continues to live longer. For those born in the second half of the 20th century, chronic diseases replaced acute infections as the major causes of death (Sahyoun et al., 2001). How we continue to live our best possible lives is a question often asked by not only common people but by experts. There have been numerous studies on the aging population and this continues to be a popular source of study. To find a solution for improved quality of life at an advanced age, one must be able to identify the problems that occur with an aging population as life expectancy has increased by 16 years.

1.2 Successful aging and independent living

Aging has been an intriguing topic for some dating back to 382 B.C (Majeran, 2011) when Plato an infamous philosopher first pondered the idea of age and aging. Plato believed that by living a healthy life one can create harmony between body and soul. Majeran continues to write that Plato identified aging and disease as two different phenomena. Aristotle (Plato's student) shortly thereafter suggested that aging was a disease in itself which leads to the deterioration of intellect. While these were famous philosophers, not scientists they allowed the a birthing of interest from the scientific community: What is aging?

Gerontological research was initially not focused on successful aging but rather concentrated on the negative consequences which included: risk of illness, loneliness and decline. It was not until the early 1900's when scientist took a true interest in aging and the process of aging. It has only been within the last few decades that a new perspective has emerged (Gergen & Gergen, 2001) which focuses more on positive outcomes and their determinants in old age.

There have been several different labels that have been used for aging such as "positive aging," "productive aging," "aging well," and "optimal aging". In 1999, Sheidt, Humpherys, and Yorgason coined the term "successful aging." Dillaway and Byrnes (2009) have determined this term "successful aging" to have the greatest impact in gerontology and in political arenas.

The evolution of how we define aging and health has made many adjustments and evolutions through time but has similar underlying ideas (Hung et al., 2010; Peel, 2004). Rowe and Kahn (1987) defined successful aging as the absence of physical impairment and chronic diseases, as well as optimal social participation and mental well-being. The fundamental idea to age healthily one must be free of disease or impairment is something that has been agreed upon throughout the years, but more recently this idea has been disputed and modified. There have been disagreements among researchers as to what successful aging really is due to lack of consensus (Rowe & Kahn, 1987). They also identified the aging process to either be "successful" or "usual" depending on physical health, cognition, and social engagement (Rowe & Kahn, 1987).

The lack of consensus had led some researchers (Bowling, 2007) and (Depp et al., 2006) to recognize two main ideologies of gerontological research one being biomedical based the other being a psychosocial approach. The biomedical approach has been studied by numerous scientists for quite some time to current, some examples are the following: Andrews et al., 2002; Bowling, 2007, Estes et al., 1989, Nikolich-Žugich et al., 2016, Strawbridge et al., 1996. This approach measures successful aging by social engagement and functional ability. The psychosocial perspective focuses on the aging process itself and the adaptations individuals make by utilizing psychological resources. The psychosocial perspective is based on Baltes, research conducted in 1987 creating what is a lifespan developmental approach meaning that successful aging is identified as a lifelong process of balance between gains and losses.

The inevitable process of aging contributes to declines in muscle mass (sarcopenia), bone--mineral density, muscle strength and endurance, cardiorespiratory fitness, balance, and flexibility (Chodzko-Zajko et al., 2009; Ignasiak et al., 2018,). Together these contribute to loss of functional performance or the capacity to perform normal everyday activities safely and independently without fatigue (Sahyoun et al, 2001; Skrzek et al., 2012).

Falls are a major global health problem; WHO, (2021) published that 684,000 fatal falls occur each year, which makes them the second most common cause of death from unintentional injury after traffic accidents. All around the world, mortality from falls is highest among people over 65 years of age (NIH, 2022; WHO, 2021). Walking safely without the fear of falling is something most do not think of when thinking of independent living but falling is one of the main causes of death and morbidity in the elderly (Burns et al., 2018; Kłak et al., 2017). Falls in the

aging population occur due to a loss of functional performance (Tang et al., (2022), Sahyoun et al., 2001; Wiśniowska-Szurlej et al., 2017).

According to WHO (2018) approximately 28–35% of people aged 65 and over fall each year which increases to 32–42% for those over 70 years of age. The frequency of falls increases with age and frailty level (Leszko et al., 2015; Kłak et al., 2017). Older people who are living in nursing homes fall more often than those who are living in a community (Cameron et al., 2021; Datta et al., 2021). Approximately 30–50% of people living in long-term care institutions fall each year with 40% of them experienced recurrent falls (WHO, 2007). Buczak-Stec et al., (2013) reported that in Poland 30–60% of long-term care residents aged 65 years and older and 20% of hospitalized people of age 65+ experience falls at least once a year. Aging and frailty, the condition of being weak and delicate, go hand in hand (Leszko et al., 2015; Kłak et al. 2017).

The prevalence of falls varies among countries as well. A study in the South-East Asia Region found that in China, approximately 31% of older adults fell each year whilst in Japan it was found that 20% of older adults fell each year (WHO, 2017). Yet another study in the Region of the Americas (Latin/Caribbean region) found the proportion of older adults who fell each year ranging from 21,6% in Barbados to 34% in Chile (WHO, 2008). Regardless of location, the rate of falls continues to rise. In the United States there are about 36 million falls are reported among older adults each year—resulting in more than 32,000 deaths (CDC, 2020). In a publication by Moreland et al. (2020) reported that in 2018, 27,5% of adults aged ≥65 years reported at least one fall in the past year (35,6 million falls) and 10,2% reported a fall-related injury (8,4 million fall-related injuries).

As fall rates continue to rise, the rate of hospital admissions due to falls for people at the age of 65 and older in Poland accounted for 70% of hospital admissions in 2010 equal to 31,712 hospitalizations (Buczek-Stec et al., 2013). According to WHO (2008) falls for the aging population (60+) Australia, Canada and the United Kingdom of Great Britain and Northern Ireland (UK) range from 1,6 to 3,0 per 10,000 population. Fall injury rates resulting in emergency department visits of the same age group in Western Australia and in the United Kingdom are higher: 5,5–8,9 per 10,000 population total (WHO, 2018). Falls and consequent injuries are major public health problems that often require medical attention (Schwendimann et al., 2006; Kannus, 2005).

Falls lead to 20–30% of mild to severe injuries and are the underlying cause of 10–15% of all emergency department visits (Hill, 2004). Falls account for more than 50% of injury related hospitalizations among people over 65 years and older (Oliver et al., 2000). The major underlying causes for fall-related hospital admissions are hip fracture, traumatic brain injuries, and upper limb injuries (Peel et al., 2002). The duration of hospital stay due to falls varies. The hospital visit can range from four to fifteen days in Switzerland, Sweden, USA, Western Australia, Province of British Columbia, and Quebec in Canada (WHO, 2017). Falls are the leading most common cause of nonfatal trauma-related hospital admissions among older adults (Oliver et al. 2000).

Hospitalizations that occur due to a fall resulting in a hip fracture can be up to 20 days; with the increase of age and frailty level, there is an increase in likelihood that an older person may stay in the hospital for the rest of their life (WHO, 2007). Authors have reported that a fall in which a hip fracture results mortality rate can be more than 27% within a year if surgically repaired and up to 79% if fracture is left not repaired (Negrete-Corona et al., 2014; Panula et al., 2011). In 2010, it was reported by Buczak-Stec et al., that Poland for older adults almost one-third of hospitalizations (31,4%) resulted from femur fracture (14,356 hospitalizations). Fall fatality rate for people aged 65 and older in the United States of America (USA) is 36,8 per 100,000 population (46,2 for men and 31,1 for women) whereas in Canada the mortality rate for the same age group is 9,4 per 10 000 population (WHO, 2018).

Falls account for 40% of all injury deaths (WHO, 2018). In 2020, the standardized death rate due to falls in people aged 65 years and older in Poland was 43,1 per 100,000 population in this age group, higher than the average value in European Union countries (40,9) and WHO European Region countries (WHO, 2023). The Administration on Aging (U.S. Department of Health & Human Services, 2012) determined that every 19 minutes an older adult will die from a fall.

1.3 Factors influencing healthy aging

The WHO (2015), defines healthy aging as: the process of developing and maintaining the functional ability that enables well-being in old age. There are three main components that influence healthy aging; how active one is mental health, physical activity, and social involvement. Social deprivation causes an increase in physical and mental problems as individuals age these become more and more apparent (Thompson, 2017). The decrease in physical activity causes sarcopenia which prevents the elderly from being able to be as self-sufficient and independent (Rogucka et al., 2000; Ignasiak et al., 2018).

National Council on Aging (2022) reported that older adults in the United States are disproportionately affected by chronic conditions, such as diabetes, arthritis, and heart disease. Nearly 95% percent have at least one chronic condition, and nearly 80% of have two or more. Chronic diseases can limit a person's ability to perform daily activities, cause them to lose their independence, and result in the need for institutional care, in-home caregivers, or other long-term services and supports (Center for disease and Control and Prevention, 2013). Today, death in the United States is largely reserved for the elderly. Roughly three-fourths of all deaths are at ages 65 and older (WHO, 2018). The top three leading causes of death in the United States for people over the age of 65+ is heart disease, cancer, and stroke (Gorina et al., 2005).

The latest estimates from the Family Resources Survey (2022) indicate that 14,6 million people in the UK had a disability in the 2020/21 financial year. This represents 22% of the total population. Data collected by "Narodowy Spis Powszechny" in 2011 indicated that there are 4,7 million disabled people in Poland (4,697,500); This amounted to 12,2% of the population in Poland. If the average age of onset of ill health is unchanged, increased life span would mean more years of ill health before death for an individual and a greater proportion of people with disability. Due to the prevalence and increase in disabilities, there is a large interest in what one calls successful aging. There are concerns with the rising of disabilities, through research and observation has mentioned that the age of onset of ill health might, however, rise more quickly than our life span increases, resulting in "compression of morbidity," (Fries, 2000). The increase in disability has its' financial costs on a country as well.

Another problem among older adults are suicides. According to the World Health Organization it was reported that in 2014 there were 804,000 suicides worldwide. Organization According to the Center of Disease of Control and Prevention there were 46,000 suicides in the United States in 2020, 9,137 were made of people aged 65 and up. The World Health Organization in 1998 has defined suicide as an act deliberately initiated and performed by a person in the full knowledge or expectation of its fatal outcome. Older adults plan suicide tediously and have a higher level of success of suicide completion (Conwell et al., 2011); one in four seniors will successfully complete suicide while only 1 in 200 youths (Smith, 2021). If a senior fails completion of suicide the recovery rate from a failed suicide attempt typically will leave long lasting effects and will not recover fully (Smith, 2021). Suicide in the elderly often draws less attention or is neglected as Dombrovski et al (2005) suggests this may be due to a lower economic impact.

The economic impact on each region varies as does the aging population; we observe a greater economic impact with the aging population as the aging population is greater. As we live longer we become more vulnerable in needing to utilize the healthcare system or encountering hospitalization (Arzetbl, 2012). The importance of healthy aging is to also prevent hospitalizations or illnesses that could negatively impact the economic health of a country. Peter Peterson (1999) argued that "Global aging could trigger a crisis that engulfs the world economy and may even threaten democracy itself." Previous U.S Federal Reserve chairman, Alan Greenspan, in 2003 had concerns on the aging population, "it makes our social security and Medicare programs unsustainable in the long run." The rise in population aging and decline in fertility rates are a concern due to active labor participation rates (Diamond 2002). The demographic change will cause many of the systems in place for retirees to be unattainable (Holzmann 2000). Though such negativity may surround the aging population research has continued in this field of Gerontology to improve quality of life.

Polish seniors are supported by the national and local governments; they get extra money (two times a year) from the Polish social security system. According to the NFZ, in 2020, the reimbursement of medicaments for people aged 60 and more equaled 5,9 billion, i.e. almost 63% of the total drug reimbursement costs in Poland. It was also reported by the National Health Fund (2020) data, financial means for a refund of geriatric care in an out-patient specialized health care and hospital treatment amounted to PLN 107,1 million, of which 96,2% was allocated to hospital

geriatric care. In Poland In the United States individuals over the age of 65, 95% percent have at least one chronic condition, and nearly 80% of have two or more (National Council of Aging, 2022); multiple chronic diseases account for two-thirds of all health care costs (Center for disease and Control and Prevention 2013) and 93% of Medicare spending (Centers for Medicare and Medicaid Services, 2013). Meanwhile in the United States less than 3% of U.S. health care dollars are spent on prevention to improve overall health (Rabah et al., 2020).

In a recent study by Saint-Maurice et al., in 2020 a group of adults 40 and older found that taking 8,000 steps or more per day, compared to only taking 4,000 steps, was associated with a 51% lower risk of death from all causes. We know that exercise has many benefits to maintain health and increase life expectancy in 13 studies it has been shown that approximately 0,4 to 6,9 years of life gained be gained due to leading an active lifestyle (Reimers Et al., 2012). As these studies show increasing physical activity has been shown to correlate with an increase in healthy aging and life expectancy.

Being socially active is also one of the key factors to healthy aging. Social activity in the aging population increases the feeling of connectives and decreases solitude. An aging community does indeed require a social community and social interactions to maintain a healthy outlook and overall well being. The World Health Organization (WHO, 2019) has established international guidelines for age friendly communities that include the encouragement of active aging by optimizing opportunities for health, participation, and security in order to enhance people's quality of life as they age.

1.3.1 Role of physical activity in successful aging

WHO (2018) defines physical activity as bodily movements produced by skeletal muscles resulting in expenditure of energy. Physical activity includes exercise, sports, and physical activity to maintain daily living. Physical activity is a preventable factor against noncommunicable diseases such as certain types of cancers, heart disease, diabetes, stroke to name a few WHO (2018). Physical activity is also shown to improve mental health (Schuch et al., 2016), improve quality of life and well being (Camboim et al., 2017). These benefits can be acquired with a minimum of 150 minutes of physical activity a week for older adults according to WHO (2017), despite this the

crude global percentage of inactivity is 21,4% (Dumith et al., 2011). This means that approximately a quarter of adults are not participating in the recommended amount of weekly activity WHO (2017). WHO (2017) recommends a holistic approach to incorporating physical fitness and states that balance, strength training, and aerobic fitness is all equally important when creating a physical fitness regimen.

The aging process is something that cannot be avoided which is why it is important to stay active. An increase in activity slows the systematic aging process, and we have a decrease in all the aforementioned issues associated with aging (Andrieieva et al., 2017; Conn et al., 2003). A decrease in physical strength, cardiovascular fitness, stability, and flexibility may lead to an elderly adult that is no longer confident in completing everyday tasks independently. The continued decrease in confidence in the completion of adult daily activities becomes a self-debilitating cycle.

Physical activity reduces cholesterol, decreases fat, increases muscle mass, increases circulation, improves heart health, (Nystoriak et al. 2019) and also releases feel good hormones overall improving mood (Kvam et al. 2016). Both being overweight and underweight can lead to further health issues as we know from obesity we can have heart problems, develop diabetes, high blood pressure, and loss of muscle mass (Nystoriak et al. 2019). Being underweight can also increase bone fracture, osteoporosis and loss of muscle mass. As people age muscle function may decline and due to this may lose their independence (Golubnitschaja et al. 2021). In 2019 a study by Adelnia et al. researchers found that moderate to vigorous physical activity is strongly associated with muscle function, regardless of age. This suggests that exercise may be able to prevent age-related decline in muscle function.

Ignasiak et al., (2009), Grześkowiak et al., (2009), and Ignasiak et al. (2013) have conducted research with older women and men aged 50 to 76 years of age using senior fitness test comparing results with older Americans. Ignasiak et al. (2009) found that older and living in an institution significantly lowered the individuals fitness levels. Individuals that were in an institution compared to those living independently had significantly lower levels of physical fitness levels (Ignasiak et al. 2009). Grześkowiak et al. (2009) research showed that female fitness in a social welfare home for the elderly had significantly lower results for the senior fitness test with the exception of lower body flexibility. Ignasiak et al. (2013) through research also observed that aging adults in the Polish population were performing worst in the senior fitness test comparatively to those in the United States.

Exercise is shown to be an important component of a multifactorial intervention, particularly when applied consistently for ten weeks or longer (Dizdar et al., 2017). Mobility impairment and low physical performance can predict the loss of independence in the ability to perform activities of daily living (King et al., 2002). Physical activity has been shown to improve balance and reduce the risk of falls in later life (Chang et al., 2004). Indeed, regular exercise has beneficial effects on older people's physical function: improving mobility, flexibility, and upper and lower limb function (Keogh et al., 2014). All the aforementioned articles mention physical activity and exercise play a key role in prevention, and in the management of diseases, to counteract sarcopenia and falls as well as improving physical performance and thus improving activities of daily living.

Physical activity has proved to increase one's lifespan (WHO, 2018). This is an important component of one's longevity. An increase in physical fitness will allow older adults to combat the natural process of aging where there is a natural degeneration of muscles. By continuing to exercise these parts, we are able to live longer, healthier lives with a decreased likelihood of fall related incidents (Crandall et al. 2015).

Not only does physical activity affect and combat the natural aging process and improve muscle tone and health, physical activity also affects how our brain works (Basso and Suzuki, 2017). A mechanism that improves the functioning of the brain through exercise are growth factors (Cotton et al. 2007). Growth factor allows for increase in brain plasticity. Long term exercises have been found to improve neurogenesis and neuroplasticity due to an increase in brain derived neurotrophic factor – BDNF (Sleiman et al. 2016).

Sleiman et al. published research in 2016 on mice studying mice where the experimental group were able to use an exercise wheel for 30 days while the control group was not. Through this study it was found that brain derived neurotrophic factor has been shown to improve cognitive functioning due to the increase in levels post exercise for the 30 days. In this particular study it further showed that they were also able to identify that when brain derived neurotrophic factor increased it was due to the enzyme histone deacetylases no longer inhibiting the production of it; this has also been shown to be the case in other research by Sada et al., 2020; de Almeida et al., 2017; Kozikowski et al., 2014. Through further research it was discovered that a molecule β-hydroxybutyrate located in the liver is inhibited by the enzyme histone deacetylases thus in the

end increasing brain derived neurotrophic factor (Yan et al., 2022; Chriett et al., 2019). Further studies have shown that in as little as a 4 week physical activity program enzymes positively involved in histone acetylation/deacetylation are positively influenced by the epigenetic mechanisms that determine an enhancing in the expression of brain derived neurotrophic factor (Maejima et al., 2018).

The increase in BDNF through exercise also influences mood; BDNF effectively decreases depression. In the National Institute for Health and Care Excellence (2022) it is stated that depression is one of the leading causes of disability in an individual's life. Depressive symptoms include: low mood, loss of interest or pleasure in most activities, and a range of associated emotional, cognitive, physical, and behavioral symptoms (such as sleep and appetite disturbance, lack of concentration, low self-confidence, agitation, guilt or self-blame, and suicidal thoughts or acts).

Centers for Disease Control and Prevention in 2022 reported that depression affects 1–5% of older adults living in the general community, 11,5% of older adults who are hospitalized, and 13,5% for older adults who require home health care. Older adults comprise 12% of the population and approximately 18% of suicides (Smith, 2021). Cross-sectional studies have shown that depressed adults are found to be more sedentary than non-depressed individuals (Helgadottir et al. 2015). The Physical Activity Guidelines Advisory Committee Report in 2008 reported that physically active people have a 45% lesser chance of becoming depressed compared to inactive people.

Physical activity can help with counteracting and preventing depression and its' symptoms (Roshanaei-Moghaddam et al., 2009). The deriving of BDNF mostly affects the hippocampus which can enhance plasticity and synaptogenesis and reduce neurodegeneration (Kowiański et al., 2018). At the molecular level, motor activity causes changes in neurotransmitters such as serotonin, noradrenalin, and acetylcholine (Lista et al., 2010). These changes collectively respond in a way to decrease depression and its' symptoms.

Mandolesi et al., (2018) through research have identified that exercise is related to increased performance in working memory and cognitive flexibility. Further research showed that motor activity improves memory performance in behavioral tests due to genetic mechanisms in the hippocampus and the frontal cortex (Gomez-Pinilla & Hillman 2013). After some examination we can see that physical activity is necessary for successful aging.

One of the many benefits from physical activity is the decrease in cholesterol, physical activity lowers lipoprotein cholesterol that is transported in the blood by lipoproteins (Wang, 2017; Kodama et al., 2007). Analyzing high density lipoprotein and low density lipoprotein separately when associated with physical activity demonstrate that individuals involved in physical exercise have a reduced overall low density lipoprotein and an increase in high density lipoprotein (Franczyk et al., 2023; Wang, 2017). A healthier cholesterol level results with an increase in physical activity with higher levels of high density lipoprotein and lower levels of low density lipoprotein thus improving heart health and reducing chances of congestive heart failure. Adopting healthy lifestyles such as reasonable physical activity, a balanced diet, and stable lean body weight are known to reduce risk factors for heart disease thus slowing the process of inevitable aging (Bamidis, et al., 2014).

1.3.2 Cognitive performance in aging adults

As the aging population increases as does the prevalence of dementia and other cognitive impairments. Preserved **c**ognitive performance in aging adults is of utmost importance. What is considered healthy cognitive aging and is there a way to slow the cognitive aging process down? As we age many of our cognitive abilities begin to deteriorate; short-term working memory, processing speed, retrieval of memories/information and problem-solving (Eyler et al., 2011). The frontal cortex of the brain is responsible for executive functioning this part of the brain declines with the aging process (Peters, 2006). Atrophy in the brain occurs before detectable cognitive changes occur (Jernigan et al., 2001).

A report recently undertaken by Alzheimer Europe (2019) reported that there 7,853,705 people diagnosed with dementia; from this report 525,084 of those diagnosed were Polish people. The incidence rates for dementia including dementia of the Alzheimer's type increase across the 5-year age groups from 2,8 per 1000 person-years within 65–69 years up to 56,1 per 1000 persons in the older than 90-year group (Kukull et al., 2002). In the United States people over the age of 71 have a 14% chance of having dementia and 10% of which have Alzheimer's (Plassman et al., 2007). When individuals reach over 90 there is a 37% prevalence for dementia (Plassman et al., 2007). Mild cognitive impairment is not taken into consideration when these statistics are

presented; mild cognitive impairment affects 22% of the aging population over the age of 71 with 12% progressing to dementia yearly (Plassman et al., 2008).

Evidence has suggested that carriers of apolipoprotein E4 have a genetic predisposition for the development of dementia (Intlekofer et al., 2013). Intlekofer et al. published in 2013 which demonstrated that physical activity may benefit those that carry E4. Interestingly enough research has demonstrated that carriers of the E4 allele have potential to have an even greater benefit than those that are non-carriers (Pearce et al., 2022). Thus, physical activity being potentially helpful in the delay of dementia.

Erickson et al., (2019) conducted a randomized study that involved a control group which only engaged in stretching exercises while the experimental group engaged in aerobic type exercises. After the intervention there was a difference found between groups, the experimental group was found to have an increase in spatial memory and executive function while to control group did not have improvement in these areas (Erickson et al. 2019). In longitudinal studies with the aging population between 79 and 90, the more physical activity was reported for individuals between 60 and 75 was associated with less cognitive decline over the 11-year period (Gow et al., 2017).

After age 50 muscle strength declines 12–14% per decade (Lindle et al., 1997). Sarcopenia is related to loss of functional ability, independence, increased fractures, and increase in falls. Insulin Growth Factor promotes neuronal growth, survival and differentiation which helps with preserving cognitive function (Cassilhas et al., 2007). An increase in growth factors have been reported in the aging population with moderate to high levels of physical activity (Cassilhas et al. 2007). An over expression of insulin growth in the aging population can help protect muscle thus protecting against sarcopenia (Moran et al., 2007). A way to increase insulin growth factor is to incorporate strength training for the elderly population as a preventative treatment for sarcopenia (Moran et al., 2007).

Physical activity has a positive effect on brain structure as can be observed in Figure 3, the more physically active one is it has been shown that there is a larger grey matter volume; this is especially true for frontal and temporal regions (Bugg et al., 2011). In addition, Marks et al. (2007) through research have suggested that there is a causal relationship between cardiovascular exercise and white matter which is another key marker in brain health. Marks et al. (2007) conducted the

study over a six month period and observed an increase in white matter volume with those that adhered to an aerobic exercise program.

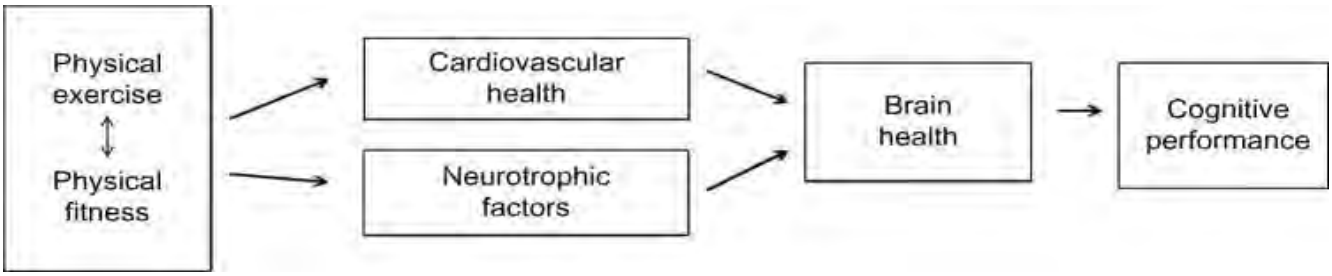


Figure 3: Factors involved in the acceptability of physical activity interventions (Devereux-Fitzgerald et al. 2016). An intervention with high enjoyment and high perceived value is associated with optimal acceptability.

1.3.3 Quality of life in old age

According to the World Health Organization (2012), quality of life includes physical health, mental health, emotional well-being, and social functioning. The World Health Organization (2012), defines Quality of Life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns.

Population aging has sparked a lot of interest in what quality of life means for the elderly and how to measure it. With an aging population, there are role changes that occur due to retirement and environmental changes such as separation from children (meaning they move out or away). Individuals find themselves to be social beings typically in their role which allows for the development of self-conceptualization; while performing the role individuals are able to be self--actualized according to role theory (Kim, 2007). With changes in an individual's role as is inevitable with aging individuals tend to lose self-conceptualization. The study of quality of life started as early as the 1930's and it began to be measured as a result of intervention outcomes, with a particular focus on the fields of psychology, physical education, medicine, and social welfare.

In 1937 a joint project of New York's City Research Bureau of the Welfare Council, City Department of Public Welfare, and State Department of Social Welfare examined the medical needs of elderly people receiving public assistance in New York City. They were the first to have

developed a functional scale for adults that studied and analyzed differences “between those who are incapacitated in various ways for normal living and those whose capacity for normal living is not seriously impaired.” The patients were classified in four categories: I, no obvious disability; II, up and able to get about; III, homebound; and IV, bedridden. This was the earliest attempt to examine a non-biological aspect of patients’ daily behavior which included objective measurements of functional health status that had been defined as the ability to perform routine self-care and complete basic physical activities, and level of independent living (The Criteria Committee of the New York Heart Association, 1939).

1.4 Overview of Interventions Applied to Improve QoL in Aging Adults

Interventions have been created to assist with well-being in the aging communities and residential communities to help offset some of the previously mentioned issues associated with aging. The effectiveness of intervention programs focusing on different domains of the aging population have been conducted for many years; the review of literature allows to classify them into certain aspects of life. Some such intervention programs are physical activity, interventions to reduce social isolation, multifactorial interventions, cognitive behavioral therapy, musical programs, meal delivery, e-health interventions and multi-component, and vaccinations (Ndegwa et al., 2020).

Research has been conducted that has confirmed that community-based intervention programs can improve functional outcomes and reduce nursing home admissions in older people (Tinetti et al., 1994). Due to the growth rate of the aging population, there has been an increase in interest in life satisfaction within this age group (He et al 2015). The loss of mobility and independence leads to lower quality of life and a heavier burden on the healthcare system (Freiberger et. al 2012). In regards to this age group there are key factors in having a happy and satisfying life, one of the key factors is social engagement (He et al., 2015; Fancourt et al., 2018). Social engagement has been defined as having meaningful and purposeful interactions while maintaining close relationships (Rowe et al. 1997).

Social engagement supports well-being by encouraging individuals to feel good about themselves, bringing meaning to their lives, helping them feel a sense of belonging, and providing opportunities for using their skills (Tang et al. 2017). It has been reported by Douma et al. (2017) residents in nursing homes spend less time participating in physical activities and socializing than older adults living in the community and were found to be isolated to their rooms (Donovan et al. 2014). Limited independence, feeling of social isolation, loneliness, and decreased physical activity are common in the nursing home population (Prieto-Flores et al. 2011).

Social isolation in the aging population is shown to be decreased when social games are incorporated into everyday living, due to the fact that they encourage interactions with others while also stimulating the mind. Older aged adults who are isolated have been reported to have a 50% increase in developing dementia (Kuiper et al. 2015), 30% increase risk of coronary artery disease or stroke (Valtorta et al. 2016; Holt-Lunstad et al. 2016), and 26% risk increase of all causes of mortality (Holt-Lunstad et al. 2015). Not only does isolation have a negative effect on mortality but it also is the leading cause for depression (which too leads to negative impacts on mortality) in older adults (just as for the rest of the population); It has been recognized through several studies that isolation or being isolated is a main contributor to depression older adults (Cacioppo et al. 2016; Matthews et al. 2016; Noguchi et al. 2021). Depression wreaks havoc on the mind and body thus leading to the above mentioned illnesses. This is why it is important to encourage and promote such interactions, especially with older adults as they may experience the loss of their significant other.

Social games bring individuals together, key factors that influence these changes are value and enjoyment (Devereux-Fitzgerald et al. 2016). Based on the enjoyment of the activity there is an increase in the value of the social game itself. The Figure 4 (below) shows just this. The impact of the experience itself can be categorized in two parts: enjoyment and value. The increase in enjoyment and value allows for moderate to high acceptability. When both are optimized or perceived as a high level of enjoyment and of high value it is then optimally accepted by the individual. When social games were incorporated, Mays et al. (2020) found participants reported

less severe levels of loneliness and social isolation. Fishlender et al. (2019) found participation as a predictor for improvements in function tests.

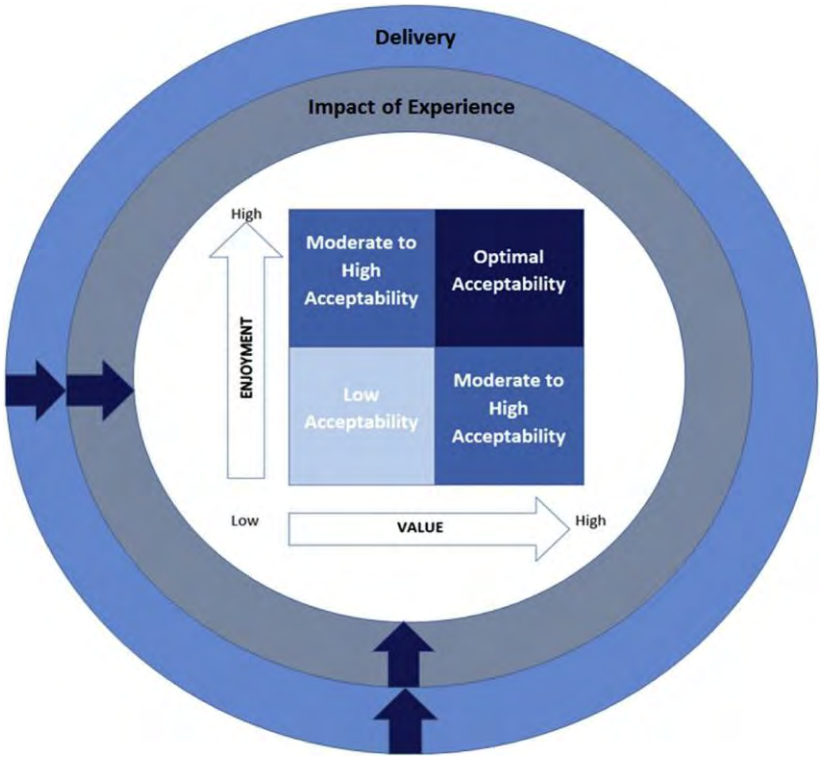


Figure 4: Putative mechanisms by which social connections influence morbidity and mortality. Adapted, National Academies of Sciences, Engineering and Medicine, 2020 and Holt-Lunstad and Smith 2016.

The aging population emphasizes the importance of developing effective strategies for meeting the needs of the aging population. Interventions that have been used for aging adults can be divided into three components; physical, cognitive, and multicomponent. In a review by Creighton et al. (2022), community-dwelling adults, ≥60 years of age were analyzed based on physical activity intervention programs and enjoyment outcome. There were a total of 1205 aging adults included in this review. In conclusion, all the physical intervention aids showed an increase in enjoyment. The physical activity intervention included: strength, balance, coordination, flexibility, and moderate aerobic exercises.

Another type of physical intervention aid used for the aging population is a destabilizing platform. Wolfson et al. (1993) utilized short-term exposure to altered sensory input or destabilizing platform on community-dwelling elderly of at least 75 years of age for 45 minutes, 3 times a week for 3 months. The movement results in significant improvement in sway control and inhibition of inappropriate motor responses, resulting in improved balance during repetitive testing.

Dancing is another intervention aid that is increasingly used as it combines many diverse features making it a promising neuroplasticity-inducing tool (Kattenstroth et al., 2013). The investigation by Kattenstroth et al. (2013) investigated the effects of a 6-month dance class one hour a week on a group of healthy elderly individuals compared to a matched control group. Through investigation, it was found that in the dance group, beneficial effects were found for posture, reaction times, cognitive, tactile, motor performance, and subjective well-being.

A multifactorial intervention involving nutrition and physical activity on the elderly was investigated by Rydwik et al. (2013). In this study, there were four groups made up of ninety-six community-dwelling elderly women (n = 58). The groups consisted of the following: a physical training program (aerobic, muscle strength, balance), a nutritional intervention program (individually targeted advice and group sessions), a combination of these interventions, and lastly a control group. The study lasted for 12 weeks and showed the positive effect on lower-extremity muscle strength directly after the intervention.

In another multifactorial investigation by Park et al. (2023), sixty participants aged ≥ 65 years (81,5 ± 4,3 yrs.) were divided equally into a control group, diet group, aerobic exercise and diet group, and aerobic exercise with electromyostimulation and diet group. The groups participated for 8 weeks in the program where the diet was provided twice daily with added protein, exercises performed for 45 minutes at 50–70% maximum heart rate for three days a week, and the electromyostimulation was applied on each limb in 8 weeks. These results show that multi--component interventions appear to improve physical fitness and vascular function.

In 2008 Buzia et al. presented a new cognitive therapy in a randomized study with elderly people (n = 238) who did not suffer cognitive impairment. Buzia (2008) concluded that the most significant finding in this study was that learning potential continued at enhanced levels in trained subjects over an intervention period lasting two years, thereby increasing rehabilitation potential and contributing to successful aging.

Social activity is another component when measuring quality of life. Clarke et al. (1992) developed a randomized controlled trial in 1985 to test the effect of social intervention over 3 years among elderly people, aged 75 and above, living alone. A lay worker offered the experimental group (n = 261) individual packages of support that aimed at enhanced social contacts. All reported improved self-perceived health status, where the experimental group showed significantly greater improvements than did the control group.

One of the social games developed with success in the USA is Bingocize® which has been shown to combat some of loneliness and isolation through a socially interactive game (Crandall et al. 2020). It was created in 2011 at Western Kentucky University by Dr. Jason Crandall. Bingocize® is a simple program that strategically combines the game of bingo and exercise in either 12 or 10-week studies of the program. The first study and publication of Bingocize® was in 2015 called Older Adults' Functional Performance and Health Knowledge After a Combination Exercise, Health Education, and Bingo Game. Older adults residing in assisted living facilities attended a 10 w10-weeklth program and the adherence rate was found to be over 90% (Crandall et al. 2015).

Bingocize® is an evidence-based intervention that combines the game of bingo, exercise, and health related questions. Bingocize® significantly improved knowledge of health questions. Furthermore, Bingocize® significantly improved muscular strength, flexibility, balance, and cardiorespiratory fitness as assessed using the Senior Fitness Test battery. Western Kentucky University states that as a result the Bingocize® program met the Active Community Living/Administration on Aging (ACL/AoA) Evidence-Based Programs Review Committee highest-level criteria for evidence-based disease prevention and health promotion program and is also SNAP-Ed Education Approved.

Bingocize® was created as an intervention to not only attract older individuals but to retain their attention by utilizing a fun, interactive game to allow for the exercise of the body and mind. Bingocize® is an evidence-based intervention that may be used as preventative care for the older population to help with any onsets of negative symptoms associated with aging. Bingocize® is a fun interactive game that challenges the mind, moves the body, and increases social interactions. After several more studies the game has been found to have a high adherence rate of over 80% (Shake, et al., 2018; Crandall et al. 2015; & Crandall et al. 2019) in the United States.

2. Aim and Research Questions

Exercise is shown to be an important component of a multifactorial intervention, particularly when applied consistently for ten weeks or longer (Dizdar, et al. 2017). Mobility impairment and low physical performance can predict the loss of independence in the ability to perform activities of daily living (King et al. 2002). Physical activity has been shown to improve balance and reduce the risk of falls in later life (Chang et al. 2004). Indeed, regular exercise has beneficial effects on older people's physical function: improving mobility, flexibility, and upper and lower limb function (Keogh et al., 2014). Using community-based group exercise programs which incorporate motivators, such as social support, has been shown to be one approach to increase physical activity levels and adherence for older people (Hernandes et al. 2013). Bingocize® includes all three key components: exercise of mind and body in a social environment. As in previous research conducted by Dr. Crandall et al (2014), it is expected for significant improvement in all three areas: (1) cognition, (2) aspects of functional (physical) performance, (3) The intervention group will show differential improvements over the control group in all tested areas. The aim of this study is to determine whether the 12 weeks of Bingocize® intervention be effective in showing significant differences pre and post-intervention in Poland for cognition, physical fitness, and quality of life as it has shown in the United States.

For the purposes of this study, the main interest is answering the following research questions:

1) How will the 12 weeks of the Bingocize® intervention program affect cognitive abilities in Polish older adults?
2) Can the level of physical fitness be influenced by participating in a 12-week Bingocize® intervention program for the elderly Polish population?
3) What are the effects of the Bingocize® intervention program in the quality of life for Polish seniors?
4) What is the role of cognitive and physical factors in the quality of life of older adults participating in the Bingocize® intervention program?

3. Materials and Methods

3.1 Study Participants

Recruitment began in 2018 after a conference was held in Krakow, Poland, introducing Bingocize® to the senior population. The seminar was held by City Hall of Krakow through the Senior Innovator program. The seminar was informative and taught individuals how the game is played and its purpose. The seminar provided attendees with statistical background information and the key purposes of the evidence-based game called Bingocize® During the convention, the recruitment process began by collection of voluntarily provided contact information.

The interested individuals were each individually contacted and after agreement they went through a screening process. The inclusionary criteria included: participants being over the age of 60+, normal or corrected normal-vision, no history of severe neurological impairment, mobility (i.e. not wheelchair bound), no structured physical activity (<150 minutes per week) for the past six months, telephone mini-mental status examination (MMSE) score of >17, and lastly personal approval. The exclusionary criteria included: color blindness, severe neurological impairment, wheelchair bound, and participation in a regular physical activity program for the last six months. Participants in both groups were asked to maintain their normal lifestyle and refrain from any scheduled or planned physical activity for the duration of the study.

The qualifying aging adults were then placed in one of four locations where the pre and post--testing would take place and the 12-week intervention program itself would be held. The meetings were held at senior centers and a monastery throughout Krakow. Older adults attending the Krakow, Poland Senior Center (N=63; age 72,41 ± 9,23) were recruited and randomly 1:1 assigned to experimental (*n*=32; social game with exercise) or control (*n*=31 no exercise) condition. The randomization process was not influenced and everyone had the same (1:1) chance of hitting either experimental or control group (Kim, Shin 2014). Figure 5 shows the flowchart of study enrollment and recruitment.

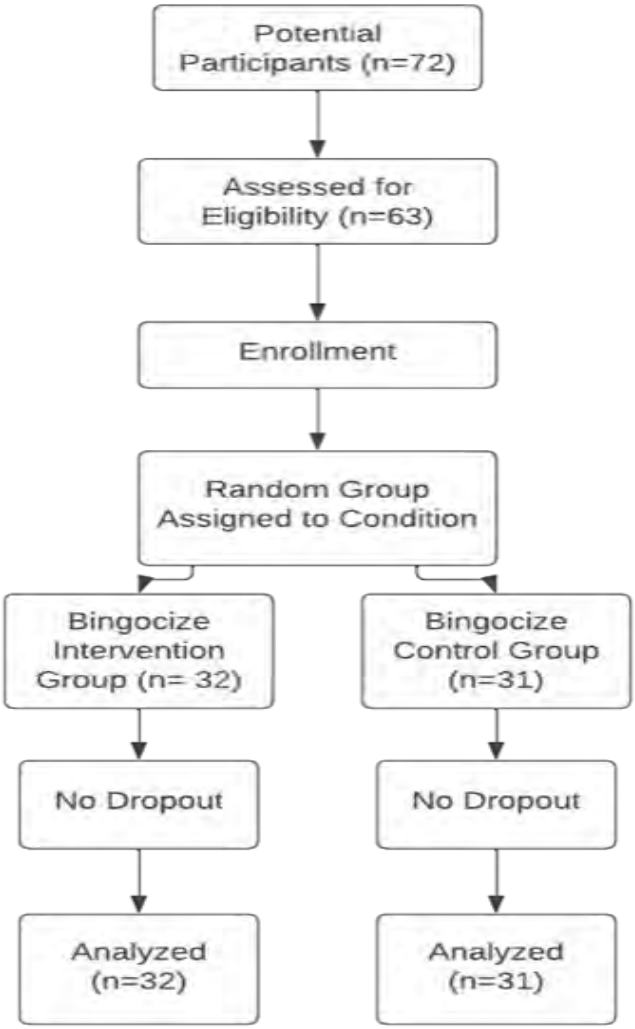


Figure 5: Flowchart study of enrollment, allocation and analysis

One of such location was called the Assembly Servants of the Sacred Heart of Jesus specific for seniors. The second location was at a senior center located at Dywizjonu 303. The third location, the second of the senior centers, was in the community center on Berka Joselewicza in Krakow. The fourth and final location was also a senior center on Borkowskiego in Krakow. The testing itself began the same day after the consent was signed and the questionnaire was complete. The testing took course in a week's period until all participants completed each test. When testing was complete the 12-week Bingocize® intervention began the first week of August. The group then met twice weekly for 12 weeks for Bingocize® and an additional week for post-testing. Each

location had a minimum of two volunteers at all times present during the 12-week Bingocize® intervention and also during test taking. The volunteers all received appropriate training for the Bingocize® game utilizing a link provided by Dr. Crandall with official training instructions. After completion of the training, each volunteer received a certificate of knowledge and completion. Bingocize® has two versions: there is a hard copy version and a mobile app version (the mobile-app version requires one to have a mobile device such as a tablet). Each member involved in the game is provided with a randomized Bingocize® card that is either handed out physically or the mobile app generates a random customization of the numbers, this is so that each individual can have an opportunity to win and there are no repeating cards or duplicates.

Figure 6: Example of what the electronic wheel looks like in the Bingocize® game a screenshot was taken by a tablet being utilized for the game.

Figure 6 shows an example of the electronic wheel being spun, the lever will determine which number is called out. In this example, number 18 is chosen. The number chosen will either have a mental health question or an exercise associated with the number (these are all randomly assigned within the program). The question then must be answered correctly or the exercise completed by the individual, the instructor will perform the exercise with the participants. After completion, a "smiley face" is acquired in place of the number.

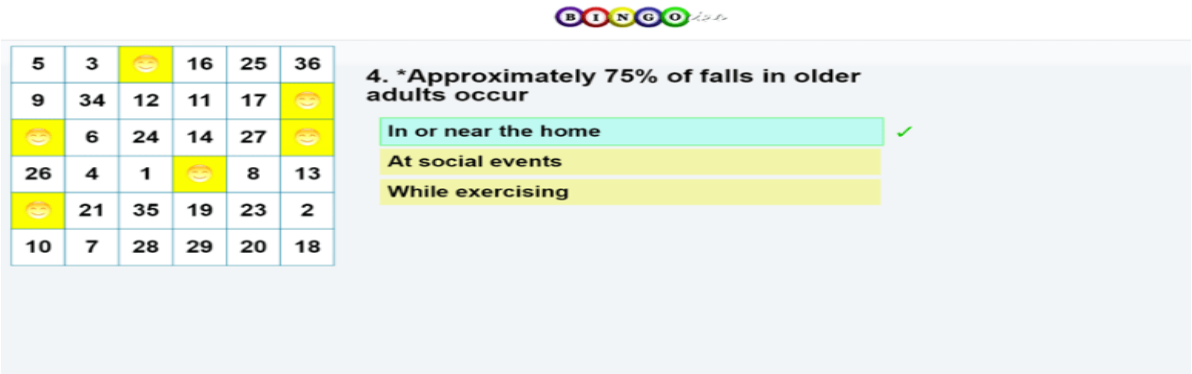


Figure 7: Screenshot taken with a tablet used in the Bingocize® game to show an example of a particular health question.

Figure 7 shows "smiley faces" covering numbers below where exercises have been correctly performed or questions had been answered correctly. Figure 5 shows what the mobile-based app may look like with an example question provided. When the answer is correct the associated number on the number card is covered with a smiley emoji. When there is a row of consecutive smiley faces diagonal or across then the person will yell out "BINGO!". The numbers are then checked by the instructor and if in fact, all numbers are correct then that participant wins the game.

During the Bingocize® game participants were asked to perform exercises alternating with health questions and then as a result were rewarded with a number for their Bingocize® digitized chart (which was on a tablet). Tablets were provided by the city of Krakow through the Center of Activity for Seniors (the game also has a paper version if these were not to be available).

3.2 Methods Used

In Bingocize® there are three main components that were taken into consideration: cognitive performance, life satisfaction, and functional performance. These three key components together are essential in increasing overall well-being and have been shown to be fundamental parts in the prevention/reduction of the aging process. The game also allowed for a social environment for the participants to enjoy (Taylor et al., 2020).

The experiment used a 2:2 design, Groups: Exercise + Health Education vs. Health Education-only and Time: Pre- vs. Posttest. The participants were randomly assigned to a group

due to small differences in group. The random assignment resulted in *n*= 32 for the experimental group and *n*= 31 for the control group. The Experimental Group's bingo games incorporated both a series of exercises (described further below) and multiple-choice questions about health topics related to osteoarthritis and fall risk; in contrast, the Control group's bingo games only incorporated the multiple-choice health topic questions. Over 100 questions from Bingocize® were translated to Polish and written into the application; an example can be seen in the Appendix 5.

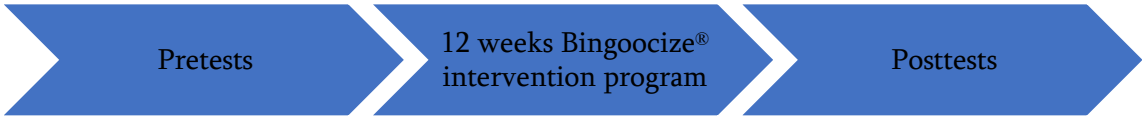


Figure 8: Study protocol

Study protocol is presented in Figure 8. First, the participants self-reported their age which was recorded, the experimental groups average age was 68,95 and for control group it was 75,88. Then each participant was weighed and height was measured pre and post 12-week intervention. Also, each participant's BMI was calculated and recorded pre and post 12-week intervention.

Choosing appropriate assessment tools is essential for the reliability and accuracy of measurements. Any changes in an aging adult can result in hospitalization or illness that can contribute to a decline in the ability to perform daily tasks. The ability to perform daily tasks is important in the aging population so that they may continue to live independently and within a community. The assessment tools are vital in providing information about the aging adult so that a baseline can be developed and an appropriate rehabilitation program be developed if needed or a preventative program implemented. The baseline that is established allows for early recognition of the changes so that additional and appropriate interventions can take place to help aid in whatever area there is a decline seen.

Multiple tests were conducted to assess cognitive functioning and to establish baseline functioning, pre and post 12-week intervention. The measure of cognitive functioning ability was assessed with the following tests: Color Trails Test, Controlled Oral Word Association Test, Mini Mental Status Exam, and Lifetime cognitive activities.

Functional performance is important for older adults to perform activities of daily living; this was measured by The Senior Fitness Test. The test measures physical fitness (using Senior

Fitness Test composed of 6 trials) for both experimental and control groups pre and post--intervention program. The types of exercises are described below. The individual fitness test items involve common activities such as getting up from a chair, walking, lifting, bending, and stretching. The exercises test lower body strength, upper body strength, lower body flexibility, upper body flexibility, agility, and aerobic fitness.

WHO-QOL-BREF was used to assess quality of life, pre and post 12-week intervention. Independence was measured pre and post 12-week intervention. To assess independence two questionnaires we used: Fall Efficacy Scale International and Lawton and Brody Activities of Daily Living Scale.

3.2.1 Cognitive Tests

Selected aspects of cognition were measured using the following tests: Color Trails Test, Controlled Oral Word Association Test, Mini Mental Status Examination, and Lifetime Cognitive Activities.

Color Trails Test

Frontal and executive functioning was assessed using the Color Trails Test (CTT). CTT was developed as a culturally fair analog of the Trail Making Test (Armitage 1946). The test was developed to activate frontal executive cognitive abilities same as the original Trail Making Test (D'elia et al., 1996).

Instructions are given verbally. The test requires only a pencil and the test itself. The administrator is required to have a stopwatch to time how long it takes the participant to complete each part of the test. The test should take between 3–8 minutes and anything taking longer than the allotted time must be counted as an incomplete. The test was given pre 12-week intervention to determine a participant's baseline and then administered again post 12-week intervention to observe if there were any differences after the 12-week intervention period.

The CTT has numbered circles which are printed with vivid pink or yellow backgrounds that are perceptible to color-blind individuals. CTT is made up of two parts – CTT1 and CTT2. For CTT1, the respondent uses a pencil to rapidly connect the same colored circles (pink) numbered

1–25 in sequence. For CTT2, the respondent rapidly connects numbered circles in sequence but alternates between two colors (pink and yellow). The length of time to complete each trial is recorded, along with qualitative features of performance indicative of brain dysfunction, such as near-misses, prompts, number sequence errors, and color sequence errors. The test takers are each given an untimed practice trial for both CTT1 and CTT2 to ensure that the participants understand how to complete the test. The administrator of the test times with a stopwatch how long it takes for the participant to complete the test. The scoring of the test is compared to normative data that had been derived from a sample of 1,528 participants (see Appendix 4).

Controlled Oral Word Association Test

Verbal fluency was measured with the Controlled Oral Word Association Test (COWAT). The test is a neuropsychological test in which participants have to produce as many words as possible from a category in a given time (60 seconds) (Lezak et al. 2012). This test was developed to measure verbal fluency which is an indication of frontal lobe dysfunction (Wysokiński et al. 2010). This category can be semantic, including objects such as animals or fruits, or phonemic, including words beginning with a specified letter, such as S, for example. Participants are to exclude proper nouns, numbers, and the same words with a different suffix. Two common forms are used, one of which includes the letters C, F, and L and the other F, A, and S (Benton et al. 1983). The testing requires a total of 5–10 minutes. The scoring is done by calculating the total number of acceptable words produced for all three letters that were included in the testing. Errors and word repetitions do not count towards a final score. COWAT is a subtest of the Multilingual Aphasia Examination (Benton et al. 1983). In the presented study the letters F, A, and S were used.

The test was administered by volunteers as no additional training is required. The instructions were read aloud to the participants involved in the study. The administrator of the test would say a letter aloud and begin the stopwatch. The participants would be given 60 seconds to name words associated with the letter. The administrator would write the words down as the participant would say them aloud. The administrator would then calculate the final score based on words that were acceptable as stated previously following guidelines. The test was administered 12-weeks pre intervention to determine baseline for verbal fluency and 12-weeks post intervention to observe any differences after the 12-week intervention.

Mini Mental Status Examination

Cognitive impairment was measured with the Mini Mental Status Examination (MMSE), which is the most globally used measurement tool for this type of dysfunction (Kurlowicz et al. 1999). The MMSE is an assessment tool used to measure cognition assessing domains of orientation, attention, concentration, memory, visual construction, and language (Folstein et al. 1975). The assessment tool first appeared in inpatient psychiatric hospitals dating back to 1975 (Devenney et al. 2017). When the assessment is used to assess cognitive impairment it has been shown to be associated with mental incapacity in aging adults when the tool is administered correctly (Raymont et al. 2004).

The MMSE takes approximately 10 minutes to complete and is easily administered. Participants are required to answer questions based on the domains mentioned above (example of question below). Each response to each question or task provided is associated with a score that can range from 1–5. The final score can range from 0–30 points, with the higher the score the better the performance (see Appendix 4 for attached MMSE). The test was administered by volunteers at the senior centers or from the monastery whichever locations the aging adults met for the testing and for the 12-week intervention program.

Example questions:

"What is the year? Season? Date? Day of the week? Month?" 5pts. possible

"Where are we now: State? County? Town/city? Hospital? Floor?"5 pts. possible

Lifetime Cognitive Abilities Test

How active one is throughout the course of their life was measured by using the Lifetime Cognitive Abilities Test (LCAT). It is administered to the aging population to determine how active one has been throughout the years until the present moment. The test asks how active one was with certain tasks at specific ages. The tasks associated with each age are specific to that age. The ages in question are age 6, 12, 18, 40, and the present moment. Each number represents an activity level, the participants are to choose which level of activity corresponds to the described task at the listed age. The numbers representing activity levels are on a Likert scale 1–5, 1 being the least active and 5 being the most active.

Example questions:

1 = Once a year or less, 2 = Several times a year, 3 = Several times a month, 4 = Several times a week, 5 = Every day or about every day.

At age 6 how often:

Did someone in your home read to you?

Did you play games? (i.e. checkers, cards)

3.2.2 Physical Fitness Test

Functional performance was measured by the Senior Fitness Test (SFT). The test was developed by Rikli and Jones (2000). One of the many benefits to using the SFT is that it has a high reliability of 0,93–0,98 according to Hasseberg et al. (2014) where reliability was measured using an Intraclass Correlation Coefficient model in this case. The level of physical fitness also called 'functional fitness', is defined as "having the physiologic capacity to perform normal everyday activities safely and independently without undue fatigue" can be determined by various test protocols (Rikli & Jones 2000). This is why the SFT has been used globally as it has a high reliability and is well adapted for the aging population.

The SFT was used in this study to test functional performance in aging adults, the test was administered in Polish. The test was done pre and posttest 12-week intervention period to determine functional performance in the elderly. The test was administered by the author of the dissertation. This test is designed in such a way that it is able to test strength, endurance, flexibility, agility, and balance (Rikli & Jones 2000).

Exercises:

1. Chair Stand – The purpose of this test was to measure leg strength and endurance. Participants stood up from a chair repeatedly within a 30-second timeframe and any completed seat and stand was counted.
2. Up and Go – This test is to measure agility, speed, and balance. An individual would be told to "go" and a stopwatch would be started. The participant would get up from the chair (that had the back against the wall for stability) and walk 8 feet around a cone and back to the same chair

to be seated once again. The result would be reported in seconds by the time taken to complete the circuit when the participant would be completely seated the timer would be stopped.

3. Arm Curl – This test measures upper body strength and endurance. This test is completed with the dominant arm. Women were provided with a 5lbs weight and men with an 8lbs weight, this exercise was measured in the number of curls completed within 30 seconds while seated and feet remaining flat on the floor.
4. Back Scratch Test – This test measures upper body flexibility and general shoulder range of motion. An Individual would attempt to touch hands behind their back by reaching one arm over the shoulder with palms facing outwards and fingertips downwards, the other hand would reach up the back with palm facing outwards and fingertips facing upwards. If fingertips touched the measurement would be 0, if fingertips did not touch it was measured in negative cm, if able to touch past point 0 the distance past would be measured in positive cm.
5. Chair Sit and Reach – This test was provided to measure lower body flexibility. The individual would sit in a chair and reach towards their toes while exhaling and bending at the hip. The knees were kept straight and must be able to hold the position for 2 seconds. When they would reach their toes it was considered the neutral point being reported as 0, any distance prior to reaching the toe was measured in negative cm and anything past the toe was measured in positive cm.
6. Two-Minute Step Test – This test measures aerobic endurance. Aging adults were to complete steps in place within a 2-minute period. The steps were counted only when a step was completed in the appropriate manner. The appropriate way to complete a step is when the knees are lifted to a height midway between the patella and iliac crest when standing.

3.2.3 Quality of life

Quality of life of participants was measured using three questionnaires: WHOQOL-BREF, Lawton and Brody Instrumental Activities of Daily Living Scale, and Fall Efficacy Scale International

WHOQOL-BREF

Quality of life was measured utilizing the WHOQOL-BREF. The WHOQOL-BREF is an assessment that measures quality of life throughout one's lifetime within the context of an individual's culture, value systems, personal goals, standards, and concerns (WHOQOL Group, 1994). WHOQOL-BREF is a short version of WHOQOL the assessment was created by the WHOQOL Group (WHOQOL Group, 1994). The pilot version of WHOQOL had 236 questions relating to quality of life, after 15 international field centers and at least 300 participants later they were able to downsize the WHOQOL to 100 questions (WHOQOL Group, 1994). The group that was involved in creating the test wanted to ensure that the test would be applicable cross-culturally, this is why it is important to note the 15 international field centers (WHOQOL Group 1994) the list of centers involved can be found in the appendix page. The WHOQOL has 100 questions relating to quality of life in various domains and subdomains of life the WHOQOL-BREF has 26 such questions. This test was developed to give a measurement to the "missing measurement in health" (WHO 2012). The WHOQOL-BREF was found to be an accurate and reliable assessment as an alternative to using the WHOQOL (WHOQOL Group 1998).

The WHOQOL-BREF test is self-administered where 4 domains of life are tested. The four domains are: somatic, psychological, social, and environmental. The questions ask for the participant to think of the past four weeks and respond honestly to each question. The answers all are associated with a numerical value. The numerical value chosen by the participant is then entered into a formula for calculation specific to the WHOQOL-BREF. The administrator of the test scores the test based on answers and the given formula, the higher the result, the more one is satisfied with their life. The scores range from 0–100 (WHO 2012).

Lawton and Brody Instrumental Activities of Daily Living Scale

How well an adult is performing in the present moment has been assessed by using the Lawton and Brody Instrumental Activities of Daily Living Scale – IADL (Graf 2008). There are eight functional domains that this test covers: using the telephone, shopping, food preparation, housekeeping, transport, medication, and finances. The tool is also able to determine how one is improving or deteriorating over a range of time when the individual is assessed periodically. The test takes a total of 10–15 minutes to administer.

This test is self-administered requiring only pen and paper. The individual completing the assessment requires no additional training or education. The assessment is made up of listed various tasks and the individuals are to choose how capable they are of completing the listed task and circle it. Each level of completion is associated with a numerical value (either 0 or 1). To calculate a score the answers to each task are added up as answered by the aging adult. The summary score ranges from 0 (low function, dependent) to 8 (high function, independent). For this study, the test is administered before the 12-weekk intervention to determine baseline and post 12-week intervention to observe any differences in the eight functional domains.

Example:

Circle answer:

A. Ability to Use Telephone:

1. Operates telephone on own initiative-looks up and dials numbers, etc.(1pt.)
2. Dials a few well-known numbers (1pt.).
3. Answers telephone but does not dial (1pt.)
4. Does not use the telephone at all (0 pts.)

Fall Efficacy Scale International

The level of concern one has in regards to falling was measured by using the Fall Efficacy Scale International – FESI (Yardely et al. 2006), it is a 16 item self-administered questionnaire. This test requires only pen and paper and no additional training or education is required. The test is an adaptation of the original test by Tinetti in 1990 titled FES. The FESI kept the original ten items from the Fall Efficacy Scale and also added 6 original items with cross-cultural validity (Yardley L. Et al. 2005). The FESI was translated into Polish by Zak and Kozlowska. The reliability of the test is 0,81 to 0,88 where the internal reliability is 0,89 to 0,92 (Dewan & McDermid 2014).

The FESI includes functional activities that are to determine the test takers' fear of falling. The functional activities are listed and then the test taker is to circle a corresponding numerical value on a scale of 1 (not at all fearful of) to 4 (very fearful of) how they feel about the corresponding activity listed. The test has a maximum of 64 points (very strong fear) to 16 (no fear). The circled numbers are added up to determine the level of fear the participant has of falling.

The test was administered pre 12-week intervention program to establish baseline and post 12-week intervention to determine any differences in the 16 functional activities.

Example:

FESI (Scale 1–4 of difficulty):

Cleaning the house (e.g. sweeping, vacuuming, dusting)

Getting dressed or undressed

3.3 Statistical Methods

Demographics of participants were collected: age, height, weight, and BMI pre and post 12-week intervention. This data was analyzed using the Two-Sample t-Test. The two-sample t-test is a method used to test whether the unknown population means of two groups are equal or not. The test was used since the values are independent, and are randomly sampled from two normal populations and the two independent groups have equal variances (Wheelan 2014).

Two-Sample t-Test Formula:

$$t = \frac{m - \mu}{s/\sqrt{n}}$$

The collected results from Senior Fitness Test, Fall Efficacy, Lawton and Brody, Color Trails Test, Controlled Oral Word Association Test, Mini Mental Status Exam, WHOQOL-BREF, and Lifetime Cognition Test were subjected to statistical analysis. The mentioned tests all were conducted pre and post 12-week intervention. The analysis completed was done using a mixed model analysis of variance (or mixed model ANOVA) as this study that contains (a) a continuous dependent variable, (b) two or more categorical independent variables, (c) at least one independent variable that varies between-units, and (d) at least one independent variable that varies within--subjects (Dodge 2008).

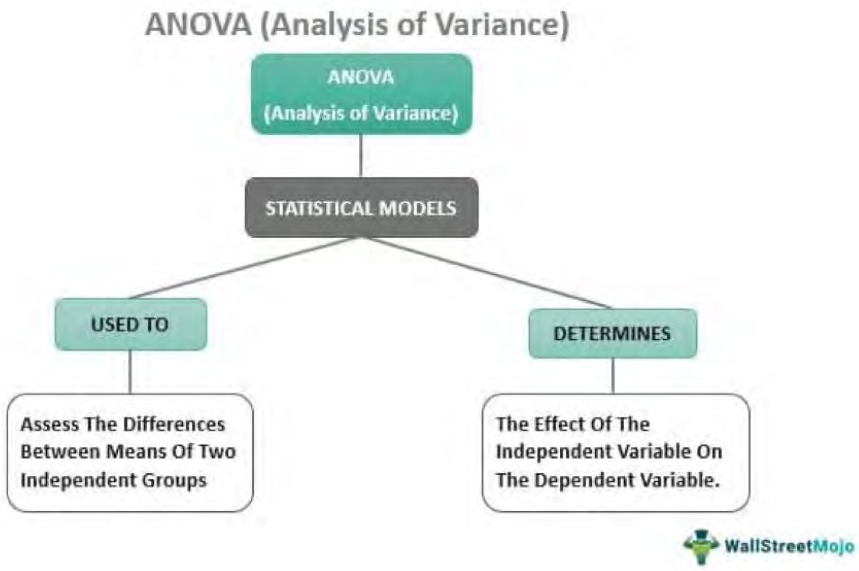


Figure 9: ANOVA flowchart

The analysis used one between-subject independent variable/factor (a group, of two categories depending on the variant of the Bingocize® game) and one within-subject independent variable/factor (a repeated measure, also of two categories: pre and post-test), as well as a number of dependent variables. Since the results of all tests were recorded as quantitative variables, the appropriate computational procedure was a mixed model analysis of variance (2×2/ two-way Mixed Model ANOVA).

The mixed model ANOVA was used for this study as there are between-subjects variables and one dichotomous within-subjects variable with repeated measures for pre and post-testing after the 12-week intervention. This method allows us to examine differences between one measurement of a particular variable and another measurement of the same variable for a given subject. The goal here was to examine changes in an outcome variable over time. This statistical method describes if the dependent variable changes according to the level of the independent variable.

This data analytic approach allows to see whether two independent variables (the group and the repeated measurement) affect the dependent variable and whether they do so in an interdependent manner. The testing procedure involves checking whether both the main effects of the independent variables and the effect of their interaction are statistically significant. As Murrar and Brauer write (2018): „A main effect is the effect of a particular independent variable, averaging across all levels of the other independent variable(s).” and “An interaction is present when the

effect of one independent variable is stronger at one level of the other independent variable than at the second level of that same independent variable".

These three effects can be obtained with the following statistical models:

$$a).\ (Y_1+Y_2)/2 = b_0 + b_1X + e$$

$$b).\ (Y_1-Y_2) = b_0 + b_1X + e$$

where:

Y_1 is the pre-test value of the dependent variable,
Y_2 is the post-test value of the dependent variable,
X is the variant of Bingocize® game (i.e. group),
e refers to the residuals (the error),
b_0 coefficient represents the main effect of repeated measurement,
b_1 coefficient represents the main effect of a) group or b) interaction of group and repeated measurement.

The Least Significant Test was developed in 1935 by Fischer. The LSD test is able to identify which group differs when rejecting the null hypothesis. The null hypothesis being that Bingocize® does not affect physical fitness, cognition, or quality of life after a 12-week intervention. For this reason, the LSD test was used to calculate the least significant difference when this null hypothesis was rejected. This test was applied when there was a significant difference observed. With utilization of the LSD test (after conducting ANOVA) we are able to determine where to make direct comparisons between two means from two individual groups. Any difference larger than the LSD is considered a significant result (Glen 2023). Alpha is set at 0,05.
LSD Formula:

$$LSD_{A,B} = t_{0.05/2,DFW}\sqrt{MSW(1/n_A + 1/n_B)}$$

The distributions of all dependent variables were checked before performing the tests. For this purpose, the Shapiro-Wilk test was used. The tests performed showed that almost all variables had distributions close to normal. The variables on the normality of whose distributions there were

doubts were IADL, MMSE, WHOQL – Q1 and WHOQL – Q2. For these variables (in addition to parametric tests), appropriate non-parametric tests were performed (Mann-Whitney U-test and "Wilcoxon t-test for dependent samples"). Despite not meeting the assumption of normality of distribution, the conclusions of the nonparametric tests were the same as those of the parametric tests – with the exception of the test for the IADL variable. For this reason, in order to keep the presentation of results clear, it was decided to present common tables for all variables. In the place where the result of the non-parametric test differed from the result of the parametric test (with the IADL variable) an appropriate annotation was made.

Spearman correlation is a statistical measure in which the strength of association between two variables and the direction of the relationship is evaluated (Hinkle et al., 2003). The correlation coefficient's value is between +1 and -1. The strength of the relationship between variables changes as we go from ±1 (perfect degree of association between variables) to 0 (no correlation). The closer to 0 the result is the weaker the association. The + indicates a positive relationship while one variable increases the other variable also increases. The - indicates a negative relationship where one variable increases the other variable decreases.

Spearman rank correlation formula:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

ρ = Spearman rank correlation

di = the difference between the ranks of corresponding variables

n = number of observations

Correlations coefficients between 0,10 and 0,29 indicate a minimal association, coefficients between 0,30 and 0,49 represent a moderate association, and coefficients of 0,50 or more indicate a high association.

Statistical significance was assumed at the level of $p < 0,05$ for all the applied tests. Calculations were performed using Statistica v. 13.1 software by StatSoft (Wroclaw, Poland) in the Biostructure Research Laboratory of the Wroclaw University of Health and Sport Sciences, certified according to ISO 9001.

4. Results

All the participants involved in the study that were included in the evaluation process met the inclusionary criteria. The results are shown below for the Bingocize® intervention pre and post. There were not any gender-specific instructions within the assessment tools themselves so no differences were made between male and female participants and were assessed equally.

4.1 Demographic characteristics of the participants in control and experimental groups

First, it was checked whether the control (CG) and experimental (EG) groups differed in a statistically significant way in terms of basic somatic characteristics. Differences in height and age of the two groups were verified. Pre and post body weight (BW) and body mass index (BMI) were also measured.

Table 1. Mean and standard deviation of age, BMI, height, and weight in the EG and CG (significant differences ($p<0,05$) are shown in bold).

Variables	EG N = 32		CG N = 31		t – test independent	
	Mean	SD	Mean	SD	t	p
Age	68,95	5,29	75,88	9,96	**-2,65**	**0,0121**
Height	165,26	7,81	167,34	8,38	-0,77	0,4466
Weight	70,54	6,27	70,26	6,28	70,72	6,80
BMI	25,84	1,73	25,74	1,73	25,27	1,88

According to the two-sample t-Student test results, there was not a significant difference in height between EG (M = 165,26 cm, SD = 7,81 cm) and CG (M = 167,34 cm, SD = 8,38 cm; $t(34) = -0,77$, $p > 0,05$). However, the second test conducted showed statistically significant differences between the groups in terms of age. According to the results the CG (M = 75,88 years, SD = 9,96 years) was significantly older than the experimental group (M = 68,95 years, SD = 5,29

years; t(34) = -2,65, p < 0,05). The results of the tests are shown in Table 1. Even though the groups were randomized somehow all of the participants aged 80+ made it into the control group.

As can be seen in Table 2, the average weight of people assigned to the EG and CG before the experiment began was respectively: 70,54 kg and 70,72 kg. After the experiment, the average weight of people in the EG decreased slightly (to 70,26 kg), while in the CG it slightly increased (to 70,92 kg).

A similar trend was, of course, observed with regard to BMI index. Before the experiment the average BMI score in the experimental group was 25,84, and in the CG it was 25,27. After the experiment the average BMI score in the EG decreased slightly (to 25,74), and in the CG it slightly increased (to 25,34).

An ANOVA test was conducted to test the effect of the experiment on participants' weight. As shown in Table 3, the observed differences in mean body weight were too small to be significant. According to the results (F(1,34)= 0,04, p>0,05), the EG and CG did not differ significantly in terms of body weight, nor did the experiment (Bingocize® game) have an effect on participants' body weight (F(1,34)= 0,33, p>0,05). However, despite the lack of significance of the main effect of group or experiment (replay), there was a statistically significant crossover interaction. As can be seen in Graph 1. in the EG, the average weight of participants decreased as a result of the experiment, while in the CG it increased with no significant difference.

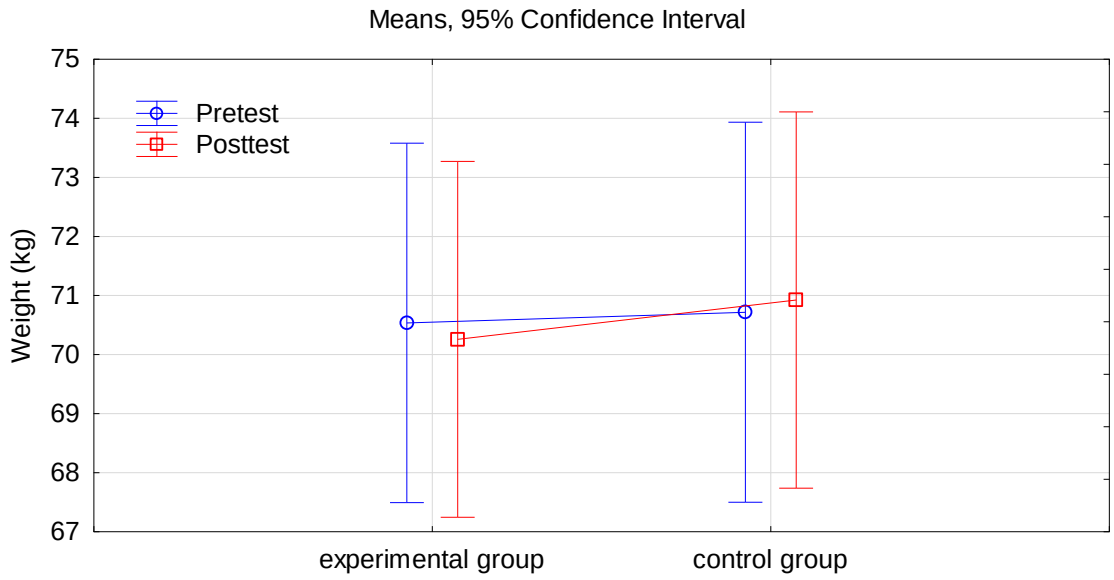
Since weight (with participants' height, after all, unchanged) translates directly into a BMI score, the same pattern is also observable for BMI seen in Graph 2.

Table 2. Mean and standard deviation of weight and BMI in the EG and CG

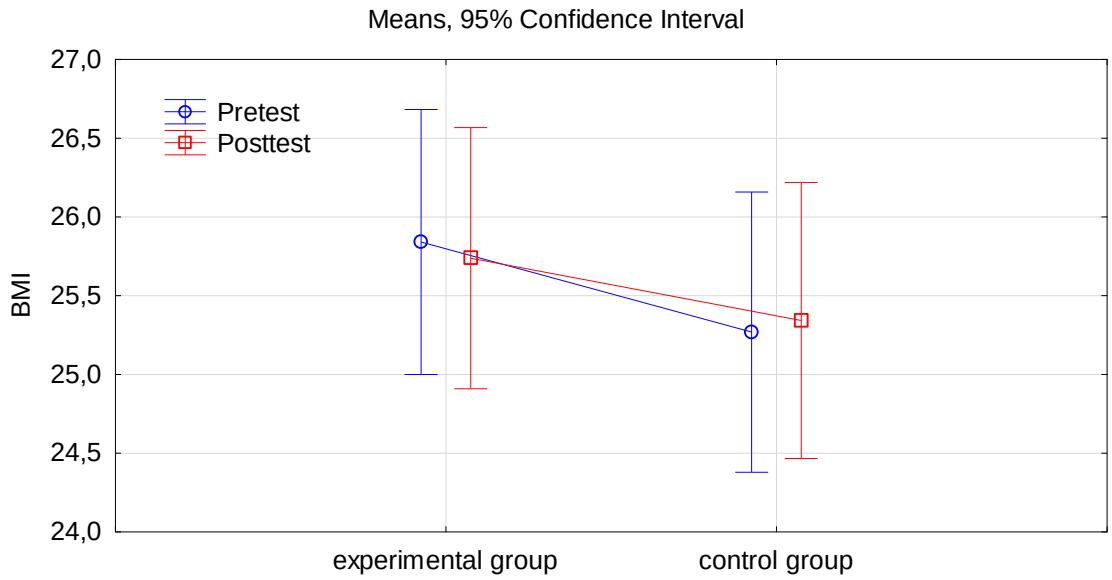
Variables	EG N = 32				CG N = 31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Weight	70,54	6,27	70,26	6,28	70,72	6,80	70,92	6,66
BMI	25,84	1,73	25,74	1,73	25,27	1,88	25,34	1,83

Table 3. Results of ANOVA for weight and BMI

Variables	Main Effect						LSD Test; Probabilities for post-hoc tests, p- values			
	Group (CG vs EG)		Repeated measurement		Interaction effect		Pre – Post test		CG vs. EG	
	F	p	F	p	F	p	CG	EG	Pre	Post
Weight	0,04	0,8464	0,33	0,5720	14,34	**0,0006**	**0,0337**	**0,0032**	0,9340	0,7607
BMI	0,66	0,4239	0,40	0,5301	15,12	**0,0004**	**0,0318**	**0,0023**	0,3455	0,5131



Graph 1. Average weight in CG and EG before and after the experiment.



Graph 2. Average BMI score in CG and EG before and after the experiment

4.2 Cognitive area

To test the effect of the experiment on the cognitive area, ANOVA (one-way in a mixed--design) tests were conducted with a post-hoc test using the LSD procedure (alpha = 0,05) – separately for each test (and part of the test if the test had multiple parts).

With regard to the cognitive area, the analysis of variance revealed significant differences in the average scores of the CTT and COWAT tests (all their parts). The MMSE assessment between the EG and CG and before and after the experiment turned out to be insignificant.

With regard to the result of COWAT and CTT, the overall differences between the groups were not statistically significant.

In both the EG and CG, playing Bingocize® resulted in an increase in the average COWAT 1, COWAT 2, and COWAT 3. As can be seen in Table 6 all differences came out to be statistically significant in both EG and CG. In both the EG and CG, playing Bingocize® resulted in a slight decrease in the average CTT 1 which is statistically significant. A slight decrease in the average CTT 2 score was observed in both EG and CG in both cases as shown in table 6 turned out to be statistically significant.

As can be seen in Graph 3, in both the EG and CG, playing Bingocize® resulted in a slight increase in the average COWAT 1 score (by 1,73 points in the EG and 2,76 points in the CG).

Both the EG and CG, playing Bingocize® resulted in a slight increase in the average COWAT 2 score (by 1,68 points in the EG and 1,53 points in the CG) as can be seen in graph 4.

As can be seen in Graph 5, in both the EG and CG, playing Bingocize® resulted in a slight increase in the average COWAT 3 score (by 2,37 points in the EG and 1,94 points in the CG).

Graph 6 shows both the EG and CG playing Bingocize® resulted in a slight decrease in the average CTT 1 score (by 0,15 points in both groups).

In Graph 7, both the EG and test CG, playing Bingocize® resulted in a slight decrease in the average CTT 2 score (by 0,33 points in the EG and 0,23 points in the CG).

The result of the Lifetime Cognition Test before and after the experiment was also compared. The test consists of several modules, 4 of which relate to the subjects' past. Therefore, the measurement of these modules was carried out only once before the study. T-tests for two independent groups were conducted to see if the EG and CG differed in terms of activities at different stages of life.

Table 4. Mean and standard deviation of scores in cognition tests in the EG and CG

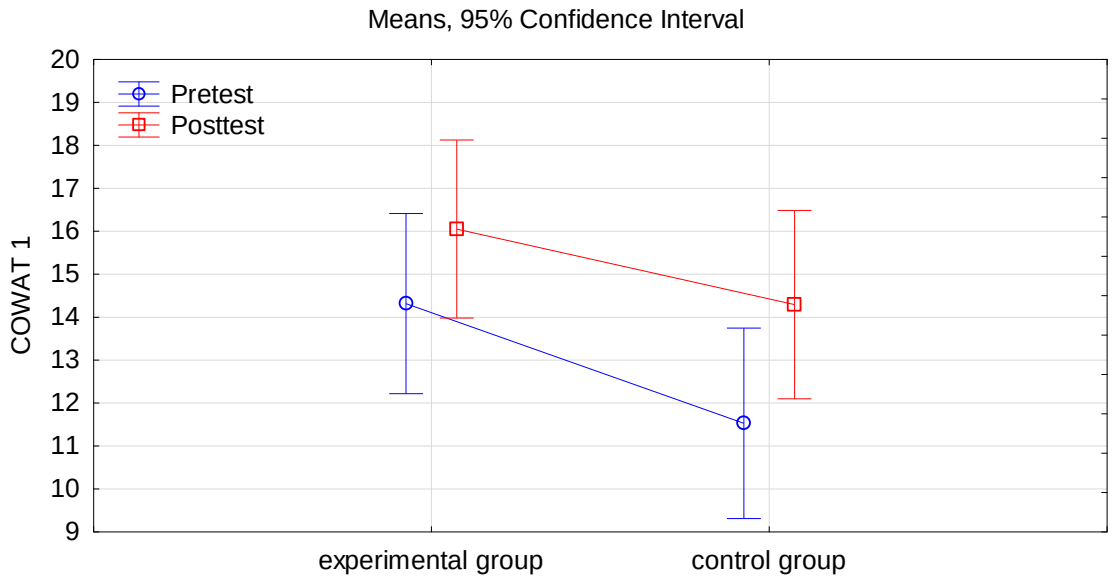
Variables	EG N = 32				CG N = 31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CTT 1	1,05	0,46	0,90	0,45	1,18	0,39	1,03	0,40
CTT 2	2,17	0,69	1,84	0,66	2,29	0,80	2,06	0,80
COWAT 1	14,32	4,52	16,05	4,30	11,53	4,47	14,29	4,61
COWAT 2	16,53	6,25	18,21	6,58	15,82	6,28	17,35	5,98
COWAT 3	9,74	3,59	12,11	4,43	9,00	4,30	10,94	5,08
MMSE	11,58	0,90	11,58	0,90	11,65	0,79	11,47	0,72

Table 5. Results of ANOVA (significant differences (p<0,05) are shown in bold) in cognitive tests.

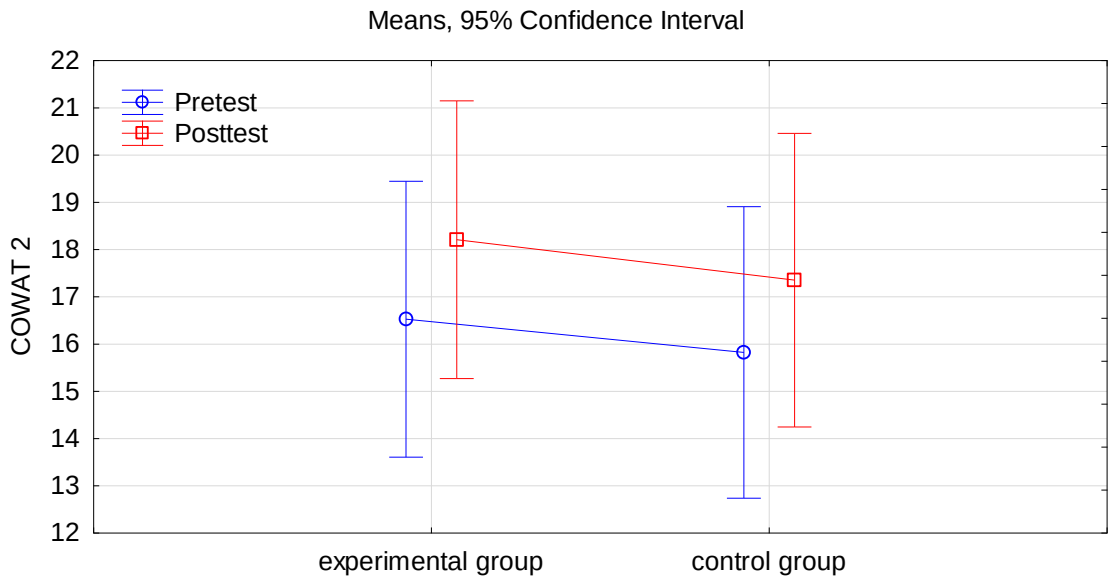
Variables	Main Effect					
	Group (EG vs CG)		Repeated measurement		Interaction effect	
	F	p	F	p	F	p
CTT 1	0,86	0,3592	36,99	**0,0000**	0,00	0,9653
CTT 2	0,51	0,4782	29,40	**0,0000**	0,99	0,3259
COWAT 1	2,37	0,1330	98,52	**0,0000**	5,14	**0,0299**
COWAT 2	0,14	0,7068	15,12	**0,0004**	0,04	0,8525
COWAT 3	0,45	0,5082	45,93	**0,0000**	0,45	0,5062
MMSE	0,01	0,9346	0,42	0,5199	0,42	0,5199

Table 6. Analysis of variance with replay measurements – LSD Test; probabilities for post-hoc tests; significant differences (p<0,05) are shown in bold.

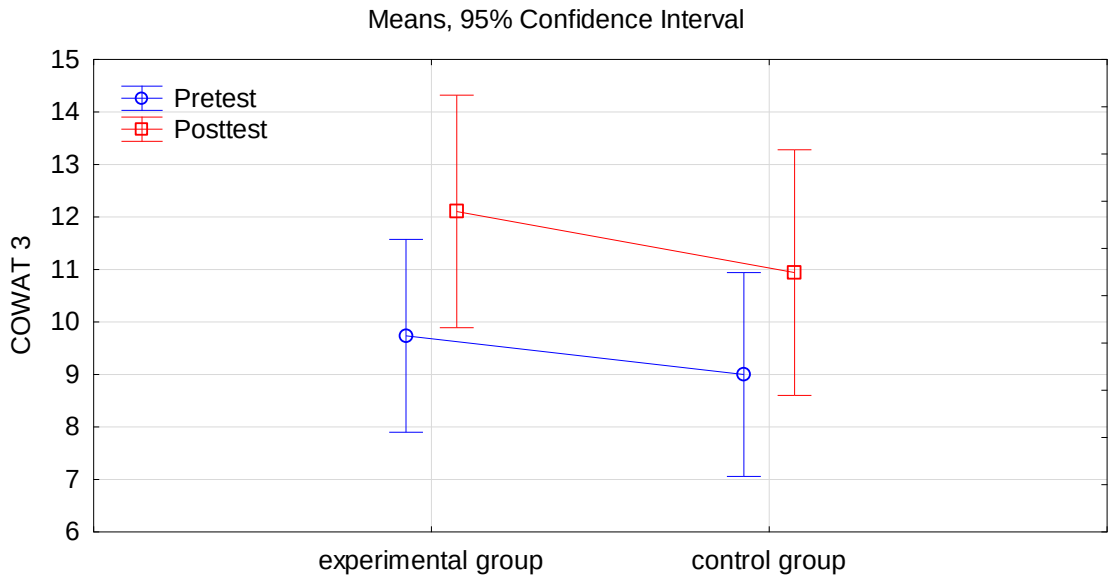
Variables	LSD Test; Probabilities for post-hoc tests, p- values			
	PRE – POST		EG vs CG	
	EG	CG	Pretest	Posttest
CTT 1	**0,0001**	**0,0002**	0,3699	0,3621
CTT 2	**0,0000**	**0,0045**	0,6251	0,3688
COWAT 1	**0,0000**	**0,0000**	0,0703	0,2468
COWAT 2	**0,0055**	**0,0155**	0,7395	0,6850
COWAT 3	**0,0000**	**0,0002**	0,6159	0,4292
MSSE	1,0000	0,3771	0,8079	0,6989



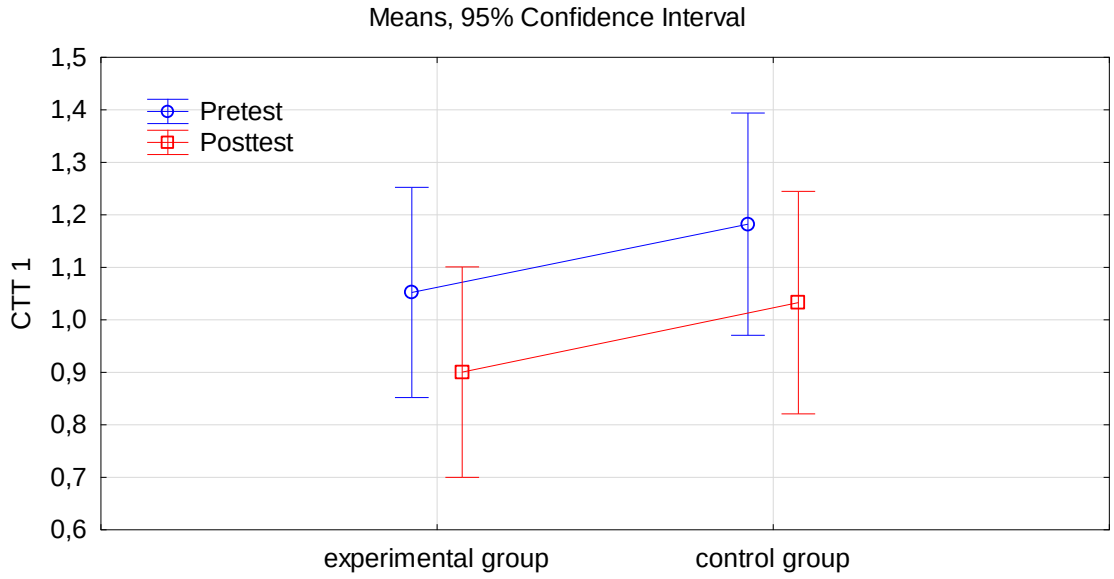
Graph 3. Average scores of COWAT 1 in CG and EG before and after the experiment.



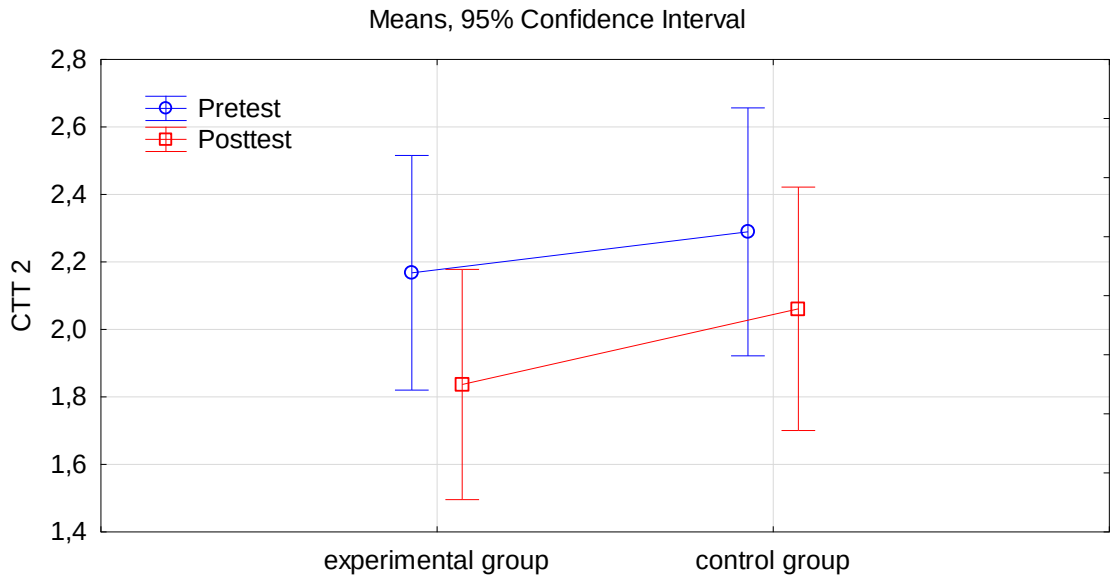
Graph 4. Average scores of COWAT 2 in CG and EG before and after the experiment.



Graph 5. Average scores of COWAT 3 in CG and EG before and after the experiment.



Graph 6. Average scores of CTT 1 in CG and EG before and after the experiment.



Graph 7. Average scores of CTT 2 in CG and EG before and after the experiment.

Table 7. Means, standard deviations and the results of t-tests of Lifetime Cognition modules of EG and CG.

Variables	EG		CG		t – test	
	Mean	SD	Mean	SD	t	p
LC - 6	9,53	3,66	7,35	3,30	-1,86	0,0709
LC - 12	16,63	4,56	14,35	4,87	-1,45	0,1565
LC - 18	18,68	3,94	15,00	4,70	-2,56	**0,0153**
LC- 40	18,37	2,87	15,94	4,41	-1,98	0,0561
LC- cur	15,74	4,15	17,63	3,70	15,59	3,39
LC - all	77,84	15,65	79,74	15,14	68,06	17,39

The average score achieved by the subjects from EG was higher than the average score of the corresponding module of the CG at all modules. The result of the t-test for independent groups ($t(34)= -2,56$, $p<0,05$), however, indicated that only in the case of LC-18 module did the control group achieve a statistically lower score. This difference, however, did not translate (as can be seen in Table 8.) into a statistically significant difference between the two groups in terms of the total score.

Table 8 shows the EG, LC-cur test measurement score (both before and after the experiment) was higher than the corresponding score in the CG. This has a direct bearing on the

LC-all score, in which the same trend is seen (due to the correlations described above regarding the 4 modules on the past).

However, the results of the ANOVA conducted do not indicate that there are statistically significant differences between the groups (the main effect of the group did not cross the assumed threshold of significance for either LC – cur or LC – all). The results obtained, however, indicate a statistically significant main effect of repeated measurement, meaning that regardless of the version of the Bingocize® game, regular participation alone has a positive effect on the LC – cur. This result necessarily also translates into LC – all, although the observed differences are obviously lower, as they are offset by the unchanged score of the 4 partial modules.

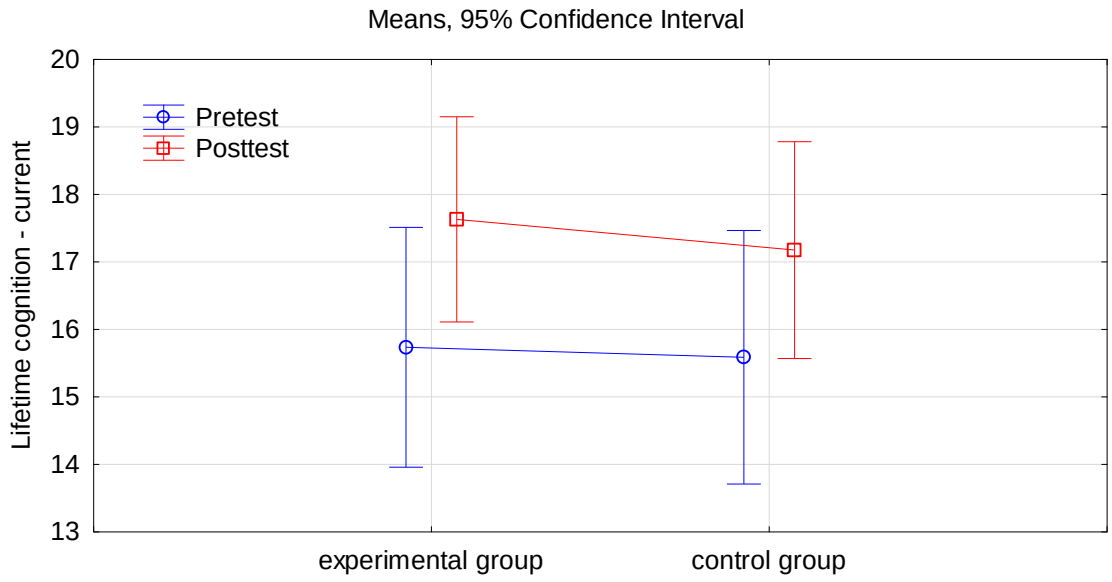
As can be seen in the charts below (Graphs 8 and 9), a higher test score can be observed in both groups: EG and CG. Graph 8 also shows the leveling of the difference between the pre--experiment and post-experiment measurements LC – cur. The significance of the differences in both groups is also confirmed by the post-hoc test results in Table 15.

Table 8. ANOVA results; Significant differences (p<0,05) are shown in bold for Lifetime Cognition

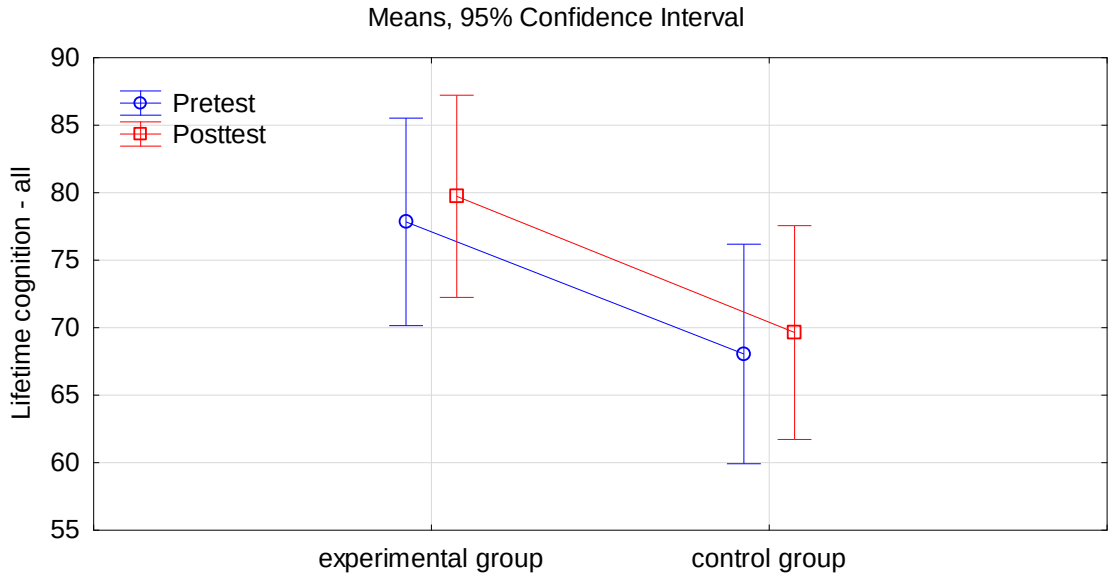
Variables	Main Effect					
	Group (EG vs CG)		Repeated measurement		Interaction effect	
	F	p	F	p	F	p
LC – cur	0,07	0,7953	44,10	**0,0000**	0,34	0,5628
LC – all	3,35	0,0760	44,10	**0,0000**	0,34	0,5628

Table 9. LSD Test Probabilities for post-hoc tests; Significant differences (p<0,05) are shown in bold for lifetime cognition

Variables	LSD Test; Probabilities for post-hoc tests, p- values			
	PRE – POST		EG vs CG	
	EG	CG	Pretest	Posttest
LC – cur	**0,0000**	**0,0002**	0,9008	0,7028
LC – all	**0,0000**	**0,0002**	0,0807	0,0721



Graph 8. Average scores of LC – cur in EG and CG before and after the experiment. The average scores pretest and posttest for LC – cur for both EG and CG increased.



Graph 9. Average scores of LC – all in EG and CG before and after the experiment. The average scores pretest and posttest for LC – all for both EG and CG increased.

4.3 Physical fitness

As shown in Table 11, with regard to the average number of repetitions in chair-stand, arm curl, step test and 8ft up and go(s) exercises performed by the participants, significant overall differences could be observed between the EG and CG. In contrast, significant overall (independent of whether or not participants performed physical exercise during the game) differences between measurements at the beginning and end of the experiment could be observed for all types of exercise.

In table 10 we observe the average number of repetitions in exercises: chair stand and arm curl achieved by subjects in the EG was overall significantly higher than the average number of repetitions for subjects in the CG (as indicated by the statistical significance $p<0,05$ of the main group effect with the variables: chair stand (repetitions) and Arm Curl (repetitions). Playing Bingocize® significantly increased the number of repetitions of these exercises in both the EG and CG in a similar manner (interaction effects between factors were found to be statistically insignificant $p>0,05$).

Performing a set of physical exercises while playing Bingocize® however, had an effect on the number of repetitions in the step test exercise, as evidenced by the significant replay x group interaction effect. As can be seen in Table 10, the average number of repetitions was higher in the EG (compared to the CG) both at the beginning and at the end of the experiment, and the increase in the number of repeats also occurred in both groups, but it was much greater in the EG. During the experiment, the average number of repetitions in the EG increased by an average of 30,37 (from 108,95 to 139,32), and in the CG by an average of 9,17 (from 88,59 to 97,76).

In the case of the Chair sit and reach exercise, only the main effect of the experiment (replay) turned out to be significant. The game of Bingocize® (regardless of whether the participants performed a set of additional physical exercises during it or not) had a positive effect on the outcome of this exercise. Participants in the EG were able to reach further after the experiment then before it started by 2,79 cm, and the control group by 1,41 cm.

Also in the 8ft up and go exercise, participants from the CG generally performed with longer average times than participants in the EG. As demonstrated by the LSD test (whose results are presented in Table 12.), playing Bingocize® alone (without additional physical exercise) was not

able to improve the results achieved in this exercise (p>0,05 for pre-post differences in the control group). Task performance time decreased significantly only in the EG (from 5,76 to 5,00 s).

Also in the case of the Back scratch exercise, the results significantly improved for the participants only in the variant with additional physical exercises. The average for the EG before the experiment was M = -3,47 cm, and after the end M = -1,74 cm, which means an significant improvement by an average of 1,73 cm.

Table 10. Mean and standard deviation of SFT– exercises in EG and CG

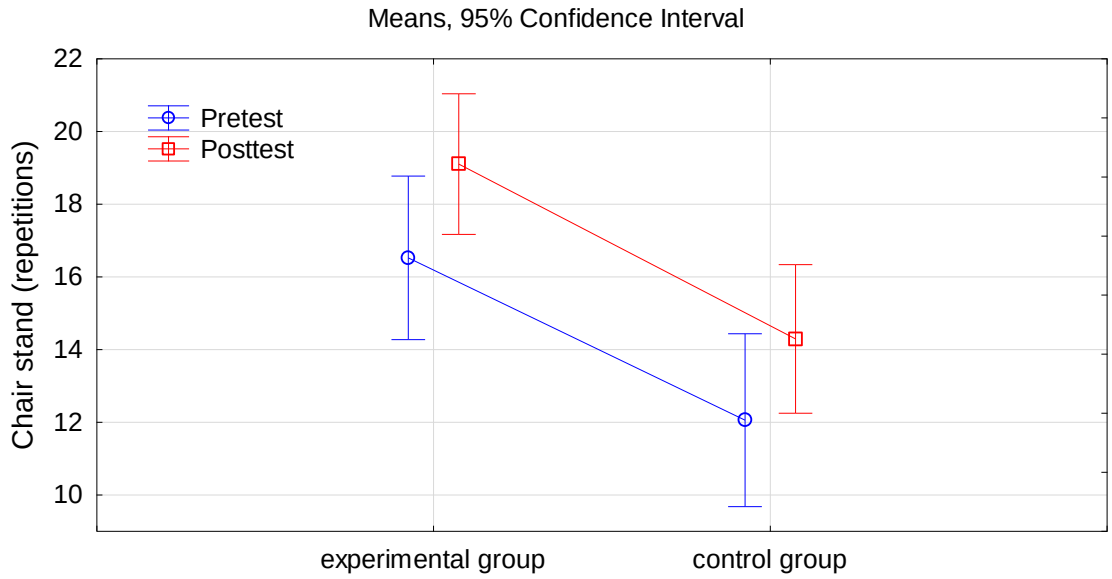
Variables	EG N = 32				CG N = 31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Chair stand (repetitions)	16,53	4,72	19,11	4,23	12,06	4,94	14,29	4,06
Arm Curl (repetitions)	24,74	5,66	27,42	5,78	19,59	6,49	21,76	5,66
Step Test (repetitions)	108,95	33,29	139,32	38,95	88,59	33,12	97,76	31,89
Chair sit and reach (cm)	0,79	8,48	3,58	5,86	-2,65	14,89	-1,24	13,85
8ft up and go (s)	5,76	0,85	5,00	0,58	7,30	2,81	7,14	2,63
Back scratch (cm)	-3,47	8,83	-1,74	8,46	-5,94	14,37	-5,82	14,16

Table 11. Results of ANOVA (significant differences (p<0,05) are shown in bold).

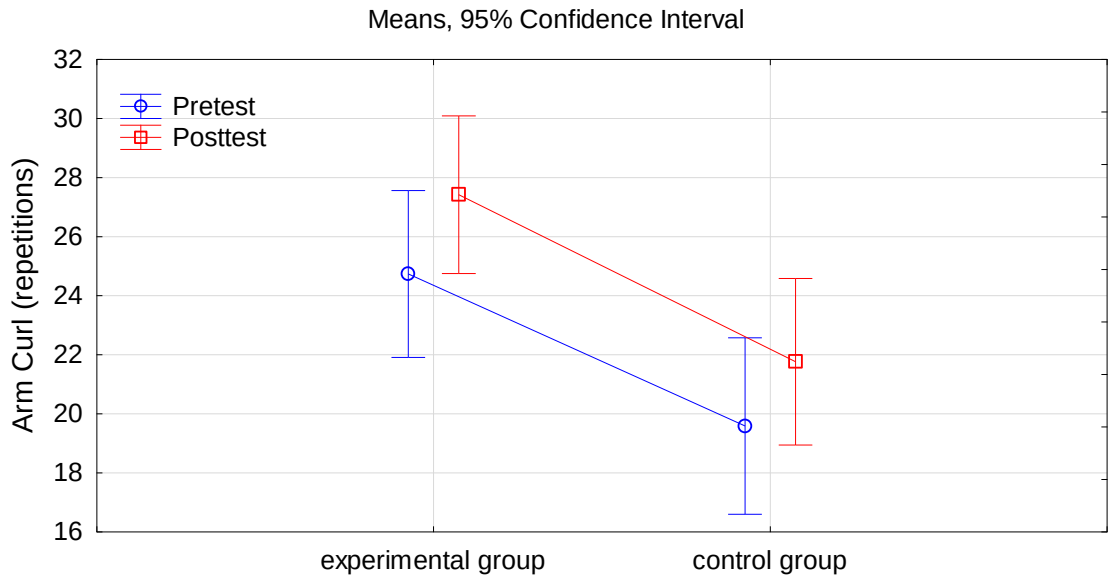
Variables	Main Effect					
	Group (EG vs CG)		Repeated measurement		Interaction effect	
	F	p	F	p	F	p
Chair stand (repetitions)	10,56	**0,0026**	26,41	**0,0000**	0,13	0,7160
Arm Curl (repetitions)	7,89	**0,0082**	33,59	**0,0000**	0,37	0,5489
Step Test (repetitions)	7,48	**0,0098**	81,09	**0,0000**	23,29	**0,0000**
Chair sit and reach (cm)	1,26	0,2696	9,63	**0,0038**	1,04	0,3161
8ft up and go (s)	8,29	**0,0068**	18,12	**0,0002**	7,81	**0,0085**
Back scratch (cm)	0,72	0,4024	5,98	**0,0198**	4,56	**0,0400**

Table 12. LSD Test (Least Significant Differences); probabilities for post-hoc tests; significant differences (p<0,05) are shown in bold for SFT.

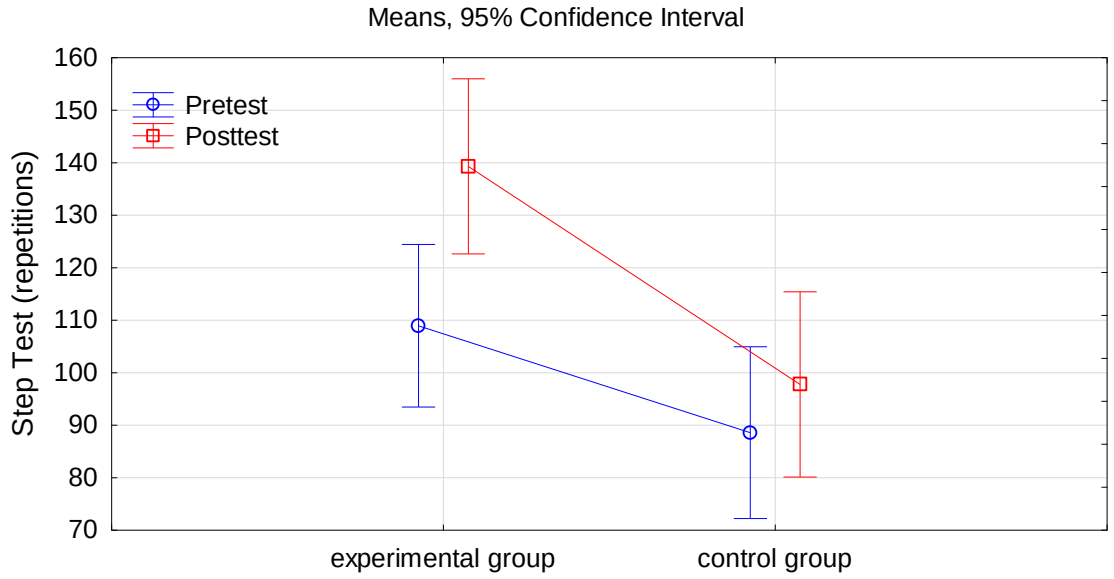
Variables	LSD Test; Probabilities for post-hoc tests, p- values			
	Pretest – Posttest		EG vs. CG	
	EG	CG	PRE	POST
Chair stand (repetitions)	**0,0003**	**0,0024**	**0,0049**	**0,0026**
Arm Curl (repetitions)	**0,0000**	**0,0011**	**0,0128**	**0,0067**
Step Test (repetitions)	**0,0000**	**0,0069**	0,0857	**0,0009**
Chair sit and reach (cm)	**0,0051**	0,1604	0,3640	0,2059
8ft up and go (s)	**0,0000**	0,3215	**0,0233**	**0,0021**
Back scratch (cm)	**0,0021**	0,8322	0,5294	0,2999



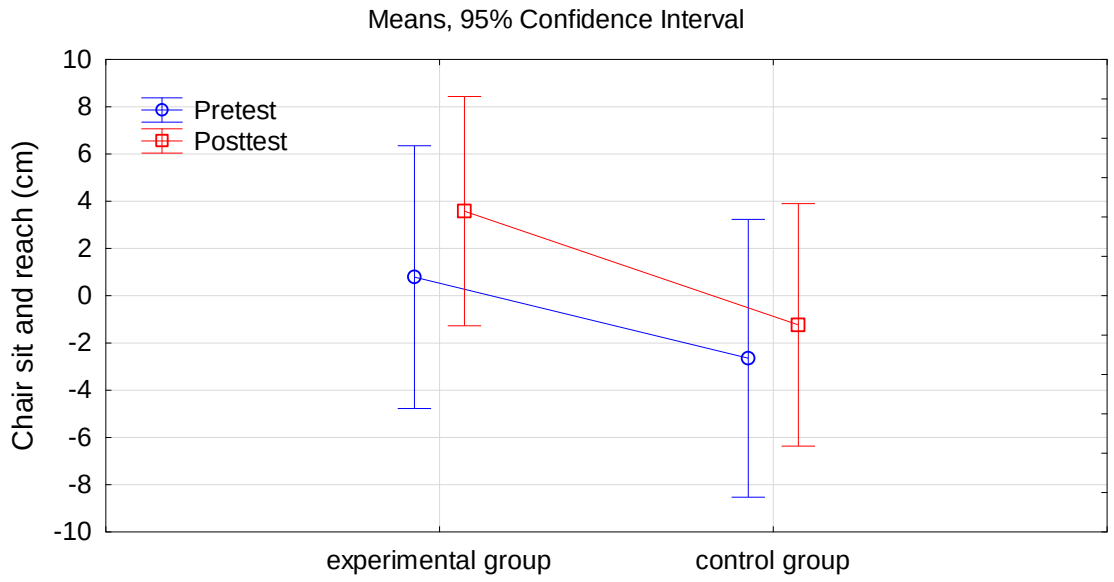
Graph 10. Average score of chair stand pre and posttest for EG and CG. EG and CG averages both significantly increased.



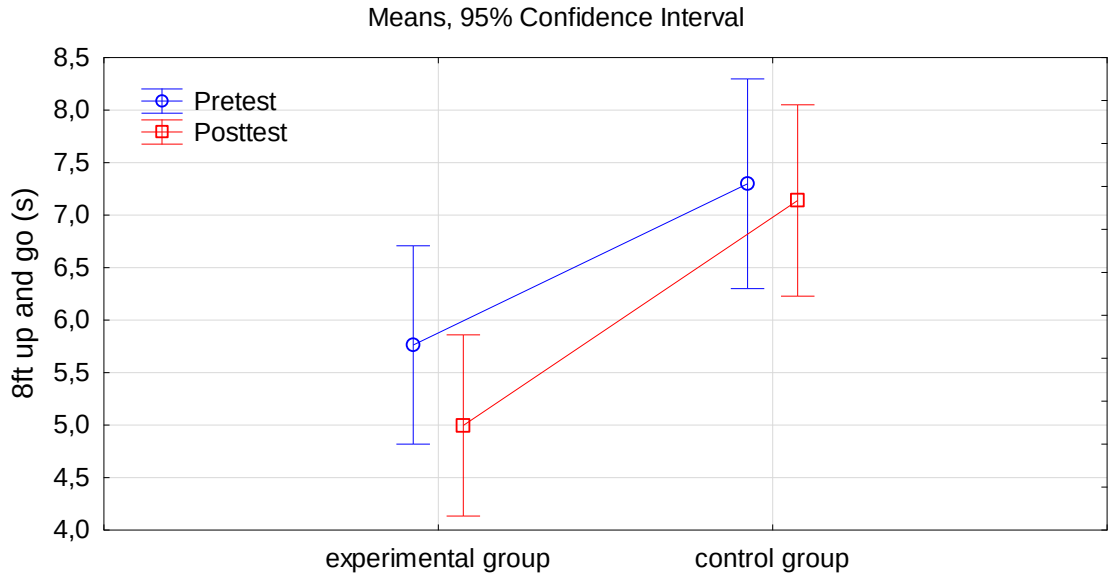
Graph 11. Average score of arm curl pre and posttest for EG and CG. EG and CG averages both significantly increased.



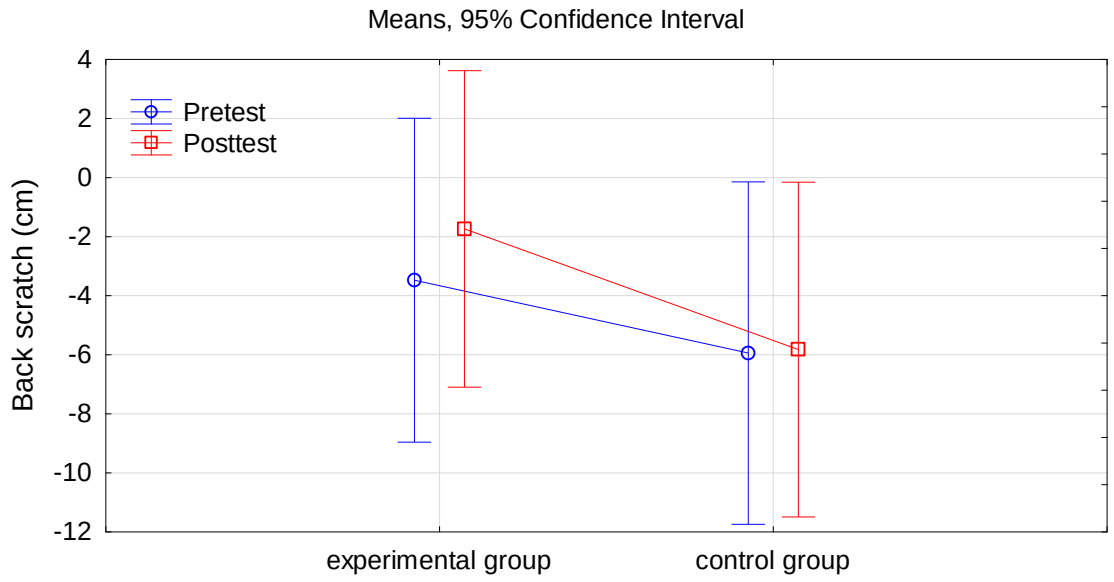
Graph 12. Average score of step test pre and posttest for EG and CG. EG and CG averages both significantly increased.



Graph 13. Average score of chair sit and reach for EG and CG. In only EG average significantly increased.



Graph 14. Average score of 8ft up and go for EG and CG. In only EG average significantly increased.



Graph 15. Average score of back scratch for EG and CG. In only EG average significantly increased.

4.4 Quality of life

Table 13 revealed differences in terms of the average results of the FESI and IADL tests between the EG and CG, before and after the experiment. These differences turned out to be insignificant.

The ANOVA test reveals that there is no significant differences for FESI and IADL test for EG and CG ($p > 0,05$).

The LSD Test reveals that there is no significant differences for the FESI and IADL test for EG and CG for pre and post testing and in between groups for pre and post testing ($p > 0,05$).

Table 13. Mean and standard deviation of FESI and IADL in EG and CG

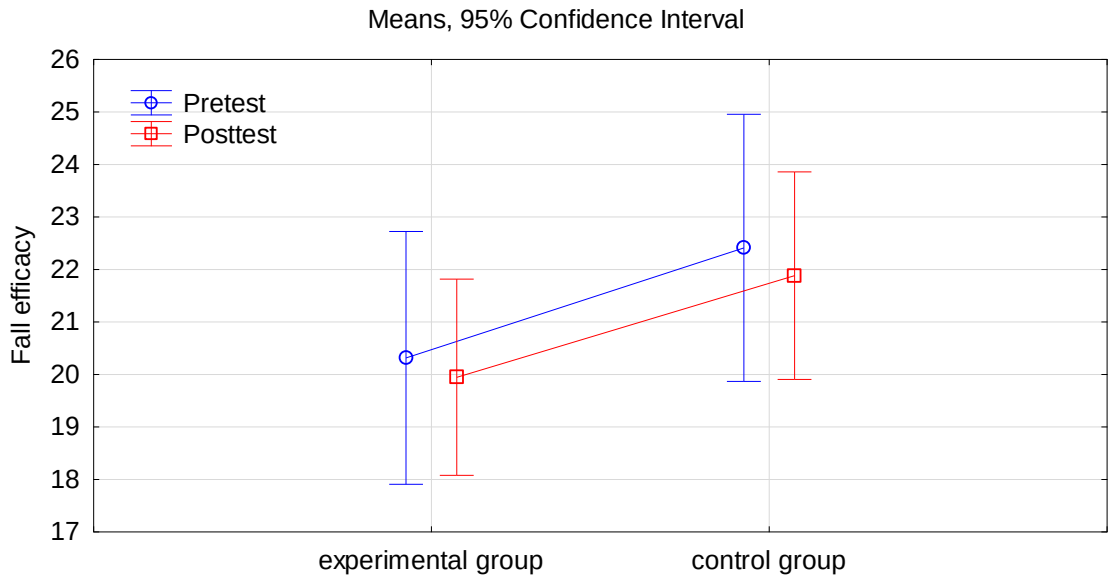
Variables	EG N = 32				CG N=31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
FESI	20,32	3,30	19,95	2,91	22,41	6,66	21,88	4,96
IADL	23,63	0,83	23,95	0,23	23,24	1,71	23,59	0,94

Table 14. Results of ANOVA (significant differences (p<0,05) are shown in bold.

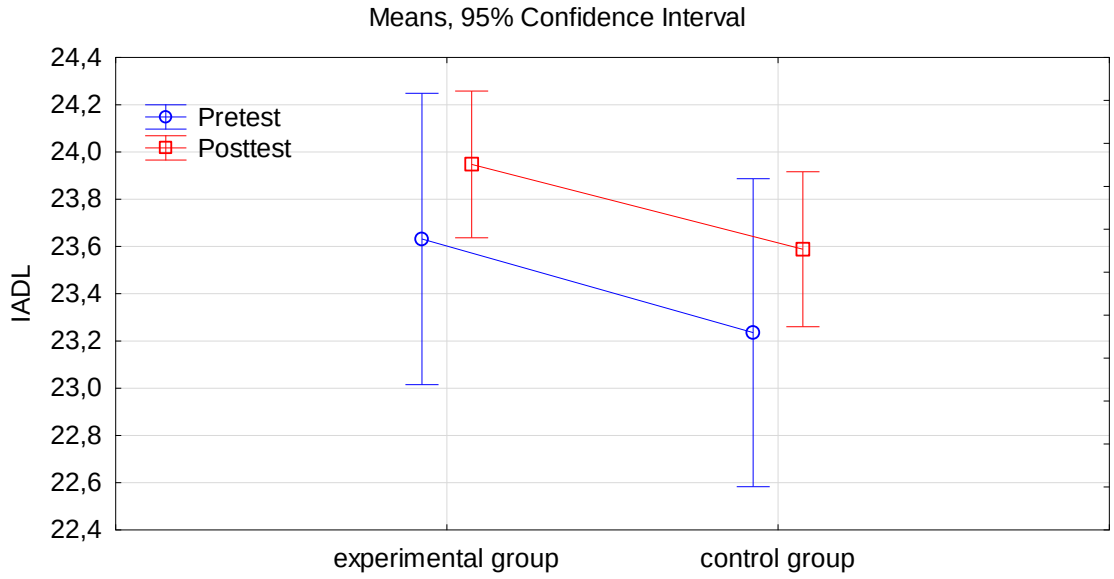
Variables	Main Effect					
	Group (EG vs CG)		Repeated measurement		Interaction effect	
	F	p	F	p	F	p
FESI	1,90	0,1771	0,83	0,3690	0,03	0,8713
IADL	1,44	0,2388	4,87	**0,0341**	0,02	0,9031

Table 15. LSD test probabilities for post-hoc tests; significant differences (p<0,05) are shown in bold.

Variables	LSD Test; Probabilities for post-hoc tests, p- values			
	Pretest – Posttest		EG vs CG	
	EG	CG	PRE	POST
FESI	0,5902	0,4650	0,1817	0,2169
IADL	0,1385	0,1180	0,2624	0,3093



Graph 16. Average scores of FESI in EG and CG before and after the experiment. The average scores pretest and posttest for both EG and CG decreased.



Graph 17. Average scores of IADL in EG and CG before and after the experiment. The average scores pretest and posttest for IADL for both EG and CG increased.

The study also examined how playing Bingocize® affects overall life satisfaction assessed using a shortened version of the WHOQL test. To capture the potentially different effects of the experiment on particular domains of life, separate ANOVA tests were conducted for all domains the mental health domain (WHOQL – D1), the psychological domain (WHOQL – D2), the social domain (WHOQL – D3), the environmental domain (WHOQL – D4) and two general questions: "How would you rate your quality of life?" (WHOQL – Q1) and "How satisfied are you with your health?"(WHOQL – Q2).

Table 16. Mean standard deviation of WHOQL domains and its specific subdomains and questions in EG and CG

Variables	EG N = 32				CG N = 31			
	Pretest		Posttest		Pretest		Posttest	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
WHOQL – D1	22,37	2,59	23,68	2,83	22,59	2,50	23,82	2,98
WHOQL – D2	21,26	2,42	22,63	2,85	20,29	2,05	21,82	2,19
WHOQL – D3	11,47	2,29	12,37	2,31	11,24	1,99	12,12	2,03
WHOQL – D4	27,63	3,58	28,47	3,08	29,06	4,51	29,94	4,46
WHOQL – Q1	3,68	0,48	4,11	0,57	3,82	0,81	3,94	0,66
WHOQL – Q2	3,47	0,96	3,89	0,88	3,47	0,80	3,76	0,83

Visible in Table. 16 differences were observed between the scores for individual domains – excluding WHOQL – Q2, to which the average response before the experiment was identical in both groups before and after the experiment proved to be statistically insignificant. However, all main effects of the experiment (repeated measures) turned out to be statistically significant, meaning that the main effect of playing Bingocize® (regardless of whether the game variant included additional physical exercise or not) had an impact on the test score.

As shown in Table 17, with regard to WHOQL test, ANOVA test revealed significant differences in the average scores achieved by the participants before and after the experiment of all measured items of quality of life.

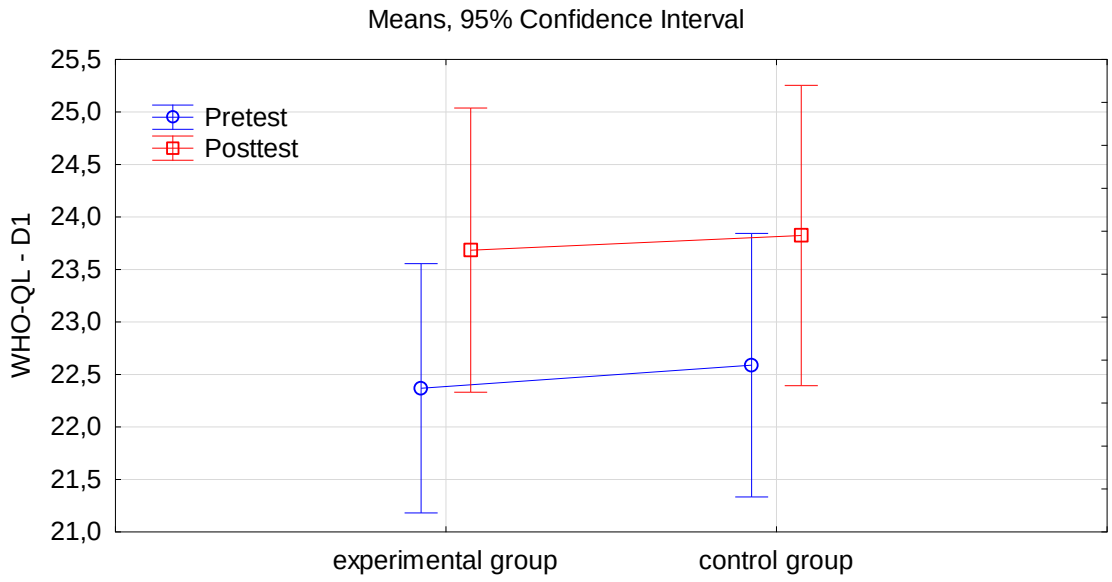
From Table 18. It can be inferred from the results of the post-hoc tests, statistically significant differences were found in the measurements in its four domains (WHOQL – D1, WHOQL – D4) in EG and CG. With regard to the WHOQL – Q1 and WHOQL – Q2 questions, significant differences were noted only in the EG.

Table 17. ANOVA results; significant differences (p<0,05) are shown in bold for WHOQL in EG and CG

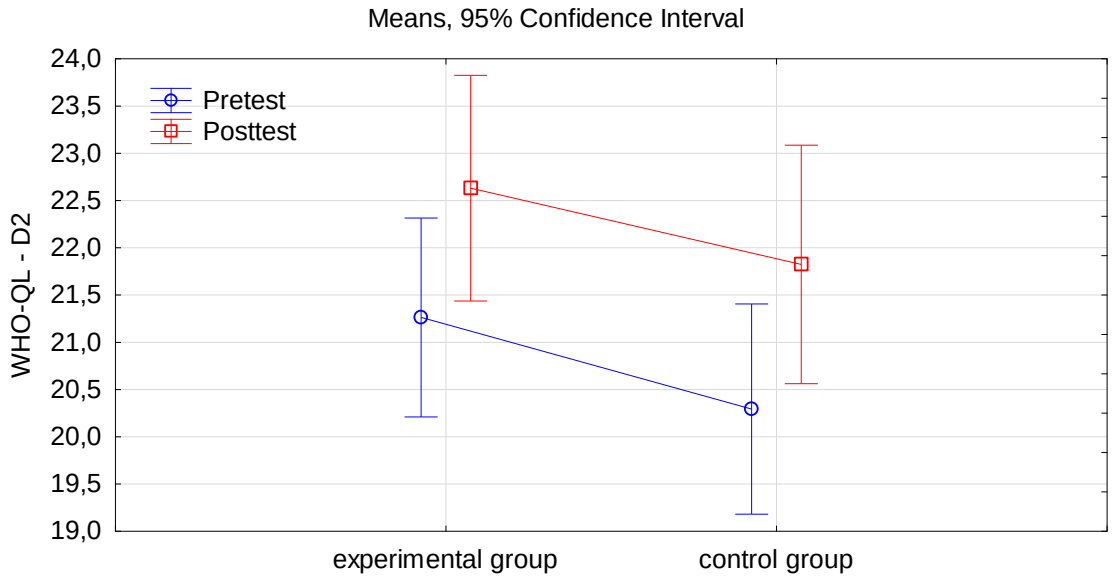
Variables	Main Effect					
	EG vs CG		Repeated measurement		Interaction effect	
	F	p	F	p	F	p
WHOQL – D1	0,04	0,8400	31,43	**0,0000**	0,03	0,8606
WHOQL – D2	1,28	0,2661	66,27	**0,0000**	0,21	0,6540
WHOQL – D3	0,12	0,7295	24,36	**0,0000**	0,00	0,9728
WHOQL – D4	1,27	0,2675	11,59	**0,0017**	0,01	0,9371
WHOQL – Q1	0,00	0,9496	10,54	**0,0026**	3,35	0,0762
WHOQL – Q2	0,06	0,8073	11,02	**0,0022**	0,35	0,5597

Table 18. Analysis of variance with replay measurements – LSD Test (Least Significant Differences); probabilities for post-hoc tests; significant differences (p<0,05) are shown in bold.

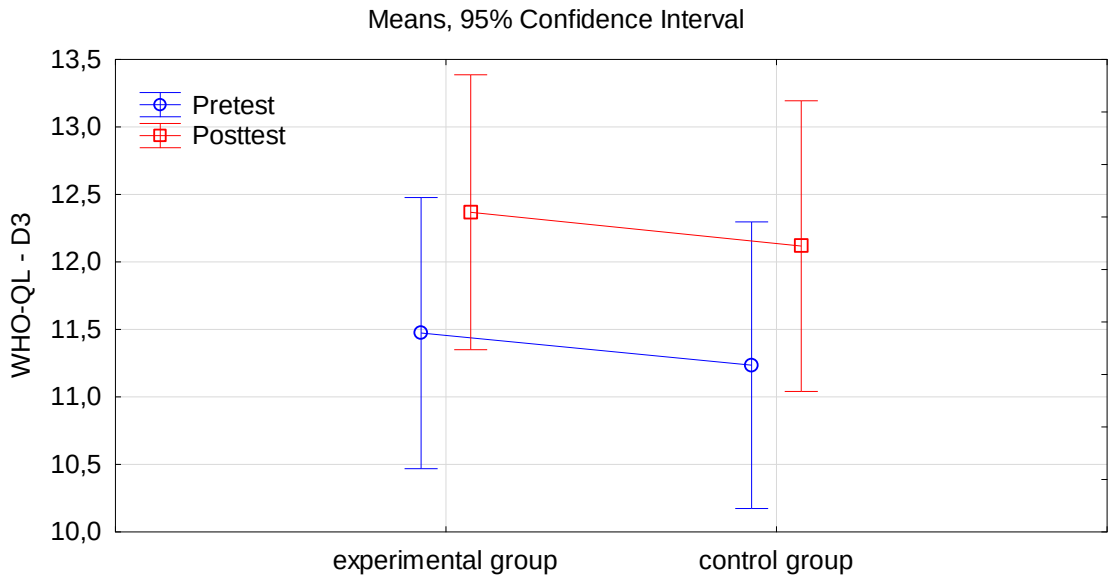
Variables	LSD Test; Probabilities for post-hoc tests, p- values			
	PRE – POST		EG – CG	
	EG	CG	PRE	POST
WHOQL – D1	**0,0002**	**0,0007**	0,8108	0,8793
WHOQL – D2	**0,0000**	**0,0000**	0,2367	0,3224
WHOQL – D3	**0,0010**	**0,0019**	0,7438	0,7310
WHOQL – D4	**0,0211**	**0,0221**	0,2826	0,2695
WHOQL – Q1	**0,0008**	0,3359	0,5135	0,4420
WHOQL – Q2	**0,0075**	0,0688	0,9916	0,6576



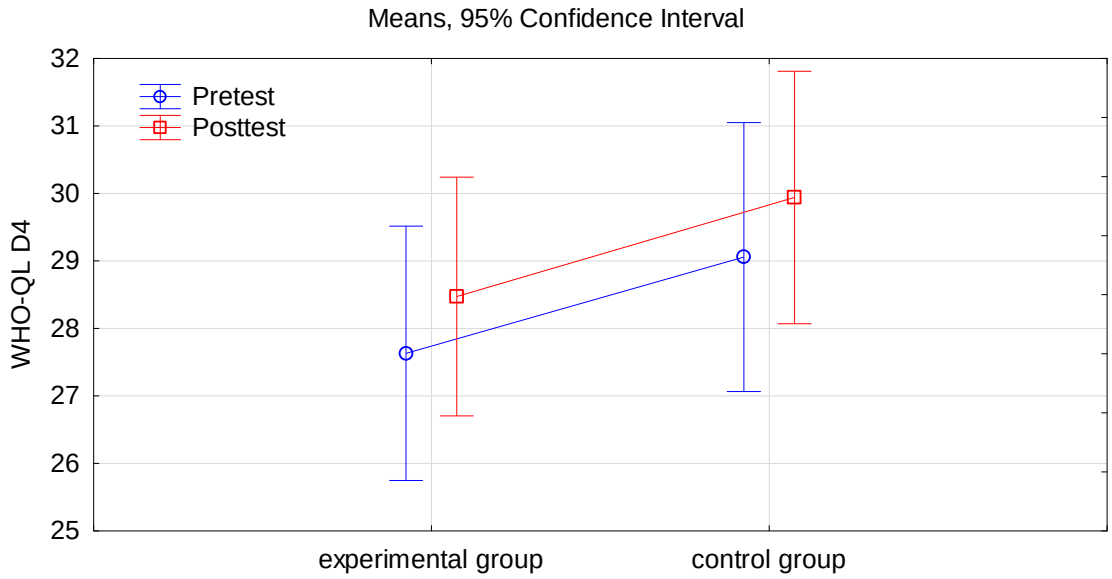
Graph 18. Average scores of WHOQL – D1 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – D1 for both EG and CG increased.



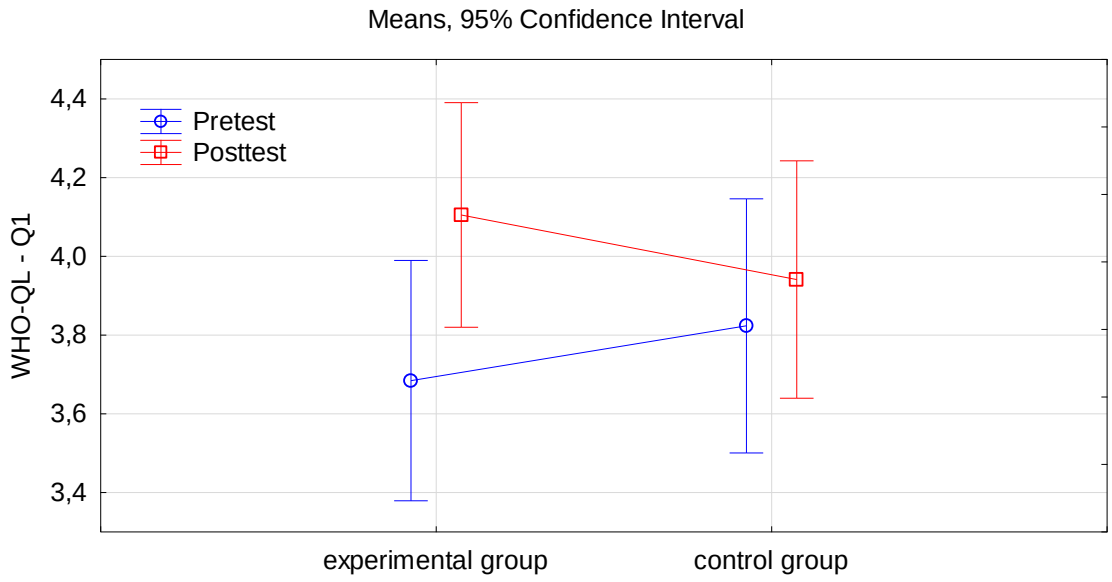
Graph 19. Average scores of WHOQL – D2 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – D2 for both EG and CG increased.



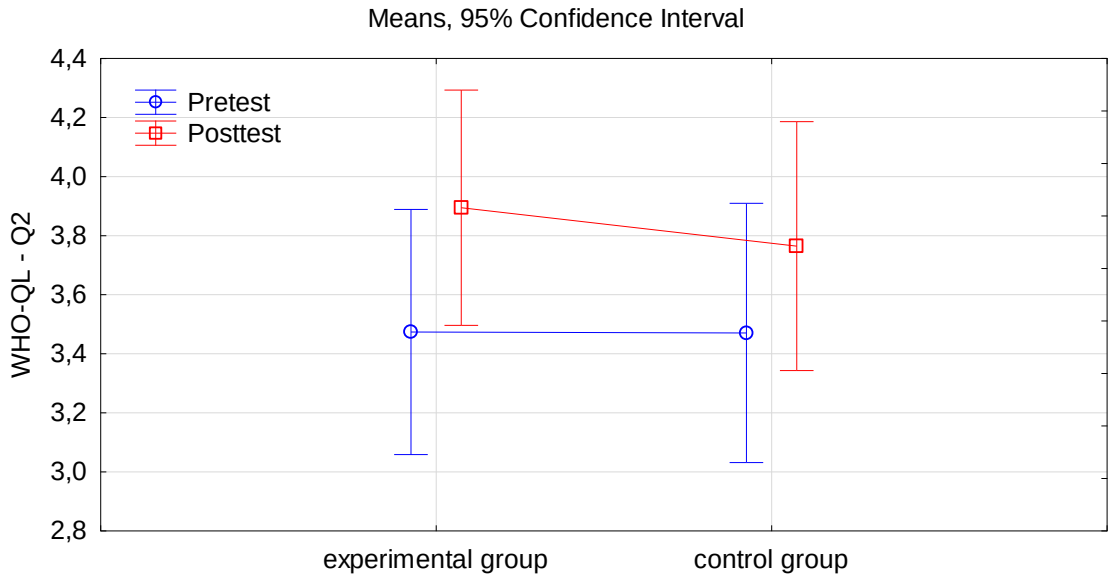
Graph 20. Average scores of WHOQL – D3 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – D3 for both EG and CG increased.



Graph 21. Average scores of WHOQL – D4 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – D4 for both EG and CG increased.



Graph 22. Average scores of WHOQL – Q1 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – Q1 for both EG and CG increased.



Graph 23. Average scores of WHOQL – Q2 in EG and CG before and after the experiment. The average scores pretest and posttest for WHOQL – Q2 for both EG and CG increased.

4.5 Analysis of correlations occurring between the level of cognitive functions, physical factors and quality of life in experimental and control groups (pretest vs posttest)

Relationships between variables reflecting cognitive functioning and showing the level of functional performance and the subjects' quality of life, both in the context of its individual domains, as well as health and overall sense of quality of life, are presented in tables 19–20. As can be seen the relationships between the included variables are sporadic, both in the study group and in the control group.

Table 19. Spearman's correlation pretest for EG and CG (significant coefficients are bold; p < 0,05)

Variable	EG pretest – WHO-QL						CG pretest – WHO-QL					
	D1	D2	D3	D4	Q1	Q2	D1	D2	D3	D4	Q1	Q2
Weight	0,13	-0,21	-0,28	-0,13	-0,32	-0,24	-0,01	-0,18	-0,15	0,00	0,29	0,28
BMI	0,03	0,18	0,03	0,28	0,04	0,18	0,16	-0,38	-0,30	-0,30	0,04	0,15
CTT 1	0,14	0,14	0,01	-0,24	0,32	0,05	0,09	-0,31	0,21	-0,08	0,23	-0,12
CTT 2	0,08	-0,02	0,00	-0,03	0,27	0,00	0,16	-0,43	0,13	0,01	-0,03	0,00
COWAT 1	-0,03	-0,19	-0,19	-0,20	-0,47	0,32	-0,12	-0,19	0,06	-0,15	0,12	-0,11
COWAT 2	-0,05	-0,01	0,02	0,09	-0,40	0,18	-0,12	0,12	-0,05	0,07	-0,01	0,21
COWAT 3	0,29	0,16	0,22	0,29	-0,28	0,20	-0,54	-0,07	-0,13	-0,09	-0,44	-0,31
MMSE	-0,29	-0,16	0,00	-0,21	0,24	-0,23	0,15	-0,15	-0,10	0,15	-0,32	0,07
Chair stand	0,03	-0,15	0,15	0,38	-0,03	0,38	-0,14	-0,14	0,04	-0,01	-0,15	0,10
8ft up and go	-0,18	-0,07	-0,28	-0,22	0,21	-0,14	0,32	0,60	0,42	0,24	0,10	-0,07
Arm Curl	0,00	-0,18	-0,36	0,31	-0,42	0,23	-0,23	-0,22	-0,24	-0,02	0,11	0,04
Back scratch	0,22	0,38	0,10	0,25	0,00	0,34	-0,19	-0,14	0,02	-0,07	-0,05	-0,11
Chair sit and reach	0,43	0,12	0,27	0,15	-0,06	0,29	0,20	-0,05	-0,32	0,16	-0,20	-0,03
Step Test	0,22	-0,02	0,34	0,33	0,05	0,32	-0,04	-0,49	-0,18	0,17	0,00	0,02

Spearman's correlations pretest for EG showed a medium association for WHOQL – Q1 and COWAT 1 with a score of -0,47. A medium association was also shown for WHOQL – D1 and FESI with a score of -0,48.

Spearman's correlation pretest for CG showed a large association between WHOQL – D1 and COWAT 3 with a score of -0,54. A large association can also be observed between WHOQL – D2 and 8FT up and go with a score of 0,60 for CG. A medium association between WHOQL – D2 and Step Test with a score of -0,49.

Table 20. Spearman's correlation posttest for EG and CG (significant coefficients are bold; p < 0,05)

Variable	EG posttest WHOQL						CG posttest WHOQL					
	D1	D2	D3	D4	Q1	Q2	D1	D2	D3	D4	Q1	Q2
Weight	-0,05	-0,15	-0,12	-0,21	-0,25	-0,02	0,03	-0,13	-0,21	0,09	0,29	0,24
BMI	0,06	0,12	0,04	0,21	0,45	0,34	0,03	-0,41	-0,54	-0,25	-0,09	-0,18
CTT 1	0,33	0,32	0,26	0,05	-0,01	0,12	0,12	0,01	0,10	-0,14	0,03	0,09
CTT 2	-0,10	0,16	0,08	0,15	0,04	-0,02	0,34	-0,07	-0,11	-0,12	-0,12	0,11
COWAT 1	-0,11	-0,50	-0,19	-0,14	0,21	0,26	-0,26	-0,25	-0,01	-0,14	-0,13	-0,04
COWAT 2	0,08	-0,24	0,09	-0,09	0,43	0,18	-0,24	0,00	-0,07	-0,14	-0,22	-0,09
COWAT 3	0,32	0,04	0,24	0,23	0,31	0,32	-0,46	-0,15	-0,01	-0,12	-0,45	-0,30
MMSE	-0,14	-0,09	0,04	0,19	0,00	-0,37	-0,09	0,17	-0,22	-0,13	-0,41	-0,21
Chair stand	-0,08	-0,19	0,24	0,17	-0,20	0,20	-0,03	-0,40	-0,18	0,20	0,07	0,11
8ft up and go	0,02	-0,01	-0,13	-0,16	-0,02	-0,06	0,39	0,69	0,48	0,19	0,16	0,25
Arm Curl	0,06	0,03	-0,24	0,00	-0,25	0,26	-0,12	-0,04	-0,12	0,11	0,14	0,05
Back scratch	0,23	0,16	0,10	0,26	0,50	0,25	-0,33	-0,44	-0,11	-0,17	-0,35	-0,25
Chair sit and reach	0,03	-0,48	0,01	0,09	0,11	0,13	0,17	-0,14	-0,27	0,23	-0,07	-0,12
Step Test	0,20	-0,15	0,13	0,13	-0,01	0,00	-0,14	-0,59	-0,27	0,16	-0,16	-0,21

For EG posttest there was a high association between WHOQL – D2 and COWAT 1 with a score of -0,50. EG posttest results also showed a moderate association between WHOQL – D2 and Chair sit and reach where the Spearman's correlation coefficient is -0,48. Lastly for EG a score of 0,50 was produced for WHOQL – Q1 and Back scratch which indicates a high association.

Spearman's correlation in CG for posttest showed a high association for WHOQL – D3 and BMI with a result of -0,54. In CG there was also a high association between WHOQL – D2 and Arm Curl and Step Test, the scores produced were 0,69 and -0,59 respectively.

Table 21. presents correlations between cognitive functioning and functional performance and the level of IADL and FESI. It can be observed that there are more often occurring associations between IADL and cognitive functioning and physical performance then was shown before. The associations between FESI and cognitive function and physical performance have a higher occurrence as well.

Table 21. Spearman's correlation pre and posttest for CG and EG (significant coefficients are bold) $p < 0,05$

Variable	IADL				FESI			
	Pretest		Posttest		Pretest		Posttest	
	EG	CG	EG	CG	EG	CG	EG	CG
Weight	0,03	0,28	0,30	0,40	-0,39	-0,44	-0,19	-0,33
BMI	0,33	0,14	0,22	0,10	-0,10	-0,10	-0,14	-0,21
CTT 1	0,00	0,03	0,34	0,33	0,10	-0,27	0,01	-0,29
CTT 2	0,03	0,07	0,26	0,15	0,00	-0,08	0,18	0,00
COWAT 1	0,01	0,53	0,13	0,58	-0,23	-0,01	-0,16	-0,15
COWAT 2	0,00	0,64	-0,06	0,51	-0,18	-0,62	-0,12	-0,72
COWAT 3	0,16	0,45	-0,02	0,51	-0,41	-0,33	-0,35	-0,25
MMSE	-0,21	-0,31	-0,45	-0,34	0,38	0,24	0,60	0,08
Chair stand	0,29	0,57	-0,24	0,48	-0,33	-0,50	0,07	-0,53
8ft up and go	-0,21	-0,47	-0,13	-0,51	0,53	0,41	0,40	0,44
Arm Curl	0,48	0,56	0,35	0,44	-0,39	-0,53	-0,37	-0,61
Back scratch	-0,18	0,50	-0,02	0,66	-0,15	-0,22	-0,16	-0,28
Chair sit and reach	-0,28	0,34	-0,30	0,55	-0,27	-0,48	0,03	-0,52
Step Test	0,00	0,40	-0,30	0,62	-0,59	-0,44	-0,31	-0,30

Spearman's correlation for the EG pretest showed there was a high association found between FESI and 8ft up and go (0,53), and Step Test (-0,59). The EG posttest showed a high association between FESI and MMSE where $\rho = 0,60$ Spearman's correlation showed a high association for CG pretest between FESI and COWAT 2 (-0,62), IADL (-0,53), Chair stand (-0,50), and Arm Curl (-0,53). For CG posttest a high association was found COWAT 2 (-0,72), Chair stand (-0,53), Arm Curl (-0,61), and Chair sit and reach (-0,52). No significant correlations were found for EG posttest.

Spearman's correlation also showed a high association for CG between IADL and COWAT 1 (0,53), COWAT 2 (0,64), Chair stand (0,57), Arm Curl (0,56), and Back scratch (0,50). A high association is shown posttest for CG between IADL and COWAT 1 (0,58), COWAT 2 (0,51), COWAT 3 (0,51), 8ft up and go (0,51), Back scratch (0,66), Chair sit and reach (0,55), and Step Test (0,62). A medium association between IADL and Chair stand is observed for CG in posttest where $\rho = 0,48$. In the EG for pretest there is a moderate association seen between IADL and Arm Curl (0,48).

5. Discussion

Considering the current situation with population aging in Poland and the low percentage 25,1% of Polish older adults (age 65+) being physically active (GUS 2021) and cognitive decline in 68,4% (Karczewska et al. 2019) is cause for concern. In the years 1990–2019 in Poland, the average life expectancy for women increased by 6,5 years and for men by 7,8 years, demographic forecasts predict the continuation of this process (GUS 2021). Women's life expectancy in 2030 is approximately 84,0 years, and men at 77,3 years; however, a long life does not necessarily mean a healthy life (GUS, 2021). Regular physical activity in older people has a number of health benefits, such as reducing the risk of cardiovascular disease, functional limitations, cognitive impairment, and improving wellbeing and mental state (Chodzko-Zajko et al. 2009; Paterson et al. 2010).

Low levels of physical activity are one of the major risk factors for mortality from non--communicable causes worldwide (Haileamlak 2019; Katzmarzyk et al. 2022; Romanowska et al. 2022). With an increase in physical activity, we have the possibility of seeing a healthier, longer living aging population; physical activity helps reduce obesity, cardiovascular problems, issues with blood pressure, and sleep quality (WHO 2022). As mentioned before physical activity also improves cognition and improves brain health (CDC 2023). There are long-term negative effects from a sedentary life resulting in poor overall poor quality of life (Romanowska et al. 2022). A lack of social engagement and physical activity are major contributors to residents continued decline in functional status, activities of daily living and increased fall risk in long-term care (Dipietro et al., 2019).

The purpose of this study was to investigate whether or not a 12 week Bingocize® intervention program would benefit aging Polish adults to increase physical activity, improve cognition and quality of life. Bingocize® is a multifactorial program incorporating exercise, health questions and social engagement that has been implemented in 35 U.S states (Shake et al. 2021). Bingocize® a evidenced based program, has been used in nursing homes and community centers to assist with increasing physical activity, improving cognition among aging adults, and increasing social engagement (Crandall et al. 2015). The role of exercise and social engagement promote brain health and may slow the decline of cognition among aging adults as has been published by Chen et al. (2019) and Livingston et al. (2017). Bingocize® is approved as an obesity treatment and

prevention program by the United States Department of Agriculture and the United States (U.S.) National Council on Aging as an evidence-based falls prevention program (Shake et al. 2021).

The 12-week intervention program with Bingocize® showed there was not a significant difference (pretest vs. posttest and CG and EG) observed in body weight and BMI ($p<0,05$). Even though there was a small decrease in weight in the EG and a slight increase in the CG it was proved to not be of significant value. The results observed may have been due to the fact that there was no dietary plan in place or monitoring this may have been a contributing factor to why there was not a change in weight or BMI observed. In addition, the number of participants could have also played a role in the lack of change observed.

Blundell et al. (2015), suggested that there is considerable individual variability with regard to exercise and appetite/food intake. Influences on intake include fat and fat-free mass, resting metabolic rate, and hormonal responses, which vary from person to person, making the individual response to exercise and weight loss difficult to predict. Caudwell et al. (2015) agreed with this notion and explained that there seemed to be a large difference in individual responses to physical activity. Nonresponders to weight loss strategies demonstrated a much greater degree of hunger and subsequent food intake, which was sufficient in quantity to explain the weight differences (Caudwell et al. 2015).

Similar results were observed when a multimodal intervention was used in the following review: Weight Loss Interventions in Older Adults with Obesity: A Systematic Review of Randomized Controlled Trials Since 2005 by Batsis et al. (2016) examined 19 studies. The duration of the programs ranged from 6 to 18 months (n=405 participants, age range 66,7–71,1). The weight loss in the intervention groups ranged from 0,5 to 10,7 kg (0,1–9,3%). Five of these studies had a resistance exercise program accompanied with a dietary component. Of these groups, greater weight loss was observed in groups with a dietary component than those with exercise alone. Exercise alone led to a better overall physical function then the baseline established but no significant weight loss was observed. Also, in a pilot study by Crandall et al. (2015), physically inactive older adults attended twice weekly sessions at a community senior center for 10 weeks for 45–60 minute sessions; 18 women, M age = 75,1 (8,63) years. Pre and post body weight, body mass index, and functional performance were measured. Functional performance was assessed

using the Senior Fitness Test battery. Using paired-sample t-tests, significant improvements were found in all functional performance measures, but not in weight or BMI ($p < 0,05$).

The results of the Senior Fitness Test turned out to be all significant for the EG, this can be observed in Table 12. The average number of repetitions in chair-stand, arm curl, step test, and 8ft up and go exercises performed by the participants, significant overall differences could be observed between the EG and CG. Significant overall differences between measurements at the beginning and end of the experiment could be observed for all types of exercise for EG. For the step test, chair stand, and arm curl the average number of repetitions for the EG turned out to be significantly higher than for the CG even though average results increased for both groups. The main effect for the chair sit and reach turned out to be significant, participants were able to reach further in both groups but they were able to reach on average much further in the CG. In the 8ft up and go exercise and back scratch exercise there was a significant improvement in the EG seen but not seen in the CG refer to Table 12.

Findings of significance have also been found in other such studies when an exercise program is implemented in one group and compared to one that does not receive the intervention. A particular study by Seco et al. (2013) used a unimodular intervention. The length of the study was a 9-month training program with over 200 older adults, Seco et al. (2013), found improvements in flexibility which may prevent skeletal muscle disorders and improve mobility. Significant improvements in strength ($p < 0,0001$), flexibility ($p < 0,0001$), heart rate after exercise ($p < 0,0001$), and balance ($p < 0,0001$) were observed at the end of the training program. Flexibility and balance ($p < 0,0001$) improvements were maintained at the end of the detraining.

In the study by Song et al. (2012) there were combined exercise training and self--management education in community-dwelling diabetic older adults. Triglycerides, weight, body BMI, and diabetes self-management behavior showed significant differences compared with wait--listed controls who continued their usual activities. Furthermore, Pahor et al. (2014) compared the effects of long-term exercise versus health education alone. They compared two groups of older adults: one that participated in a long-term exercise program and one that participated in a health education only program. The exercise program significantly reduced major mobility disability over 2,6 years when compared with the health education program alone.

Also in the study: The effects of Bingocize® on physical fitness and executive function with older adults in England (Middleton et al. 2021), aging adults would meet twice weekly for 10 weeks. This project's aim was to examine the effects of Bingocize® on English older adults' physical fitness and executive function. The major finding was the reduction in repeated chair sit--to-stand test time and the 3m walk. For walking speed, there was a 7,5% improvement and for sit-to-stand 24,3% improvement in scores. Further research by Crandall et al. (2015) Bingocize® which was administered to older adults, 18 women, M age = 75,1 (8,63) years, and participated 2 days per week (45–60 minute sessions) for 10 weeks. Pre and post body weight, BMI, and functional performance were measured. Functional performance was assessed using the Senior Fitness Test battery. Using paired-sample t-tests, significant improvements were found in all functional performance measures, but not in weight or BMI ($p < 0,05$). Which is comparable to this study's findings as BW and BMI did not change but all SFT scores improved.

The interesting part of our findings in SFT scores for Polish aging adults is that there were improvements seen not only for the EG but for the CG as well, that were of significance. While the increase in average scores for the CG was not as high as the EG the results were still significant for three parts of the test. The scores did not improve for CG for the following: chair sit and reach, 8ft up and go, and back scratch. In the CG there was not seen an improvement in these exercises due to the fact that these particular activities may require additional training to see a significant improvement.

It was observed that participants formed friendships in both groups and they were seen having friendly competition with one another during in the game. This may have been the case for the SFT score improvement also, they too were competing with one another. Volunteers mentioned they would overhear certain participants comparing scores and making banter over the test results.

Participants were tested for independence (which is one of the indicators for quality of life) before and after the 12-week period of playing Bingocize® Two tests were used to measure independence: Fall Efficacy Scale International and Lawton and Brody Test Instrumental Activities of Daily Living Scale. There were differences observed between the EG and CG but these turned out to be insignificant (see Table 15).

Minimal levels of muscular strength and balance are necessary for older adults to remain mobile, capable of performing activities of daily living, and to reduce fall risk (Freiberger et al.

2012). Freiberger et al. (2012) compared three multicomponent exercise interventions over the course of 16 weeks and found a combination of strength, balance, and endurance training improved functional performance for up to 24 months. However, these findings did not translate to improved fall-related psychological outcomes or reduced incidence of falls. This demonstrates the need for a different approach.

The test results for the independence questionnaires for both CG and EG left little room for improvement of the test scores. The participants in our study were high functioning without limitations. This assessment tool developed a baseline for our participants. Our participants proved to be confident and independent based on test results. The assessment tools measured no significant differences therefore our participants remained at their baseline meaning no negative changes occurred over the course of the intervention program.

For cognitive function, the CTT was administered. In both the EG and CG, playing Bingocize® for 12 weeks resulted in a slight decrease in the average CTT 1 and CTT 2 scores which are statistically significant as shown in Table 6. Meaning that the test took less time to complete which was the goal here. In addition, the Controlled Oral Word Association Test (letters F, A, and S), was administered for cognitive function. It was observed that there was an increase in the average COWAT 1, COWAT 2, and COWAT 3. This means that there was an increase in ability to produce a number of words in a given time associated with a letter or category that was provided by the test administrator. Table 6 also shows all three parts of the COWAT test came out to be statistically significant in both EG and CG.

Another measure for cognitive function was the MMSE. This assessment tool between the EG and CG and before and after the experiment turned out to be insignificant. Lastly, the Lifetime Cognitive Abilities Test was used where we observed the LC – cur test measurement score (both before and after the experiment) in EG was higher than the corresponding score in the CG. The average scores pretest and posttest for LC-all (which accounts for all responses at all ages up until the present moment) for both EG and CG increased (which can be observed on Graph 8 and 9).

The results presented are evidence that engaging in a multimodal or unimodal game--centered health promoting activity can lead to higher levels of mental health activation in Polish aging adults. There is convincing evidence that health promotion programs (e.g., exercise programs geared toward older adults) can help older adults better manage their chronic conditions by

improving health activation (Conn et al. 2003). Health activation is defined as the knowledge, skill, and confidence in managing aspects of their own healthcare (Biedenweg et al. 2014).

Participation in just bingo alone has been found to increase socialization and some aspects of cognitive performance in older adults with Parkinson's and Alzheimer's diseases (Sobel, 2001). It is important because studies have reported that increases in health activation predict decreases in hospitalization and increases in medication adherence (Greene et al., 2015).

In the study: The effects of Bingocize® on physical fitness and executive function with older adults in England (Middleton et al. 2021), aging adults would meet twice weekly for 10 weeks. The multifactorial intervention program, Bingocize® led to small but significant cognitive improvement demonstrated by the tests of executive function.

Park et al. (2011) administered an integrated exercise and health education program for older adults with hypertension. Exercise self-efficacy, social functioning, and systolic blood pressure were all significantly improved compared to those of the waitlisted group.

Other recent intervention studies have demonstrated that cognitive function and brain integrity can be maintained, or even improved, through increasing the frequency and duration of moderate to vigorous exercise (Erickson et al. 2011). In a randomized controlled trial with 120 older adults, it was shown that aerobic exercise training increases the size of the anterior hippocampus, leading to improvements in spatial memory. Exercise training increased hippocampal volume by 2%, effectively reversing age-related loss in volume by 1 to 2 years according to Erickson et al. (2011).

The results showed a significant improvement in both EG and CG for cognitive areas (aside from the MMSE). There could be several reasons for this being the case. Bingocize® is a fun interactive game that in itself is stimulating. The individuals playing the game were also learning something new facts each time they played in the EG and CG as they were both given health questions to answer. The CG was given more health questions as the EG had exercises alternating with the health questions. The benefits gained from the exercises for improvement in cognition may not have been enough to outweigh the benefits from the additional health questions. In addition, most of the participants never even heard of bingo, had never used a tablet before, or the internet, these are all factors that could influence cognition. Scientists have discovered that taking up several new tasks at the same time boosts mental power and protects people against Alzheimer's

disease (Studer-Luethi et al. 2022; Miyamoto et al. 2018). These skills range from studying new languages, using an iPad, writing music to painting; any new learned information repeated to be memorized has a positive effect on the brain. Though there was an increase in EG and CG this may be why there was not any observed between group differences for pre and post-testing.

For WHOQL significant differences were observed in the average scores achieved by the participants before and after the experiment of all measured items, domains, and total score as seen in Table 18. The WHOQL – Q1 and WHOQL – Q2 questions, significant differences were noted only in the EG (see Table 18). These significant findings may have been observed due to the EG group perceiving the intervention with the physical activity component as being more beneficial. It shows promise that Bingocize® can indeed improve one's perception of quality of life and their health in the present moment.

These results are consistent with other investigations that have found older adults are more likely to participate in exercise programs that are enjoyable and allow for social support. Bingocize® has shown there is an increase in social engagement through program participation which is an indicator of quality of life (Crandall et al. 2015). Crandall et al. (2019) have found the Bingocize® adherence rate to be 93–95% on average. This allows us to believe that the game itself is considered to be fun and engaging as compared to other health intervention programs. The adherence rate of health intervention programs were found to be approximately 73% (McPhate 2013) and Osho et al. (2017) reported the average adherence rate to be as low as 66%.

Still, there is a strong need for scientifically well-designed programs which compare and contrast the benefits of multimodal health promotion programs versus single-domain interventions. However, there are encouraging signs that the software-based application of Bingocize® is adaptable to the older adult population in Poland. Through the study, it was shown to have positive physical fitness outcomes in the EG and CG, positive cognitive effects for both EG and CG, and positive outcomes for certain aspects of quality of life. This trial of Bingocize® has shown to be promising for further research as evidenced by the results.

The study in Poland was comparatively more difficult to implement as the game Bingo itself is not well or if at all known. There was a portion of time prior to the studies dedicated to educating the elderly not only on how to play the game (Bingocize® but also how to use a tablet. The cultural

difference here was something that was to be overcome but was well received. This could continue to be a potential barrier in the ease of implementing such a program in the Polish community.

The study had its limitations due to sample size. There needs to be a larger sample size in order to provide a larger statistical report. The larger sample size and results would be able to more closely approximate the population and reduce interference.

Even with the EG and CG being randomized all but one member of the age 80+ made it into the CG, it resulted in the CG's average of participants being significantly older than the EG. This could have significant influences on the assessing pre and post-tests. To help reduce the chance of this reoccurring the sample size must be larger.

Questionnaires utilized in the study are well known and used worldwide. However, they have answers that are self-reported and one may not provide the most accurate of information; there may be an over estimation or under estimation of the reported task ability. There may also not be enough information provided to detect smaller changes in functional ability (Gallo et al. 2006).

In the game Bingocize® the questions that were asked may have not been cognitively stimulating for the participants. The questions were created originally with the game being used in the United States so there also could be cultural bias as the questions were created for Americans. While some of the questions were adapted with statistics involving aging Polish adults the questions may have not been advanced enough. There were comments made at the end when gathering a survey of what the participants enjoyed and what they did not enjoy and there were 5 comments in regard to the questions being too easy. One of the individuals involved in the study specifically said "I thought the questions were much too easy, so much so I even felt offended."

6. Conclusions

This research aimed to identify the results of application of Bingocize® concerning cognitive function, physical fitness, and quality of life in the aging population. Randomized EG and CG met for 12 weeks where the intervention took place twice a week for 60 minutes. The EG in addition to the Bingocize® game had physical exercises to complete during the game itself.

The conducted research and detailed analysis of the obtained results made it possible to draw the following conclusions:

1. In regard to the cognitive area significant differences were found for attention, verbal, fluency and cognitive activities in both groups. It can be concluded that playing Bingocize® can be used to improve cognition in the aging population.

2. Significant overall differences could be observed in the EG in all components of physical fitness. The CG group significant differences were only seen in three components, which are directly related to the activities one would perform on a daily basis. Therefore, it can be concluded that Bingocize® can be used to improve physical fitness in the aging population.

3. In the EG and CG significant differences were seen after the intervention in all domains, in addition EG saw a significant difference in perceived physical health and quality of life. This suggests that in order to improve physical health and quality of life of older adults the key factor is the physical activity component.

4. The relationships between cognitive variables, physical fitness, and quality of life are irregular. It appears that there are factors than the one's considered in this study (cognitive and physical functioning) that are important for the subjects' quality of life. It is crucial for further research to identify other factors that would play a key role in enhancing the quality of life of seniors.

Abstract

The number of people aged 60 or older will rise from 900 million to 2 billion between 2015 and 2050 (moving from 12% to 22% of the global population) (WHO 2018). Recent gerontological studies indicate, health and social care services required by disabled older persons will be a growing burden and a major societal concern for the next century (Stuck et al. 1999). An intervention plan in response to this situation is to devise and implement strategies for preventing or delaying the onset or decline in cognition, physical health, and quality of life for aging adults.

Bingocize® was created as an intervention to not only attract older individuals but to retain their attention by utilizing a fun, interactive game to allow for the exercise of the body and mind. Bingocize® is an evidence-based intervention that may be used as preventative care for the older population to help with onsets of negative symptoms associated with aging. Using community--based group exercise programs which incorporate motivators, such as social support, has been shown to be one approach to increase physical activity levels and adherence for older people (Hernandes et al., 2013). Bingocize® includes all three key components: exercise of mind and body in a social environment. Previous research conducted in the United States by Dr. Crandall et al., (2014) shows that there was significant improvement in cognitive and physical health after the intervention program. The aim of this study was to determine whether the 12 weeks of Bingocize® intervention will be effective in showing significant differences pre and post-intervention in Poland for cognition, physical fitness, and quality of life.

The study included 63 elderly people, who were randomly divided into two groups – test and control. They participated for 12 weeks in an intervention program that included health education (control group) and health education and exercise (experimental group) using Bingocize. The pre- and post-tests assessed changes in cognitive functioning, physical fitness and quality of life.

In conclusion it was found that playing Bingocize® can be used to improve cognition in the aging population. In addition, there were significant overall differences observed in the experimental group in all components of physical fitness therefore it can be concluded that Bingocize® can be used to improve physical fitness. In both groups there were significant differences seen after the intervention in all domains for quality of life. The experimental group saw added benefits in that they perceived physical health and quality of life to improve also. This

suggests that in order to improve physical health and quality of life of older adults the key factor is the physical activity component. Lastly, it appears that factors other than cognitive and motor functions are important for the subjects' quality of life. It is crucial for further research to identify other factors that would play a key role in enhancing the quality of life of seniors.
Keywords: older adults, quality of life, cognitive functions, social game, intervention

Streszczenie

Liczba osób w wieku 60 lat lub starszych wzrośnie z 900 milionów do 2 miliardów w latach 2015–2050 (z 12% do 22% światowej populacji) (WHO, 2018). Badania gerontologiczne wskazują, że usługi opieki zdrowotnej i społecznej wymagane przez niepełnosprawne osoby starsze będą coraz większym obciążeniem i głównym problemem społecznym w następnym stuleciu (Stuck i in., 1999). Plan interwencji w odpowiedzi na tę sytuację polega na opracowaniu i wdrożeniu strategii zapobiegania lub opóźniania wystąpienia lub pogorszenia funkcji poznawczych, zdrowia fizycznego i jakości życia starzejących się dorosłych.

Bingocize® został stworzony jako interwencja mająca na celu nie tylko przyciągnięcie starszych osób, ale także utrzymanie ich uwagi poprzez wykorzystanie zabawnej, interaktywnej gry, która pozwala na ćwiczenie ciała i umysłu. Bingocize® to oparta na dowodach interwencja, która może być stosowana jako opieka profilaktyczna dla starszej populacji, aby pomóc w wystąpieniu negatywnych objawów związanych ze starzeniem się. Wykazano, że korzystanie z grupowych programów ćwiczeń opartych na społeczności, które zawierają motywatory, takie jak wsparcie społeczne, jest jednym z podejść do zwiększenia poziomu aktywności fizycznej i przestrzegania zaleceń przez osoby starsze (Hernandes i in., 2013). Bingocize® obejmuje wszystkie trzy kluczowe elementy: ćwiczenia umysłu i ciała w środowisku społecznym. Wcześniejsze badania przeprowadzone w Stanach Zjednoczonych przez dr Crandall i in. (2014) wykazały, że po programie interwencyjnym nastąpiła znaczna poprawa zdrowia poznawczego i fizycznego. Celem niniejszego badania jest ustalenie, czy 12-tygodniowa interwencja Bingocize® będzie skuteczna w wykazywaniu znaczących różnic przed i po interwencji w Polsce w zakresie funkcji poznawczych, sprawności fizycznej i jakości życia.

W badaniach wzięły udział 63 osoby starsze, które podzielono randomizacyjnie na dwie grupy badaną i kontrolną. Uczestniczyli oni przez 12 tygodni w programie interwencyjnym w którym prowadzona była edukacja zdrowotna (grupa kontrolna) oraz edukacja zdrowotna i ćwiczenia fizyczne (grupa eksperymentalna) z wykorzystaniem Bingocize. W badaniach pre i post oceniono zmiany w poziomie funkcjonowania poznawczego, sprawności fizycznej oraz jakości życia.

Podsumowując, stwierdzono, że gra w Bingocize® może być wykorzystywana do poprawy funkcji poznawczych w starzejącej się populacji. Ponadto w grupie eksperymentalnej

zaobserwowano znaczące ogólne różnice we wszystkich komponentach sprawności fizycznej, dlatego można stwierdzić, że Bingocize® może być stosowany do poprawy sprawności fizycznej. W obu grupach zaobserwowano znaczące różnice po interwencji we wszystkich domenach jakości życia. W grupie eksperymentalnej zaobserwowano dodatkowe korzyści w postaci poprawy zdrowia fizycznego i jakości życia. Sugeruje to, że w celu poprawy zdrowia fizycznego i jakości życia osób starszych kluczowym czynnikiem jest aktywność fizyczna. Wreszcie, wydaje się, że czynniki inne niż funkcje poznawcze i motoryczne są ważne dla jakości życia badanych. Kluczowe dla dalszych badań jest zidentyfikowanie innych czynników, które odgrywałyby kluczową rolę w poprawie jakości życia seniorów.

Słowa kluczowe: osoby starsze, jakość życia, funkcje poznawcze, gra towarzyska, program interwencyjny

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9. Appendices

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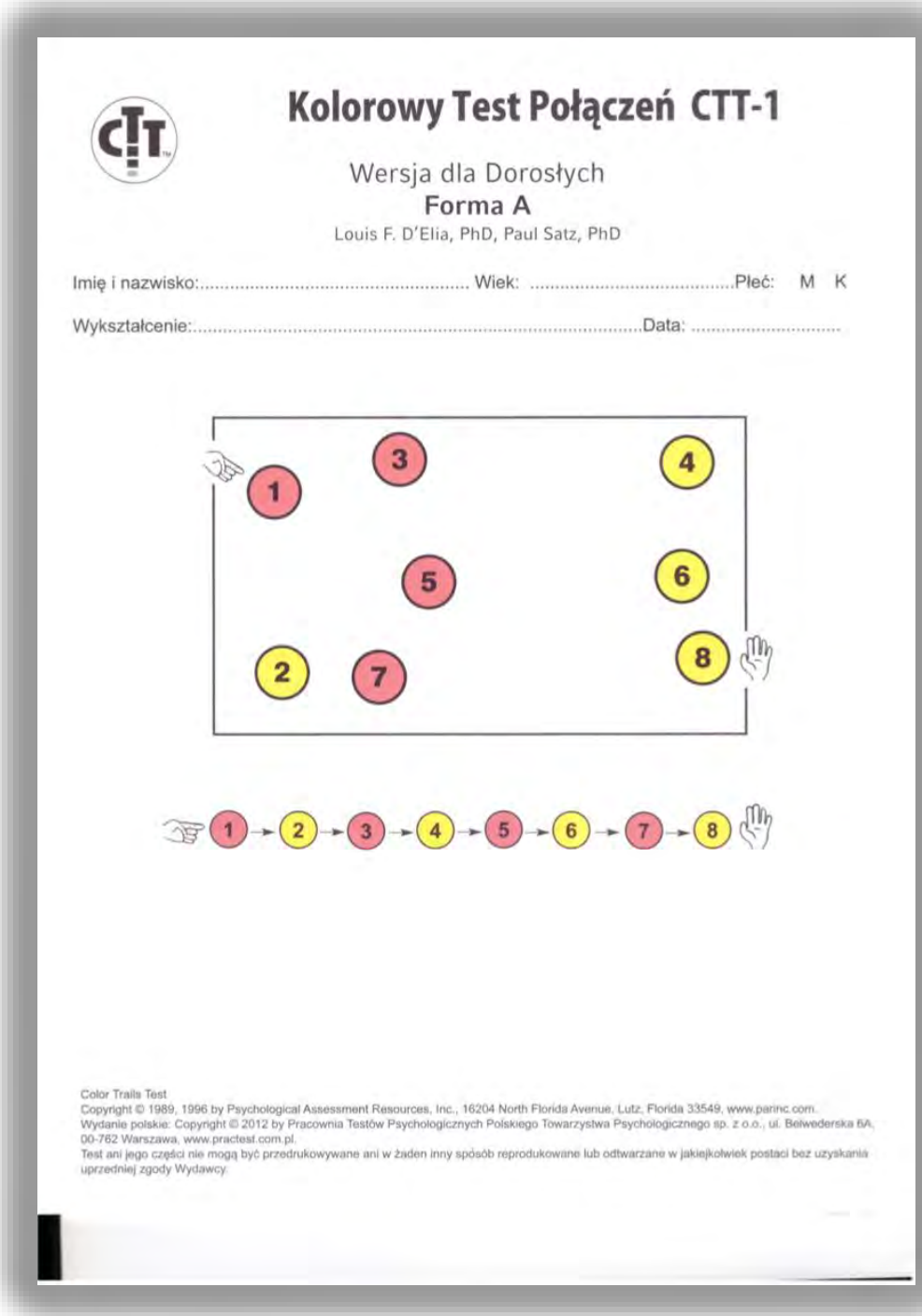
Color Trials Test



Kolorowy Test Połączeń CTT-1

Wersja dla Dorosłych

Forma A

Louis F. D'Elia, PhD, Paul Satz, PhD

Imię i nazwisko:..... Wiek: .....Płeć: M K

Wykształcenie:.....Data: .....

Kolorowy Test Połączeń CTT-2

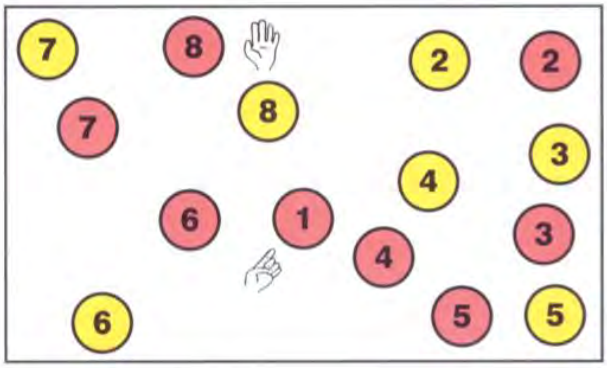
Wersja dla Dorosłych

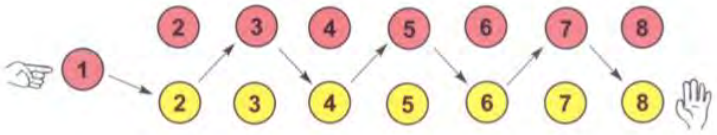
Forma A

Louis F. D'Elia, PhD, Paul Satz, PhD

Imię i nazwisko:..... Wiek: .....Płeć: M K

Wykształcenie:.....Data: .....





MMSE

Krótka skala oceny stanu psychicznego
Mini-Mental State Examination (MMSE)
Arkusz odpowiedzi

1. Orientacja w czasie i miejscu

Orientacja w czasie

Jaki jest teraz rok? ☐
Jaka jest teraz pora roku? ☐
Jaki jest teraz miesiąc? ☐
Jaka jest dzisiejsza data (którego dzisiaj mamy?) ☐
Jaki jest dzisiaj dzień tygodnia? ☐

Orientacja w miejscu

W jakim kraju się znajdujemy? ☐
W jakim województwie się znajdujemy? ☐
W jakim mieście się teraz znajdujemy? ☐
Jak nazywa się miejsce, w którym się teraz znajdujemy? ☐
Na którym piętrze się obecnie znajdujemy? ☐

2. Zapamiętywanie

Wymienię teraz trzy słowa. Kiedy skończę, proszę, aby je Pan/Pani powtórzył(a). *Poniższe słowa wypowiadamy wolno i wyraźnie (jedno słowo na sekundę).*

byk ☐ mur ☐ las ☐ ☐

Proszę je zapamiętać, bo zapytam o nie powtórnie za kilka minut.

3. Uwaga i liczenie

Proszę odejmować kolejno od 100 po 7, aż powiem stop. ☐ ☐ ☐ ☐ ☐ ☐

4. Przypominanie

Proszę wymienić trzy słowa, które Pan/Pani miał(a) wcześniej zapamiętać.

byk ☐ mur ☐ las ☐ ☐

5. Funkcje językowe

Nazywanie

Prosimy o nazwanie dwóch przedmiotów, które kolejno pokazujemy badanemu (ołówek, zegarek).

Jak nazywa się ten przedmiot? ☐
Jak nazywa się ten przedmiot? ☐

Powtarzanie

Proszę dosłownie powtórzyć następujące zdanie:

Ani tak, ani nie, ani ale. ☐

Wykonywanie poleceń

a) Proszę uważnie posłuchać treści całego polecenia, a następnie wykonać to polecenie:

– proszę wziąć kartkę do lewej/prawej ręki ☐
– złożyć ją oburącz na połowę ☐
– i położyć ją na kolana. ☐

b) *Pokazujemy badanemu tekst polecenia zamieszczony na okładce:* Proszę zamknąć oczy. Proszę przeczytać to polecenie i je wykonać.

Pisanie

Dajemy osobie badanej czystą kartkę papieru i prosimy o napisanie dowolnego zdania.

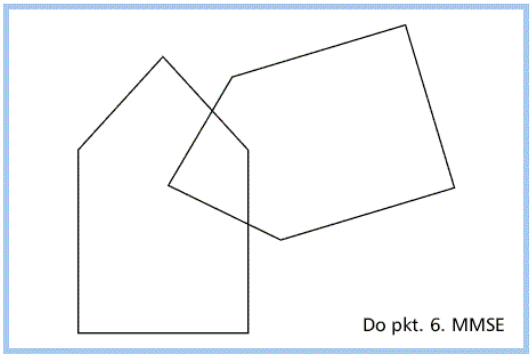
Proszę napisać na tej kartce jakieś dowolne zdanie ☐

6. Praksja konstrukcyjna

Proszę przerysować ten rysunek tak dokładnie, jak tylko jest to możliwe ☐

Rysunek zamieszczony jest na odwrocie Arkusza odpowiedzi.

Ogólna liczba punktów ☐☐



Do pkt. 6. MMSE

WHOQOL BREF

Kolejne pytania dotyczą jakości Pana życia, zdrowia i innych dziedzin.
Przeczytam pytania oraz możliwe odpowiedzi. Proszę wybrać najbardziej właściwą odpowiedź. Jeśli nie jest Pan pewien, która z odpowiedzi jest właściwa, to proszę podać pierwszą o której Pan pomyślał, z zasady jest ona najbliższa prawdy. Proszę myśleć o swoim poziomie życia, nadziejach, przyjemnościach i troskach.

		Bardzo zła	Zła	Ani dobra/ani zła	Dobra	Bardzo dobra
1	Jaka jest Pana/i jakość życia?	1	2	3	4	5

		Bardzo niezadowolony	Niezado-wolony	Ani zadowolony/ani niezadowolony	Zadowolony	Bardzo zadowolony
2	Czy jest Pan/i zadowolony/a ze swojego zdrowia?	1	2	3	4	5

Następne pytania dotyczą nasilania stanów których Pan/i doznawał/a w ciągu 4 tygodni.

		Wcale	Nieco	Średnio	W dużym stopniu	W bardzo dużym stopniu
3	Jak bardzo ból fizyczny przeszkadzał Panu/i robić to, co Pan/i powinien/powinna?	5	4	3	2	1
4	W jakim stopniu potrzebuje Pan/i leczenia medycznego do codziennego funkcjonowania?	5	4	3	2	1
5	Ile ma Pan/i radości w życiu?	1	2	3	4	5
6	W jakim stopniu ocenia Pan/i, że Pana/i życie ma sens?	1	2	3	4	5
		Wcale	Nieco	Średnio	Dość dobrze	Bardzo dobrze
7	Czy dobrze koncentruje Pan/i uwagę?	1	2	3	4	5
8	Jak bezpiecznie czuje się Pan/i w swoim codziennym życiu?	1	2	3	4	5
9	W jakim stopniu Pańskie otoczenie sprzyja zdrowiu?	1	2	3	4	5

Poniższe pytania dotyczą tego jak Pan czuje się i jak się Panu wiodło w ciągu ostatnich 4 tygodni.

		Wcale	Nieco	Umiarkowanie	Przeważnie	W pełni
10	Czy ma Pan/i wystarczająco energii w codziennym życiu?	1	2	3	4	5
11	Czy jest Pan/i w stanie zaakceptować swój wygląd (fizyczny)?	1	2	3	4	5
12	Czy ma Pan/i wystarczająco dużo pieniędzy na swoje potrzeby?	1	2	3	4	5
13	Na ile dostępne są informacje, których może Pan/i potrzebować w codziennym życiu?	1	2	3	4	5
14	W jakim zakresie ma Pan/i sposobność realizowania swoich zainteresowań?	1	2	3	4	5

		Bardzo źle	Źle	Ani dobrze/ani źle	Dobrze	Bardzo dobrze
15	Jak odnajduje się Pan/i w tej sytuacji?	1	2	3	4	5
		Bardzo niezadowolony	Niezadowo-lony	Ani zadowolony/ani niezadowolony	Zadowo-lony	Bardzo zadowolony
16	Czy zadowolony jest Pan/i ze swojego snu?	1	2	3	4	5
17	W jakim stopniu jest Pan/i zadowolony/a ze swojej wydolności w życiu codziennym?	1	2	3	4	5
18	W jakim stopniu jest Pan/i zadowolony/a ze swojej zdolności (gotowości) do pracy?	1	2	3	4	5

19	Czy jest Pan/i zadowolony/a z siebie?	1	2	3	4	5
20	Czy jest Pan/i zadowolony/a ze swoich osobistych relacji z ludźmi?	1	2	3	4	5
21	Czy jest Pan/i zadowolony/a ze swojego życia intymnego?	1	2	3	4	5
22	Czy jest Pan/i zadowolony/a z oparcia, wsparcia, jakie dostaje Pan/i od swoich przyjaciół?	1	2	3	4	5
23	Jak bardzo jest Pan/i zadowolony/a ze swoich warunków mieszkaniowych?	1	2	3	4	5
24	Jak bardzo jest Pan/i zadowolony/a z placówek służby zdrowia?	1	2	3	4	5
25	Czy jest Pan/i zadowolony/a z komunikacji (transportu)?	1	2	3	4	5

Poniższe pytanie odnosi się do częstotliwości doznań, jakich Pan doświadczał w okresie ostatnich 4 tygodni

		Nigdy	Rzadko	Często	Bardzo często	Zawsze
26	Jak często doświadczał/a Pan/i negatywnych uczuć, takich jak przygnębienie, rozpacz, lęk, depresja?	5	4	3	2	1

Czy ma Pan/i jakiś komentarz do tych pytań?

Lawton and Brody Instrumental Activities of Daily Living Scale

Lp.	Czynność	TAK, samodzielny	NIE, niesamodzielny
1.	Użycie telefonu	1=przynajmniej odbiera	0=NIE korzysta
2	Zakupy codzienne	1=TAK	0=NIE lub z pomocą
3	Przygotowanie posiłków	1=TAK samodzielnie	0=NIE lub tylko podgrzewa
4	Codzienne porządki	1=TAK bez pomocy	0=NIE lub z pomocą
5	Pranie	1=jeśli cokolwiek pierze	0=NIE jest w stanie
6	Środki transportu	1=samodzielnie korzysta	0=Wymaga pomocy
7	Własne leki	1=Zażywa w sposób właściwy	0=Wymaga jakiejkolwiek pomocy
8	Rozporządzanie swoimi pieniędzmi	1=Samodzielnie, podczas codziennych zakupów	0=NIE posługuje się

Total score:...../8 points

Interpretation: the more points the better the instrumental performance

Źródło: Lekarz Rodzinny, dodatek, Marzec 2007

Example of Bingocize® Questions and Exercises Translated into Polish

Session 1		
1. Osoby o umiarkowanym lub wysokim ryzyku upadku mogą zmniejszyć to ryzyko poprzez: a. stosowanie odpowiednich leków b. Aktywność fizyczna c. Poprawę bezpieczeństwa w domu d. Wszystkie odpowiedzi są prawidłowe 2. Około 75% upadków u osób starszych występuje: a. W domu lub w jego pobliżu b. Na imprezach towarzyskich c. Podczas ćwiczeń fizycznych d. Podczas pracy w ogrodzie		
	Sets	Total Time
Marsz na miejscu (march in place)	2	30s
Skłon w bok w siadzie na krześle z jednoczesnym wyprostem ręki nad głową (mermaids)	2	30s
Zrób krok do przodu a potem do tyłu, obróć się w prawo wokół własnej osi, obróć się w lewo wokół własnej osi, stań na prawej nodze, stań na lewej nodze (Cueing Drill)	2	30s
W siadzie zrób okrągłe plecy wciągając brzuch, potem rozluźnienie, ręce oparte na udach (Round and release)	2	30s
3. Poprawa bezpieczeństwa w domu może: a. Utrudnić opiekę nad osobą starszą b. Przyczynić się ograniczeń aktywności c. zwiększyć niezależność i bezpieczeństwo d. Utrudnić codzienne czynności 4. Jakie jest / są najczęstsze czynnik / -i ryzyka upadku starszych osób w ich domu? a. Przypadek b. Problemy zdrowotne c. Brak zabezpieczeń w domu, bałagan w domu d. Wszystkie powyższe		

Wstawanie z krzesła bez pomocy rąk (Chair Stands)	2	15s
Taśma theraband oplata plecy od tyłu, końce taśmy trzymane są w rękach, wypychanie ramion w przód, rozciągana taśma napina się (Chest Press)	2	15s
5. Przewody elektryczne, luźne chodniczki lub dywaniki oraz nieporządek w ciągach lokomocyjnych są: a. Bardzo potrzebne w domu b. Zagrożeniami, stwarzającymi ryzyko upadku c. Nie mają znaczenia dla upadków d. Ochroną 6. Jakie są 3 miejsca domu / mieszkania stwarzające największe ryzyko upadku dla seniora? a. Garaż, wejście i salon b. Ogród, salon i kuchnia c. Schody wejściowe, schody wewnętrzne i niebezpieczne łazienki d. Pokój dzienny, pralnia i kuchnia		
Marsz w miejscu (march in place)	2	15s
Pociaganie rękami w górę taśmy theraband, stojąc na niej (Low Row)	2	15s
Bingo Rolls (4)		
Pozycja siedząca, nogi zgięte w kolanach obok siebie. Przenoszenie prawej nogi w bok poprzez jej zgięcie w stawie biodrowym (do odwiedzenia) i powrót, podobnie druga noga (Side Steps)	2	15s
Siad na taśmie theraband, ręce trzymają końcówki taśmy, podnoszenie ramion w górę, przy wzrastającym oporze ze strony taśmy (Shoulder Press)	2	15s
7. Warzywa, owoce, zboża, białka i nabiał są a. Produktami żywnościowymi, które należy spożywać co dwa dni b. Pięcioma grupami żywności dla zdrowej diety c. Nie są potrzebne do prawidłowej diety d. Traktowane wyłącznie jako żywność śniadaniowa 8. Właściwa dieta może a. Zwiększyć ryzyko chorób przewlekłych b. Pomagać w leczeniu chorób przewlekłych c. Zmniejszyć energię życiową d. Zmniejszą funkcje odpornościowe organizmu		

Prostowanie nóg w siadzie z uniesieniem ich ponad poziom (Leg Extension)	2	15s
Stawanie na placach z rękami opartymi o krzesło (Heel Raise)	2	15s
9. Jaki jest łatwy sposób na stwierdzenie, czy żywność jest pełnoziarnista? a. Sprawdzenie tego na etykiecie opakowania b. Każdy chleb, płatki i krakersy są pełnoziarniste c. Mówi o tym słowo "naturalny" na etykiecie d. Każde jedzenie jest pełnoziarniste 10. Spożywanie produktów pełnoziarnistych może pomóc w: a. Kontroli masy ciała b. Funkcjach odpornościowych organizmu c. Utrzymaniu dobrej pamięci d. Utrzymaniu zdrowych płuc		
Prawe ramię przełożone na lewą stronę przed klatką piersiową i krzyżowane drugim (Single Arm Crossover)	2	30s
„Agrafka” najpierw prawą ręką a potem lewą (Back Skratch)	2	30s
Pozycja siedząca, nogi wyprostowane lekko nad podłożem, palce stóp mocno pociągamy ku sobie – zgięcie grzbietowe stóp (Calf Stretch Seated)	2	30s
Pozycja siedząca, noga wyprostowana lekko nad podłożem, krążenia stopy prawej, potem zmiana stopy (Ankle Flex)	2	30s
11. Ile filiżanek mleka beztłuszczowego lub o niskiej zawartości tłuszczu należy spożywać codziennie? a. 1 filiżankę b. 3 filiżanki c. 5 filiżanek d. 2 filiżanki 12. Jeśli ktoś nie toleruje mleka, z jakimi produktami przyjmować może odpowiednie ilości wapnia ? a. Ziemniaki i kalafior b. Owoce i warzywa c. Ryż i warzywa d. Jedzenie bez laktozy, żółty ser, jogurt, jarmuż i kapusta		
Bingo Rolls (4)		