MINISTERUL EDUCAȚIEI

UNIVERSITATEA “BABEȘ-BOLYAI” CLUJ-NAPOCA FACULTATEA DE EDUCAȚIE FIZICĂ ȘI SPORT

ȘCOALA DOCTORALĂ

Ph.D. THESIS SUMMARY

# THE INFLUENCE OF PHYSICAL EXERCISE ON GAIT QUALITY IN KINETO-PROPHYLAXIS OF COXARTHROSIS

**Scientific coordinator**: Prof. Univ. Dr. Emilia Florina Grosu

PhD student: Adela Neamțu-Popescu

2023

LIST OF PUBLISHED SCIENTIFIC PAPERS

1. Authors: Paul Florin Druta, Adela Neamtu, Ioan Crastiu, Calin Pop Gozman, Simoiu D, Liviu Bereteu, Vibration Effect on Some Tissues Biomechanical Review: Sisy 2020, IEEE, 18th Art. no. 9217075 pp119-124 Doi: 101109/sisy50555.2020.9217075;https://ieeexplore.ieee.org/document/9217075
2. Authors: Adela Neamtu, Ioan Calin Gozman-Pop, Daniel Vladaia, Dorin Simoiu, Sorin Deac, Liviu Bereteu, Determination of Bone Tissue Viscoelastic Properties by Vibroacoustic SISY Magazine 2020, IEEE 18th International Symposium of Intelligent Systems and Informatics, Art No. 9217098 p89-94 Doi: 10.1109/SISY50555.2020.9217098; https://www.researchgate.net/publication/347152961_Determination_of_Bone_Tissue_Viscoelastic_Properties_by_Vibroacoustic_Measurements
3. Adela Neamţu-Popescu; Gheorghe Draganescu; Liviu Bereteu, Analysis of whole-body vibration on rheological models for tissues; Mechanics and Materials Strength Department Politehnica University of Timişoara, Bd. Mihai Viteazul, no. 1, 300222, Timisoara, Romania; IOP Conference Series: Materials Science an Engineering 294 (2017) 012087 doi: 10.1088/1757-899X/294/1/012087; International Conference on Applied Sciences (ICAS2017); https://iopscience.iop.org/article/10.1088/1757-899X/294/1/012087/pdf
4. Daniel Vladaia, Adela Neamtu-Popescu, Steliana Stanciu, Dorin Simoiu, Liviu Bereteu; The effect of vibration exposure on posterior lower limbs skin temperature during the warm-up process of athletes; Mechanics and Materials Strength Department Politehnica University of Timisoara, Bd. Mihai Viteazul, no. 1, 300222; AVMS(2019), 037, V1. SPRINGER PROCEEDING IN PHYSICS, 251, ACOUSTIC AND VIBRATION OF MECHANICAL STRUCTURES ISSN:0930-8989 ISBN: 978-3-030-54135-4 DOI: 10.1007/978-3-030-54136-1; https://oa.mg/work/10.1007/978-3-030-54136-1_30
5. Adela Neamtu-Popescu, Marius Miclea, 2017, The effect of whole body vibration on spasticity and locomotor performance; University Student Conference 1 December 1918, Alba Iulia; http://ccefsk.uab.ro/upload/10_18_volum_conferinta_ccefsk_uab_2018.pdf
6. Authors: Paul Florin Druta, Adela Neamtu, Ioan Crastiu, Calin Pop Gozman, Simoiu D, Liviu Bereteu Vibration Effect on Some Tissues Biomechanical Models Magazine: Sisy 2020, IEEE, 18th Art. no. 9217075 pp119-124 DOI101109/sisy50555.2020.9217075

https://ieeexplore.ieee.org/document/9217075

7. Popescu Alin Marcel, Neamțu-Popescu Adela, Ordean Mircea Nicolae and Enache Alexandru Valentin Journal of Abstracts - International Scientific Conference - "Education, Sport and Health" ISSN: 2601–4998; ISSN-L: 2601-4971 **Awarness of the importance of quality management in the field of medical recovery services in Romania / Conștientizarea importanței managementului de calitate în domeniul serviciilor de recuperare medicală din România**; http://www.defs.unibuc.ro/conferintaub/administrare/cpanel/file-manager/uploads/Journal%20of%20abstracts%202021.pdf
8. Adela Neamțu-Popescu, Vlad Teodor Grosu SEC IASR 2023, International Scientific Conference,Sports, Education, Culture Interdisciplinary Approaches in Scientific Research, May 24-28, 2023 **Influence of physical exercise on Power Plate vibration platform on spatial-temporal parameters of walking**. https://fieps-seciasr.ugal.ro/images/2023/PROGRAM_FIEPS_SEC_IASR_2023.pdf

KEY WORDS: prophylaxis, coxarthrosis, physical exercise, gait quality, kineto-prophylaxis, vibration, WBV, vibrating platform.

TABLE OF CONTENT

INTRODUCTION

The majority of the population over the age of 60 is diagnosed with coxarthrosis and thus ends up presenting for recuperative treatment in recuperative centers complaining of pain. Unfortunately, only when the pain worsens does the person decide to seek specialist treatment. Many times the patient tries to cure his pain by himself, resorting to anti-inflammatory or analgesic medication that proves to be effective for a short period of time, then he consults the

specialist and finally, often late, he arrives at physical therapy. In coxarthrosis, the medication does not treat the cause, but only relieves, or not, the symptom, i.e. the pain. Both acute and chronic pain must be treated using appropriate pain management, as multiple adverse reactions can be caused and patients' health and quality of life can be compromised. Nowadays there are many pain relievers and treatment tools available to provide sufficient pain relief for almost all patients. Unfortunately, there are still patients suffering from pain due to inadequate and/or inconsistent pain therapy. Spacek, A. (2006)

But what proves effective is movement. Kinetic programs manage to reduce pain and correct imbalances that occur in the hip joint. Patient-perceived improvement occurred after an 8-week program following an exercise program for patients with coxarthrosis. (French, 2013) The choice of this topic does not want to observe pain, but to improve the quality of life by maintaining a balanced posture, therefore also a healthy coxo-femoral joint, by observing the influence of physical exercise on the quality of walking in the kineto-prophylaxis of coxarthrosis. Thus the intervention of medication and side effects can be reduced and the pain caused by delayed coxarthrosis.

# PART I – SPECIALIST LITERATURE REVIEW

## CHAPTER 1

## GENERAL ASPECTS REGARDING COXARTHROSIS

Coxarthrosis is one of the musculoskeletal conditions that contribute significantly to years lived with disability. As coxarthrosis is more prevalent in the elderly (approximately 70% are over 55 years of age), the global prevalence is expected to increase with the aging of the population. The typical onset is in the late 40s to mid-50s, although coxarthrosis can also affect younger people, including athletes and people who suffer joint injuries or trauma. (Popescu R., 2004)

The World Health Organization proposes several key prevention and control strategies in coxarthrosis. In particular, reducing joint overuse, for example, related to workload and promoting a healthy lifestyle through regular physical activity and maintaining a normal body weight.

Maintaining a healthy lifestyle and being diagnosed early and following a treatment plan is the best way to slow down a disease, including coxarthrosis.

Exercise can strengthen the hip stabilizer muscles that are affected in coxarthrosis and help with mobility. Other therapeutic approaches, such as manual therapies, can help the hip joint move properly and allow people to continue with their daily activities.

It is important that people remain motor independent. Hip arthroplasty restores functional capacity, restores motion, and can improve quality of life for most people with severely damaged joints. These hip replacement surgeries are beneficial to the patient, but also carry risks, including patient death.

Education and counseling are important to help people manage a healthy life. (Long H, 2022) Most guidelines suggest that opioid analgesics, glucosamine, and nutritional supplement therapies are not effective for coxarthrosis, and there is insufficient evidence to suggest that stem cell therapy is beneficial.

People prone to coxarthrosis should talk to a physical therapist to build an early and personalized care plan that is part of their life. It is easier to prevent than to treat. Maintaining regular physical activity and maintaining a healthy weight can help reduce the onset of the disease, its symptoms, and the risk of their progression.

Exercise prophylaxis in coxarthrosis is rather poorly studied, compared to pharmaceutical prophylaxis. According to Peter Gotzsche, professor of research, development and analysis at the University of Copenhagen, prescription drugs are the 3rd leading cause of death after heart disease and cancer. Mortality occurs due to adverse drug effects. It is very important for the population to stay healthy, and physical exercise is one of the most accessible, cheap and safe ways to keep a balance in the body. Comparison of physical exercise with saffron supplementation on metabolic balance in overweight and obese women leads to beneficial results, intense intermittent exercise with saffron supplementation being an appropriate strategy for health and obesity prevention, the latter being one of the risk factors for coxarthrosis . (Hasanvand, 2020)

Where risk factors have been identified in coxarthrosis, with few exceptions, no preventive strategy has been shown to be beneficial. The major risk factors for osteoarthritis are old age, injury and obesity. However, there is limited or no evidence that these are modifiable or to what extent their modification is effective in preventing the development of gonarthroses and coxarthroses or in preventing symptoms and progressive disease in people with an early predisposition to these diagnoses. (Ratzlaff, 2010)

Despite the perception that coxarthrosis only affects older adults, many people develop coxarthrosis before age 65 and live decades with pain and disability. It is essential to understand why some adults develop coxarthrosis early in life and the consequences of aging

with this condition. Key risk factors are joint injuries, certain occupations (eg tactical athletes), obesity and abnormal hip shape. Young adults with coxarthrosis report significant mental health problems and challenges in the workforce. Primary/secondary prevention strategies require more attention. For young adults with coxarthrosis, education and self-management strategies, particularly as part of a coordinated care strategy, may be ideal. Many people live decades with coxarthrosis and need proactive treatment strategies to delay the need for joint replacement. We urgently need to continue studying young adults. (Driban, 2020)

Due to the frequency and possible complications, coxarthrosis has a high social impact, with its advanced stages eventually leading to irreversible damage involving major complications or surgical interventions. In the early stages, conservative treatment plays a key role in preventing complications and slowing down the degenerative process. The combination of appropriate drug therapy (DT) and rehabilitation treatment (RT) - including individualized physical therapy (PT) and adapted occupational therapy (OT) - provides good results. The benefits of combining RT with DT in patients with coxarthrosis are highlighted, thus revealing the benefits of combining RT with DT in patients with coxarthrosis, especially in the early stage, aged up to 50 years. (Radu, 2022)

Even though coxarthrosis is a degenerative process that cannot be cured and is somewhat inevitable, adopting a healthy lifestyle is a prophylactic factor and a method to approach to live with this condition at a higher level of quality of life.

In the first part, the anatomy and physiology of coxarthrosis is described as follows: the articular bone hip, the soft tissues of the hip joint - ligaments / means of joining / intra-articular structures, the musculature of the hip - the extra-articular movement structures. Continued with the biomechanics of the coxofemoral joint.

Coxarthrosis is a chronic disease that affects the hip joint, causing significant pain, increased disability and progressive cartilage degeneration. Coxarthrosis is common in adults over the age of 50 and is a leading cause of disability worldwide. Degenerative changes and chronic cumulative joint damage include cartilage denaturation and destruction, sclerosis and cyst formation of subchondral bone, osteophyte formation, synovial lesions, and changes in surrounding structures. (Kurth, 2021)

Coxarthrosis occurs when inflammation and injury to the hip joint causes the cartilage tissue to break down. In turn, this malfunction causes pain, edema, and deformities. Cartilage is a firm, rubbery material that covers the ends of bones in normal joints. It is mainly made up of water and protein. The main function of cartilage is to reduce joint friction and serve as a "shock absorber". The shock-absorbing quality of normal cartilage comes from its ability to

change shape when compressed. It can do this because of its high water content. Although cartilage can be repaired when it is damaged, the body does not grow new cartilage after it is injured. (Felson, 1988)

As one of the most common conditions in adults, coxarthrosis, this diagnosis is based on a combination of radiographic findings and characteristic clinical symptoms. The lack of a radiographic consensus definition has apparently led to variation in the published incidence and prevalence of coxarthrosis. The chronological sequence of degeneration includes the following basic symptoms on conventional radiographs and CT: joint space narrowing, osteophyte development, subchondral demineralization/sclerosis, and cyst formation, as well as loose bodies, malalignment, and joint deformity. MR imaging allows additional visualization of early symptoms and/or signs of activity, such as cartilage edema, cartilage tears and defects, subchondral bone marrow edema, synovial edema and thickening, joint effusion, and muscle atrophy. The scientific dispute concerns the significance of (minimal) joint malalignment (eg, impingement, dysplasia, etc.) and forms of malpositioning that have a high probability of leading to coxarthrosis. Moreover, without any doubt, preservation of joint isolation and gender differences are important additional basic diagnostic principles that have gained great interest in recent years. In research, various MR procedures such as Na and H spectroscopy, T2 mapping, etc. with MR in the ultrahigh field allow the study of cartilage metabolism and its changes in early degenerative osteoarthritis ("biochemical images"). There is no doubt that even in a few years, new profound knowledge in this field is expected. (Imhof, 2009)

Patients who have coxarthrosis often have problems walking. Diagnosis can be difficult at first. This is because the pain can occur in different locations, including the groin, thigh, buttocks or knees. The pain may be stabbing and sharp, or it may be aching, and the hip is often stiff. (Chan Kim, 2015)

Considering the evolution of human development, it is impossible not to notice that nature has established two extremely important phenomena of harmonious self-organization - proportion and symmetry - in the structure of the musculoskeletal system. This is nothing but an expression of the law of proportionality and the balanced consistency of the parts of the human body united into one whole. The main connecting and coordinating elements in this unique system of harmony of form and function are numerous joints. (Uktamovich, 2022)

Factors that can contribute to coxarthrosis include joint damage, age, and being overweight. In addition, coxarthrosis can sometimes be caused by other factors: the joints may not have formed correctly, there may be genetic (inherited) defects in the cartilage, the person may put extra

stress on the joints, either by being overweight or by activities that involving the hip or due to a change in the center of gravity. (Felson, 1988)

Coxarthrosis is probably frequently secondary to developmental defects. However, it appears that in many cases the developmental defects are severe enough to cause coxarthrosis. To delineate other causes, it may be necessary to examine risk factors separately in those with and without the developmental disorder. Although large epidemiologic studies are best able to identify the relative contributions of specific risk factors while controlling for other risk factors, new studies must focus on important unresolved questions. First, longitudinal studies with comprehensive follow-up using repeated radiographic assessments are needed to identify factors that cause disease development or onset of symptoms. Second, cohorts with early and possibly asymptomatic disease should be followed to determine the causes of disease progression or regression and the natural history of the disease. Such cohorts may include people at high risk of injury, such as sports enthusiasts or manual workers. (Felson, 1988)

According to the medical rehabilitation protocol of the patient with coxarthrosis, we can classify as follows: Primitive coxarthrosis: simple primitive coxarthrosis, rapidly degenerative primitive coxarthrosis, primitive ankylosing coxarthrosis; Secondary medical, mechanical and accidental coxarthrosis: chondrocalcinosis, coxarthrosis secondary to infectious coxitis, coxarthrosis from aseptic necrosis of the femoral head, coxarthrosis from Paget's disease, congenital malformations of the hip (congenital dysplasia, subluxation, congenital dislocation, acetabular protrusion), acquired dystrophies: coxa plana, coxa retrorsa, secondary coxarthrosis after acetabular fracture, post-traumatic femoral neck fracture, limb length inequality (greater than 4 cm), chondrolateral hip arthrodesis. (Vizdoaga, 2017)

We know that osteoarthritis is a disease with an unknown etiology, but there are certain factors that lead to this condition according to the medical rehabilitation protocol in coxarthrosis (Wataru Watanabe, 2002): heredity, age, sex, obesity, bone density, hypermobility, other diseases such as HTA (hypertension) or diabetes, mechanical stress resulting from overuse from certain sports activities or certain jobs, postural abnormalities, trauma, congenital diseases, secondary cartilage changes.

Risk factors are divided into general factors and local factors. General factors are: gender (female), heredity (congenital type II collagen gene disorder, type II collagen gene mutation, HLA genes), race/ethnicity, advanced age, nutrition, obesity, and hormonal status (eg, postmenopausal) . The local factors are represented by the professional demand, the joint trauma as antecedent, the sports activity performed, the vicious development of the bones and joints, the weakening of the periarticular muscles. joint surgery. (Vizdoaga, 2017)

# CHAPTER 2
# CLINICAL PICTURE AND EVALUATION OF COXARTHROSIS

From the clinical picture of coxarthrosis, we mention that it manifests itself as degeneration of the articular cartilage. It is differentiated by primary coxarthrosis (unknown causes) and secondary coxarthrosis (congenital malformations, rheumatism, accidents, circulatory problems, etc.). It is a common diagnosis that leads to muscle atrophy in the stabilizing muscles of the hip. Loss of cartilage leads to increased joint stiffness. At the same time, pain also appears, being initially associated with movement after periods of inactivity and stress. Later, the pain also occurs during the night and at rest, which leads to an increasing limitation of the range of walking and finally to a decrease in the quality of life.

Coxarthrosis is accompanied by pain and limitation of joint mobility, and often the first lesions appear around the age of 40, or even sooner, but the symptoms are ignored and the condition degenerates. But with the right treatment, hip replacement surgeries could be delayed or even canceled.

As causes, many hereditary diseases can lead to coxarthrosis. These are usually conditions involving damage to the connective tissue (ligaments, bones and joints) or collagen diseases, for example Stickler syndrome. (Aresti, 2016)

The symptoms of coxarthrosis depend on the degree of the disease. The major signs of the disease include: joint pain, which does not go away even during rest, and night pain, the pain intensifies even with little physical effort and extends to the groin, knee, shin and hip, constant tension of the pelvic muscles or of the hip, stiffness and significant limitation of joint mobility, limping while walking, crackles, deformation of the joint. Over time, the patient's limb becomes shorter and the muscles atrophy.

Most often, coxarthrosis is complicated by the destruction of bone tissue. Other complications of coxarthrosis include aseptic necrosis of the femoral head, protrusion of the acetabulum, destruction of cysts in the acetabular region.

One of the most real complications that occurs in the case of coxarthrosis is the need for joint replacement. There is a hypothesis about the possible role of specific immune reactions in the pathogenesis of severe clinical forms of dysplastic coxarthrosis, there are patients at high risk for possible post-surgical complications. (Dmitrieva, 2009)

Currently, the following diagnostic methods are used: X-ray examination. This allows us to visualize the condition of the hips and highlight the symptoms, ultrasound examination.

This examination is necessary to define the stage of the disease and to locate the degenerative-dystrophic source. computed tomography or magnetic resonance imaging. Most often, MRI is preferred because of the absence of X-rays and detailed visualization. The device allows scanning in layers, finding out the stage of the disease and discovering it in the early stages of development.

Patients must understand that coxarthrosis is a progressive disease. Even if it is diagnosed in the early stages and treated with drugs, there is no 100% guarantee that it will be completely eliminated. In most cases, the disease can be stopped, but practice shows that the mechanism of its development restarts in 5-10 years.

## CHAPTER 3
## MOTIVATION OF TOPIC CHOICE AND REFLECTION IN SPECIALTY LITERATURE

Although we cannot prevent much of the hip pathology, we can think of ways to reduce the risk of early onset or worsening of coxarthrosis. Just by simply losing body weight can help prevent the progression of coxarthrosis, and physical exercise, done properly, reduces the risk of pain. Joint overuse of the hip, pain that occurs during exercise, improper footwear, running on hard surfaces are issues that can make us pay attention in the prevention of coxarthrosis. Also dietary supplements such as glucosamine, a clam derivative, enhanced with chondroitin improve cartilage preservation and reduce inflammation. (Susan, 1998)

Prophylaxis consists in the application of the procedures necessary to prevent the occurrence of a disease or at least to limit the injuries it produces.

Osteoarthritis is ranked as the 11th largest contributor to global disability. (Jennifer Durst, 2020). Exercise is a basic treatment in coxarthrosis. The physical activity health competency model describes the possibilities of empowering patients to exercise in the best possible health-promoting way, taking into account their own physical condition. Face-to-face supervision is the gold standard for exercise guidance.

Following the reviews we have carried out regarding the effects that the Power Plate vibrating platform has on the human body, we mention the following benefits:

- Physical exercise on the vibrating platform increases peripheral blood flow, but does not change skeletal muscle oxygenation. This type of vibration appears to be an important factor in both muscle oxygenation and peripheral blood flow. (Games, 2015)
- Increasing the muscle mass of the lower limbs. In this study, the muscle activity of the lower limbs was analyzed during whole body vibration. The subjects performed standard isometric

exercises, without loading, on the vibrating platform: high squat, low squat and single leg squat. The muscle activity of the muscles: rectus femoris, vastus lateralis, vastus medialis and the gastrocnemius muscle in 15 young men was recorded by electromyography. The exercises were performed in two conditions: with whole body vibration (35 Hz) and without (control group). A significant increase in muscle activity was noted when whole body vibration was used. (Roelants, 2006)

- Whole body vibration significantly increases oxygen consumption under conditions of moderate load, which leads to an effective increase in caloric consumption in people with low fitness levels, using lower loads during training. (Serravite, 2008)

- Balance and mobility were improved in residents with limited functional dependencies of a care home, through exercises involving whole body vibration. Fatigue and loss of interest may reduce the effects of exercise in institutionalized individuals. A lower volume of exercise but with the same effect would be an alternative. So, 24 subjects, who fit into this typology, 15 women and 9 men with an average age of 77.5 years, were entered into this study that spanned a period of 6 weeks. Subjects performed static exercises that involved whole-body vibration. Bautmans, I. E. (2005)

-Decreases the risk of falling. This study spanned a 12-month period and involved a whole-body vibration postural control training program in healthy seniors. 220 subjects were involved who were divided into 3 groups. A group of 94 people performed exercises on the vibrating platform, a group of 60 people opted for fitness training with exercises for cardiovascular, strength, balance and stretching and the control group of 66 people. The training frequency was three times a week. Balance was measured using a computerized posture platform after 6 months and after 12 months of training. Training on the vibrating platform was associated with a reduction in the frequency of falling on the vibrating platform when vision was disturbed. (Bogaerts, 2007)

- Workouts that involve whole body vibration are effective in improving the cardiorespiratory system and increase muscle strength. The study spanned a 1-year period and targeted community-dwelling adults over 60 years of age. A total of 220 adults took part in the study and were divided into 3 groups. The group that used the vibrating platform, the group that opted for classic fitness exercises to increase endurance, strength and balance, and the control group, which did not participate in any training. The considerable increase in heart rate was observed in the subjects who used the vibrating platform, but also in the subjects who performed the classic fitness exercises. In both groups, an increase in oxygen intake in the body and an increase in muscle strength were noticed. (Bogaerts, 2007)

- "Whole body vibration improves walking in individuals with spinal cord injuries." This result was reached by Ness, L.L. and E.C. Field-Note in the pilot study of this name. We wanted to find out if the repeated use of whole body vibration brings improvements in walking functions in patients with spinal cord injuries. The subjects of this study were 12 people who performed treatment on the vibrating platform for 4 weeks with a frequency of 3 times a week. Gait speed was assessed by a 3D image. The influence of whole-body vibration on secondary gait characteristics, including cadence, stride length, and hip-knee coordination, was also evaluated. Increased walking speed, statistically significant increases in cadence, increased stride length and coordination were observed after using the vibrating platform. (Ness, 2009)

"Steindler defines walking as "alternative bipedalism" because really walking consists of an alternation of movements and support positions of one pelvic limb, which the other limb then repeats identically" (Sbenghe, 2008)

The direction of movement of the body is given by the way we position the foot, and this positioning is given by the ankle joint. The joints found in the pelvis also have a structure favorable to statics and bipedal walking, with a high degree of mobility in the forward direction. In human walking, a cyclical movement occurs, each of the two lower limbs having the role of propellant and support in turn. The support gives us body stability during movement, an essential fact in supporting balance. Maintaining joint mobility leads to the establishment of walking trajectories and is influenced by muscle activity, gravity and osteo-muscular levers.
Walking is initiated by bending the trunk forward, the body's center of gravity is transferred forward of the base of support, one lower limb extends, and the other lower limb becomes pendulous leaving the ground to project forward, to be fixed on the ground again before the supporting member. (Sbenghe, 1987)

An important aspect in the practice of physical exercises on the quality of life is also the individual's personality. How motivated he appears in practicing the exercises, which then influences his quality of life. Based on an extensive literature review, and empirically tested using fitness center members in Taiwan, Europe, and the United States as respondents, the results indicate that individuals with a positive personality tend to have higher levels of motivation and participation in physical exercise. So personality and exercise participation then had an impact on individuals' quality of life in terms of improving physical health. The results of the study provide valuable information not only to marketing managers of fitness or recovery centers, but also to government officials to promote health and quality of life by boosting exercise motivation and exercise participation. (Huang, 2007)

Prevention of coxarthrosis through physical exercise should be a priority part of the national medical system, this condition being disabling and with a great negative socio-economic impact.

The incidence of coxarthrosis globally is high, with a reported mortality rate following hip arthroplasties.

Physical recovery has been researched over time in the case of coxarthrosis, but studies specifically focused on the prevention of coxarthrosis through the intervention of physical exercise on vibrating platforms are reduced globally.

The factor of premature aging of the coxo-femoral joint can be combated by physical exercises applied on the vibrating platform, which have an influence on the muscles, bone density, proprioception and the cardio-vascular system.

The general idea is the physiotherapist's attempt to correct the population's posture in time, following the aging by developing correct schemes of preventive exercises for the hip.
The element of originality proposed in the present research results from the application of preventive physical exercises for the hip on vibrating platforms.

# PART II – PRELIMINARY RESEARCH ON GAIT QUALITY IN KINETO-PROPHYLAXIS OF HIP DISEASES

## CHAPTER 4

## THE INFLUENCE OF PHYSICAL EXERCISE ON GAIT QUALITY IN KINETO-PROPHYLAXIS OF HIP DISEASES

30 equally divided subjects participated in the preliminary research. 15 subjects were part of the control group and another 15 subjects were part of the experimental group. These 30 subjects were initially and finally assessed with the BTS G-Walk device to observe gait quality indices. The study spanned a period of 6 weeks as follows: the pilot study lasted 6 weeks (October 2021-November 2021), the implementation of the exercise program (October 2021 – November 15, 2021) completed with the novelty element that is the vibrating platform and testing final in November 2021;

In the preliminary study, two questionnaires applied to a number of 438 people were introduced to observe the opinion of the population regarding the degree of interest in the state of health, the idea of physical activity, of a healthy body and awareness of prevention.

Coxarthrosis is one of the most serious diseases of the musculoskeletal system due to its incidence, low effectiveness of non-invasive treatment and severe disability due to symptoms. Disturbance of the normal way of walking resulting from the symptoms of this disease can have an influence on its efficiency, on the increase of energy consumption and on the occurrence of incorrect compensatory reactions. All physical therapy activities that reduce these disorders are prioritized. By evaluating the effectiveness of manual therapy and traditional physical therapy for walking in elderly people with degenerative changes of the hip joint, it was shown that manual therapy had a positive effect on the quality of walking and the distance covered by patients with degenerative changes of the hip joint. (Podczarska & Kawa, 2019)

In the given context, in carrying out our research we started from the following premises:

1) A modified plantar footprint leads to a change in the body's center of gravity from normal.

2) An altered center of gravity from an organism's normal leads to early joint wear of the hip joint.

3) Scientifically combining physical exercise with vibrating platforms is beneficial in improving the angle of the center of gravity.

4) The relationship between the physiotherapist and the patient is based on trust and consensus, and the purpose of such a relationship is not only for treatment but also for prevention so that the patient remains in good health as he gets older.

The purpose of the preliminary research is to observe the influence of a physical therapy program, performed on a vibrating platform, on the spatio-temporal parameters of walking, by performing a gait analysis report before and after performing the physical therapy program, and then developing an exercise protocol with the aim prophylactic in coxarthrosis. We also want to observe the degree of interest of the population in maintaining health.

A thorough evaluation of the biomechanics of the hip is required to select the most effective techniques and methods for its re-education. With the clearest possible understanding of the forces that appear on the hip joint we are moving towards current and effective solutions, trying to analyze and identify appropriate strategies by designing an exercise program on vibrating platforms to help in the prevention of hip joint degeneration.

The hypothesis of the preliminary work is: the geometric changes that occur at the level of the pelvis at the time of walking can lead over time to the early wear of the cartilage, therefore to coxarthrosis, but by maintaining as close as possible the quality indicators of walking, the onset of coxarthrosis can be delayed. These geometric changes can be due to changes in the posture of the pelvis, decreased muscle strength in certain groups of muscles involved in the stability of the hips, idiopathic coxarthrosis, secondary coxarthrosis, congenital conditions or after changes that occur after various traumas, advancing age or, changing the center of gravity of the organism. There is a solid foundation in the literature. The importance is solid considering the often encountered casuistry. The problem of the research topic lends itself to the conditions given by the material, human and temporal resources at our disposal, as well as by the skills of the researcher.

The postural changes that occur at the level of the pelvis change the body's center of gravity and lead to a change in the joint load at the level of the femoral neck and to the suffering of the joint cartilage, favoring coxarthrosis. In early coxarthrosis, symptoms occasionally appear after intense or sustained physical activities. In these cases, rest often leads to the disappearance of symptoms. When coxarthrosis worsens, symptoms intervene with simple activities and persist during physical activity, for example: while walking on a flat surface. But when we talk about an advanced degree of degeneration of the hip joint, so in an advanced coxarthrosis the pain persists even when physical activity ceases. The hypothesis starts from the idea that when the muscular balance at the level of the hip joint is improved or restored, the symptoms of coxarthrosis improve or disappear. But the most important aspect is the prevention of coxarthrosis. Preventive programs require early intervention to maintain adult hip joint health.

The objectives of the preliminary study are to establish an exercise protocol that:

- Corrects the biomechanics of the hip by creating a muscular balance at the level of the hip muscles through physical exercises;
- Prevents the installation of joint pain or ankylosing of the hip;
- Regain hip mobility;
- Improve or correct the vicious gait.

The research methods used were:

- The bibliographic study method - we made an extensive documentation by studying an important number of specialized articles, regarding the current aspects related to coxarthrosis prophylaxis, the influence of the vibration of the whole body on the body and the influence of physical exercise in the coxo-femoral joint, assessment methods and therapeutic intervention.

-The observation method allowed the evaluation of the studied lots.

- The case study method allowed us to investigate real situations; We chose this research method because in the preliminary research we aimed to carry out case studies, through which we would check the subjects, the results could be interpreted and thus we could anticipate a possible evolution of the research extended to a larger number of patients, given the small number of patients we have access to.

-We used the questionnaire method to collect data on the interest in maintaining health and to observe physical condition.

-Statistical method-used for processing the collected data and identifying relevant biomechanical parameters in monitoring the effectiveness of the exercise program intervention.

After analyzing the data from the GPPAQ questionnaire, out of 438 responses 61 respondents, i.e. a percentage of 13.9% fall into the inactive category, 191 respondents, i.e. a percentage of 43.6% fall into the moderately active category, 120 respondents , i.e. 27.4% fall into the moderately active category, and summing point d) with point e) we notice that the active population consists of a percentage of only 18.3%, i.e. 80 respondents.

In the analysis of the data from the Health Questionnaire, the answers were structured within the 27 points from 1 to 27, and within each point 5 ways of answering were offered ("It does not characterize me at all", "It characterizes me very little measure", "It characterizes me to some extent", "It characterizes me relatively well", "It characterizes me a lot") in an Excel database.

It is observed that the interest in one's own health characterizes most of the respondents. Thus, it is found that this aspect "characterizes them very much" for 42.9% of the participants in the questionnaire and "characterizes them relatively well" for 25.9% of them. Of the total number of respondents, only 4.3% have no interest in their own health, while 9.7% show little interest in their health, and 17.8% show some interest.

The ratio of those who are interested in their health to those who show less or no interest in this topic is favorable to those who are more interested. If we take into account those interested, i.e. the answers under "characterizes me a lot" and "characterizes me relatively well", it is found that they total 68.8%, compared to the answers for "does not characterize me at all",

"characterizes me to a very small extent" and "characterizes me to some extent" which total 31.2%.

- This result is a positive one that gives hope in terms of the population's interest in health status. At the same time, we can conclude that it is necessary to stimulate the population regarding the interest shown for their own health by adopting behavioral and attitudinal changes
- From the synthesis of the answers, it follows that the interest shown by the respondents for their health is manifested according to several objective and qualitative factors with which they interfere. Not only the simple desire of a person denotes his interest in his own health, but also different connections of the individual with social, family, educational, financial factors, etc.
- In the same context, the role of the state in establishing and implementing sustainable policies in the field of health that favors increasing people's access to health services should be mentioned.
- The stages of the doctoral thesis
- Specifically, the research period took place between March 2020 and September 2023. The stages of the research took place in the following sequence:
    - Permanent bibliographic study;
    - It included the control group and the experimental group;
    - The preliminary research took place between March 2020 and January 2022:
    - March 2020 – May 2020 we selected the evaluations to introduce in the research, namely Tanita Evaluation, BTS G Walk, BTS P Walk;

I selected the groups of subjects based on inclusion and exclusion criteria, presented in the research design, in the period May 2020 – March 2021, extended interval due to the pandemic situation;

- April 2021 – September 2021 dissemination and analysis of the Questionnaire on Health and the Questionnaire on physical activity, in order to observe the population's interest in maintaining health;
- the pilot study included the initial testing with the BTS G-WALK device, the implementation of the exercise program, completed with the element of originality that is the vibrating platform, and the final testing in September 2021;
- the pilot study lasted 6 weeks, included the control group and the experimental group and included the initial testing carried out in October 2021, the implementation of

the exercise program, carried out in October - November 2021, completed with the element of originality which is the vibrating platform and the final testing in November 2021;

- writing a preliminary research report (December 2021-January 2022);

The actual research started in October 2021 and included initial testing through body analysis with the TANITA device, static balance analysis with eyes closed with the BTS P WALK device represented by a baropodometry board and the G walk system for gait assessment, the program was implemented of exercises carried out during 6 months (October 2021 – March 2022) and the final testing in April 2022;

- analysis, processing and interpretation of the results obtained in the actual research until the end of 2022;
- writing the doctoral thesis January 2023 – September 2023;

The tools and equipment available for the implementation of the research program consisted of: properly equipped physiotherapy room (mattresses, treatment bed, mirrors, weights, balls, elastic bands, trellis), consultation/evaluation office, BTS G-Walk system, BTS G device -WALK is a wireless system for analyzing the spatio-temporal parameters of walking and the kinematics of the pelvis, consisting of an inertial sensor that we positioned on the fifth lumbar vertebra (L5), thus allowing a functional analysis of walking. The BTS G-WALK system was used to obtain accurate, objective and quantitative data. The tests are easy to execute and do not require time to prepare the subject. The system provides an automatically generated report that contains the recorded data compared with normative values. I have also used the laptop, camera and vibrating platform.

Measurements of the temporal-spatial parameters of gait are used by doctors and physiotherapists to diagnose gait disorders, monitor disease progression and control the effect of various therapeutic methods. It is indicated that the G-Walk system can be used to assess the walking characteristics of healthy subjects. The vibrating platform is an exercise tool with several benefits for the body. As the full body vibration technology used, I opted for the Personal Power Plate, which has a set frequency of 35Hz, a 30 or 60 second timer, a set of straps, rubber mat, power cord and a remote control for easy operation.

We have developed a program of exercises that will be performed on the vibrating platform, which will lead to the improvement of the stabilization of the pelvis, implicitly also to the balancing of the center of gravity and to the improvement of the quality of walking.

In June 2022, a batch of 15 young people was evaluated. Each subject performed, in this order, the following:

Initial gait assessment using the BTS G-Walk system to observe the gait quality index. Immediately after, the subject was invited to the vibrating platform where he performed a calup of 25 exercises, and then, immediately after the completion of the exercises, the gait was reassessed by the original method to see if there were any positive changes in the gait quality index.

The inertial sensor was positioned on the fifth lumbar vertebra (L5).

To obtain the walking quality index, the BTS G-WALK system observes the spatiotemporal parameters of walking and if they change through the physical exercise performed on the vibrating platform, wanting to orient ourselves towards the prevention of osteoarthritis of the hip.

Gait information is measured by pressure sensors and ground reaction force sensors that measure the force exerted by the subject's feet on the floor when walking.

We observed the following spatio-temporal parameters: duration of analysis, cadence, speed, gait cycle duration, step length and number of steps taken over a distance of 7 meters. These parameters were measured for normalization and we will analyze the gait quality indices. We analyzed spatio-temporal gait parameters before and after performing physical exercises on the vibrating platform. Paired group t-test was performed to compare the results between the initial testing and the final testing of the experimental group on the static balance test with eyes open.

We note that there was a significant difference ($p < .05$) in stride length measurements between initial and final testing; $t = 2.522$, $p = 0.024$ (Table 13). In conclusion, physical exercise elongates the muscle fiber and allows the stride length to increase.

This data was further processed by the software of the BTS G Walk device and led to gait quality indices. Analyzing the averages of the evaluated parameters for the 15 subjects tested in the experimental group, we notice that: the average of the testing of the analysis duration decreases from 19.31 sec. at 18.32 sec. The average of the cadence test, i.e. the number of steps/min, increases from 104.82 to 113.14. Average speed testing increases from 1.36m/sec to 1.49m/sec. Average gait cycle duration testing 1.085 sec. at 1.13 sec. The average step length test increases from 1.50m to 2.16m. The average number of steps taken per test distance decreases from 9.8 to 9.06 steps / 7m.

Analysis duration refers to the time required for the subject to perform the gait analysis. Cadence is the regular and uniform movement of the walking step and the number of

steps it takes. Speed is the ratio between the space traveled by a subject and the time used to travel this space; The gait cycle is given by the phases that make up the gait and which always follow each other in the same order. Initially, walking begins with support on both MIs, then support on one MI and swing or forward movement on one MI. The walking cycle has two periods: support and swing (oscillation, swing). Support is divided into the following phases: initial contact or heel attack; the middle support position or the middle support with the middle of the sole; completing the support with loading towards the forefoot; detachment from the ground.

The balance is also divided into: the initial oscillation, the middle oscillation and the terminal one. In normal walking, 60% of the duration of a walking cycle is represented by support and 40% by balance.

The length of the step is given by the distance we travel with each step. Stride length is dependent on several factors, including body morphology, muscle strength, and flexibility. We can also see an improvement in the quality of walking. Gait analysis is fundamental to identify the occurrence of disorders affecting motor behavior by studying and evaluating different sets of movement parameters.

Walking requires good posture and movements done in a certain way. Subjects were advised to walk as correctly as possible:

• The head is raised. The gaze is forward, not to the ground. The chin is parallel to the ground.

• The neck, shoulders and back are relaxed

• The arms swing slightly, with the elbow slightly bent. A slight purposeful back and forth movement of the arms is recommended. Shoulders move naturally.

• The abdominal muscles are slightly tense and the back is straight, not arched forward or backward.

• Even gait, stepping on the foot first with the heel and then rolling to the toes.

Compared to the values from the initial evaluation and with the aim of getting as close as possible to the normal standard that the BTS G-Walk system generates, we notice that changes in the spatio-temporal parameters occur after performing the physical exercises on the vibrating platform. These changes are ascending or descending compared to the initial assessment, but they lead to equalizing the number of steps and normalizing the duration of the walking cycle, which leads us to think about the possibility of easily correcting the symmetry of the pelvis and balancing the posture. Correct posture reduces the risk of osteo-articular degeneration of the hip with age. The duration of the gait analysis has a decreasing trend. The cadence tends to increase which means that the gait becomes more rhythmic and uniform and that the movement

becomes more regular. Walking speed also increases in most of the tested subjects, a matter made possible by better muscle control and better stability. The length of the step has a tendency to increase, a fact that leads us to think about better muscle elasticity acquired after performing physical exercises on the vibrating platform. We know that vibration relaxes muscles and reduces muscle contractions. As long as the stability and center of gravity of the body is maintained in a normal or as close to normal, as long as the soft tissues are kept strong and elastic, osteoarticular wear is delayed to appear.

We also analyzed gait quality indices and the paired group t-test was performed to compare the results between the initial testing and the final testing of the experimental group on the BTS G-Walk left walk quality test. In this, an improvement is observed between the initial testing and the final testing but the difference is not statistically significant ($p > .05$) between the initial testing ($M = 95.100$, $SD = 3.313$) and the final testing ($M = 96.293$, $SD = 2.885$); $t = -1.616$, $p = .064$ (Table 15). The t-test for paired groups was performed to compare the results between the initial testing and the final testing of the experimental group on the BTS G-Walk test for right walk quality. An improvement is observed between the initial testing and the final testing but, the difference is not statistically significant ($p > .05$) between the initial testing ($M = 95.187$, $SD = 2.914$) and the final testing ($M = 95.733$, $SD = 2.481$); $t = -.751$, $p = .232$ (Table 16).

Next observed was the control group that was initially tested with the BTS G-Walk device and then for 6 weeks did not perform any exercise supervised by our research but performed a minimum of 30 minutes of movement per week , which included cycling or walking or gardening or any leisure activity or tennis or swimming. At the end of the 6 weeks, the 15 subjects ( Table 13 ), of which 6 women and 9 men, of the control group were re-evaluated to observe if positive changes occur in gait quality indices.

No significant improvement in gait quality was observed in the control group after 6 weeks of minimal physical activity for the control group. The gait quality index in the final assessment, without performing hip stabilization exercises on the vibrating platform, increases insignificantly from a mean of 96.54% to 96.77% for the 15 subjects. Paired group t-test was performed to compare results between baseline and post-test of the control group on the BTS G-Walk test for left walk quality. An improvement is observed between initial testing and final testing but the difference is not statistically significant ($p > .05$) between initial testing ($M = 96.680$, $SD = 1.989$) and final testing ($M = 96.853$, $SD = 1.987$); $t = -1.096$, $p = .146$ (Table 19). Paired group t-test was performed to compare results between baseline and post-test of the control group on the BTS G-Walk test for right walk quality. An improvement is observed

between initial testing and final testing but the difference is not statistically significant ($p > .05$) between initial testing ($M = 96.407$, $SD = 2.159$) and final testing ($M = 96.507$, $SD = 1.953$); $t = -.269$, $p = .396$ (Table 20).

Through the pilot study we are trying to decide how best to carry out this research project, which methods are best to pursue and complete it. By being methodologically rigorous, we can save time and reduce the risk of errors or problems.

The hypothesis is verified by the fact that the gait quality indices improve after performing hip stabilization exercises on the vibrating platform, from an average of 95.04615% to 95.91538% confirming the hypothesis.

From the disseminated questionnaire, we observe the population's interest in maintaining a state of health as good as possible with advancing age and awareness of the importance of prophylaxis.

The favorable evolution represented by the improvement of walking quality through an exercise program on the vibrating platform confirms the research hypothesis, proving effectiveness in the prophylaxis of coxarthrosis.

From the synthesis of the answers, it follows that the interest shown by the respondents for their health is manifested according to several objective and qualitative factors with which they interfere. Not only the simple desire of a person denotes his interest in his own health, but also different connections of the individual with social, family, educational, financial factors, etc.

# PART III – RESEARCH ORIGINAL REGARDING THE INFLUENCE OF PHYSICAL EXERCISE ON GAIT QUALITY IN KINETO-PROPHYLAXIS OF COXARTHROSIS

## CHAPTER 5

## INFLUENCE OF PHYSICAL EXERCISE ON GAIT QUALITY

Two batches of 24 subjects each were entered into the actual research. These 48 subjects were evaluated with the Tanita machine to analyze muscle mass, bone mass, metabolic age, visceral fat, phase angle and BMI. Our study continued with static balance assessment with eyes closed and eyes open with the BTS P WALK device to observe the distribution of plantar

pressures in static and the distribution of the center of gravity, then rapid walking analysis was performed with the BTS G-Walk observing the symmetry of the gait. The study spanned a period of 6 months as follows:

The actual research lasted 6 months, between October 2021 and March 2022, it included the control group and the experimental group. We have implemented the exercise program complete with the novelty element which is the vibrating platform. The control group was initially tested with the Tanita device, the BTS P WALK and the BTS G-Walk, after which, for 6 months, they did not perform physical exercise supervised by our research, but performed a minimum of movement for 30 minutes per week, which included cycling or walking or gardening or any team sport or tennis or swimming. At the end of 6 months, control subjects were reassessed to see if there were positive changes in static plantar pressure distribution and center of gravity distribution and in gait quality indices. The experimental group was initially tested with the Tanita device, BTS P WALK and BTS G-Walk, after which, for 6 months, they performed a course of 25 physical exercises on the vibrating platform designed to stabilize the pelvis, supervised by our research, performing 3 workouts per week, which included three repetitions of the 25 exercises during each workout.

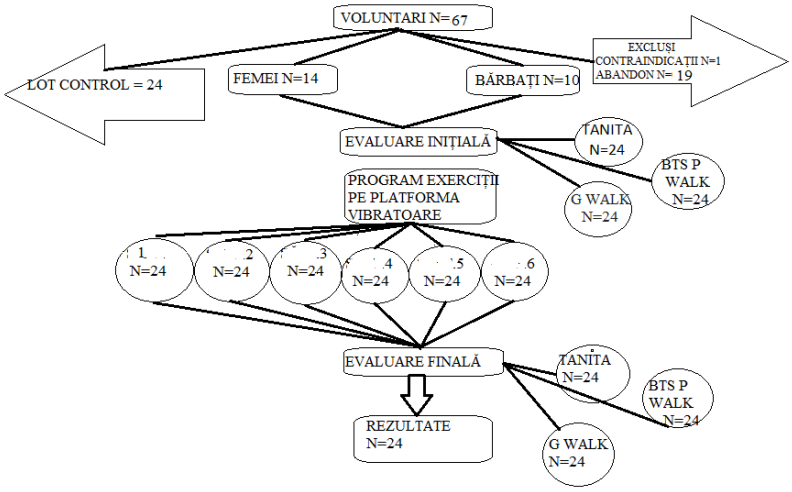
The research itself differs from the preliminary research by increasing the number of subjects entered into the study, by introducing the Tanita test sample and the BTS P WALK sample, by increasing the time dedicated to the study from 6 weeks to 6 months, and by increasing the number of sessions from 1 to 3 sessions/week and repetitions of the exercise program from 2 series to 3 series.

Many recent reviews have shown that exercise is effective in reducing the risk of falling, which can lead to various injuries. Exercise should be part of prevention programs. Through all the inconsistencies throughout the studies, one fact remains clear: muscle function and fitness are essential for independent living. Moderate physical activity is appropriate to improve health and to modify certain risk factors such as falls, which involve poor strength and balance. Balance, strength, coordination and reaction time training should be included, and to reduce the risk of fractures, resistance weight training is required (Simey P, 1999).

However, it must be recognized that physical activity and exercise take many forms and it is important to select the means we will use in the experiment, taking into account benefit and risk. Some activities, often of high intensity or duration, may put some people at increased risk of falling during the activity, and care should therefore be taken. Much research is still needed on the types, amounts, variety, and safety of physical activity for effective prevention.

There is also a need to develop and include effective training equipment both in free time and in a gym when considering preventive training However, the role of exercise in maintaining quality of life, even if not -it achieves its intended purpose, it should not be underestimated. With confidence in balance and movement, to be able to walk correctly or lift from the floor without help, we can move towards independent living. (Skelton, 2001)

The actual research design:




The actual research premises are:

1. An altered foot print results in the body's center of gravity shifting from normal as seen in the figure.

2. A body's altered center of gravity from normal leads to early joint wear of the hip joint.

3. Scientifically combining physical exercise with vibrating platforms is beneficial in improving the angle of the center of gravity.

4. Predisposition to obesity increases the risk of coxarthrosis with age.

5. The relationship between the physiotherapist and the patient is based on trust and consensus, and the purpose of such a relationship is not only for treatment but also for prevention so that the patient remains in good health as he ages.

The aim of the research was to evaluate the effects of an exercise program on vibrating platforms over a period of 6 months on the quality of walking in subjects with an average age of 27 years for the kineto-prophylaxis of coxarthrosis, by observing the tendency to normalize walking.

Research objectives

Postural assessment for the early observation of physical deficiencies and the establishment of a physical exercise protocol on a vibrating platform that:

- Corrects the biomechanics of the hip by creating a muscular balance at the level of the hip muscles through physical exercises;
- Prevents the installation of joint pain or ankylosing of the hip;
- Regain hip mobility;
- Improve or correct the vicious gait;.
- Improve or correct the footprint of the plant on the ground.

Improvements in gait quality were observed in the pilot study, an argument that allows us to expand the research by increasing the number of subjects and introducing new assessments. In the research itself, we issued the following hypotheses:

Hypothesis 1: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improvement in walking quality.

Hypothesis 2: The application of a program of physical exercises performed on a vibrating platform for 6 months can lead to the correction of the angle of the body's center of gravity.

Hypothesis 3: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improved balance.

Hypothesis 4: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improved proprioception.

The stages of conducting the actual research:

The actual research lasted 6 months (October 2021 – March 2022); Initial testing (October 2021) with TANITA, BTS P WALK and BTS G WALK devices; Final testing in April 2022; Analysis, processing and interpretation of the results obtained in the actual research until the end of 2022.

Research methods used: bibliographic study method; observation method; the experimental method; statistical method; graphic method; case study method; qualitative and quantitative research;

The inclusion and exclusion criteria of the subjects in the experimental research were established as follows: the inclusion criteria in the experimental study, identical to those in the preliminary study as follows: age between 18 and 49 years; gender: female / male; race: Caucasian; all subjects are healthy; subjects can participate in study visits. The exclusion criteria are identical to those in the preliminary study: internal osteosynthesis materials; pregnancy, acute thrombosis, cardiovascular diseases, pacemaker, open wounds or recent operations, hip or knee prostheses, acute hernia, disc diseases, spondylitis, diabetes, epilepsy, migraines, tumor formations, recent inflammations; alcoholics, subjects with psychiatric problems, subjects likely to go to another region during the study;

In order to be able to participate in this study, the subjects must sign, before inclusion in the study, a consent by which they agree to participate after understanding what the research consists of. See Appendix 1.

Evaluation methods: The testing and evaluation equipment used in the preliminary study and in the experimental study are scientifically validated and approved. We used the Tanita device, the BTS P WALK represented by a baropodometry board and the G Walk analysis system.

We started by evaluating the subjects with a body analysis with the TANITA machine. Thus we obtained metabolic parameters and body composition parameters to monitor the stage our subjects are in by obtaining data on: desired weight according to age, gender and height, visceral fat, body fat mass, FFM (fat-free mass) , muscle mass indicates the weight of muscles in the body and includes skeletal muscles, smooth muscles and the water contained in these muscles. BMI (Body Mass Index), bone mass. Research has shown that exercise and muscle tissue development are closely related to healthy bone tissue. Although it is unlikely that noticeable changes in bone structure will occur in a short period of time, it is important to develop and maintain healthy bones with a balanced diet and plenty of exercise. Metabolic age indicates the average age associated with that type of metabolism. If the metabolic age is higher than the actual age, it is an indication that the metabolic rate needs to be improved. Exercise will build healthy muscle tissue, which will improve your metabolic age. When we want to calculate the metabolic age, it is calculated according to the metabolic rate of the subject, compared to the metabolic age of people of the same age. The phase angle provides a picture of overall health, particularly cell integrity and quality. It has also been used to predict body cell mass and has been used as a nutritional indicator in adults and children. A low phase angle is consistent with the inability of cells to store energy and an indication of breakdown in the selective permeability of cell membranes. A high phase angle is consistent with large amounts of intact cell membranes and body cell mass.

We continued the evaluation with static balance analysis with eyes closed with the BTS P WALK device represented by a baropodometric plate through which we evaluated the distribution of static plantar pressures and the distribution of the center of gravity. To succeed in analyzing the influence of physical exercise on walking quality, we opted for the Walk+ Protocol, offered by the G Walk analysis system. It allows quick and accurate gait analysis. The data resulting from this evaluation process provides an objective analysis of the amotricity as well as the results of the selected therapy. In addition, the device's features include a comparison tool that provides us with a pre- and post-treatment evaluation. The parameters offered to us by

the Walk + Protocol are the following: Spatio-temporal parameters (global and differentiated for the right and left sides); General kinematic parameters (global and differentiated for the right and left sides); Symmetry index, propulsion index; Kinematics of the pelvis.

The intervention program began with the evaluation of the subjects with a body analysis with the TANITA device. I continued with assessment and measurement with the BTS P WALK and BTS G WALK, after which I intervened with the implementation of the physical exercise program for hip stability.

Numerous lower body problems can be caused by changes in pelvic stability. Our body works as a whole and when certain regions are not functioning at their optimal capacity, the body will find a way to move using other muscles or use the joints in a less efficient way. This program is intended to normalize the soft tissues responsible for hip stability.

We focus on intensive physical therapy exercises with an emphasis on range, sensory calibration, effort, stability and balance. It is important to realize that we often consider certain joint movements to be too wide, but in fact they fall within normal limits.

Quantification of the exercise program intervention: 72 one-hour sessions three times per week over 6 months delivered 1:1 by a physical therapist, ensuring protocol standardization, emphasizing feedback to the performing subject, and providing methods objectives to improve the execution of the exercises as correctly as possible.

The program consists of 25 exercises designed to stabilize the hip. All exercises focus on range of motion and are repetitive, sustained or functional. Compared to the classically performed exercises for hip stability, the participants use the vibrating platform on which they will perform the 25-exercise set.

Wanting to implement this exercise program it was formed and developed in the pilot study to verify its effectiveness in gait parameters. 67 people were initially selected, of which only 48 were able to fully complete the actual research. The reasons for dropping out were due to the pandemic situation that led to the impossibility of complying with the exercise program. The program took place during the period (October 2021 - March 2022), 6 months, 3 days a week, in total 72 sessions at the physical therapy room. After completing the exercise program. after 6 months, we re-evaluated the subjects with the BTS P WALK and BTS G WALK .

We started the research with body assessment of the subjects and looked at muscle mass, bone mass, metabolic age, visceral fat and phase angle. In 9 subjects out of a total of 24, i.e. at a percentage of 37.5%, the metabolic age compared to the biological age appears increased, as does visceral fat, thus a context with a predisposition towards obesity and early joint degeneration.

After observing the body mass index, we notice that a percentage of 45.83%, i.e. 11 people fall into the category of people with a normal body weight. A similar percentage, of 45.83%, also 11 people, out of a total of 24, fall into the category of those who exceed the desired weight, namely overweight 33.33% and Obese I a percentage of 12.5%, and two other people, out of the 24 evaluated, fall into the underweight category, 8.34%.

Body assessments with the Tanita device for the 24 subjects participating in the study were carried out to observe their body parameters and it was found that for a percentage of 33.33% it is necessary to introduce physical exercises into their lives to regulate their body mass index , adipose tissue, visceral fat, FMM and metabolic age, entering the disease risk category. However, these subjects do not present associated pathologies, which leads to the idea of implementing a physical exercise program still with a prophylactic purpose. The rest of the percentage of 66.66% of the evaluated subjects must be encouraged and supported to keep their physical condition, likewise, by implementing a prophylactic exercise program.

Our study continued with the assessment of static balance with eyes closed and eyes open with the BTS P WALK device. Subjects were placed, one at a time, on the baropodometry plate. We observed the distribution of plantar pressures in static and the distribution of the center of gravity. I opted for and evaluation with eyes closed, because at the moment the subject no longer has landmarks in space, the body positions itself as perceived proprioceptively, without compensatory tendencies. We also observed foot typology and weight distribution, i.e. if body weight is distributed more on one foot than the other, by analyzing plantar pressures, identifying overloads and postural asymmetries.

We want to observe the change that appears in the static assessment with eyes closed and eyes open after applying the exercise program over a period of 6 months, with three training sessions per week, in placing the angle of the center of gravity as close to normal as possible.
We performed the BTS P WALK assessment with eyes closed as follows in the figure below to observe the barycenter (center of gravity) for each individual subject. We also observe the imprint of the soles on the ground to be able to fit into certain physical deficiencies of the subject's foot, if they exist. We continued with the initial open-eyed assessment for observation of the center of gravity and elliptic surface.

We performed slow gait analysis and fast gait analysis observing gait symmetry. This index gives us information about the subject's ability to accelerate. The closer the index gets to 100%, the more symmetry there is along the path. The subjects are non-pathological presenting an index greater than 90%. The assessment was carried out according to the model of the graphs presented in the intervention program for the assessment of pelvis angles.

A program of exercises performed on the vibrating platform was carried out and implemented in the pilot study to lead to the best stabilization of the pelvis. Each exercise was repeated 3 times for 60 seconds or 120 seconds at a three-dimensional vibration frequency of 30 Hz during exercise and at a frequency of 60 Hz during massage.

Emphasis was placed on correct posture and correct breathing of the subjects as they performed the exercise program on the vibrating platform. They were asked to breathe correctly, abdominally, in order to have the best possible intake of oxygen and to be able to sustain the rhythm of the exercises. The exercises were performed bilaterally, with each MI separately.

Compared to classic exercise, as the platform vibrates, it stimulates the muscle fibers, causing them to contract and relax, sometimes up to 60 times per second. This makes the exercise the person is doing more effective. which is why whole-body vibration training is gaining traction.

We observed the values of the angle of the center of gravity, expressed in degrees and the elliptical surface expressed in $mm_2$ for the 24 subjects and the change that appears in the static assessment with eyes closed and eyes open after applying the exercise program for a period of 6 months, with the performance of 3 training sessions per week, in the distribution of plantar pressure and placing the center of gravity as close to normal as possible.

Following body evaluations with the Tanita device, we notice that out of 24 evaluated subjects, 7 of them, i.e. a percentage of 29%, could be classified among people with a predisposition to coxarthrosis, being prone to obesity, a condition that leads to wear and tear coxo-femoral joint.

After the static evaluation with eyes closed and eyes open with the BTS P WALK device we observe that a percentage of 70% of the subjects present a physical deficiency of the foot classified as hollow foot. The imprint of the hollow foot on the ground influences the posture of the pelvis, leading it into retroversion, a fact that can negatively influence the coxo-femoral joint over time. Thus, it appears necessary, in our opinion, to introduce into the subjects' lives some prophylactic physical exercises for postural stabilization and balancing of the pelvis.

Paired group t-test was performed to compare the results between the initial testing and the final testing of the experimental group on the static balance test with eyes open.

There was a significant difference ($p < .05$) between initial testing ($M = 5.031$, $SD = 2.963$) and final testing ($M = 3.388$, $SD = 2.134$); $t = 2.972$, $p = .003$ (Table 51).

In conclusion, static balance with eyes open is also improved. Even in the case of the evaluation with open eyes, we observe the improvement of balance and proprioception.

There are three sensory systems that provide contact with the cerebellum to maintain trunk stability when the eyes are open: vision, proprioception, and vestibular, but only two of the three systems are required to maintain balance.

When visual input is removed, instability due to lack of vision can be teased apart from other sensory deficits.

I evaluated fast walking because this type of locomotion requires better stability and balance. Walking step is more stable at speeds between 10 m/min and 60 m/min and more efficient than normal walking at slow or very slow speeds of 10–30 m/min.

Gait asymmetries are frequently observed in the population and are related to decreased gait speed, decreased balance, increased risk of falls, and increased metabolic cost. Interventions designed to improve gait asymmetries have different methods and outcomes.

The Wilcoxon signed ranks test was performed to compare the results between the initial testing and the final testing of the experimental group on the brisk walking symmetry index test.

An improvement is observed between initial testing and final testing but the difference is not statistically significant ($p > .05$) between initial testing ($M = 92.729$, $SD = 7.785$) and final testing ($M = 94.904$, $SD = 3.466$); $Z = -.654$, $p = .513$ (Table 53).

The literature suggests that a wide range of methods can be used to improve spatio-temporal asymmetries. However, future research should further examine gait asymmetries. In addition, researchers should explore the frequency and duration required for different intervention strategies to achieve the greatest improvement in gait asymmetries and determine the best symmetry equation for quantifying gait asymmetries.

The control group was initially tested with the TANITA machine, BTS P WALK and BTS G-WALK, after which, for 6 months, they did not perform physical exercises supervised by our research, but performed a minimum of movement for 30 minutes per week, which included cycling or walking or gardening or any team sport or tennis or swimming. At the end of 6 months, the 24 control subjects were reassessed to see if there were positive changes in static plantar pressure distribution and center of gravity distribution and in gait quality indices. The Wilcoxon signed ranks test was performed to compare the results between the initial and final testing of the control group on the static balance test with eyes closed. There was no significant difference ($p > .05$) between initial testing ($M = 5.749$, $SD = 2.161$) and final testing ($M = 5.800$, $SD = 2.447$); $Z = -.514$, $p = .607$ (Table 80). N=number of subjects, Z=Wilcoxon test value The Wilcoxon signed ranks test was performed to compare the results between initial testing and final testing of the control group on the static balance test with eyes open. There

was no significant difference ( p >.05) between initial testing ( M = 5.547, SD = 2.231) and final testing ( M = 5.511, SD = 2.521); Z = -.500, p = .617 (Table 81). Paired group t-test was performed to compare results between pretest and posttest of the control group on the brisk walking symmetry index test. There was no significant difference (p >.05) between the initial testing (M = 96.175, SD = 2.275) and the final testing (M = 95.566, SD = 1.417); t = 1.866, p = .075 (Table 83).

GENERAL CONCLUSIONS

1. It is necessary to approach the parameters that are objective in the postural changes that can be installed at the level of the pelvis.
2. Postural evaluations and gait evaluations are necessary to observe the presence of changes that set in early and may later lead to coxarthrosis.
3. At the level of the pelvis, the change in the center of gravity can lead over time to the wrong loading of the hip joint and to the early wear of the articular cartilage due to the overloading of a certain area.
4. The development of coxarthrosis certainly involves several factors, but segmental alignment has a very important role in maintaining joint health and requires further research.
5. We observe that the angle of the center of gravity has a tendency towards normalization when the subjects are evaluated with their eyes closed, in 17 subjects out of a total of 24, i.e. a percentage of 70.83%, thus proving the effectiveness of the exercise program in the following objectives that we proposed.
6. We interpreted the results by observing the improvement of symmetry indices in fast walking and the tendency to normalize the angle of the center of gravity (Table 53) after performing the physical exercise program for stabilizing the hip on the vibrating platform. The improvement in walking quality is checked. Having a normal gait can support the maintenance of a healthy coxofemoral joint.
7. Thus establishing the physical exercise protocol on a vibrating platform corrects the biomechanics of the hip (Table 51) by creating a muscular balance in the hip musculature through physical exercises; Improves or corrects gait (Table 13, Table 53); Improve or correct the footprint of the plant on the ground ( Table 49); It increases the level of proprioception when the subjects are in orthostatism with their eyes closed or open (Table 51); The parameters we evaluated represent a means of modulating the exercise program, therefore the results obtained in this research demonstrate the need for the quantification of evaluations and responses; The hip stabilization exercises used favor the correction of pelvic alignment and center of gravity;

The angle of the center of gravity has an evolution towards the normal range; No adverse effects were reported.

8. The hypothesis from the preliminary study is confirmed: the geometric changes that occur at the level of the pelvis at the time of walking can lead over time to the early wear of the cartilage, therefore to coxarthrosis, but by maintaining as close as possible the quality indicators of walking, the appearance of coxarthrosis can be delayed.

9. The actual study confirms:

Hypothesis 1: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improvement in walking quality.

Hypothesis 2: The application of a program of physical exercises performed on a vibrating platform for 6 months can lead to the correction of the angle of the body's center of gravity.

Hypothesis 3: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improved balance.

Hypothesis 4: Applying a physical exercise program performed on a vibrating platform for 6 months can lead to improved proprioception.

## Bibliografie


Bastian, J. C. (2004). “Vibrația dupa ligamentoplastie” . *Deutsche Zeitschrift fur Sport¬medizin.* .

Bogaerts. (2007). “Efectele vibrației întregului corp în controlarea posturii la persoanele de vârsta a treia”. *Gait & Posture. Vol. 26,*, 309-316.

Chan Kim, i. M. (2015). Association of hip pain with radiographic evidence of hip osteoarthritis: diagnostic test study. *The bmj*, 351.

De Ridder R, L. J. (2019). De Ridder R, Lebleu J, Willems T, De Blaiser C, Detrembleu C, Roosen P. 2019. Concurrent validity of a commercial wireless trunk tri-axial accelerometer system for gait analysis. *Journal of Sport Rehabilitation* , 28(6):1-13.

Durst Jennifer, I. R. (2020). Effectiveness of Human Versus Computer-Based Instructions for Exercise on Physical Activity - Related Health Competence in Patients with Hip Osteoarthritis. *Randomized Noninferiority Cross Trial German Clinical Trial Register*.

French, H. P. (2013). Exercise and Manual. Physiotherapy Arthritis Research Trial (EMPART) for Osteoarthritis of the Hip: A Multicenter Randomized Controlled Trial. *ARCHIVES OF PHISICAL MEDICINE AND REABILITATIOM*, 302-314.

Games, K. S. (2015). Whole-Body Vibration and Blood Flow and Muscle Oxygenation: A Meta-Analysis. *Journal of Athletic Training*, 50-55.

Hasanvand, B. a. (2020). Comparison of the Effect of Different Intensities of Exercise Training with Saffron Supplementation on the Metabolic Balance in Overweight and Obesity Women. *Fahimeh*.

Huang, C.-H. L.-Y.-L. (2007). The influences of personality and motivation on exercise participation and quality of life. *SOCIAL BEHAVIOR AND PERSONALITY*, 1189-1209.

Imhof, I. N.-H. (2009). Coxarthrosis – an update. *Springer Link*, 400-409.

Kim, Y. P. (2020). How do global sagittal alignment and posture change after total hip arthroplasty? *INTERNATIONAL ORTHOPAEDICS*, 267-273.

Kurth, A. A. (2021). Osteoarthritis - Causes and Therapy 2021. *OSTEOLOGIE*, 33-48.

Leonardi L, A. M. (2017). A wearable proprioceptive stabilizer for rehabilitation of limb and gait ataxia in hereditary cerebellar ataxias: a pilot open-labeled study. Ne. *Neurological Sciences* , 38:459-463.

Long H, L. Q. (2022). Long H, Liu Q, Yin H, Diao N, Zhang Y, Lin J et al. Prevalence trends of site-specific osteoarthritis from 1990 to 2019: Findings from the global burden of disease study 2019. . *Arthritis Rheumatol*, 74(7): 1172-1183.

Muro-de-la Herran A, G.-Z. B.-Z. (2014). Gait analysis methods: an overview of wearable and non-wearable systems, highlighting clinical applications. . *Sensors* , 14:3362-3394.

Ness, L. ș.-N. (2009). “Vibrația întregului organism îmbunătățește mersul la indivizii care au suferit leziuni ale maduvei spinării.” . *Gait & Posture. Vol. 30(4),* , 436-440.

Pau M, L. B. (2014). Pau M, Leban B, Collu G, Migliaccio GM. 2014. Effect of light and vigorous physical activity on balance and gait of older adults. . *Archives of Gerontology and Geriatrics* , 59:568-573.

Podczarska, M., & Kawa, M. (2019). Application of selected physiotherapeutic methods and the qualitative gait assessment in elderly people with degenerative changes of the hip joint. *BALTIC JOURNAL OF HEALTH AND PHYSICAL ACTIVITY*, 101-108.

Popescu R., T. R.-G. (2004). Ghid de evaluare clinică și funcțională în recuperarea medicală. *Ed. Medicală Universitară*.

Radu, A.-F. B. (2022). Highlighting the Benefits of Rehabilitation Treatments in Hip Osteoarthritis. *Medicina - Lithuania*.

Roelants, M. S. (2006). Journal of Strength and Conditioning Research. *Journal of Strength and Conditioning Research.* , 124-129.

Sbenghe. (1987). *Kinetoterapie profilactică, terapeutică și de recuperare.* București: editura Medicală.

Serravite, D. D. (2008). Efectul acut al modificarilor frecvenței, amplitudinii si sarcinii în consumul de oxigen în timpul vibrației întregului corp”. *Prezentare de postere la întâlnirea anuală a ACSM.* .

Simey P, P. B. (1999). Physical Activity and the Prevention and Management of Falls and Accidents among Older People. *Guidelines for Practice. London: Health Education Authority*.

Susanne, T. (1998). Glucosamine. *Sage Journals*.

Tao W, L. T. (2012). Gait analysis using wearable sensors. *Sensors*, 12:2255-2283.

Uktamovich, K. B. (2022). Coxarthrosis in the Structure of Diseases of the Musculoskeletal System: Modern View on Etiology, Pathogenesisand Treatment Methods. *European Journal of Innovationin Nonformal Education(EJINE)*, 226-231.

Wataru Watanabe, E. I. (2002). Early MRI findings of rapidly destructive coxarthrosis. *Springer Link*, 31, pages35–38 .

Zaki R, B. A. (2012). Statistical methods used to test for agreement of medical instruments measuring continuous variables in method comparison studies: a systematic review. *PLOS ONE* .