T.C.

YEDİTEPE UNIVERSITY

INSTITUTE OF HEALTH SCIENCES

MASTER'S PROGRAM IN PHYSIOTHERAPY AND REHABILITATION

EFFECTS OF NEURODEVELOPMENTAL THERAPY PROGRAM COMBINED WITH VESTIBULER TRAINING ON BALANCE IN CHILDREN WITH CEREBRAL PALSY

MASTER THESIS

EZGİ ENİŞER, PT.

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PROF. DR. FERYAL SUBAŞI

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 29/05/2020 tarih ve 2020/05-64 sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ
Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

I hereby declare that this thesis is my work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

EZGİ ENİŞER

DEDICATION

I would like to dedicate this thesis to my dear son Kerim ENİŞER, who makes the world more beautiful with his presence.

EZGİ ENİŞER

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LIST OF SYMBOLS AND ABBREVIATIONS

CP	Cerebral Palsy
CNS	Central Nervous System
CIMT	Constraint Induced Movement Therapy
SIT	Sensory Integration Therapy
VR	Virtual Reality
NDT	Neurodevelopmental Therapy
GMA	General Movement Assessment
CUS	Cranial Ultrasound
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
ROM	Range of Motion
OMD	Oromotor Dysfunction
COM	Center of Mass
GTO	Golgi Tendon Organ
FES	Functional Electrical Stimulation
RIP	Reflex Inhibiation Postures
VR	Vestibular Rehabilitation
GMFCS	Gross Motor Function Classification System
GMFM-88	Gross Motor Function Measure-88
PBS	Pediatric Balance Scale
TUG	Timed Up and Go Test
PNT	Postrotary Nystagmus Test
VOR	Vestibuloocular Reflex
BMI	Body Mass Index
SPSS	Statistical Package Analyze for Social Sciences

ABSTRACT

Enişer, E. (2020). Effects of Neurodevelopmental Therapy Program Combined with Vestibular Training on Balance in Children with Cerebral Palsy. Yeditepe University, Instıtute of Health Science, Department of Physiotherapy and Rehabilitation, MSc thesis, İstanbul.

The purpose of the study was to investigate the effects of a neurodevelopmental physical therapy program combined with vestibular training on balance in children with cerebral palsy (CP). Twenty-eight children diagnosed with CP were included in the study in Private Sancaktepe Special Education and Rehabilitation Center. All participants were divided into two groups with simple randomization. While Group 1 (Study Group) was receiving the vestibular training along with the neurodevelopmental physical therapy, Group 2 (Control Group) participated only in neurodevelopmental physical therapy programs. Both groups continued physiotherapy programs throughout six weeks, a total of 12 sessions. The assessments were applied to children before and after the intervention. The level of the motor function was evaluated by Gross Motor Function Measure-88 (GMFM-88). Pediatric Balance Scale (PBS) and Timed Up and Go Test (TUG) were used to evaluate the dynamic balance. Also, vestibular system assessment was conducted with Postrotary Nystagmus Test (PNT) before the intervention. According to the results of the present study, Group 1 showd statistically significant improvement for pre and post-intervention results in all tests ($p<0.05$). When comparing to pre and post-intervention results, there is a significant improvement in E dimension of GMFM-88 and PBS results in Group 2 ($p<0.05$). However, there were no significant differences in none of the assessments when the difference between pre and post-intervention results in intergroup variables is considered. Consequently, we could not find any positive effect of vestibular training combined with the neurodevelopmental physiotherapy on balance in children with CP.

Key Words: vestibular training, neurodevelopmental treatment, balance, cerebral palsy

ÖZET

Enişer, E. (2020). Serebral Palsi'li Çocuklarda Vestibüler Eğitim ile Kombine Edilmiş Nörogelişimsel Tedavi Programının Denge Üzerine Etkileri. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon Bölümü, Yüksek Lisans Tezi, İstanbul.

Bu çalışmanın amacı nörogelişimsel fizyoterapi programına ek olarak uygulanan vestibular eğitimin serebral palsili çocuklarda denge üzerine etkilerinin incelenmesidir. Çalışmaya Özel Sancaktepe Özel Eğitim ve Rehabilitasyon Merkezi'nde rehabilitasyon programına devam eden 28 çocuk dahil edilmiştir. Katılımcılar basit randomizasyon ile 2 gruba ayrılmıştır. Çalışma grubu nörogelişimsel fizyoterapi programının yanında vestibüler eğitim alırken, kontrol grubu yalnızca nörogelişimsel fizyoterapi programına katılmıştır. Her iki grup da fizyoterapi programa 6 hafta boyunca toplamda 12 seans devam etmiştir. Değerlendirmeler tedavi öncesi ve tedavi sonrası olarak yapılmıştır. Motor seviye Kaba Motor Fonksiyon Ölçütü-88 (KMFÖ-88), dinamik denge Pediyatrik Denge Ölçeği (PDÖ) ve Zamanlı Kalk ve Yürü Testi (ZKYT) ile değerlendirilmiştir. Vestibüler sistem ise tedavi oncesinde Postrotary Nistagmus Testi (PNT) ile değerlendirilmiştir. Çalışmanın sonucunda grup içi tedavi öncesi ve sonrası farka bakıldığında Grup 1 butun testlerde anlamli fark gosterirken, Grup 2 sadece KMFÖ-88`in E bölümünde ve PDÖ`de istatistiksel olarak anlamlı fark göstermiştir ($p<0.05$). Ancak, gruplar arası fark ele alindiginda hiçbir değerlendirmede anlamlı fark elde edilememiştir. Sonuç olarak, vestibüler eğitim ile kombine edilmiş nörogelişimsel tedavi programının SP'li çocuklarda denge üzerinde herhangi bir olumlu etkisi bulunamamıştır.

Anahtar Kelimeler: vestibuler eğitim, nörogelişimsel tedavi, denge, serebral palsi

1. INTRODUCTION AND PURPOSE

Cerebral Palsy (CP) is defined as a static encephalopathy that leads to movement, posture and motor coordination problems and may occur at the prenatal, perinatal or postnatal periods. It can affect approximately 2,1 per 1000 live births and its etiology is heterogeneous. CP is classified according to movement patterns as spastic, dyskinetic (dystonia or choreoathetosis), ataxic and mixed type and topographically as quadriplegic, hemiplegic or diplegic [1,2].

Central Nervous System (CNS) lesion in CP can have both motor and sensory impairments. Motor impairments cause a lack of muscle co-activation and development of abnormal movement compensations, therefore difficulties to maintain normal postural control and balance can be seen in CP [3]. Sensory impairments include the vestibular system that plays a vital role in gaze stabilization, balance control and posture [4]. Eventually, balance and postural control are affected negatively by two pathways in CP. In addition, sight and hearing problems, nutrition problems, speech disturbances, cognitive problems, emotional and sensory impairments and epileptic seizures can accompany CP [5].

In the management of CP, physiotherapy takes a prominent role. The purpose of the physiotherapy approaches for CP is improving the level of physical independence of the child and improving the quality of life. There are wide range of techniques applied in physiotherapy sessions by therapists to enhance motor and sensory impairments such as Cardiorespiratory training, Constraint-Induced Movement Therapy (CIMT), Sensory Integration Therapy (SIT), Virtual Reality (VR), hippotherapy, electric stimulation and taping. One of the most widely used therapeutic approaches for children with CP is Neurodevelopmental Therapy (NDT). It is asserted that regulating muscle tone and enhancing postural alignment with certain handling, hence promoting active participation and improving functional skills are the aim of NDT [6]. There are several studies investigating the efficacy of NDT and showing that it has positive effects on gross motor function [7], spasticity [8], postural control and balance [6]. However, it is argued that NDT has low-quality clinical evidence [9].

Activation of the motor responses which are necessary to maintain optimal balance can be possible with the integration of the impulses coming from visual, somatosensorial and vestibular systems [10]. The vestibular sytem is associated with balance, coordination, development of muscle tone, proximal joint stability and postural control along with the extraocular muscles providing development of visual motor integration. Also, it is responsible for the spatial relationships of an individual within an environment and providing sense of security [11]. Therefore, we think that effective vestibular training combined with the NDT can be more effective to improve balance status of children with cerebral palsy.

As far as we know, there are very few published articles investigating that how to balance status is affected if the vestibular training program combines with the NDT approaches in physiotherapy sessions of cerebral palsied children. Consequently, the purpose of this study is to compare the combined NDT program covering vestibular training versus the NDT program only on balance in CP.

Two hypotheses identified in the study:

H0: The children with CP participating in the vestibular training combined with NDT did not have more beneficial effects on balance than participating in the NDT only.

H1: The children with CP participating in the vestibular training combined with NDT had more beneficial effects on balance than participating in the NDT only.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Cerebral Palsy

2.1.1. Definition of Cerebral Palsy

Cerebral Palsy is defined as a group of disorders result from non-progressive defects that occurred in the immature fetal or infant brain, causing the failure of the development of movement and posture. The disturbances of sensation, cognition, communication, perception and/or seizures are seen frequently along with the motor deficiency in CP [12]**.** Therefore, disorders that can be seen in CP consists of a range of motor problems from mild motor inabilities such as in one extremity that interferes with sporting activities to the severe motor difficulties involved no voluntary movement including speech [13].

2.1.2. Causes and Risk Factors of Cerebral Palsy

Orthopedic surgeon Little defined the main reasons for CP as prematurity, asphyxia neonatorum, and birth trauma in 1862 [14]. Common causes of CP can be categorized into three classes according to the timing of the brain damage. These classes are prenatal, perinatal or postnatal causes.

- Prenatal causes encompass congenital malformations, vascular incidents and maternal infections during the first and second trimesters of pregnancy.
- Perinatal causes are considered as obstructed labor, antepartum hemorrhage or cord prolapse, causing hypoxia.
- Postnatal causes include infection and injuries for most cases of CP [15].

The most important risk factors for CP are expressed as low-birthweight, intrauterine infections and multiple gestations [16].

2.1.3. Epidemiology of Cerebral Palsy

The prevalence of CP is estimated at 2.11 per 1000 live births. Recently, this prevalence is remained stable because while improved survival in preterm infants and higher numbers of multiple births can cause increasing the prevalence of CP, factors such as using the antenatal corticosteroids, cooling for term-born asphyxiated infants, and using magnesium sulfate can cause a decline in the CP prevalence [17].

In Turkey, the prevalence of CP was detected as 4.4 per 1000 live births. When risk factors are examined, perinatal and postnatal reasons are showed more possible factors than prenatal causes in Turkey [18,19].

2.1.4. Diagnosis of Cerebral Palsy

Identifying infants with CP especially in premature newborns has been made progress over the last 50 years. General Movement Assessment (GMA) that an assessment of the spontaneous movement of an infant is useful on predicting the probability of having CP in the first few months of life. Also, retained primitive reflexes is a significant sign for suspecting CP [20].

As neuroimaging techniques, using Cranial Ultrasound (CUS), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are convenient to detect site and extent brain lesions. Approximately 85% of children have abnormal MRI or CT findings, with over half of these children having periventricular white matter injuries. [20, 21]

In the diagnosis of CP, along with motor insufficiency, the failure of the child to reach motor milestones at appropriate chronological age is taken into consideration and there is a medical history confirming that the child is not losing function (indicates not progressive disease) [5].

2.1.5. Classification of Cerebral Palsy

Cerebral Palsy is classified as topographically, meaning which parts of the body are affected, the types of motor deficiency defining the main features of the motor findings and the severity of motor deficiency [22].

Table 2.1. Classification of the CP as Topographically [23]

MAJOR TYPES	DESCRIPTION OF IMPAIRMENTS
Monoplegia	▪ One extremity involved, usually lower
Hemiplegia	▪ Both extremity on the same side involved ▪ Usually, upper extremity involved more
Paraplegia	▪ Both lower extremities equally involved
Diplegia	▪ Lower extremities more involved than upper extremities ▪ Fine-motor/sensory abnormalities in upper extremity
Quadriplegia	▪ All extremities involved equally ▪ Normal/no head/neck control

Table 2.2. Classification of the CP as the Types of Motor Deficiency [23]

MAJOR TYPES	DESCRIPTION OF IMPAIRMENTS
Spastic	▪ Velocity-dependent increase in muscle tone with passive stretch ▪ Joint contractures are common
Choreoathetoid	▪ Dyskinetic or continual, purposeless movements ▪ Joint contractures are uncommon ▪ Dystonia or hypotonia can be associated
Rigid	▪ Hypertonicity occurs in the absence of hyperreflexia, spasticity and clonus ▪ "Cogwheel" or "lead pipe" muscle stiffness
Ataxic	▪ Disturbance of coordinated movement, most commonly walking ▪ Normal head/neck control
Hypotonic	▪ Low muscle tone and normal deep tendon reflexes
Mixed	▪ Features of more than one type ▪ No head/neck control

2.1.6. Associated Factors of Cerebral Palsy

Abnormal Muscle Tone: Tonus problems in cerebral palsy can seen as both hypotonia and hypertonia. While hypotonia refers to a decrease in muscle tone, hypertonia refers to increased muscle tone. Hypertonia includes;

- spasticity which is defined as velocity depends increase in resistance in motion resulting from hyperexcitability of the stretch reflex.
- rigidity which is described as stretch resistance without velocity.
- dystonia which is increased muscle tone with abnormal posturing and repetitive movements

Spasticity is the most common motor problem and affects 85% of children diagnosed with CP. It can affect muscles that cross more than one joint mostly [24].

Musculoskeletal Problems: Resulting from the hyper-excitability of the stretch reflex, there are some changes in the structure of muscles of children with CP. Increased muscle tone, a marked loss of sarcomeres, and increased stiffness may lead to the limitation of the range of motions (ROM) of the joints, deformities and contractures which is tightening of muscle, or a group of muscles, that prevents normal movement of the associated limb or other body parts [25].

Loss of Selective Motor Control: "the ability to perform isolated joint motion without using mass flexor/extensor pattern or undesired movement of other joints" is defined as selective motor control. Because of the white matter damage, this mechanism can not work properly in children with CP. Therefore, they have difficulties in voluntary movement and functional tasks [24].

Muscle weakness: Reduction in motor unit synchronization, poorly coordinated recruitment of motor neurons and muscle atrophy can be listed as causes of muscle weakness in CP. Also, a decrease in muscle size, contractile force of muscle fibers and neuronal drive may lead to a decline in the strength of spastic muscles [24].

Other Conditions: Oral Motor Dysfunction (OMD) which are dysphagia, dysathria and drooling, impairments in vision, hearing and mental function, disturbances in sleep can be seen in CP. Also, there may some impairments in cognitive features such as speech and language, attention, memory, executive functions, written language and arithmetic [24]. Another common and important comorbidity among patients with CP is epilepsy which occurs in 10% to 60% of patients [26].

Problems with the positioning of the body in space and standing postural misalignments, which result from alterations due to skeletal deformities can push the child to develop some postural compensatory strategies in cerebral palsied children. In some cases, the excessively forward-leaning trunk can cause anterior displacement of the center of mass. Therfore, children who are presented lordotic postural pattern developed an anterior pelvic tilt and excessive lumbar curve in the spine. On the other hand, with an excessively backward-leaning trunk, swayback postural pattern which is characterized by a posterior pelvic tilt and insufficient lumbar curve in the spine can emerged [27].

There are also some gait alterations in children with CP. Limited knee flexion, hip hyperflexion and increased lumbar lordosis can be seen with an overactive Achilles tendon unit. Especially, in children with bilateral spastic CP, walking on the toes with increased hip and knee flexion is common. Moreover, excessive dorsiflexion with excessive flexion at the knee and hip joint may lead to crouch gait pattern [28].

2.2.Postural Control and Balance

Balance can be described as the capacity to maintain and/or regain the center of mass within the base of support, so all forces and torques acting on the body are in equilibrium [29,30]. When balancing in a standing or sitting position are components of static balance, sustaining postural position during motor activities such as reaching is defined as dynamic balance [31].

Postural control is maintaining the position of a part of the body to the environment or an external object moving in the environment or to the body itself [32]. Recently, it is asserted that two main theories play a role in the explanation of postural control development. These theories are the Reflex/Hierarchy Theory and the Systems Theory. According to the Reflex/Hierarchy Theory, appearing and disappearing the reflexes takes place with the maturation of the cortical structures that responsible for these reflexes in the central nervous system to occur more functional and voluntary motor responses. It classifies the reflexes as behavioral reflexes, correction reactions and balance and protective reactions. The Systems Theory claims that postural control is a complex process including changes of the musculoskeletal system, development of motor coordination strategies, development of sensory systems and strategies and development of cognitive systems [33]. Both theories aim to facilitate the understanding of typical and atypical motor development [24].

Sustaining stability is a dynamic processing. The human body produces muscle force to control the position of the center of mass (COM) continuously. Appropriate muscle tonus is considered as one of the main mechanisms that supports the body against gravity and protects the body from collapsing. Postural control and balance are complex tasks also involving major parts of the nervous system. Cerebellum, basal ganglions, motor cortex and cortical pathways are stated as significant neural structures maintaining both static and dynamic balance in different studies. Moreover, the postural control system uses the feedback mechanism between the brain and the musculoskeletal system. This feedback mechanism includes postural reactions which are balance, correction and protective reactions. Postural strategies are another factor that controls the postural stability. They are used when the human body encounters a perturbation or to initiate a voluntary movement. Ankle, hip and stepping are components of the postural strategies and they are activated during standing [34].

Maintaining balance and postural stability is also ensured by sensory systems which are visual, somatosensory and vestibular systems. Performing a specific postural task with sustaining postural stability and occuring intricate motor replies comprises multisensory information process as well as complicated relationships between sensory and motor information [30, 35].

2.2.1. Sensory Systems that Have Effects on Postural Control and Balance

2.2.1.1. Visual System

The visual system receives information about the surrounding environment [36]. Focal and ambient visions are components of the visual system. While focal vision performs localizing features in the environment, ambient vision is sensitive for movement [37].

Optic nerve tissue starts to develop on the 22nd day of pregnancy. In the 5th week of pregnancy, retina and lens develop and optic nerve starts to shape from the 8th week of pregnancy [38].

The visual system enables the recognition of the objects and detection of their movements in the space. Besides, it perceives that where the body locates in the space, the relationships between the body parts and movements of the body. Therefore, it regulates posture and contributes to continuity of postural control [33].

2.2.1.2.Proprioceptive System

Proprioception provides information about the musculoskeletal system related to general muscle tone and the position and movement of the body and the limbs in space [39].

Muscle spindles are responsible for collecting information for the central nervous system about muscle length and movement [39]. Also, joint position sense and motion sensing are generated by the muscle spindles [40]. Golgi Tendon Organ (GTO) located in the muscle tendon is another receptor that provides proprioceptive information to CNS. It is sensitive to tensile forces and when it is stimulated, tension within the muscle and the tendon decreases [41]. These senses are essential for motor control and function.

Mechanoreceptors, thermoreceptors and nociceptors are three primary sensory receivers of the somatosensory system. A mechanical stimulus such as pressure or vibration is collected by mechanoreceptors. Thermoreceptors are sensitive to temperature changes and nociceptors also called “free nerve endings” are sensitive to pain [42].

Development somatosensory system start to from on the 3rd week of pregnancy. In the 3rd trimester, the fetus becomes active and it kicks, turns and bumps into uterus walls, and somatosensory inputs are provided in intrauterine life [38].

2.2.1.3.Vestibular System

The vestibular system is the sensory system responsible for sustaining spatial orientation and vision. Also, it provides information about balance reflexes by transmission head acceleration and gravity impulses to centers associated with postural and ocular orientation in our body [43]. The vestibular system is fully functional before any other sensory system during development. It starts to develop on 5th week of pregnancy. The fetus responds to motion stimulus on the 10th week, vestibular organs reach exact size and shape on the 20th week of pregnancy. Moro reflex is presented on the 8th month of pregnancy [38].

Semicircular canals (orthogonal to each other) and otolites (the saccule and utricle) are sensory organs located in the head. While saccular otoliths detect vertical linear acceleration of the head, utricular otoliths detect horizontal linear acceleration [43,44]. Another function of the otolith organs is providing information about the direction of gravity. In contrast to the otolith organs, semicircular canals sense rotational motions and angular acceleration. Also, gaze stability is maintained by horizontal semicircular canals [44].

Vestibular organs have special cells called sensory hair cells. Along with endolymphatic fluid flow, sensory hair cells generate afferent impulses and transmits the impulses to medulla where the vestibular nuclei are located via vestibular nerve [45]. Vestibular inputs that come from the sensory organs, cerebellum and spinal cord are organized by vestibular nuclei and they are transmitted to the antigravity muscles of the neck, body and extremities through the vestibulospinal tract, one of the descending pathways. Besides, these impulses stimulate the motor nuclei of the eye muscles in order to ensure the gaze fixation [33].

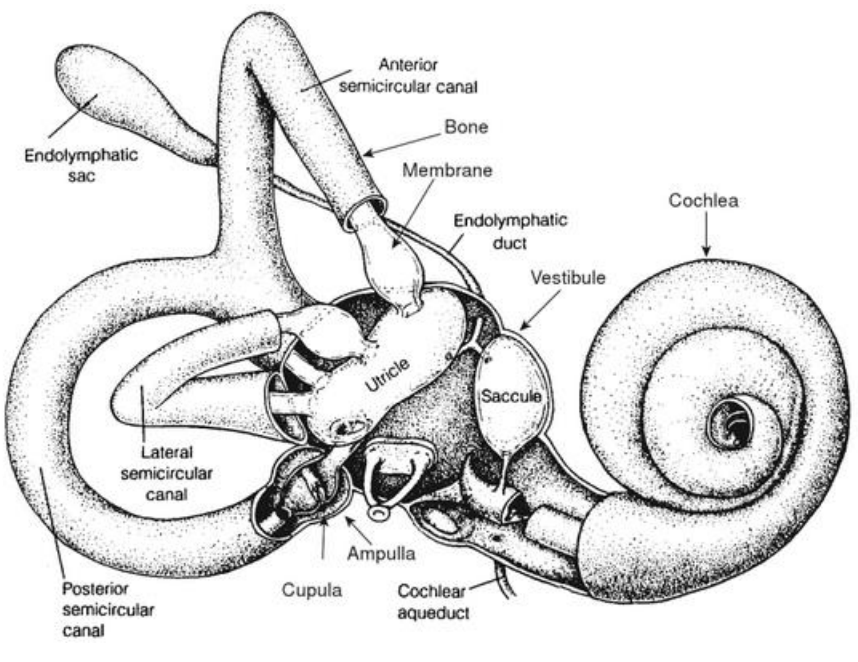


Figure 2.1. Vestibular Organs [44]

The vestibular system has several functions in contunity of postural control and balance. These functions are the perception of body position and self-motion, orienting the trunk to vertical, controlling the position of the body's COM via postural movements and stabilizing the head during postural movements [44]. When controlling the position of COM vestibulospinal tract promotes the extensor muscle activity while suppresses the flexor muscle activity. Also, it coordinates the interactions between the head and eye movements and helps the stabilization of the head. [46]. Another important factor for spatial orientation and balance is gaze stability (provided by semicircular canals) because it gives a stable visual reference.

Perception of motion may be altered by changing the position of the head to the body. Optimal stimulation of vestibular system is essential throughout the life for maintenance of homeostasis. Bending the head to the side, jumping up and down, running, swinging or spinning are examples of the activity that provides vestibular stimulation [47]. There are some effects of vestibular stimulation on CNS. It is demonstrated that vestibular stimulation causes vasodilation of the cerebral blood vessels and increasing the neural activity in cortex and midbrain. Thalamus activation which inhibits the pain pathway can increase with vestibular stimulation. Also, because of the connection of vestibular system and limbic system, vestibular stimulation regulates emotion [48].

2.2.2. Postural Control and Balance in Cerebral palsy

Postural stability is a complex task involving major parts of the nervous system. Therefore, it is not surprising that children with CP show postural impairments.

The primary causes of balance disorders in children with CP are considered as the deterioration in reciprocal innervation and co-contraction mechanism. Coordination of the motor movements is ensured with reciprocal innervation of the antagonist muscles. Also, the co-contraction of these muscles is required for proximal joint stabilization during the distal joint movements. In children with CP, these mechanisms do not work properly [49]. Furthermore, the brain damage of cerebral palsied children results in persistent movement and posture disorder. These complex disorders mostly lead to developing different compensatory strategies [50]. It is claimed that a failure leading to a malalignment in posture can have significant consequences for postural control development, balance, motor control of standing and walking abilities in children with CP [27].

In the experimental studies investigating reactive postural control have demonstrated that there is an abnormal increase in postural sway and the speed of the COM displacement when standing in children with CP. It is asserted that, compared to children with typical development, less complex movement strategies, simultaneous activation of all joints with patterns alterations, requirement more time to recover from perturbations are seen in children with CP [27].

On the other hand, recent neuroimaging studies revealed that there are significant changes in white matter fibers that bind to the sensory cortex, demonstrating the breakdown of sensory connections as well as motor connections in CP [51] and these significant changes are observed in 45% of the children with CP [52]. In order to achieve successful motor task performance, qualified sensory impulses that help correction of possible motor mistakes are required. With proper integration of sensory stimuli, children can produce adaptive behaviors in the activity of daily living. Therefore, sensory impairments have a negative effect on functional performance [52].

Strabismus, refraction anomalies (hypermetropia, myopia, and astigmatism), reduced visual acuity, amblyopia, accommodation impairments, retinopathies, nystagmus, and cerebral visual impairments may be seen in children with CP [53]. The severity of the visual impairments can increase with the level of motor impairments. Proprioception problems in children with CP mostly occur in the detection of passive movements and the sense of the position of body parts. Impaired two-point discrimination or impaired stereognosis also can be seen in CP [24]. Also, it is suggested that vestibular dysfunctions can be seen in children with CP because of white matter lesions, pathological changes in the cortical structures and vestibulospinal axons deficits [54].

In children with CP, because of the interactions between the sensory system, the central nervous system and the musculoskeletal system are affected, maintaining postural control and balance is a challenging task for these children [55].

2.3.Rehabilitation of Cerebral Palsy

Cerebral palsy is a complex therapeutic problem. Based on evidence, there are wide range of physiotherapy approaches to use in the rehabilitation of CP such as:

- Constraint-Induced Movement Therapy (CIMT) aims to improve motor outcomes of the affected limb with movement restriction of the unaffected limb and intense training of the affected limb in hemiplegic CP [56]. It is argued that CIMT had a beneficial effect compared with no/sham intervention especially for children with hemiplegic cerebral palsy in terms of both activity and participation [57].
    - Hippotherapy that asserts improving in postural balance, weight distribution and motor skills along with the strength of trunk muscles thank to providing dynamic support base with equine movement [58]. It is recommended for therapists using hippotherapy as forms of therapy in order to improve posture and balance, and consequently to influence functioning in activities of daily life and quality of life in children with CP [59].
    - Virtual Reality (VR) Therapy that provides task-specific practices, visual and auditory feedback, enhancement of problem-solving skills and maintain motivation during therapies with immerse and three-dimensional simulating the real world. It is suggested that for improvement of arm function, ambulation, and postural control VR is a viable intervention in children with CP [60].
    - Sensory Integration Therapy (SIT) which provides intense proprioceptive, vestibular and tactile stimulations, and overcoming sensory problems with receiving, modulating, organizing and interpreting the information come from the senses [61]. In the literature, there are some studies showing the effectiveness of SIT on sensory integration problems, gross motor function and activity of life in children with CP [61, 62].
    - Robot-Assisted Therapy uses games with robots to stimulate the motor coordination, cognition, memory and attention level of children [63]. It is asserted that Robotic therapies for the rehabilitation in children with CP improve joint mechanical properties, motor control performance and functional capability in balance and mobility through using portable robot which provides combination between passive strectching and active movement [64].

- Exercise therapy including strengthening and aerobic exercises have great effects in children with CP. Recently, it is demonstrated that different type, duration and intensitiy of exercises provide reduction in depency and muscle deficits, improve cardiorespiratuar fitness and flexibility, and improve quality of life [65].

Also, it is shown that there is some evidence about using Functional Electric Stimulation (FES) [66], orthostatic devices [67] and kinesiotaping [68] adjunct with other therapeutic approaches to protect and support joint, reduce spasticity and improve gait for rehabilitation children with CP in previous studies.

2.4.Neurodevelopmental Treatment (NDT)

Neuro-Developmental Treatment (NDT) defined as ‘a holistic and interdisciplinary clinical practice model informed by current and evolving research that emphasizes individualized therapeutic handling based on movement analysis for habilitation and rehabilitation of individuals with neurological pathophysiology’. It is used by occupational, physical, and speech therapists, it requires integrated and interdisciplinary working for the rehabilitation of patients with neurological disorders such as stroke, traumatic brain injury, CP, or other related disorders [69].

NDT has a ‘living concept’ meaning the practice of NDT, as well as portions of the philosophy and theory of NDT, have changed across time. In the beginning, its main principle was the inhibation of abnormal reflexes and muscle tonus. Reflex inhibation postures (RIP) were used to ensure this. In the therapy, passive-static treatment, full control of the physiotherapist and long term running an activity took over. Then, to inhibit abnormal patterns of movement using ‘key points of control’ was promoted, and reducing handling, facilitation of postural reactions, improving and functioning of normal motor development stages were emphasized. After that, environmental arrangement with adaptive materials, ensuring to participate in activity of daily living, providing sensory-motor integration and enhancing hand function and hand-eye coordination took an important place in therapies [70].

Contemporarily, NDT is expressed as active dynamic treatment. Goal-directed activities are promoted with facilitations by therapists. Tactile, proprioceptive, vestibular and verbal stimulations are used to regulate tonus, to teach activity and to ensure stability. Also, it is important to ensure communication between child, therapist and parents throughout the therapy.

NDT approaches are shaped according to the information obtained from motor control, motor learning and motor development studies [69].

Motor control: Motor control is defined as the ability to organize or manipulate mechanisms that are necessary for movement. Central Nervous System (CNS) regulates the numerous muscles and joints for coordinated functional movement and uses sensory inputs from the environment and the body itself to select and control movement [33]. In neurological disorders, understanding the impairments in CNS is important to determine more efficacious implementations.

Motor learning: Motor learning is the mechanism that causes a lasting change in motor behavior. A task becomes meaningful when it carried out in everyday life, not when it is accomplished for the first time. Then, when it is performed with minimum effort, skill has been gained. Achieving a task by the patient only in therapy sessions is insufficient. Treatment aims to ensure that the individual can participate in home, school and social environments without external assistance. Therefore, in the NDT concept, the therapists consider motor learning principles such as focusing on achievement on specific desires, optimizing body position and alignment, providing possibilities to repetition [69].

Motor development: Motor development expresses the emergence of motor abilities and the changes based on experiences, maturation and aging in that abilities during the whole lifetime. Individual factors, environmental factors and integration of all maturing body systems constitute the motor development [69]. Thus, knowledge of normal motor development helps therapists to understand abnormal motor development and to select the most appropriate treatment method [71].

There are several studies investigating the efficacy of NDT and showing that it has positive effects on gross motor function [7], spasticity [8], postural control and balance [6].

2.5.Vestibular Rehabilitation (VR)

Vestibular Rehabilitation (VR) is a therapy that comprises exercises including eye, head and body movements which may stimulate balance-related components of the body [72]. VR aims to improve the impairments resulting from vestibular dysfunction. VR includes adaptation exercises to improve gaze stability, habituation exercises that leads to the appearance of the symptoms, and substitution exercises which stimulate the use of other sensory systems and anticipatory responses to provide gaze stability and balance [73].

Because of the interaction between the vestibular system, CNS and peripheral nervous system, the prevalence of vestibular disorders can increase when a neurological disability occurs. In CP, a large span of brain involvement might encompass the central vestibular system impairments. Also, motor inabilities can cause decrease in the use of vestibular end-organs, and limitations in their development [74].

In children with CP, poor balance and postural control, motor developmental delay and inability to maintain stable vision are presented as a result of vestibular and oculomotor impairments [75]. When the previous studies are examined, it is indicated that vestibular rehabilitation has positive effects on postural control, mobility, emotional well-being and social participation in children with CP [76].

3. MATERIAL AND METHOD

This study is a pilot study aiming to investigate the effects of vestibular training combined with the neurodevelopmental treatment program on balance in children with cerebral palsy. Our study protocol was approved by Yeditepe University Clinic Research Ethics Committee (26.09.2018 and report number: 1521) (Appendix 4).

3.1.Subjects

The sample of the study consists of 28 children (18B, 10G) diagnosed with Cerebral Palsy (CP) reported from pediatric neurologist and continued to physical therapy sessions in Sancaktepe Special Education and Rehabilitation Center between November 2018-April 2019. Informed and written parental consent was obtained from subjects (Appendix 1).

3.1.1. Inclusion Criteria

Children;

- who are diagnosed with CP by a pediatric neurologist,
- whose parents sign a voluntary informed consent,
- who are in 5-16 age group,
- who have level I or II of Gross Motor Function Classification System,
- who can walk without assistive devices,
- who had not a surgical operation or botox injection at least for 6 months,
- who are able to understand given commands were included the study.

3.1.2. Exclusion Criteria

Children;

- who received botox injection during the study,
- who had uncontrolled seizures were excluded the study.

3.1.3. The flow of Research

Children who met the inclusion criteria were divided into Group 1 (Study Group) and Group 2 (Control Group) with simple randomization. Thirty-two cerebral palsied children evaluated, and twenty-eight children completed the therapy. Four children were excluded from the study due to various reasons: one of the children had uncontrolled seizures, one of them received botox injection after the first assessment and two of them were not willing to complete the therapy program. The Flowchart diagram is shown in Figure 3.1.

All cases who were participated in the study were evaluated and recorded before the treatment. While children in Group 1 recieved 30 minutes of NDT and 15 minutes of vestibular training, children in Group 2 received only 45 minutes of NDT twice a week. After the 6 weeks of therapy evaluations were performed again. 5 minutes resting period was given to children between every evaluation. Children were evaluated after the treatment according to monthly schedule that is detdermined by the rehabilitation center. Therefore, optimal time can not be provided for children to prevent fatigue and maintain motivation.

3.2.Evaluation

In this study, children were classified with Gross Motor Function Classification System (GMFCS) according to motor function level. The gross motor function evaluated with Gross Motor Function Measure-88 (GMFM-88), while the functional balance and mobility evaluated with Pediatric Balance Scale (PBS) and Timed Up and Go Test (TUG). For the assessment of the vestibular system function of children Postrotary Nystagmus Test (PNT) was used. Also, a structured questionnaire was used to evaluate the sociodemographic features of children and parents.

3.2.1. Structured Questionnaire

The structured questionnaire prepared by researchers applied face to face interviews. The first part of the questionnaire included age, height, weight and BMI to examine physical features of children. The second part of the questionnaire was about birth history and clinical characteristics of children (type of birth, timing of birth, multiple gestations and gender, type of CP, GMFCS level, medication, seizures, use of assistive devices, duration of rehabilitation, visual status, auditory status, mental status). Third part of the questionnaire included items about the sociodemographic features of parents (age, education level and consanguinity of parents).

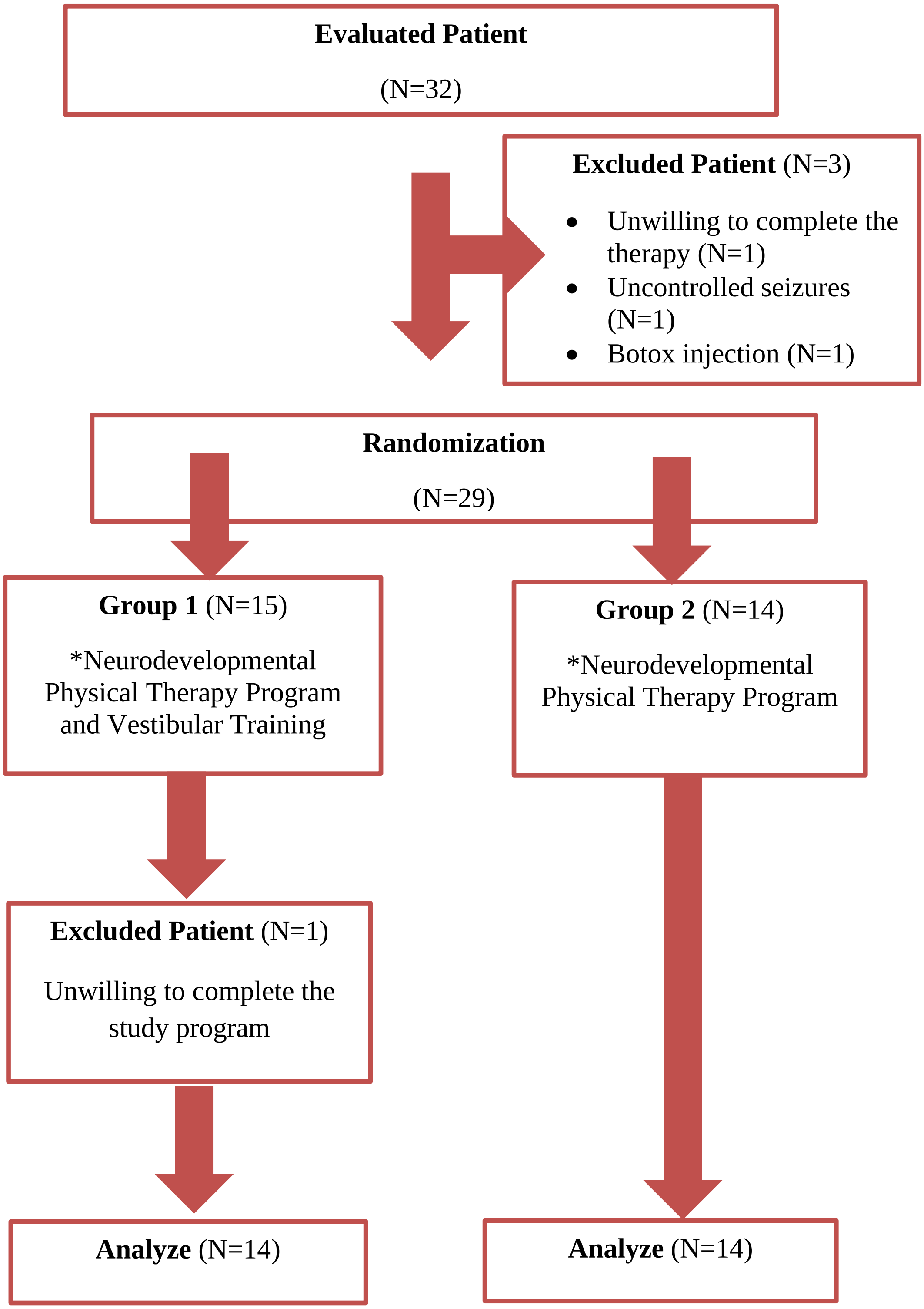


Figure 3.1. Flowchart Diagram

3.2.2. Gross Motor Function Classification System (GMFCS)

Children were classified with GMFCS and only children who had level I and II of GMFCS were included in the study. We used the Turkish vesion of GMFCS which is implemented by Kerem Gunel et al [34].

GMFCS was first developed for children under 12 years of age with CP and then expanded to contain 12 to 18 years of age [77]. GMFCS evaluates the child's self-initiated movements with the emphasis on sitting, displacement and mobility. The main criteria for defining the five-level classification system is that the difference between levels is meaningful in daily life [78].

General characteristics of each level are listed below:

<u>Level I</u> : Walks without any constraints

<u>Level II</u> : Walks with constraints

<u>Level III</u> : Walks using hand-held mobility tools

<u>Level IV</u> : Self-motion is restricted, can use motorized mobility tool

<u>Level V</u> : Can be moved in a wheelchair pushed by hand.

3.2.3. Gross Motor Function Measure-88 (GMFM-88)

Gross Motor Function Measure has two versions (GMFM-66 and GMFM-88), we used Turkish vesion of GMFM-88 which contains 88 items to evaluate gross motor function.

GMFM-88 is a tool that is commonly used by physiotherapists to measure the changes in gross motor function over time in children with cerebral palsy. It focuses on the quality of the gross motor activities can be performed by 5 years old normally developing child [79]. It is put forth that, for the assessment of the functional motor abilities, GMFM-88 is a useful and valuable tool. It can detect clinically significant changes in gross motor function in children with CP under the age of 17 [80]. It contains 5 dimensions [81]: Lying and Rolling (A), Sitting (B), Kneeling and Crawling (C), Standing (D) and Walking, Running and Jumping (E). These dimensions consist of 88 items in total and each item is scored from 0 to 3 (0: Does not initiate, 1:

Initiates, 2: Partially completes and 3: Completes). Total score is calculated by dividing to five the sum of the percentage of each division [82].

3.2.4. Pediatric Balance Scale (PBS)

The Turkish version of Pediatric Balance Scale (PBS) which is the regulated version of the Berg Balance Scale for children by Franjoine et al. [83] was used to evaluate the functional balance of the children in the activity of daily living.

PBS provide a standardized protocol to assess balance for children 5 to 15 years of age with mild to modarete motor impairments [83]. It consists of 14 items and each item is scored from 0 to 4 point(s). The highest score can be obtained from the scale is 56 [82]. It assesses several functional activities such as sitting, standing, transferring, stepping, reaching and turning. Total administration and scoring time are less than 15 minutes [83].

3.2.5. Timed Up and Go Test (TUG)

Timed Up and Go Test was used to evaluate the walking speed, postural control, functional mobility and balance of the children who were participated in the study. It is founded that the TUG test is a reliable, responsive and highly valid clinical tool to assess mobility and balance in children with CP who are ambulatory, between 3 and 10 years of age and in GMFCS levels I-III [84, 85].

When the children were evaluating, a chair without back support was placed 3 meters away from the wall and children sit on the chair. Then, the children were asked to stand up from the chair, touch the sign on the wall, come back and sit again. The duration from standing to sitting again was recorded (Figure 3.2.). 3 trials were performed with one-minute resting period and the main value of the trials was taken into consideration [86].

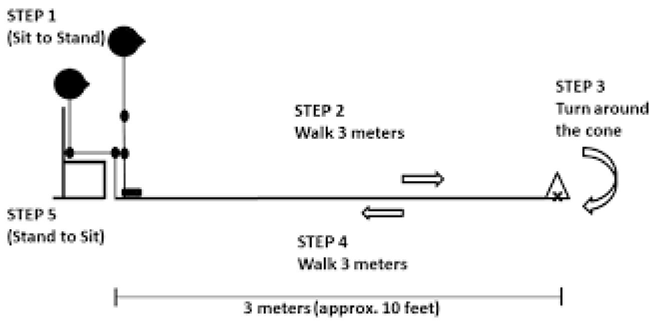


Figure 3.2. Timed Up and Go Test [90]

3.2.6. Postrotary Nystagmus Test (PNT)

Postrotary Nystagmus Test was used to evaluate the vestibular system function and integrity of the Vestibuloocular Reflex (VOR) after rotation of the head in space. Using the rotational chair was introduced by the Austro-Hungarian otologist and Nobel Prize winner Robert Barany in 1907. Then, based on this paradigm Ayres published the Southern California Postrotary Nystagmus Tests (SCPNT) [87].

When performing the test, children were seated on the rotatable platform with 30^o head flexion and were rotated for 20 seconds. We used a swing while we were rotating the children. All children could hold their head at 30^o flexion without any external assistance. At the end of the 20 seconds the nystagmus appeared in the eyes of the children was observed and the total duration of the nystagmus was recorded [88].

According to Ayres [89], some children may have to vestibular stimulation hyporesponsive means there is no nystagmus or very short duration of nystagmus, while some of them may be hyperresponsivity means the duration of nystagmus takes a longer time.

3.3.Treatment Protocol

3.3.1. Neurodevelopmental Therapy Program

All the children who participated in the study received the Neurodevelopmental Therapy Program twice a week throughout 6 weeks, as in the study conducted by Hossini et al. [90]. Children attended to therapy according to monthly schedule that is detdermined by the rehabilitation center. Therefore, optimal time can not be provided for children to prevent fatigue and maintain motivation.

Before the therapy, all children assessed with evaluation tools mentioned previously. Children were observed and motor activities that the children had difficulties were detected. After that, specific goals have been set for every child.

Goal-directed activities were performed within the games. Exercises such as postural control, weight bearing, stretching, hand-eye coordination, trunk rotation, fine motor integrated in activities. We arranged therapy room according to motor development, emotional status, sensory development and motivation of the child. Various kinds of materials such as wedges, rolls, exercise balls, tilt table, the different height of steps and the different sizes of positioning cushions were used during the therapy. Some examples of activities performed during therapy are shown in the Table 3.1. When the child performs an activity, verbal facilitations were given by the therapist. Kneeding and stroking were applied to muscles for tonus regulation. Also, parents were informed about the home exercises. However, we did not use any follow-up chart for home exercises.

In Group 1, therapy was performed for 30 minutes and in Group 2, it was applied for 45 minutes. Group 1 received vestibular training the rest of 15 minutes.

Table 3.1. Examples of Activities in NDT Program

Activity	Duration	Purpose
Climbing stairs that are formed with different height of rectangular positioning cushion and throwing the ball into the pot	10 min	Weight-bearing Hand eyes coordination
Reaching and hanging the clothes pags on the rope when standing on a tilt table	10 min	Postural control
Catching the ball when standing on a firm floor	10 min	Hand-eye coordination
Walking on the floor consisting of the various height of blocks	10 min	One leg stance Coordination
Reaching the box located right side, taking a bead from the box and putting it in another box located left side when sitting on an exercise ball,	10 min	Trunk rotation
Stringing beads	10 min	Fine motor
Standing on a wedge and doing puzzles	10 min	Active stretching

Figure 3.3. Activity Examples-1

Figure 3.4. Activity Examples-2

3.3.2. Vestibular Training Program

There is no generalized vestibular training program in literature. The intensity of vestibular training showed a variety among the studies [90, 91]. We took the physical condition, the tolerability and the fatigue level of the children into account, and along with the 30 minutes NDT program we applied the vestibular training for 15 minutes to children in Group 1.

We chose three different positions (prone, sitting, standing), three different types of equipments (a hammock, a swing, a trampoline) and three different activities (swinging, rotating, jumping) that stimulate all vestibular organs. Therefore, our vestibular training program was included:

- Swinging with the hammock in the prone position for 5 minutes,
- Rotating with the swing in sitting position for 5 minutes,
- Jumping on the trampoline while standing for 5 minutes

When children were swinging in the hammock, they picked up the toys located on the floor and put a box. They practiced holding the head in an upright position and following the visual inputs. With rotating, they activated Vestibuloocular Reflex (VOR) mechanism. Spatial orientation and extension against gravity were ensured by children with jumping on the trampoline.

Figure 3.5. Swing

Figure 3.6. Trampoline

Figure 3.7. Hammock

3.4.Statistical Analyze

Statistical Package Analyze for Social Sciences (SPSS) version 25.0 was used for data analyses. We used the Kolmogorov-Smirnov test to test the numerical variables for normality. The summary of numerical data was showed mean ± standard deviation and ratio was used for categorical data. We performed statistical analysis before and after treatment. The parametric data were analyzed with Paired Sample T-test and Independent Sample T-test while non-parametric data were analyzed with the Wilcoxon test and Mann Witney U Test. We accepted the significance level as 0.05.

4. RESULTS

The study included cerebral palsied children (n=28, 10G/18B) who referred to Sancaktepe Special Education and Rehabilitation Center, Istanbul, Turkey by a pediatric neurologist between December 2018 and June 2019.

The physical features (age, weight, height and body mass index (BMI)) of Group 1 and Group 2 are presented in Table 4.1. There were no statistical differences in age, height, weight and BMI in two groups.

Table 4.1. Physical Features of the Children

	Group 1 mean±SD	**Group 2 mean±SD**	**t**	**p**
Age (month)	125.57±39.38	128,78±31.55	-0.23	0.81
Height (cm)	139.64±20.85	142,89±17.71	-0.44	0.66
Weight (kg)	37.46±15.24	39.49±17.05	-0.33	0.74
BMI (kg/m^2)	18.41±3.43	18.48±3.59	-0.56	0.95

Data expressed as mean ± standard deviation. BMI: Body Mass Index. Group 1: Study Group, Group 2: Control Group

The type of birth, gestational age and presence of multiple gestations in Group 1 and Group 2 were given in Table 4.2. There were no statistically significant differences according to the history of the birth of the children between the two groups.

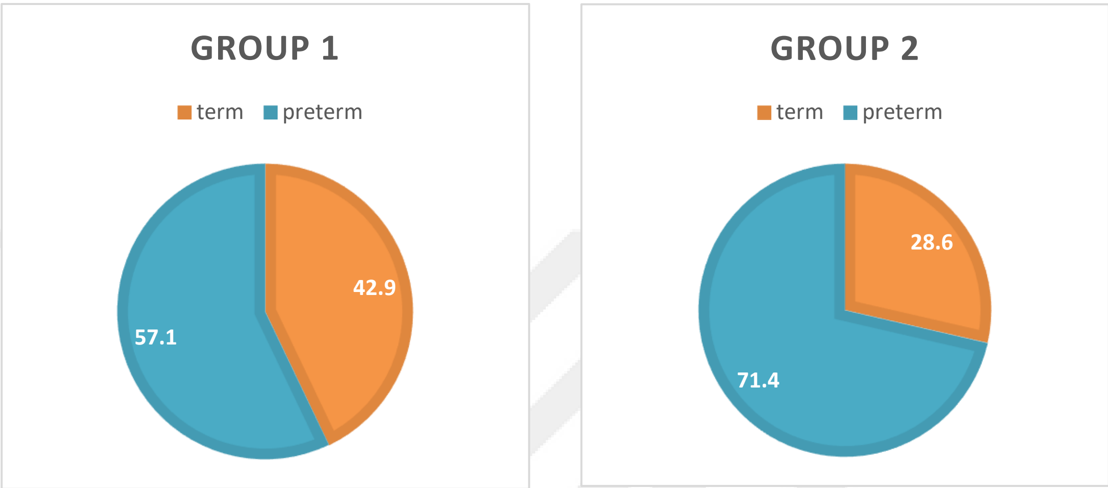
Table 4.2. History of the Birth of the Children

		Group 1 N (%)	**Group 2 N (%)**	**λ^2**	**p**
Type of Birth	Cesarean Surgery	10 (71.4)	10 (71.4)	0.0	1
	Vaginal Birth	4 (28.6)	4 (28.6)		
Gestational Age (week)	26.-30.	4 (28.5)	4 (28.5)	3.54	0.61
	30.-34.	4 (28.5)	4 (28.5)		
	34.-37.	-	2 (14.3)		
	37.-41.	6 (42.9)	4 (28.6)		
Multiple Gestations	Yes	3 (21.4)	7 (50)	2.48	0.11
	No	11 (78.6)	7 (50)		

Data expressed as n (%). Group 1: Study Group, Group 2: Control Group

The distribution of the prematurity is shown in Graph 4.1. Preterm indicates children who were born at less than 37 weeks' pregnancy, while term demonstrated children who were born after the 37 weeks' pregnancy. 57.1% of the children were preterm and 42.9% of them were term in Group 1. On the other hand, the ratio of the preterm children was 71.4% and term children was 28.6% in Group 2.

Graph 4.1. The Distribution of Prematurity



Data expressed as %. Group 1: Study Group, Group 2: Control Group

The gender, type of CP, GMFCS level, seizure history, medication, use of the assistive device, rehabilitation duration, visual status, auditory status and mental status in the study groups are present in Table 4.3. Apart from the seizure, there were not statically differences for gender, type of CP, GMFCS level, medication, use of assistive devices, rehabilitation duration, visual status, auditory status and mental status in Group 1 and Group 2 (Table 4.3).

While 7.1% of the children in Group 1 had seizures in their medical history, 42.9% of the children in Group 2 got over seizures in the past. However, any of the children included in the study did not have seizures in the past 1 year. In order to control seizures, while 7.1% of the children recieved the anticonvulsant drugs in Group 1, 21.4% of the children received the anticonvulsant drugs in Group 2 in the past (Table 4.3.). Currently, only one child in Group 1 use medication. Additionally, the numbers of the children with GMFCS level I and level II were equal in both groups.

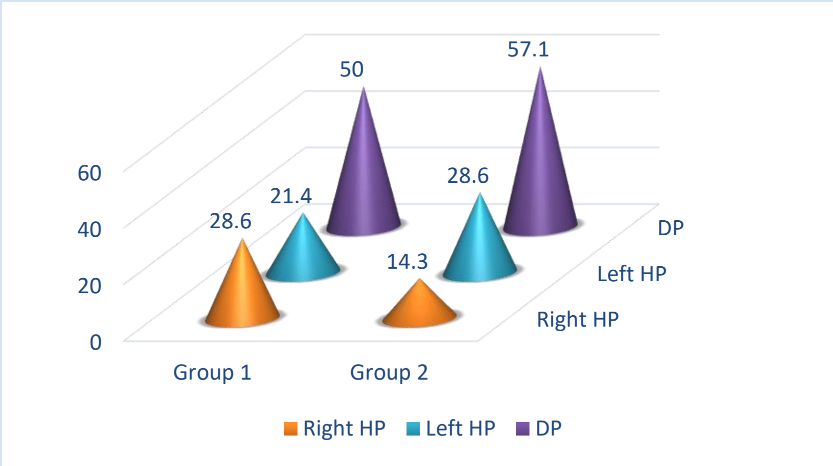
Table 4.3. Clinical Characteristics of the Children

		Group 1 N(%)	**Group 2** N(%)	**λ ²**	**p**
Gender	Girl	5 (35.7)	5 (35.7)	0	1
	Boy	9 (64.3)	9 (64.3)		
Type of CP	Right hemiparetic	4 (28.6)	2 (14.3)	0.87	0.64
	Left hemiparetic	3 (21.4)	4 (28.6)		
	Diparetic	7 (50)	8 (57.1)		
GMFCS Level	Level I	10 (71.4)	10 (71.4)	0	1
	Level II	4 (28.6)	4 (28.6)		
Seizure History	Yes	1 (7.1)	6 (42.9)	**4.76**	**0.02**
	No	13 (92.9)	8 (57.1)		
Medication	Yes	1 (7.1)	3 (21.4)	1.16	0.28
	No	13 (92.9)	11 (78,6)		
Use of the Assistive Device	No	11 (78.6)	8 (57.1)	4.97	0.29
	Double AFO	3 (21.4)	5 (35.7)		
	Single AFO	-	1 (7.1)		
Duration of Rehabilitation	From the birth	6 (42.9)	4 (28.6)	6.13	0.18
	From the age of 1	4 (28.6)	1 (7.1)		
	From the age of 2	1 (7.1)	4 (28.6)		
	From the age of 3	2 (14.3)	1 (7.1)		
	Other	1 (7.1)	4 (28.6)		
Visual Status	Normal	5 (35.7)	6 (42.9)	0.15	0.69
	Impaired	9 (64.3)	8 (57.1)		
Auditory Status	Normal	14 (100)	14 (100)	No statistics are computed	
	Impaired	-	-		
Mental Status	Normal	11 (78.6)	10 (71.4)	0.19	0.66
	Impaired	3 (21.4)	4 (28.6)		

Data expressed as n (%). CP: Cerebral Palsy GMFCS: Gross Motor Function Classification System AFO: Ankle Foot Orthosis Group 1: Study Group, Group 2: Control Group

The type of CP distribution is showed in Graph 4.2. In Group 1, the ratio of the children with right hemiparetic CP was 28.6%, left hemiparetic CP was 21.4% and diparetic CP was 50%. Similarly, 14.3% of the children had right hemiparetic CP, 28.6% of the children had left hemiparetic CP and 57.1% of the children had diparetic CP in Group 2 (Graph 4.2.). In both groups, the majority of the children had diparetic CP.

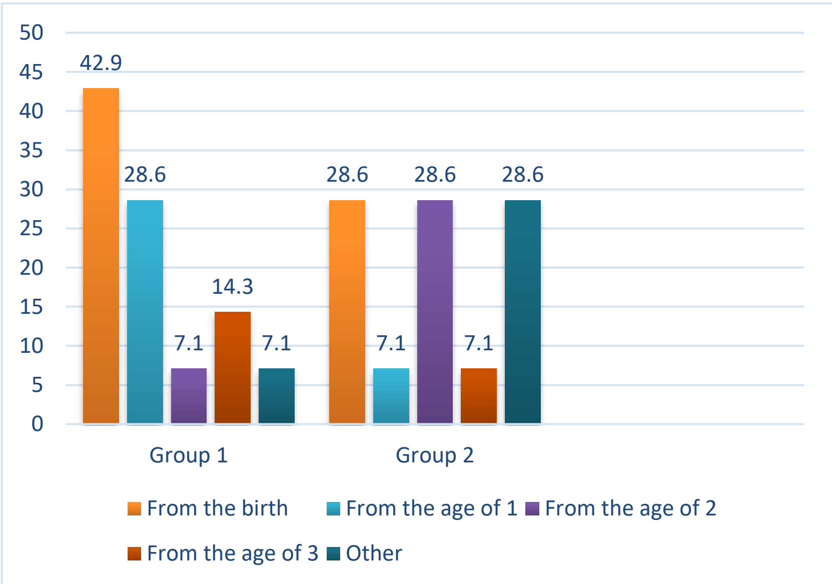
Graph 4.2. The Distribution of the Type of the CP



Data expressed as %. HP: Hemiparetic DP: Diparetic Group 1: Study Group, Group 2: Control Group

The rehabilitation duration distributions demonstrated in Graph 4.3. The ratio of the children who receive rehabilitation from the birth was 42.9%, from the age of 1 was 28.6%, from the age of 2 was 7.1%, from the age of 3 was 14.3% and other was 7.1% in Group 1. Similarly, the ratio of the children who receive rehabilitation from the birth was 28.6%, from the age of 1 was 7.1%, from the age of 2 was 28.6%, from the age of 3 was 7.1% and other was 28.6 in Group 2 (Graph 4.3.). All children in the study were already participating in physiotherapy and rehabilitation sessions.

Graph 4.3. The Distribution of the Rehabilitation Duration



Data expressed as %. Study Group, Group 2: Control Group

The sociodemographic features of the parents included education level and consanguinity are given in Table 4.4. There were no significant differences between the two groups according to the sociodemographic features of the parents. The mean value of the age of the mothers was 40.85±8.67 and the age of the fathers was 44.42±8.94 in Group 1 while the mean value of the age of the mothers was 39.85±8.50 and the age of the fathers was 43.14±8.01 in Group 2.

Table 4.4. Sociodemographic Features of the Parents

			Group 1 N (%)	**Group 2** N (%)	λ^2	**p**
Education level	**Mother**	Illiterate	-	1 (7.1)	1,86	0,6
		Primary School	8 (57.1)	8 (57.1)		
		High school	2 (14.3)	3 (21.4)		
		University	4 (28.6)	2 (14.3)		
	Father	Illiterate	-	-	2.40	0.3
		Primary school	6 (42.9)	4 (28.6)		
		High school	4 (28.6)	8 (57.1)		
		University	4 (28.6)	2 (14.3)		
Consanguinity		Yes	-	1 (7.1)	1.03	0.3
		No	14 (100)	13 (92.9)		

Data expressed as n (%). Group 1: Study Group, Group 2: Control Group

The independent sample t-test was used to compare the TUG test results with normal distribution in Group 1 and Group 2 before the intervention (Table 4.5). PBS, PNT and GMFM-88 D and E subdivisions results with non-normal distribution before the intervention between the Group 1 and Group 2 were compared with the Mann Witney U Test (Table 4.5). There was no significant difference between the two groups in TUG test, PBS, PNT, GMFM88-D and GMFM88-E results.

Table 4.5. Comparison of the TUG, PBS, PNT, GMFM88-D and GMFM88-E Results Between Treatment and Control Groups Before Intervention

	Group 1 mean±SD	**Group mean±SD**	**Significance**
TUG (s)	6.88±1.61	7.10±1.36	t: -0.38 p: 0.7
PBS	50.21±4.09	50.28±3.47	u: 96.50 p: 0.94
PNT (s)	13.23±3.18	13.90±4.10	t: -0.48 p: 0.63
GMFM88-D	78.68±17.6	85.89±10.48	u: 74.50 p: 0.27
GMFM88-E	86.07±13.8	83.42±12.45	u: 79.50 p: 0.39

Data expressed as mean ± standard deviation. Group 1: Study Group, Group 2: Control Group TUG: Timed Up and Go Test PBS: Pediatric Balance Scale PNT: Postrotary Nystagmus Test GMFM88: Gross Motor Function Measure 88

A paired sample t-test was executed to examine changes of each group across the pre and post intervention results in TUG test (Table 4.6). The results showed that while there were statically significant improvements for TUG test results during pre and post-intervention in Group 1 ($p<0.05$), there was no significant difference in Group 2. Wilcoxon test were used to determine the mean scores of PBS, GMFM88-D and GMFM88-E. In Group 1, the differences between the pre and post-intervention results of the PBS, GMFM88-D and GMFM88-E were found statistically significant ($p<0.05$). In Group 2, there was a significant difference between pre and post-intervention results of PBS and GMFM88-E ($p<0.05$). However, the difference between pre and post-intervention results of GMFM-D was not found statistically significant in Group 2.

Table 4.6. Comparison of the TUG, PBS, PNT, GMFM88-D and GMFM88-E Results for Intragroup

		Group 1 mean±SD	Significance	Group 2 mean±SD	Significance
TUG (s)	Pre	6.88±1.61	**t: 2.42**	7.10±1.36	t: 1.63
	Post	6.27±1.26	**p: 0.03**	6.7±0.97	p: 0.12
PBS	Pre	50.21±4,09	**z: -2,69**	50.28±3.47	**z: -2.71**
	Post	51.78±2.77	**p: 0.007**	51.35±2.97	**p: 0.007**
GMFM88-D	Pre	78.68±17.6	**z: -2.37**	85.89±10.48	z: -1.63
	Post	82.50±16.14	**p: 0.018**	86.99±10.37	p: 0.1
GMFM88-E	Pre	86.07±13.80	**z: -2.22**	83.42±12.45	**z: -2.58**
	Post	88.48±12.47	**p: 0.026**	85.31±12.03	**p: 0.01**

Data expressed as mean ± standard deviation. Group 1: Study Group, Group 2: Control Group TUG: Timed Up and Go Test PBS: Pediatric Balance Scale GMFM88: Gross Motor Function Measure 88

The comparison of the difference between pre and post results of TUG in intergroup variables was performed with an independent sample t-test (Table 4.7). There was no significant difference between the two groups in the pre and post-intervention results of TUG test. Mann Witney U Test was used to compare the difference between pre and post-intervention results of PBS, GMFM88-D and GMFM88-E in intergroup variables (Table 4.7). There was no significant difference between the two groups in pre and post-intervention results of PBS, GMFM88-D and GMFM88-E.

4.7.Comparison of Difference Between Pre and Post Intervention Results of the TUG, PNT, PBS, GMFM88-D and GMFM88-E in Intergroup Variables

	Group 1 mean±SD	Group 2 mean±SD	Significance
ΔTUG (s)	-0.61±0.94	-0.31±0.72	t: -0.93 p: 0.36
ΔPBS	1.57±2.06	1.07±1.07	u. 92.50 p: 0.79
ΔGMFM88-D	3.81±6.83	1.1±2.79	u: 69.00 p: 0.12
ΔGMFM88-E	2.40±5.95	1.88±3.29	u: 87.00 p:0.58

Data expressed as mean ± standard deviation. Group 1: Study Group, Group 2: Control Group TUG: Timed Up and Go Test PBS: Pediatric Balance Scale GMFM88: Gross Motor Function Measure 88 Δ: Post Values minus Pre Value

5. DISCUSSION

This study conducted with 28 cerebral palsied children whose GMFCS levels were I or II in Sancaktepe Special Education and Rehabilitation Center. The purpose of the study was to investigate the effects of the vestibular training combined with the NDT on balance in CP in comparison to NDT alone. For the evaluation of the balance parameters GMFM-88, TUG test and PBS were used.

It is claimed that the vestibular system plays an important role in motor development because of its neuroanatomical connections and physiological effects. It may also have effects on the development of the body image [93].

It has been suggested that there may be a sensory deprivation in developmentally delayed children because of the insufficient responses and slow development of their sensory and motor systems. Previous studies indicated that vestibular stimulation could improve muscular tonicity, gross and fine motor skills, reflex integration, visual exploratory behavior and arousal level [94, 95]. Repeated stimulation leads to decrease in the duration of the postrotary nystagmus and provides more accurate VOR control which has effects on retinal image stability. Retinal image stability provides a stable background for motor movements. Therefore, with the improvement of retinal image stability and inhibitory mechanism, vestibular stimulation can enhance motor performance [96]. Also, it is argued that vestibular stimulation improves postural control by activating antigravity muscles. Simultaneously, muscles in the cervical spine can be facilitated to straighten the head position and this facilitation promote maintenance of the postural control, static and dynamic balance. Furhermore, vestibular stimulation inhibits abnormal reflexes and provide normal postural alignment [97]. It is argued that vestibular stimulation is a convenient intervention for the blind, retarded, cerebral palsied, developmentally delayed and premature children [98].

The effect of vestibular stimulation on children with CP is widely studied in the literature. In two reviews published in 2012 [99] and 2018 [100], studies examining the effect of vestibular apparatus stimulation on postural muscle tone and the effect of vestibular stimulation on gross motor function in CP were analyzed respectively. These reviews demonstrated that the vestibular apparatus has effects on normal motor development and coordination, and otolith organ stimulation increases extensor muscle tone. In addition to this, it is shown that vestibular stimulation has positive effects on gross motor function and gait parameters.

Shamsoddini et al. carried out a study that includes 24 cerebral palsied children age between 2-6 and investigated the effect of SIT containing vestibular stimulation on gross motor function with GMFM-88 [61]. They applied SIT to the treatment group while the control group were treated with home exercises. After the 12 weeks of therapy, they found significant improvement pre and post-intervention results in B, C and D dimensions of GMFM-88. They argued that because the interventions focus on facilitating motor function and postural stability, SIT has more positive effects on B, C and D dimensions. Similarly, Tahir at al. investigated the effects of vestibular and proprioceptive stimulations on gross motor functioning in spastic CP [101]. They included 26 children and applied vestibular and proprioceptive stimulations 45 min, 4 days per week through the 3 months. At the end of the study, they found significant improvement in all dimensions of GMFM-88. They advocated that improvement in gravitational insecurity due to postural abnormalities and facilitation of postural stability with the initiation of the neck and head musculature can cause the improvement of gross motor function. However, there was not a control group in their study. Also, in both Shamsoddini's and Tahir's studies, other sensory inputs such as proprioceptive stimulation were used along with the vestibular stimulation. Therefore, the results of these studies do not reflect the isolated effects of vestibular stimulation. However, in our work we practiced activities intended to stimulate vestbular system and investigated the effect of vestibular stimulation alone. Besides, unlike these studies, our study continued through 6 weeks totally 12 sessions. As a result of these conditions, our results may show differentiation from these studies.

In a case study, it was suggested that 5-year-old GMFCS level IV CP children showed improvement in balance parameters with swiss ball training for 4 weeks when the GMFM scores were taken into consideration [102]. In another case study that was performed with a 19-month-old boy with hypotonic CP, vestibular stimulation applied by using different swings a total of 30 sessions [103]. Following 10 weeks of treatment the child had shown significant improvement in mental and motor scores of Bayley Infant Development Score. The authors argued that vestibular stimulation can improve the movements in space and transitioning from supine or prone to sitting and from sitting to pull to stand independently. This is because of the improvement in insufficient vestibular integration and gravitational insecurity. However, both works include only one child in their study. Therefore, results presented in these works are not generalizable in children with CP.

ElShazly et al. conducted a randomized controlled study with 30 cerebral palsy children aged 1-5 years to evaluate the effect of vestibular stimulation comprised of toy horse riding, ball therapy, tilt and scooter board activities on gross motor function [104]. In their study experimental group was received vestibular stimulation in addition to traditional physical therapy, while the control group received traditional physical therapy only. At the end of the study, the total GMFM score of the vestibular stimulation group increased and they argue that according to their results following to 6 weeks of vestibular stimulation ensures improvement in gross motor function along with the other mental, social and behavioral status. Although the duration of the study was 6 weeks as the same as our study, the duration of the therapy sessions differed. While vestibular training was performed for 15 minutes in our study, vestibular stimulation group received therapy for one hour in Elshazly et al.'s study. Also, they used different kind of vestibular materials from our study.

Kim et al. preferred to use the Independent Standing Time (ID standing time) test and TUG test for observing the effects of the vestibular stimulation on static and dynamic balance at children with CP [97]. They performed their study with 7 CP children GMFCS level II or higher. They applied vestibular stimulation with a swiss ball in two postures (prone and sitting) and three activities (up and down, to and from and spinning movements). At the end of the study, all subjects included showed improvement in the TUG test and ID standing time test. According to their results, the prone position can promote core stabilization. Also, antigravity muscle can be activated, synaptic maturation of the inhibitory tract can be accelerated, arousal level can be increased and the VOR can be improved by vestibular inputs. Therefore, the child can maintain the postural tone and postural alignment along with improvement in sensory integration and gaze stability. Consequently, vestibular stimulation using a swiss ball increased static and dynamic balance in CP according to Kim et al. However, this study methodologically differs from our work. They evaluated immediate effect of vestibular stimulation after 20 minutes one session with a small sample. Therefore, it makes no sesnse to compare the results of our study.

Chee et al. performed a study with twenty-three preambulatory cerebral palsied children with age ranging from 2 to 6 years old [105]. Authors found significant improvement between the treatment and the control groups after 16 sessions of semicircular canal stimulation. While children in the treatment group had shown improvement in the motor performance and postural reflexes evaluated with Motor Skill Test and Postural Reflex Test, children in the control group had not. They speculated that development of the motor and postural reflexes can be delayed because of imperfect vestibular control of eye movements and this improvement results from an appropriate interaction between visual and vestibular systems. However, they did not mention about the vestibular fuction level of the children before the intervention. In our study we used PNT to ensure homogeneity between the groups.

On the other hand, Khulood et al. conducted a study examining the effect of vestibular stimulation on balance [91]. 30 CP children were included in their study and they assessed the children with the Biodex balance system. Group A received a traditional physical therapy program and Group B received a traditional physical therapy program in addition to vestibular stimulation in their study. After 8 weeks of the therapy program, they found a significant difference in the overall dynamic stability index, antero/posterior stability index and medio/lateral stability index between study and control groups. Hosseini et al. evaluated changes in the center of pressure displacement and velocity parameters of 16 CP children in eyes open and closed conditions with 10 weeks of vestibular stimulation therapy [90]. In their study, one group experienced conventional occupational therapy while the other group experienced a period of vestibular stimulation in addition to conventional occupational therapy. They found a significant difference in velocity parameters between two groups and concluded that children were able to change and control the center of pressure displacement faster in the study group. Although, the focuses of these studies are related to our work, the presented results are not directly comparable to our results, since insturements employed in these works are not the same as our tests. In our study, we used functional balance assessment tests which are PBS and TUG test. The results obtained with the tests used in both Khulood's and Hosseini's studies could not be evaluated in terms of functionality.

PBS and TUG test are reliable and valid tests for functional balance assessment in pediatric population andiIn previous studies related to CP, the PBS and the TUG test had been widely used for evaluating balance [109, 110, 111, 112]. PBS evaluates several functional activities that a child must achieve independently within her/his home, school or community. It does not require any specialized format or material [83]. During the TUG test, when the child performs standing up form the chair and sitting back, his/her lower extremity muscles must be strong enough and he/she can change COM position horizontal to vertical safely. In the walking phase he/she must walk fast and in turning around phase he/she must ensure coordination between head, thorax and pelvis. Compared to the typical analysis of straight-line walking, the TUG represents the activity of daily living more. Therefore, we used PBS and TUG test in our study because functional balance takes a more important role in achieving the activity of daily living safely, easy to apply and cost-effective.

The Vestibuloocular Reflex (VOR) provides a stable visual field during head movements by stabilizing the eye muscles [87]. The eyes turn in the opposite direction of the head movement to ensure stable visual field and fixation of the object. It is important for maintenance of spatial orientation. In the present study, the vestibular system function is evaluated throughout VOR with Postrotary Nystagmus Test.

In literature, there is a study conducted by El Shemy and El-Fettah as an example of studies investigating the effect of vestibular stimulation on fine motor skills and pinch strenght in children with hemiparetic CP [106]. In their study 60 children aged 4-6 years had been divided into three groups which were study groups (B, C) and control group (A). When the control group received only conventional physiotherapy and occupational therapy, study groups received vestibular stimulation with the head was in 45 and 60 degrees from the prone position along with the conventional physiotherapy and occupational therapy. After the intervention, there were significant differences between pre and post-intervention results within all the groups. However, children who received vestibular stimulation with the head was 45 degree from prone position showed more significant improvement in fine motor skills and pinch strength than other groups. They argued that this improvement results from the effects of the vestibular stimulation on the improvement of visual-motor coordination, normalization of muscle tone and facilitation of extensor muscle tone. They also emphasized that vestibular stimulation with the head was 45 degrees from the prone position is more effective on visual-motor integration. This study shows the importance of the head position on the effect of vestibular system. In our study, we also used different body positions which also provide different head positions to stimulate different parts of vestibular system.

There are some studies that compare the effects of vestibular stimulation to another intervention in the literature. In one of these studies, authors searched the effects of vestibular stimulation versus whole body vibration on standing balance in children with spastic diplegic CP [107]. In this study, they applied vestibular stimulation (spinning, sliding and bouncing) with conventional physiotherapy to one group and the other group had been received whole body vibration in two positions (squat position and standing) with conventional physiotherapy for 5 days a week. They evaluated the children with PBS and Parents' perception on Balance (PPB). At the end of 4 weeks of the therapy, the vestibular stimulation group has shown significantly better improvement in PBS and PPB scores. The authors stated that the development of postural reactions, normalization of tone, and enhancement of motor development through vestibular stimulation lead to this improvement. In another study, Olama and Thabit investigated the differences between the effects of vibration and suspension therapy on balance in 30 hemiparetic CP aged between 8-10 [108]. While one group had received vibration therapy, the other group had received suspension therapy via using a 'spider cage' along with the regular physiotherapy program. They argued that spider cage provides improvement the function of vestibular system by stimulation otolith organs through linear displacement. Biodex balance system had been used for assessing the balance. Suspension therapy group has shown a more significant difference when comparing the vibration therapy group in Biodex balance system parameters. It is demonstrated by the authors that this improvement results from the effect of suspension therapy in the development of equilibrium reaction to maintain and regain balance during standing pattern through vestibular input.

In our study, Group 1 showed statistically significant improvement for pre and post-intervention results in the TUG test, PBS and both of the GMFM-88 dimensions ($p<0.05$). The reason for this significant difference in group 1 may be the increase in activation of postural muscles with holding the head upright while swinging in the prone position, as demonstrated in previous studies [97]. Also, spinning activity can be effective on VOR control, therefore the gaze stability may be improved. The up and down movements performed on the trampoline can provide inputs about spatial orientation and an increase in body awareness along with decrease in gravitational insecurity.

Also, according to our results, Group 2 showed statistically significant improvement in the E dimension of GMFM-88 and PBS. This improvement in Group 2 may be due to the positive effect of NDT on gross motor function, spasticity, postural control and balance. Sah et al. reported that NDT has positive effects on trunk control, balance and gross motor function in CP according to their results obtained from PBS and GMFM-88 [113]. They argued that NDT applications encompass activities providing active weight shifts to control dynamic stability and optimal alignment for reaching. Also, these applications can facilitate the normal postural controlled movements pattern. Similarly, Tekin et al. suggested that NDT can improve postural control and balance [49]. Their evaluations revealed that children had shown statistically significant improvements in GMFM-88 and PBS scores.

Additionally, in our study, there was no significant difference between pre and post-intervention results in intergroup variables. When the NDT program combined with vestibular training and the NDT program alone were compared, the NDT program combined with vestibular training was not statistically superior in improving balance. However, as shown in Table 4.7., group 1 showed more progress than group 2 in all tests at the end of the study.

We have found that only the work published by Sellick et al. presents similar results to our findings [114]. They reported that vestibular stimulation which was provided by spinning is not effective on motor development in CP since their treatment and control groups are not homogeneous in terms of initial performance, age and clinical diagnostic category. Also, they mentioned that they can not control the therapeutic history (the amount of vestibular stimulation that children experienced before the study) of the children. In our study, we eliminated this condition because we tested all children with PNT before the intervention. There was no significant difference between the two groups which means, all children in both groups had equal vestibular function status prior the study.

Another thing we should emphasize in our study is the levels of motivation and fatigue of the children. It was not possible to eliminate fatigue in some children during the study and it was difficult to overcome the low level of motivation caused by fatigue occasionally. However, it was easier to maintain motivation in children in

Group 1 because children found the vestibuler stimulation activities more enjoyable and they were willing to perform these activities.

There is no consensus about optimal number of daily training hours and optimal duration of intervention to improve motor function in children with CP. However, it is demonstrated that duration of therapy and daily dose play important role in motor function [115]. Also, it is claimed that large number of sample size is more effective to see improvement in motor function [80]. Therefore, we speculate that there can be two reasons preventing the statistical significance of the improvements. First, we think that the sample size is not large enough to show statistically significance. Second, we hypothesize that the number of the sessions conducted were not adequate to enhance the balance status of the children. Increasing the frequency of the sessions per week by keeping 6 weeks of treatment unchanged or extending the duration of the treatment (e.g 9 weeks instead of 6 weeks) can help statistically significance.

There were several limitations to our study. The most important limitation is having a small sample size to generalize the effect of vestibular training combined with NDT on balance in children with CP. The other one, we could not provide the follow-up control of the children. In addition, we conducted the study with children whose GMFCS level were I and II only.

6. CONCLUSION AND SUGGESTIONS

When the previously published studies are investigated, they have different kinds of vestibular stimulation applications. There is no generalized vestibular training program, therefore each study has its own vestibular training program protocol. Also, the intensity (duration and frequency) of the therapies showed a variety among the studies. It can be difficult to say which one of the protocols or how long the therapy duration is more effective on the balance in CP.

GMFCS level is another factor that can affect the results. It is claimed that with the lower level of GMFCS, the participants can already achieve the activities at a higher level in the GMFM dimensions, so little improvement in the GMFM scores can be shown in studies [80]. Besides, the different degrees of impairments in postural control and balance can present in children with different types of CP.

In conclusion, we could not gain a statistically significant improvement, however, as shown in Table 4.7., group 1 showed more progress than group 2 in all tests at the end of the study. Although it is not statistically significant, the positive improvements we achieved in group 1 show that vestibular rehabilitation influences balance. Most of the previous studies argue that postural control and balance in cerebral palsy are improved with vestibular training because of the effects of vestibular stimulation on muscle tone, gaze stability, abnormal reflex inhibitation, sensory integration and gravitational insecurity. Therefore, phsiotherapists can apply vestibular training in their therapy sessions to improve the balance status of children with CP.

Suggestions:

- When vestibular stimulation is added to physiotherapy sessions, activities that will stimulate all components of the vestibular system should be selected to create the best effect.
- Further studies in which the duration of therapy and frequency of sessions are higher than the present study should be conducted.
- Further studies should be conducted with children with different levels of GMFCS and different types of CP to investigate the effect of vestibular stimulation on respiration and swallowing problems along with the balance in CP.

- Home exercises should be taught to the parents clearly and their follow-up should be done with the documents kept under record or videos. Additionally, in order to see the effect of parent education on the results, further stdies can be planned by adding a group received parent education once a week.
- Physiotherapists can use the TUG test and PBS to assess the functional balance of children with CP. These tests are reliable and easily applicable evaluation tools and provides quantitive data for measuring the efficacy of the treatment.
- There are evidences about vestibular stimulation is beneficial for increasing concentration and attentiveness, improving learning and memory and managing for stress in students [116, 117]. Therefore, further studies can be planned as multidisciplinary with psychologists, speech therapists and special education teachers to support active participation, maintain motivation and improve language and academic success.

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APPENDIX 1: INFORMED WRITTEN CONSENT

T.C. YEDİTEPE ÜNİVERSİTESİ

Bu anket Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü Fizyoterapi ve Rehabilitasyon Anabilim Dalı, Yüksek Lisans Tezi için hazırlanan **"Serebral Palsili Çocuklarda Vestibüler Eğitimle Kombine Edilmiş Nörogelişimsel Tedavi Programının Denge Üzerine Etkilerinin İncelenmesi"** adlı araştırma kapsamında kullanılmaktadır. Bu çalışmanın amacı serebral palsi tanısı almış çocuklarda vestibüler eğitimle kombine edilmiş nörogelişimsel fizyoterapi programının denge üzerine etkilerinin incelenmesidir. Çalışmaya 30 serebral palsili çocuk dahil edilecek, fizyoterapi seansları haftada 2 gün ve 45 dakika sürecektir.

Araştırma ile ilgili sizden doldurmanızı istediğimiz formları doğru bir şekilde doldurmanızı ve herhangi bir şikayetiniz ya da rahatsızlığınız olduğunda bize bildirmeniz gerekmektedir. İstediğiniz zaman çalışma dışına çıkma hakkınız olduğunu bilmenizi isteriz. Bu araştırma kapsamında uygulanacak olan uygulamalarda herhangi bir risk bulunmamakta ve yapılacak hiçbir uygulama size zarar vermeyecektir. Bu araştırma dahilinde sizden herhangi bir ücret talep edilmemektedir. Bu araştırmada yer almanız nedeniyle size hiçbir ödeme yapılmayacaktır. Kişisel bilgileriniz herhangi bir amaçla, kurum yöneticileri veya üçüncü kişilerle paylaşılmayacaktır.

Katılımınız için teşekkür ederiz.

Danışman Öğretim Üyesi: Prof. Dr. Feryal SUBAŞI

Araştırmacı: Fzt. Ezgi ENİŞER-05063760767 (Araştırma süresince 24 saat ulaşılabilecek kişi)

Serebral Palsili çocuklarda vestibüler eğitimle kombine edilmiş nörogelişimsel tedavi programının denge üzerine etkilerinin incelenmesi isimli çalışmada katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. **Çalışma hakkında yazılı ve sözlü açıklama adı belirtilen araştırmacı tarafından yapıldı.** Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kızımın/oğlumun hiçbir baskı ve zorlama olmaksızın kendi rızamla katılmasına izin veriyorum.

Gönüllünün Adı Soyadı/ İmzası/ Tarih

Açıklama Yapan Kişinin Adı Soyadı/ İmzası/ Tarih

APPENDIX 2: STRUCTURED QUESTIONNAIRE

Yeditepe Üniversitesi

Sağlık Bilimleri Enstitüsü

Fizyoterapi ve Rehabilitasyon Anabilim Dalı

Bölüm 1. Demografik Özellikler

1. AD SOYAD :
2. CİNSİYET
   □KIZ □ERKEK
3. DOĞUM TARİHİ:
4. BOY :
5. KİLO :
6. ANNENİN YAŞI :
7. BABANIN YAŞI :
8. DİĞER KARDEŞLER KAÇ TANE VE SAĞLIKLI MI?
   ……………………………………………………………………………
9. ANNENİN EĞİTİM DURUMU
   □OKUMA YAZMA YOK □İLKÖĞRETİM □ÜNİVERSİTE VE ÜZERİ
   □OKUR-YAZAR □LİSE
10. BABANIN EĞİTİM DURUMU
    □OKUMA YAZMA YOK □İLKÖĞRETİM □ÜNİVERSİTE VE ÜZERİ
    □OKUR-YAZAR □LİSE
11. DOĞUM ŞEKLİ
    □SEZARYEN □NORMAL
12. DOĞUM HAFTASI
    □26-28 HAFTA □30-32 HAFTA □34-36 HAFTA □38 HAFTA VE SONRA
    □28-30 HAFTA □32-34 HAFTA □36-38 HAFTA
13. ÇOĞUL GEBELİK
    □VAR □YOK

14. ANNE BABA ARASINDA AKRABALIK
    □VAR □YOK

15. NÖBET GEÇMİŞİ
    □VAR □YOK

16. KULLANILAN İLAÇ VAR MI? VARSA NELER?
    □VAR □YOK ………………………………

17. REHABİLİTASYON GEÇMİŞİ
    □VAR □YOK

18. REHABİLİTASYON SÜRESİ
    □DOĞUMDAN İTİBAREN □1 YAŞINDAN İTİBAREN □DİĞER
    □2 YAŞINDAN İTİBAREN □3 YAŞINDAN İTİBAREN

19. SON 6 AY İÇERİSİNDE CERRAHİ OPERASYON GEÇMİŞİ
    □VAR □YOK

20. SON 6 İÇERİSİNDE BOTOX UYGULAMASI GEÇMİŞİ
    □VAR □YOK

21. YARDIMCI CİHAZ KULLANIMI
    □VAR □YOK

22. KULLANILAN YARDIMCI CİHAZ
    □SMO □AFO □TABANLIK □WALKER □DİĞER

23. HER İKİ EKSTREMİTE İÇİN DE KULLANILIYOR MU
    □EVET □HAYIR

24. SEREBRAL PALSİNİN TİPİ
    □HEMİPARETİK □DİPARETİK □TETRAPARETİK

25. GÖRME PROBLEMİ VAR MI? (GÖZLÜK KULLANIYOR MU?)
    □EVET □HAYIR

26. İŞİTME PROBLEMİ VAR MI? (İŞİTME CİHAZI KULLANIYOR MU?)
    □EVET □HAYIR

27. MENTAL YETERSİZLİK HANGİ SEVİYEDE?

    □YOK □HAFİF □ORTA □AĞIR

Bölüm 2. Motor Seviye Değerlendirmesi

Kaba Motor Fonksiyon Sınıflandırma Sistemi (KMFSS)

	Seviye I: Bağımsız yürür İleri kaba motor becerilerde daha fazla limitasyonu vardır.
	Seviye II: Cihazsız yürür, toplum içinde yürürken limitasyonları vardır.
	Seviye III: Cihazla yürür, toplum içinde yürürken limitasyonu vardır.
	Seviye IV: Limitasyonu var, toplum içinde taşınır veya tekerlekli sandalyeye bağımlıdır.
	Seviye V: Yardımcı teknoloji kullanılsa da mobilizasyon ciddi derecede sınırlıdır.

Kaba Motor Fonksiyon Ölçütü (KMFÖ-88)

Çocuk Adı:	**Tarih:**			
Terapistin Adı:	**0**	**1**	**2**	**3**
SUPİN (Sırtüstü)				
1- Simetrik postür (Başı ekstremitelerle simetrik döndürür)	☐	☐	☐	☐
2- Ellerin orta hatta gelmesi ●	☐	☐	☐	☐
3- Başı 45° kaldırma	☐	☐	☐	☐
4- Sağ kalça ve diz fleksiyonu (Tam Range)	☐	☐	☐	☐
5- Sol kalça ve diz fleksiyonu (Tam Range)	☐	☐	☐	☐
6- Sağ kolu orta hatta çapraz uzatma, oyuncağa dokunmak için kolu uzatma ●	☐	☐	☐	☐
7- Sol kolu orta hatta çapraz uzatma, oyuncağa dokunmak için kolu uzatma ●	☐	☐	☐	☐
8- Sağ taraftan yüzükoyun pozisyona dönme	☐	☐	☐	☐
9- Sol taraftan yüzükoyun pozisyona dönme	☐	☐	☐	☐
PRON (Yüzüstü)				
10- Başı masadan kaldırma ●	☐	☐	☐	☐
11- Ağırlık eller üzerinde, baş ve göğsü masadan kaldırma	☐	☐	☐	☐
12- Sağ önkola ağırlık verme, alt kolu tam öne uzatma	☐	☐	☐	☐
13- Sol önkola ağırlık verme, alt kolu tam öne uzatma	☐		☐	☐
14- Sağ taraftan sırtüstü pozisyona dönme	☐	☐	☐	☐
15- Sol taraftan sırtüstü pozisyona dönme				
16- Sağ yana 90° dönme	☐	☐	☐	☐
17- Sol yana 90° dönme	☐	☐	☐	☐
OTURMA				
18- Supin pozisyonunda, değerlendirmeci tarafından eller tutulur ve baş kontroluyla oturmaya geçme ●	☐	☐	☐	☐
19- Sağ yan yatış pozisyonundan oturmaya geçme,	☐	☐	☐	☐
20- Sol yan yatış pozisyonundan oturmaya geçme,	☐	☐	☐	☐
21- Matte otururken thoraks terapist tarafından destekli başı dik pozisyona getirme (3 sn) ●	☐	☐	☐	☐
22- - Matte otururken toraks terapist tarafından destekli başı orta hatta tutma (10 sn) ●	☐	☐	☐	☐
23- Kol destekli olarak yerde oturma (3sn)	☐	☐	☐	☐
24- Kol desteksiz olarak yerde oturma (3sn)	☐	☐	☐	☐
25- yerde otururken öne eğilip oyuncağa dokunup, kol desteksiz tekrar dikleşme ●	☐	☐	☐	☐
26- Otururken sağ tarafından arkaya doğru 45° yerleştirilmiş bir oyuncağa dokunma ●	☐	☐	☐	☐
27- Otururken sol tarafından arkaya doğru 45° yerleştirilmiş bir oyuncağa dokunma ●	☐	☐	☐	☐

28- Sağ tarafa yan oturur, kollar serbest (5sn)	□	□	□	□
29- Sol tarafa yan oturur, kollar serbest (5sn)	□	□	□	□
30- Yerde oturma pozisyonundan yüzükoyun pozisyona dönme ●	□	□	□	□
31- Yerde oturma pozisyonundan sağ taraftan emekleme pozisyonuna geçme ●	□	□	□	□
32- Yerde oturma pozisyonundan sol taraftan emekleme pozisyonuna geçme ●	□	□	□	□
33- Otururken kol desteği olmadan ekseni etrafında 90°dönme	□	□	□	□
34- Sandalye ya da taburede oturma (10sn) ●	□	□	□	□
35- Kendi kendine alçak bir tabureye oturma ●	□	□	□	□
36- Kendi kendine küçük bir sandalyeye oturma ●	□	□	□	□
37- Kendi kendine yüksek bir tabureye ayaklar sarkacak şekilde oturma ●	□	□	□	□
EMEKLEME ve DİZ ÜSTÜ (4 nokta)				
38- Karın üzerinde sürünme (>182.88cm (>6 foot))	□	□	□	□
39- Emekleme pozisyonunu koruyabilme (10sn) ●	□	□	□	□
40- emekleme pozisyonundan oturmaya geçebilme ●	□	□	□	□
41- Emekleme pozisyonunu alabilme ●	□	□	□	□
42- Emekleme pozisyonunda sağ kolu uzatabilme ●	□	□	□	□
43- Emekleme pozisyonunda sağ kolu uzatabilme ●	□	□	□	□
44- Emekleme ya da zıplamak (>182.88 cm (>6 foot)) ●	□	□	□	□
45- Öne doğru resiprokal emeklemek (>182.88 cm (>6 foot)) ●	□	□	□	□
46- Merdivenleri emekleyerek çıkma (4 basamak) ●	□	□	□	□
47- Geri geri merdivenleri emekleyerek inme (4 adım)	□	□	□	□
48- Dizüstüne gelme, kalça ekstansiyonda ●	□	□	□	□
49- Yarım dizüstü, sağ ayak önde (10sn)	□	□	□	□
50- Yarım dizüstü, sol ayak önde (10 sn)	□	□	□	□
51- Dizüstü yürüme (10 adım) ●	□	□	□	□
AYAKTA DURMA				
52- Mobilyadan tutarak ayağa kalkma ●	□	□	□	□
53- Yalnız başına anlık ayakta durma (3sn) ●	□	□	□	□
54- Bir yerden tutarak ayakta dururken, sağ ayağı kaldırma (3 sn) ●	□	□	□	□
55- Bir yerden tutarak ayakta dururken, sol ayağı kaldırma (3 sn) ●	□	□	□	□
56- Bağımsız olarak ayakta durma (20sn) ●	□	□	□	□
57- Bağımsız olarak sağ bacak üzerinde ayakta durma (10sn) ●	□	□	□	□
58- Bağımsız olarak sol bacak üzerinde ayakta durma (10sn) ●	□	□	□	□
59- Küçük bir tabureden ayağa kalkma ●	□	□	□	□
60- Sağ bacak önde yarım dizüstü pozisyondan kolları kullanmadan ayağa kalkma ●	□	□	□	□
61- Sol bacak önde yarım dizüstü pozisyondan kolları kullanmadan ayağa kalkma ●	□	□	□	□
62- Zemine doğru çömelme, kollar serbest ●	□	□	□	□
63- Çömelmiş pozisyonda oynama ●	□	□	□	□
64- Yerden bir obje alarak kalkma ●	□	□	□	□
YÜRÜME				
65- 2 elini bardan tutarak sağa 5 adım yürüme ●	□	□	□	□
66- 2 elini bardan tutarak sola 5 adım yürüme ●	□	□	□	□
67- 2 eli bir kişi tarafından tutularak yürüme (10 adım) ●	□	□	□	□
68- Bir eli tutarak yürüme (10 adım) ●	□	□	□	□
69- Yalnız başına yürüme (10 adım) ●	□	□	□	□
70- Yürürken durur, 180° geri döner ●	□	□	□	□
71- Arkaya doğru geri geri yürüme (10 adım) ●	□	□	□	□
72- Büyük bir objeyi iki elle taşıyarak yürüme ●	□	□	□	□
73- Paralel çizgiler arasında yürüme (20.32cm (8 inch) mesafeli) (10 adım) ●	□	□	□	□
74- Düz bir çizgide yürümek (10 adım) ●	□	□	□	□
75- Sağ diz düz, sol ayakla öne adım alma ●	□	□	□	□
76- Sol diz düz, sağ ayakla öne adım alma ●	□	□	□	□
77- Koşma (4.5 m), durup geri dönme ●	□	□	□	□
78- Sağ ayağı ile topa vurma ●	□	□	□	□
79- Sol ayağı ile topa vurma ●	□	□	□	□
80- Her iki ayakla yukarı sıçrama (30.48 cm (12 inch)) ●	□	□	□	□
81- Her iki ayakla öne sıçrama (>30.48 cm (>12 inch)) ●	□	□	□	□

82- Sağ ayağı üzerinde bağımsız olarak sıçramak (10 kez) (60cm) ●	☐	☐	☐	☐
83- Sol ayağı üzerinde bağımsız olarak sıçramak (10 kez) (60cm) ●	☐	☐	☐	☐
MERDİVEN ÇIKMA				
84- Barı tutarak 4 basamak merdiven çıkma, alternate olarak ●	☐	☐	☐	☐
85- Barı tutarak 4 basamak merdiven inme, alternate olarak ●	☐	☐	☐	☐
86- Kollar serbest, tutmadan merdiven çıkma (4 adım), alternate olarak ●	☐	☐	☐	☐
87- Kollar serbest, tutmadan merdiven inme (4 adım), alternate olarak ●	☐	☐	☐	☐
88- 15.24 cm (6 inch) bir basamağa her iki ayakla sıçrama ●	☐	☐	☐	☐

BÖLÜM B

Destekler
Rollator/Pusher
Walker
H çerçeveli koltuk değneği
Koltuk değneği
Quadripod
Baston
Hiçbirşey

Ortezler
Kalça kontrolü
Diz kontrolü
Ayak bileği/ ayak kontrol
Ayak kontrolü
Ayakkabı
Diğer
Hiçbirşey

Puanlama:
0= Başlatamaz
1= Bağımsız olarak başlatır
2= Kısmen tamamlar
3= Bağımsız olarak tamamlar

PUANLAMA

Hedef Alan

- A- Yatma- yuvarlanma bölümü (1-17)..................Skor / 51 X 100= .....%
- B- Oturma bölümü (18- 37)....................................Skor/ 60 x 100= ....%
- C- Emekleme – diz üstü durma (38- 51)................Skor/ 42x 100= ....%
- D- Ayakta durma (52- 64)..Skor/ 39x 100= ....%
- E- Yürüme – koşma- zıplama (65- 88)...................Skor / 72 x 100=......%

➢ Toplam bir skor hesaplanabildiği gibi, her bir bölümün kendi içinde hesaplanmasında mümkündür.

$$\textbf{TOPLAM SKOR} = \frac{\%A + \%B + \%C + \%D + \%E}{5}$$

$$\text{Hedef alan toplam skorları: } \frac{\text{hedef alanların \% puan toplamı}}{\text{Hedef alan sayısı}}$$

İlk Değerlendirme :

Son Değerlendirme :

Bölüm 3. Denge Değerlendirmesi

Pediatrik Berg Denge Skalası	Skor (0-4)
1. Oturur durumdayken ayağa kalkmak	----------
2. Ayaktayken oturma pozisyonuna geçme	----------
3. Yer değiştirmek	----------
4. Desteksiz ayakta durma	----------
5. Desteksiz oturma	----------
6. Gözler kapalı olarak ayakta durma	----------
7. Ayaklar bitişik olarak ayakta durma	----------
8. Bir ayak önde ayakta durma	----------
9. Tek ayak üstünde ayakta durma	----------
10. 360 derece dönme	----------
11. Geriye bakmak için dönme	----------
12. Yerden nesne alma	----------
13. Diğer ayağı tabureye koyma	----------
14. Ayaktayken kollar gergin öne uzanma	----------

1.Oturma Pozisyonundayken Ayağa Kalkmak Yönerge: Lütfen ayağa kalkın. Ellerinizden destek almamaya çalışın. 4 Ellerini kullanmadan ayağa kalkabilir ve kendi kendine denge sağlayabilir. 3 Ellerini kulla narak ayağa kalkabilir. 2 Birkaç denemeden sonra ellerini kullanarak ayağa kalkabilir. 1 Ayağa kalkmak ve denge kurmak için çok az yardıma ihtiyacı vardır. 0 Ayağa kalkmak için orta düzeyde ya da çok yardıma ihtiyacı vardır.	8. Bir Ayak Önde Olarak Desteksiz Ayakta Durmak Yönerge: Hastaya gösterin: Bir ayağınızı diğerinin tam önüne koyun. Bunu yapamıyorsanız, ayağınızı, topuk kısmı öteki ayağınızın başparmağı hizasına gelecek şekilde bir adım atın. (3 puan vermek için adımın mesafesi diğer ayağın uzunluğunu geçmeli ve duruşun genişliği deneğin normal yürüyüş adımındaki genişliğe yakın olmalı.) 4 Normal yürüyüş adımını bağımsız olarak atabiliyor ve 30 saniye tutabiliyor 3 Ayağını diğerinin önüne bağımsız olarak koyabiliyor ve 30 saniye tutabiliyor. 2 Bağımsız olarak küçük adım atabiliyor ve 30 saniye tutabiliyor. 1 Adım atmak için yardıma ihtiyacı var ama 15 saniye durabiliyor 0 Adım atarken veya ayakta dururken yardıma ihtiyacı var.

2. Ayaktayken Oturma Pozisyonuna Geçmek Yönerge: Lütfen oturun. 4 Ellerinden asgari düzeyde yardım alarak emniyetli bir şekilde oturabilir. 3 Ellerinden yardım alarak kontrollü bir şekilde oturur. 2 Bacaklarıyla sandalyeden destek alarak kontrollü bir şekilde oturur. 1 Kendi başına oturabilir ama kontrollü değildir. 0 Oturmak için yardıma ihtiyacı vardır.	**9. Tek Ayak Üstünde Ayakta Durmak** Yönerge: Tek ayak üzerinde tutunmadan durabildiğiniz kadar durun. 4 Bacağını bağımsız olarak kaldırıp > 10 saniye tutabiliyor 3 Bacağını bağımsız olarak kaldırıp 5-10 saniye tutabiliyor 2 Bacağını bağımsız olarak kaldırıp ≥ 3 saniye tutabiliyor. 1 Bacağını kaldırmağa çalışıyor, 3 saniye tutamıyor ama bağımsız olarak ayakta durabiliyor. 0 Deneyemiyor ve düşmemek için yardıma gereksinimi var.
3. Transfer Yönerge: Sandalyeleri transfer yapılacak şekilde göre yerleştirin. Hastaya bir kolluklu bir de kolluksuz koltuğa doğru yer değiştirmesini söyleyin. İki sandalye (biri kolluklu diğeri kolluksuz) ya da bir yatak ve bir koltuk kullanabilirsiniz. 4 Ellerini çok az kullanarak emniyetli bir şekilde transfer olabiliyor. 3 Emniyetli bir şekilde transfer olabiliyor, ellerini kesinlikle kullanıyor 2 Sözlü kılavuzlukla ve gözetimle veya gözetimsiz transfer olabiliyor 1 Yardım edecek bir kişiye gereksinimi var 0 Güvende olabilmesi için yardım edecek veya gözetecek iki kişiye gereksinimi var	**10. 360 Derece Dönmek** Yönerge: Tam daire çizecek şekilde kendi etrafınızda dönün. Durun. Sonra ters yönde tam daire çizin. 4 4 saniye ya da daha kısa sürede emniyetli bir şekilde 360 derece dönebilir. 3 4 saniye ya da daha kısa sürede sadece bir tarafa doğru emniyetli bir şekilde 360 derece dönebilir. 2 Emniyetli bir şekilde fakat yavaş bir şekilde 360 derece dönebilir. 1 Yakın gözetime ya da sözlü uyarıya ihtiyacı vardır. 0 Dönerken yardıma ihtiyacı vardır.
4. Desteksiz Ayakta Durmak Yönerge: Lütfen hiçbir yere tutunmadan iki dakika ayakta durun. 4 2 dakika emniyetli bir şekilde ayakta durabilir. 3 Gözetim altında 2 dakika ayakta durabilir. 2 Desteksiz 30 saniye ayakta durabilir. 1 Desteksiz 30 saniye ayakta durabilmek için birkaç denemeye ihtiyacı var 0 Yardım almadan 30 saniye ayakta duramaz.	**11. Ayaktayken Sağ ya da Sol Omuz Üzerinden Dönerek Geriye Bakmak** Yönerge: Sol omzunuzun üzerinden dönerek arkanıza bakın. Aynısını sağ tarafınızda tekrar edin. Gözetmen deneğin daha iyi bir dönüş hareketi gerçekleştirmesini sağlamak için deneğin arkasında yer alan bir nesneyi bakış noktası olarak belirleyebilir. 4 Her iki vücut yanından da arkaya bakabiliyor ve ağırlık aktarımı iyi. 3 Sadece bir yanından arkaya bakabiliyor, diğer yandan olan bakışta denge aktarımı çok iyi değil 2 Yanlara dönebiliyor ama dengesini koruyor 1 Dönerken gözetime gereksinimi var 0 Dengesini kaybetmemek veya düşmemek için yardıma gereksinimi var.
5. Ayaklar Yerde Ya Da Bir Tabure Üstündeyken Arkaya Yaslanmadan Oturmak Yönerge: Lütfen kollarınızı kavuşturarak iki dakika oturun. 4 Emniyetli bir şekilde 2 dakika oturabilir. 3 Gözetim altında 2 dakika oturabilir. 2 30 saniye oturabilir. 1 10 saniye oturabilir 0 Desteksiz 10 saniye oturamaz.	**12. Ayaktayken Yerden Nesne Almak** Yönerge: Ayağınızın hemen önünde bulunan ayakkabıyı/terliği alın. 4 Terliği rahatça alabilir. 3 Terliği alabilir ama gözetim eşliğinde. 2 Terliği alamaz ama terliğe 2-5 cm kadar yaklaşabilir ve kendi kendine denge sağlayabilir. 1 Terliği alamaz, almaya çalışırken de gözetime ihtiyacı vardır. 0 Terliği almayı denemez/düşmemek ya da dengesini kaybetmemek için yardıma ihtiyacı vardır.

6. Gözler Kapalıyken Desteksiz Ayakta Durmak Yönerge: Lütfen gözlerinizi kapayın ve ayakta 10 saniye hareketsiz durun. 4.10 saniye emniyetli bir şekilde ayakta durabilir. 3 Gözetim altında 10 saniye ayakta durabilir. 2 3 saniye ayakta durabilir. 1 Gözlerini üç saniyeden fazla kapalı tutamaz ama ayakta sabit durabilir. 0 Düşmemek için yardıma ihtiyacı vardır.	**13. Desteksiz Ayakta Dururken Alterne Olarak Ayağı Basamak veya Tabureye Yerleştirmek** Yönerge: İki ayağı da sırasıyla taburenin üstüne koyun. Her iki ayak da tabureye 4 kere değene kadar harekete devam edin. 4 Kendi başına emniyetli bir şekilde ayakta durabilir ve 20 saniyede 8 adımı tamamlayabilir. 3 Kendi başına ayakta durabilir ve 8 adımı 20 saniyeden daha uzun bir sürede tamamlayabilir. 2 Gözetim altında yardım almadan 4 adım tamamlayabilir. 1 Az yardımla 2 adım tamamlayabilir. 0 Düşmemek için yardıma ihtiyacı vardır/çaba gösteremez.
7. Ayaklar Bitişikken Desteksiz Ayakta Durmak Yönerge: Ayaklarınızı birleştirin ve tutunmadan ayakta durun. 4 Kendi başına ayaklarını birleştirip 1 dakika emniyetli bir şekilde ayakta durabilir. 3 Kendi başına ayaklarını birleştirip 1 dakika gözetim altında ayakta durabilir 2 Kendi başına ayaklarını birleştirip 30 saniye ayakta durabilir. 1 Yardım ile istenilen pozisyona gelebilir, ama ayaklar bitişik vaziyette ancak 15 saniye ayakta durabilir. 0 Yardım ile istenilen pozisyona gelebilir, ama bu pozisyonu 15 saniye muhafaza edemez.	**14. Ayaktayken Kollar Gergin Öne Doğru Uzanmak** Yönerge: Kollarınızı 90 derece kaldırın. Parmaklarınızı uzatın ve öne doğru uzanabildiğiniz kadar uzanın. (Gözetmen eller 90 derecedeyken hastanın parmak uçları hizasında bir cetvel tutar. Öne uzanırken hastanın parmakları cetvele değmemelidir. Hastanın en ileri uzanabildiği noktada parmak uçlarının katettiği mesafe kaydedilmelidir. Gövdenin dönmesini önlemek için, hastaya mümkünse iki kolunu da uzatmasını söyleyin.) 4 Rahatça öne uzanabilir >25 cm. 3 Rahatça öne uzanabilir >12.5 cm. 2 Rahatça öne uzanabilir >5 cm. 1 Öne uzanabilir ama gözleme ihtiyacı vardır. 0 Öne uzanmaya çalışırken dengesini kaybeder/dışarıdan destek gerekir.

(   ) Toplam Puan (Maksimum = 56)

	PBDÖ	**ZKYT**
İlk Değerlendirme		
Son Değerlendirme		

Bölüm 3. Vestibüler Sistem Değerlendirmesi

PNT: …… sn

APPENDIX 3: PERMISSION LETTER FROM THE INSTITUTION

13/08/2018

TEDAVİ ALANI KULLANIM İZİN YAZISI

Kurumumuzda 25/01/2016'dan beri aktif olarak çalışmakta olan Fzt. Ezgi ENİŞER'in **"Serebral Palsili Çocuklarda Vestibüler Eğitimle Kombine Edilmiş Nörogelişimsel Tedavi Programının Denge Üzerine Etkileri"** isimli yüksek lisans çalışması dahilinde planlanmış tedavi programını kurumumuz Özel Sancaktepe Özel Eğitim ve Rehabilitasyon Merkezi'ne ait fizyoterapi salonunda uygulamasını kabul ediyorum.

Eylem YAKUPOĞLU
Kurum Müdürü

APPENDIX 4: ETHICAL COMMITTEE APPROVAL

T.C. YEDİTEPE ÜNİVERSİTESİ

Sayı : 37068608-6100-15-1545 **27/09/2018**
Konu: Klinik Araştırmalar
Etik kurul Başvurusu hk.

İlgili Makama (Ezgi Enişer)

Yeditepe Üniversitesi Fizyoterapi ve Rehabilitasyon Bölümü Prof. Dr. Feryal Subaşı'nın sorumlu olduğu **"Serebral Palsili Çocuklarda Vestibüler Eğitimle Kombine Edilmiş Nörogelişimsel Tedavi Programının Denge Üzerine Etkileri"** isimli araştırma projesine ait Klinik Araştırmalar Etik Kurulu (KAEK) Başvuru Dosyası (**1521** kayıt Numaralı KAEK Başvuru Dosyası), Yeditepe Üniversitesi Klinik Araştırmalar Etik Kurulu tarafından **26.09.2018** tarihli toplantıda incelenmiştir.

Kurul tarafından yapılan inceleme sonucu, yukarıdaki isimi belirtilen çalışmanın yapılmasının etik ve bilimsel açıdan uygun olduğuna karar verilmiştir (**KAEK Karar No: 901**).

Prof. Dr. Turgay ÇELİK

Yeditepe Üniversitesi
Klinik Araştırmalar Etik Kurulu Başkanı