HAREKET, SAĞLIK VE TEKNOLOJİ:

SPOR EĞİTİMİNİN DEĞİŞEN PARADİGMALARI

Editör

TUĞBA MUTLU BOZKURT

BİDGE

BİDGE Yayınları

HAREKET, SAĞLIK VE TEKNOLOJİ: SPOR EĞİTİMİNİN DEĞİŞEN PARADİGMALARI

Editör: TUĞBA MUTLU BOZKURT

ISBN: 978-625-372-734-5

1. Baskı
Sayfa Düzeni: Gözde YÜCEL
Yayınlama Tarihi: 2025-06-25
BİDGE Yayınları

Sertifika No: 71374

www.bidgeyayinlari.com.tr - bidgeyayinlari@gmail.com
Krc Bilişim Ticaret ve Organizasyon Ltd. Şti.
Güzeltepe Mahallesi Abidin Daver Sokak Sefer Apartmanı No: 7/9 Çankaya / Ankara

ÖNSÖZ

Beden eğitimi ve spor bilimleri, bireyin fiziksel gelişiminin ötesinde; psikososyal bütünlüğünü, toplumsal entegrasyonunu ve dijitalleşen dünyaya uyumunu da içeren çok katmanlı bir alan hâline gelmiştir. Bu bağlamda, alan yazında ortaya çıkan güncel yönelimler; yalnızca geleneksel antrenman modellerini değil, aynı zamanda rekreasyonun bağımlılık önleyici potansiyelini, motor öğrenmenin nörofizyolojik temellerini ve dijital ortamda yürütülen egzersiz uygulamalarını da kapsamaktadır.

Bu kitap; söz konusu kavramsal ve uygulamalı değişimi disiplinlerarası bir bakış açısıyla ele almayı, beden eğitimi ve spor eğitimi alanında çalışan akademisyenler, araştırmacılar ve uygulayıcılara kuramsal derinlik ve pratik çeşitlilik sunmayı amaçlamaktadır. Kitapta yer alan bölümler; çağın gereksinimlerine yanıt veren, bilimsel temellere dayalı, yenilikçi yaklaşımları bir araya getirerek alana katkı sunmayı hedeflemektedir.

Bu çalışmanın, spor bilimleri literatürüne nitelikli bir kaynak olarak katkı sağlayacağı ve akademik tartışmalara yeni ufuklar açması dileğiyle…

Editör

Doç. Dr. Tuğba MUTLU BOZKURT

İÇİNDEKİLER

PHYSIOLOGY OF MOTOR LEARNING 1

İSMAİL MERT

SANAL DÜNYADA FİZİKSEL AKTİVİTE: RİNG FİT ADVENTURE İLE DİJİTAL EGZERSİZİN YENİ UFUKLARI 37

EMRULLAH YILMAZ, AHMETHAN YILDIRAK, TUĞBA MUTLU BOZKURT

THE IMPORTANCE OF RECREATION IN PREVENTING ADDICTION 67

İSMAİL MERT

THE IMPORTANCE OF RESISTANCE TRAINING 92

MEHMET MÜBAREK BORA, MEHMET VEYSİ BORA, ÜNSAL TAZEGÜL

BÖLÜM 1

THE PHYSIOLOGY OF MOTOR LEARNING

İSMAİL MERT[1]

Introduction

Motor learning refers to relatively permanent behavioral changes in an individual's ability to perform motor skills that occur through repeated practice or experience (Magill & Anderson, 2017). This process is not limited to observable improvements in movement performance; it also includes structural and functional changes within the nervous system (Schmidt & Lee, 2011). Unlike temporary performance enhancements observed during practice, true learning requires the formation of lasting modifications in neural circuits (Shadmehr, Smith & Krakauer, 2010). The acquisition of motor skills is of critical importance across a wide spectrum, ranging from daily life activities to professional-level athletic performance.

The behavioral and functional significance of motor learning is directly related to an individual's ability to adapt to the environment, develop new skills, and optimize their existing motor repertoire (Haibach-Beach, Reid & Collier, 2018). Motor skills, such as walking, writing, or performing complex athletic movements,

[1] T.C. Milli Eğitim Bakanlığı, Düzce Milli Eğitim Müdürlüğü, ORCID: 0000-0002-9749-8559

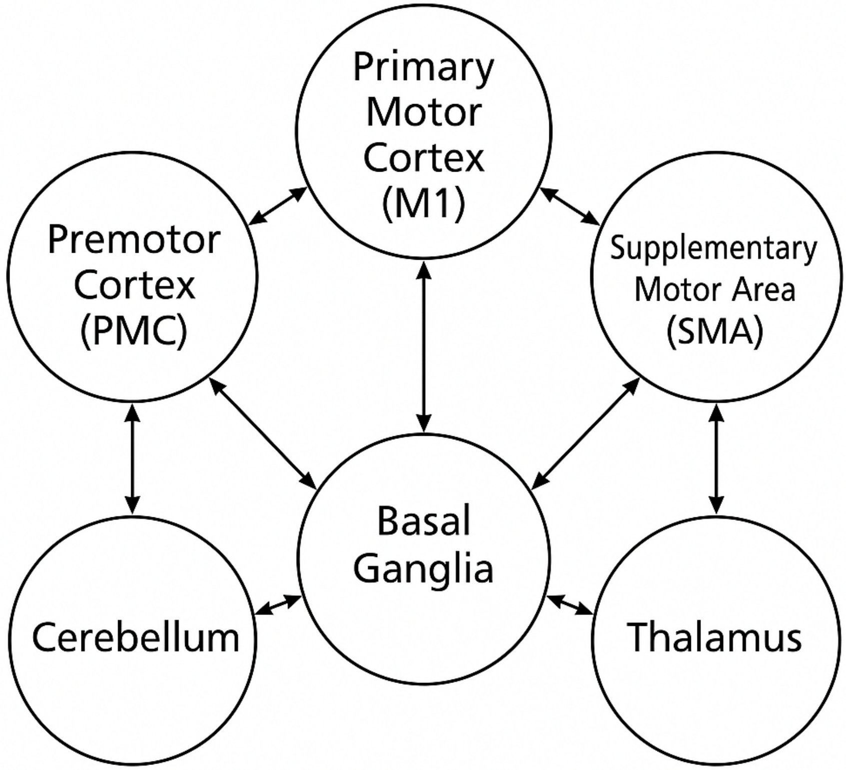
reflect the effectiveness of learning processes. The development of these skills is intertwined not only with observable performance improvements but also with cognitive processes such as attention, motivation, problem solving, and decision making (Edwards, 2010).

In this context, examining motor learning at the physiological level is of great importance. Understanding the neural control of movement reveals not only “what” is learned but also “how” it is learned. Identifying how cortical and subcortical structures (e.g., motor cortex, basal ganglia, cerebellum) contribute to different phases of the learning process (e.g., early acquisition and long-term consolidation) enables the development of effective strategies in motor skill training, neurorehabilitation, and sports sciences (Teo, 2009; Doyon & Benali, 2005; Wolpert, Diedrichsen & Flanagan, 2011). In particular, the relationship between neuroplasticity mechanisms (e.g., long-term potentiation [LTP], synaptic reorganization) and motor learning explains how learning is reinforced at the level of the nervous system (Dayan & Cohen, 2011).

Cortical and Subcortical Structures in Motor Learning

Motor learning occurs through complex interactions among various regions of the central nervous system. In this process, there is a dynamic exchange of information between cortical and subcortical structures. The key brain regions involved in motor learning and their interconnections are outlined below. The interactions among the primary motor cortex (M1), premotor cortex (PMC), supplementary motor area (SMA), cerebellum, basal ganglia, and thalamus play a critical role in motor planning, execution, and learning processes (see Figure 1).

Figure 1. Cortical and Subcortical Structures in Motor Learning.



Shows the fundamental cortical and subcortical brain regions involved in the motor learning process and the functional connections between them (Figure 1). Cortical structures such as the primary motor cortex (M1), premotor cortex (PMC), and supplementary motor area (SMA) play a role in functions such as motor planning, movement initiation, and organization, whereas subcortical structures such as the cerebellum, basal ganglia, and thalamus play critical roles in the processes of movement coordination, accuracy, sequencing, and motor program selection. In the diagram, the bidirectional information flow and interactions between these structures are indicated by arrows. For motor learning to successfully occur, this dynamic cooperation between cortical and subcortical systems is of great importance.

a. Cortical Structures

Primary Motor Cortex (M1): M1 is responsible for the direct execution of voluntary movements, particularly encoding parameters such as force, direction, and speed of movement (Kandel et al., 2013). During motor skill learning, significant structural and functional plasticity is observed in M1, including the formation of new synapses and the reorganization of neuronal activity patterns (Peters et al., 2017).

Premotor Cortex (PMC): PMC plays an important role in the preparation, planning, and initiation of movements, especially those based on external (visual or auditory) cues (Kandel et al., 2013). It is a critical region for visuomotor transformations and for learning cue-movement associations (Peters et al., 2017).

Supplementary Motor Area (SMA): The SMA is primarily involved in internally initiated, self-timed movements and in the planning and execution of complex sequences of movements (Edwards, 2010; Kandel et al., 2013). It contributes to the smooth execution of learned movement sequences.

b. Subcortical Structures Cerebellum

The cerebellum plays a central role in regulating and learning motor commands by processing error signals between expected sensory feedback and actual feedback during movement (Boyden, Katoh & Raymond, 2004). It is critically important for the timing, coordination, accuracy, and adaptation of movements. Different cerebellar modules are thought to utilize distinct learning mechanisms (e.g., long-term depression [LTD], long-term potentiation [LTP]) (Boyden et al., 2004; Kandel et al., 2013).

Basal Ganglia: The basal ganglia play a critical role in the selection, initiation, sequencing of goal-directed movements, and habit formation, particularly through reinforcement learning (Ashby, Turner & Horvitz, 2010; Rothwell, Hay & Kunz, 2021). They form closed loops with the cortex and thalamus, enabling the selection of appropriate motor programs and the suppression of unwanted movements. The dopaminergic system acts as a fundamental modulator for learning processes within this region (Kandel et al., 2013).

Thalamus: The thalamus serves as the main relay station that transmits processed information from the cerebellum and basal ganglia back to the motor cortex (Kandel et al., 2013). Specifically, the ventrolateral (VL) and ventroanterior (VA) nuclei play a crucial role in these motor loops and mediate the cortical expression of learned motor skills (Edwards, 2010).

c. Neural Networks and Functional Connectivity

Motor learning occurs not only through the activity of isolated brain regions but also through dynamic and functional changes in the connectivity between these regions. Functional magnetic resonance imaging (fMRI) studies have shown that during skill learning, functional connectivity within the motor network—particularly along cortico-striatal, cortico-cerebellar, and thalamo-cortical pathways—is strengthened and reorganized (Spampinato, Celnik & Cortes, 2021; Wu, Duff & Egan, 2022). Changes in both task-related and resting-state network connectivity have been associated with the degree and retention of learning (Spampinato et al., 2021). These findings support the idea that motor learning relies on increased efficiency of communication between brain regions.

Neuroplasticity: Cellular and Molecular Foundations

Motor learning occurs through the structural and functional reorganization of the nervous system in response to experience and environmental stimuli. This capacity for reorganization is defined as "neuroplasticity." Neuroplasticity encompasses multi-level processes such as the formation of new connections, strengthening or weakening of existing connections, and molecular-level modifications of synaptic activity (Kandel et al., 2013). These cellular and molecular mechanisms enable the acquisition, consolidation, and long-term maintenance of motor skills (Martinez & Derrick, 2019).

a. Long-Term Potentiation (LTP)

LTP is characterized by a long-lasting increase in synaptic transmission efficiency following high-frequency stimulation. In this process, glutamate released from the presynaptic terminal activates AMPA and NMDA receptors on the postsynaptic membrane. Due to the calcium permeability of NMDA receptors, intracellular signaling pathways are triggered, resulting in the insertion of new receptors into the membrane and changes in gene expression (Kandel et al., 2013). These changes solidify synaptic strengthening and support the encoding of learned motor skills into cortical maps (Martinez & Derrick, 2019).

b. Long-Term Depression (LTD)

LTD is a form of plasticity characterized by a reduction in postsynaptic response following low-frequency synaptic activity. In this process, NMDA receptor activation occurs with different kinetics and triggers phosphatase pathways that lead to the weakening of synaptic strength (Kandel et al., 2013). In motor learning, the LTD mechanism facilitates the refinement of selective connections by weakening unnecessary or erroneous synaptic responses. This is especially important for reducing movement errors and enhancing the precision of motor skills (Boyden, Katoh & Raymond, 2004).

c. Synaptogenesis and Synaptic Pruning

During the motor learning process, neural networks undergo not only transient electrical changes but also structural reorganization. The formation of new synapses (synaptogenesis) and the elimination of non-functional connections (synaptic pruning) are fundamental components of this process. While actively used synaptic pathways become stabilized, those that lose functionality are eliminated. This process contributes to the optimization of motor performance and the enhancement of energy efficiency (Peters, Chen & Komiyama, 2017). Synaptogenesis predominates during the early stages of learning, whereas pruning mechanisms ensure network stabilization in the later phases (Figure 2).

d. Neurotransmitter Systems

Neuroplasticity processes associated with motor learning are modulated by various neurotransmitters:

• Glutamate is the primary excitatory neurotransmitter involved in both LTP and LTD processes. It initiates long-term cellular changes through AMPA and NMDA receptors (Kandel et al., 2013).

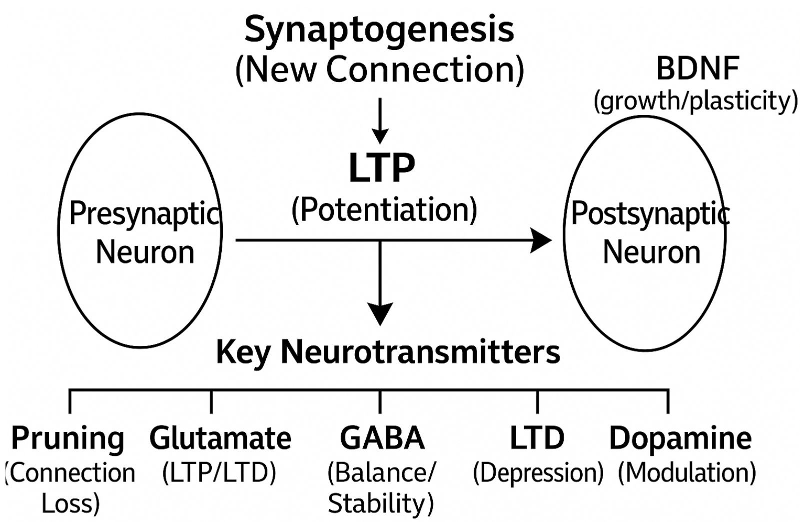
• GABA prevents excessive excitation in the motor system through its inhibitory effects. It maintains network stability by suppressing hypersynchronization in the motor cortex (Martinez & Derrick, 2019).

• Dopamine plays a role in basal ganglia circuits and modulates reinforcement learning processes. The activity of dopaminergic neurons is linked to reward expectation and motivation, contributing to the reinforcement of learned motor outputs (Rothwell, Hay & Kunz, 2021).

e. Neurotrophic Factors: BDNF and Others

Brain-Derived Neurotrophic Factor (BDNF) is one of the most potent molecular supporters of neuroplasticity, playing a crucial role in neuronal survival, synaptic plasticity, and the formation of new synapses. An increase in BDNF expression has been observed during motor learning, and this increase has been associated with the consolidation of acquired motor skills (Kandel et al., 2013). BDNF promotes synaptic strengthening through its interaction with TrkB receptors. In addition to BDNF, other neurotrophins such as NGF and NT-3 also contribute to cortical plasticity (Wu, Duff & Egan, 2022).

Figure 2. Neuroplasticity Processes and the Role of Key Molecules.



This diagram (Figure 2) illustrates the neuroplasticity mechanisms occurring in the synaptic region between presynaptic and postsynaptic neurons during the motor learning process, as well as the key factors mediating these mechanisms. Synaptogenesis (formation of new connections) and long-term potentiation (LTP) support synaptic strengthening, while synaptic pruning and long-term depression (LTD) eliminate unnecessary connections. These processes are regulated by glutamate (excitatory neurotransmitter), GABA (inhibitory neurotransmitter), and dopamine (modulatory neurotransmitter). Additionally, Brain-Derived Neurotrophic Factor (BDNF), one of the neurotrophic factors, plays a critical role in stabilizing motor learning by supporting synaptic plasticity and synaptogenesis.

The Role of the Cerebellum: Coordination and Error Correction

The cerebellum is a fundamental structure that supports the accuracy, coordination, and adaptability of movements in the processes of motor control and learning (Kandel et al., 2013: 923). It works in collaboration with various components of the motor system and plays a crucial role not only in the acquisition of new motor skills but also in enhancing the precision of already acquired movements (Boyden, Katoh & Raymond, 2004: 582).

a. Error-Based Learning

Error-based learning is the process of improving motor performance by detecting and correcting discrepancies between intended and actual movements (Dayan & Cohen, 2011: 444). In this process, the cerebellum recalibrates motor commands based on the error signal derived from the comparison between expected and actual sensory feedback (Boyden, Katoh & Raymond, 2004: 585). This mechanism enables the rapid correction of errors, particularly during the acquisition of new skills (Wolpert, Diedrichsen & Flanagan, 2011: 741).

b. Forward Models and Comparator Mechanisms

The cerebellum enables the motor system to generate forward models that anticipate the outcomes of movements before they occur (Wolpert, Diedrichsen & Flanagan, 2011: 740). Through these models, sensory consequences are predicted in advance and then compared to the actual feedback, allowing for quick error detection (Kandel et al., 2013: 925). This comparator mechanism enhances the accuracy of motor control and optimizes the stability and efficiency of movement (Edwards, 2010: 139).

c. Balance, Timing, and Adaptation

The cerebellum actively contributes to fundamental aspects of motor performance such as balance control, precise timing, and adaptation to environmental changes (Haibach-Beach, Reid & Collier, 2018: 102). Postural maintenance and the adjustment of motor responses to varying contexts are direct outcomes of cerebellar processing (Teo, 2009: 87). Moreover, it has been demonstrated that the cerebellum plays a critical role in initiating and terminating movements at appropriate times through error correction and the use of forward models (Boyden, Katoh & Raymond, 2004: 583).

Basal Ganglia: Automatization and Reinforcement

Basal ganglia are a group of subcortical neural structures that form complex connections with the cerebral cortex and the thalamus (Kandel et al., 2013). This system includes anatomical regions such as the striatum (caudate nucleus and putamen), globus pallidus (internal and external segments), substantia nigra (pars compacta and pars reticulata), and subthalamic nucleus (Kandel et al., 2013). The basal ganglia play a central role in the selection and sequencing of voluntary movements, optimization and reinforcement of motor plans (Ashby, Turner & Horvitz, 2010). Additionally, they are closely associated with reward expectation and motivation mechanisms in learning processes (Rothwell, Hay & Kunz, 2021).

a. Direct / Indirect Pathways

The basal ganglia regulate motor control through direct and indirect pathways. The direct pathway facilitates the initiation of movement by disinhibiting thalamocortical activity through inhibitory projections from the striatum to the globus pallidus internus and substantia nigra pars reticulata (Kandel et al., 2013). The indirect pathway suppresses unwanted movements by decreasing thalamic activity via the globus pallidus externus and subthalamic nucleus (Ashby, Turner & Horvitz, 2010). Dopamine modulates the balance between these two pathways by stimulating the direct pathway through D1 receptors and inhibiting the indirect pathway through D2 receptors (Kandel et al., 2013).

b. Procedural Learning

The basal ganglia perform a critical function in procedural learning, which is the acquisition of motor skills without conscious awareness (Ashby, Turner & Horvitz, 2010). Plasticity occurring in striatal circuits enables the automatization of motor behaviors and the formation of habits through repeated practice (Rothwell, Hay & Kunz, 2021). These changes are characterized by strengthening and restructuring at cortico-striatal synapses (Kandel et al., 2013).

c. Dopaminergic Reward Circuits

Dopaminergic projections from regions such as the ventral tegmental area (VTA) and substantia nigra pars compacta (SNc) regulate motor learning and reinforcement behaviors by acting on striatal neurons (Kandel et al., 2013). D1 receptor activation facilitates the direct pathway to support movement initiation, while D2 receptor activation exerts an inhibitory effect on the indirect pathway to suppress unnecessary motor programs (Kandel et al., 2013).

d. Striatum

The striatum, composed of the caudate nucleus and putamen, is the input region of the basal ganglia (Kandel et al., 2013). The dorsolateral striatum plays a key role in habit formation and automatization processes (Ashby, Turner & Horvitz, 2010). In addition to processing incoming cortical information, the striatum optimizes motor learning and movement selection through dopaminergic modulation (Rothwell, Hay & Kunz, 2021).

Neuroplasticity: Structural and Functional Reorganization in the Motor Cortex

Neuroplasticity refers to the central nervous system's capacity to undergo enduring changes in synaptic activity, neuronal connections, and network organization in response to experience, learning, or environmental modifications (Kandel et al., 2013; Martinez & Derrick, 2019). Through these plasticity processes, the motor cortex is structurally and functionally reorganized during the acquisition and refinement of motor skills.

a. Cellular-Level Neuroplasticity: LTP and LTD Mechanisms

During motor learning, persistent changes occur in the efficacy of synaptic transmission between specific neurons. Long-Term Potentiation (LTP) is characterized by a sustained increase in synaptic response following high-frequency stimulation and serves as a core mechanism in the acquisition of new motor skills (Dayan & Cohen, 2011). In contrast, Long-Term Depression (LTD) involves a reduction in synaptic strength induced by low-frequency stimulation and contributes to error correction during motor performance (Boyden, Katoh & Raymond, 2004). These synaptic plasticity processes play a critical role in the reorganization of the motor cortex in response to learning. Synapses that are activated by experience become strengthened, whereas unused connections weaken or are eliminated (Martinez & Derrick, 2019).

b. Structural-Level Neuroplasticity: Synaptogenesis and Synaptic Pruning

Neuroplasticity is not limited to changes in synaptic efficacy but also encompasses structural modifications in neural network organization. Synaptogenesis refers to the formation of new synaptic connections and facilitates the development of new pathways between motor neurons that are frequently activated through practice (Peters, Chen & Komiyama, 2017). In contrast, synaptic pruning involves the elimination of dysfunctional or unnecessary connections, allowing motor skills to be executed through a more efficient and optimized network (Kandel et al., 2013). Synaptogenesis is especially dominant during the early phases of learning, whereas synaptic pruning becomes more prominent during skill consolidation (Martinez & Derrick, 2019).

c. Network-Level Neuroplasticity: Cortical Map Reorganization

As motor skills are acquired, neuronal representation areas in the motor cortex are reorganized. Cortical map reorganization is characterized by the expansion of cortical representation areas associated with frequently used effectors (Nudo, Milliken, Jenkins & Merzenich, 1996). For example, during the learning of precise motor tasks such as piano playing or using a tool, the cortical representation of associated M1 (primary motor cortex) regions becomes larger and more defined. This has been demonstrated in both classical and contemporary research (Nudo et al., 1996; Peters et al., 2017). This reorganization process is directly based on neuroplastic mechanisms and represents the integration of both synaptic and structural changes (Spampinato, Celnik & Cortes, 2021).

d. Formation of Motor Engrams: The Lasting Trace of Neuroplasticity

Motor skills acquired through repeated practice are consolidated into lasting neural traces known as motor engrams (Martinez & Derrick, 2019). Motor engrams are structural changes organized within the motor cortex and associated subcortical structures (basal ganglia, cerebellum), which enable accurate and rapid execution of specific movements (Kandel et al., 2013). This process involves a transition from initially diffuse activation patterns in the motor cortex to specific and stabilized neural networks (Wolpert, Diedrichsen & Flanagan, 2011). Repetitive practice particularly activates both LTP/LTD mechanisms and strengthens functional connections in neural networks while eliminating unnecessary ones (Wu, Duff & Egan, 2022).

Prefrontal Cortex: Attention, Strategy, and Decision-Making

The motor learning process is not confined solely to the motor cortex and subcortical structures; it also involves higher-order cognitive functions. The prefrontal cortex (PFC) plays a central role in regulating the cognitive components of motor learning, including attention control, cognitive flexibility, performance monitoring, and decision-making (Kandel et al., 2013; Martinez & Derrick, 2019).

Attention control is critical during the acquisition and execution of motor skills. Attention enables the selective processing of sensory information from the environment and appropriately guides goal-directed motor behaviors (Dayan & Cohen, 2011). The dorsolateral region of the prefrontal cortex (dlPFC) is particularly involved in managing attentional processes and supports the focused cognitive control required for accurate motor task execution (Wolpert, Diedrichsen & Flanagan, 2011).

Cognitive flexibility is necessary throughout motor learning, allowing individuals to adapt to changing conditions and develop new strategies. It refers to the ability to shift between different motor strategies and to produce appropriate responses to unexpected environmental changes (Spampinato, Celnik & Cortes, 2021). The dorsolateral and orbitofrontal areas of the prefrontal cortex are actively engaged in integrating new information and modifying motor responses (Martinez & Derrick, 2019).

The continuous monitoring of motor performance and the development of corrective strategies based on perceived errors are facilitated by performance monitoring functions. In this process, the anterior cingulate cortex (dACC) is particularly active (Peters, Chen & Komiyama, 2017). The dACC detects errors during motor tasks, identifies performance deviations, and contributes to the initiation of appropriate corrective responses (Spampinato, Celnik & Cortes, 2021), thereby supporting more precise and effective motor learning.

Decision-making processes play a significant role both in selecting new motor skills and optimizing existing motor strategies. The dlPFC and dACC are engaged in planning motor actions, predicting their outcomes, and evaluating alternative movements (Kandel et al., 2013). Specifically, the dlPFC supports goal-directed decisions during motor selection, while the dACC evaluates performance based on reward expectations and error feedback (Wu, Duff & Egan, 2022).

In conclusion, the functions of the prefrontal cortex—such as attention control, cognitive flexibility, performance monitoring, and decision-making—not only optimize motor output but also facilitate the development of learning strategies, accelerate error correction, and support the flexible adaptation of new motor behaviors. Through this cognitive modulation, motor learning becomes more effective, durable, and adaptable to environmental changes.

Observational Learning and Mirror Neurons

a. Discovery, Structure, and the Mirror Neuron System in Humans

Mirror neurons were first discovered in the early 1990s by Rizzolatti and colleagues through experiments on the premotor cortex (area F5) of macaque monkeys (Rizzolatti & Craighero, 2004). These neurons were activated not only when the monkey performed a specific motor action, such as reaching for an object, but also when it observed another individual performing the same action. Thus, they were identified as dual-function neurons that fire during both execution and observation of actions. Although the direct presence of mirror neurons at the cellular level in humans has not been confirmed, studies using fMRI, EEG, and TMS techniques have shown the existence of a Mirror Neuron System (MNS) performing similar functions in the human motor system (Kilner & Lemon, 2013; Caspers et al., 2010). The human MNS comprises a broad network including the premotor cortex, inferior parietal lobule, and superior temporal sulcus. For example, in fMRI studies by Iacoboni et al. (1999), activations were observed in both the premotor cortex and the inferior parietal lobules while participants observed hand movements. These findings support the direct role of these regions in observational learning.

b. Functions of Mirror Neurons: Action Intention, Visuomotor Transformation, and Premotor Cortex Activation

Initially, mirror neurons were thought to be involved only in simple imitation. However, subsequent research has shown their critical role in understanding the intention behind observed actions (Rizzolatti & Sinigaglia, 2010). For example, when observing someone reaching for an object, the brain assesses not just the movement but whether the action has a goal, such as grabbing the object (Fogassi et al., 2005).

In this process, visuomotor transformation mechanisms are engaged. The visual information of the observed movement is transformed into motor plans in the premotor cortex (Kilner, 2011). This allows the observer to mentally simulate the observed action and prepare motor programs in advance, facilitating future performance of similar movements. This mechanism is particularly effective in learning complex movements or tool use. For instance, when a basketball player observes a free throw, motor templates in the premotor cortex are activated, which helps perform the same action more effectively later (Buccino, Lui & Riggio, 2004).

c. Mental Representation, Motor Imagery, and Action Observation-Execution Overlap

Observational learning is closely linked to mental representation and motor imagery processes. Motor imagery refers to the mental simulation of a movement without physically performing it (Jeannerod, 2001). Research shows that motor imagery and observational learning activate similar neural circuits. Especially the premotor cortex, supplementary motor area, and inferior parietal lobule are active during both motor imagery and observational learning (Kilner & Lemon, 2013).

The overlap between action observation and execution has been confirmed by neuroimaging studies. Motor areas activated during observation largely coincide with those activated during execution (Caspers et al., 2010). This overlap strengthens the neural foundations of learning and enhances the effect of observational learning on motor performance. For example, in a study where participants watched and later performed a dance routine, fMRI data showed significant overlap in activation in the motor cortex and premotor areas (Cross, Hamilton & Grafton, 2006).

d. Factors Influencing Observational Learning

The effectiveness of observational learning can vary depending on several factors. One such factor is the expertise level of the model being observed. Observing an expert model induces stronger motor activation and learning effects compared to observing a novice (Calvo-Merino et al., 2005).

Additionally, the observer's prior motor experience also plays a role. The mirror neuron system is more strongly activated when individuals observe actions they have previously performed themselves (Cross, Hamilton & Grafton, 2006). Moreover, attention during observation and feedback provided afterward enhance the quality of learning (Hardwick et al., 2018). For instance, when an individual watches a tennis serve while focusing intensely on visual details, motor system activation and subsequent performance improvement become more pronounced. This demonstrates that observational learning is an active, attentive, and goal-oriented process.

Sensorimotor Integration and Feedback Systems

The processing and integration of sensory information are critically important for the successful planning, execution, and learning of motor behaviors. The nervous system combines inputs from various sensory sources—such as proprioception, vestibular information, and visual input—to precisely regulate motor commands (Kandel et al., 2013). Feedback mechanisms play a vital role not only in enabling the adaptation of movement to environmental conditions but also in serving as one of the foundational components of motor learning.

The use of sensory-motor integration and types of feedback varies across different stages of motor learning. In the cognitive stage, individuals rely heavily on visual and external feedback to guide their movements. During the associative stage, both external and internal feedback are used in a balanced manner, whereas in the autonomous stage, where skills become automated, proprioceptive and internal feedback become more dominant (Fitts & Posner, 1967; Schmidt & Lee, 2011). This dynamic shift demonstrates how sensory systems are actively utilized throughout the learning process.

a. Proprioception

Proprioception is the sensory system that provides information about the position, movement, and force exerted by the body and limbs in space (Proske & Gandevia, 2012). This information is detected by proprioceptors such as muscle spindles, Golgi tendon organs, and joint receptors. Muscle spindles sense muscle length and the rate of its change, while Golgi tendon organs detect the tension produced by the muscle (Purves et al., 2018). Joint receptors perceive the angular position of joints. Proprioception provides immediate internal feedback about body position during movement, allowing for reflexive corrections. It forms the basis for rapid corrective responses (e.g., ankle reactions during loss of balance). Furthermore, it is used to optimize movement accuracy and coordination during the planning and updating of motor commands (Gandevia, 1996). Sensory deficits, particularly impairments in the proprioceptive system, can severely affect motor control and learning. For instance, in conditions such as peripheral neuropathy, reduced proprioceptive input can lead to errors in goal-directed movements and postural instability (Sainburg, Ghilardi & Poizner, 1995).

b. Vestibular System

The vestibular system is a sensory system that contributes to balance and spatial orientation by providing information about the position and movements of the head—particularly acceleration (Cullen, 2012). Vestibular information is perceived through the semicircular canals and otolith organs (utricle and saccule) located in the inner ear. The semicircular canals detect angular head movements, while the otolith organs sense linear acceleration and head position relative to gravity.

The vestibular system plays a central role in maintaining postural control and coordinating balance-dependent movements such as walking and running. It also supports the vestibulo-ocular reflex (VOR), which enables the eyes to maintain fixation on a target during head movements (Angelaki & Cullen, 2008). Dysfunction in the vestibular system (e.g., vestibular hypofunction) can negatively affect motor learning and control, leading to imbalance, spatial disorientation, and decreased motor performance (Horak, 2009).

c. Visual Feedback

Visual feedback consists of visual information from the external environment about the body and its position relative to surrounding objects. During movement planning, visual input provides a critical feedforward element for target identification and motor strategy development (Goodale & Milner, 1992). During movement execution, visual information guides ongoing adjustments (online control).

Visual feedback plays a vital role in error detection and the generation of corrective motor responses, especially during the acquisition of new motor skills or when performing tasks requiring precision (Shadmehr & Krakauer, 2008). Visual feedback can be provided both intrinsically (observing one's own movement) and extrinsically (viewing the outcome of the movement).

Disruptions in the visual system (e.g., vision loss) may slow down the learning process, impair movement planning, and reduce the quality of interaction with the environment.

d. Intrinsic and Extrinsic Feedback (KR/KP)

Intrinsic feedback refers to the information perceived by the individual through their own sensory systems (e.g., proprioceptive, vestibular, visual, auditory) as a natural result of the movement (Schmidt & Lee, 2011). For instance, a runner feeling the tension in their leg muscles or a gymnast sensing changes in balance are examples of intrinsic feedback. Extrinsic or augmented feedback is information provided by an external source that the individual cannot directly perceive through their own sensory systems. This type of feedback is classified into two categories:

Knowledge of Results (KR): This refers to information about the outcome of a movement. For example, whether a basketball shot was successful or the finishing time of a runner (Adams, 1971). Knowledge of Performance (KP): This refers to information about how the movement was performed, including the quality or kinematic features of the movement. An example would be a coach providing corrections on an athlete's jumping technique (Salmoni, Schmidt & Walter, 1984).

The timing and frequency of extrinsic feedback have a direct effect on the success of motor learning. Research indicates that immediate feedback during movement can lead to rapid performance improvements but may negatively affect long-term retention. In contrast, delayed feedback provided after the completion of movement can enhance long-term learning by encouraging individuals to develop their own error detection mechanisms (Winstein & Schmidt, 1990).

The frequency of feedback is also crucial; overly frequent feedback may inhibit the development of intrinsic error detection mechanisms, whereas optimally spaced feedback supports learning (Wulf, Shea & Lewthwaite, 2010).

e. Processing of Sensory Information in the Brain

Proprioceptive, vestibular, and visual information is processed and integrated in different regions of the central nervous system. The cerebellum plays a significant role, especially in detecting errors and generating corrective motor responses (Ito, 2006). The basal ganglia utilize sensory information in selecting movements and reinforcing appropriate motor responses (Graybiel, 2008). The motor cortex integrates incoming sensory data into motor plans, enabling precise execution of movements (Kandel et al., 2013). These structures work in coordination to analyze sensory inputs, update motor commands, and optimize movement performance throughout the motor learning process.

Spinal Plasticity: Reflex and Spinal Adaptation

It has been demonstrated that motor learning is supported not only by cortical and subcortical structures but also by plasticity processes occurring at the spinal level. The spinal cord regulates motor control and exhibits structural and functional changes under certain conditions via reflex modulation, spinal learning, and central pattern generators (CPGs) (Edgerton et al., 2004).

a. Reflex Modulation

Reflexes are modulated by spinal circuits to produce rapid motor responses to environmental changes. Experience-dependent plasticity can lead to changes in the threshold, latency, and amplitude of reflex responses (Wolpaw, 2010). For instance, a spinal reflex known as the H-reflex can either be enhanced or suppressed following specific training protocols. These changes are associated with mechanisms similar to long-term potentiation (LTP) or long-term depression (LTD) in synaptic transmission within the spinal cord (Thompson, Wolpaw & Chen, 2009).

b. Spinal Learning

Spinal learning refers to learning processes that can occur at the spinal level without cortical or brainstem input. Experimental studies have shown that certain forms of conditioned learning can take place even in animals whose dorsal roots or brain connections have been severed (Grau et al., 2006). Particularly in the conditioned flexion reflex paradigm, the spinal cord has the capacity to develop adaptive responses to environmental stimuli independently. These findings demonstrate that spinal circuits are not merely passive reflex loops but can undergo experience-dependent modifications. Such plasticity observed at the spinal level plays an important role in the early phases of motor learning, enabling rapid reflex adaptations. Moreover, these processes contribute to the automatization of movement through reinforcement of motor programs in the spinal cord.

c. Central Pattern Generators (CPGs)

Central pattern generators (CPGs) are neural circuits within the spinal cord capable of producing rhythmic motor patterns (e.g., walking, swimming) without requiring sensory input (Marder & Calabrese, 1996). CPGs play a critical role in the control of repetitive motor tasks, particularly locomotion. It has been shown that CPGs are activated during the sequential and orderly activation of leg muscles while walking (Grillner & El Manira, 2020). CPGs are also subject to experience-dependent plasticity. Experimental animal models have revealed that following spinal cord injury, restructured CPG circuits can respond to environmental stimuli and therapeutic interventions to reorganize locomotor activity (Edgerton et al., 1997).

d. Electrical Conduction and Potential Enhancement in the Spinal Cord

Another dimension of spinal plasticity is the ability of neural conduction to change in response to learning. At the spinal level, repeated stimulations or increased motor activity can enhance the speed and efficiency of action potential conduction. This occurs through activity-dependent myelination and adaptive regulation of ion channel density in axonal transmission (Fields, 2015). In the study titled “Variability of Spinal Cord Electrical Conductivity,” it was reported that individual differences exist in spinal cord electrical conductivity and that learning processes may modulate this conductivity, increasing its capacity with repeated motor activity (Sullivan & Armstrong, 2018). These findings demonstrate that functional adaptations can also occur at the spinal level. In particular, synaptic activity triggered by proprioceptive and vestibular inputs may promote reorganization of spinal neural networks. This reorganization can lead to a wide range of functional outcomes, from fine modulation of reflexes to more efficient production of motor responses (Wolpaw & Tennissen, 2001).

Sleep and Consolidation Processes

The consolidation of motor learning does not solely rely on practice and repetition, but is also completed through the process of strengthening the learned information in the brain. This consolidation largely occurs during sleep. Sleep represents a critical period during which the nervous system both stabilizes newly acquired motor skills and supports their transfer to long-term memory (Walker & Stickgold, 2006). Sleep plays a particularly crucial role in the consolidation of procedural motor skills acquired through practice (Diekelmann & Born, 2010). Furthermore, it is emphasized that this consolidation process does not occur during active practice, but rather in an "offline" phase after practice has ended (Stickgold, 2005). Specifically, different stages of sleep (REM and NREM) have been shown to make unique contributions to motor memory consolidation.

a. REM and NREM Sleep Stages

Sleep is divided into two main categories: rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep. NREM sleep encompasses slow-wave sleep (SWS) as well as lighter stages and plays an important role in the stabilization of motor memory (Diekelmann & Born, 2010). During the NREM phase, especially slow-wave activity and sleep spindles are associated with the strengthening of newly acquired motor skills within cortical networks (Fogel & Smith, 2011). REM sleep, on the other hand, is more related to the integration and reorganization of motor skills. It is believed that during REM sleep, neuronal patterns related to learned motor skills are reactivated and optimized (Maquet, 2001). The REM phase is suggested to be important in the consolidation of the more complex and creative components of motor learning.

b. Synaptic Homeostasis Hypothesis

The synaptic homeostasis hypothesis posits that sleep balances the processes of synaptic strengthening and pruning (Tononi & Cirelli, 2014). While learning results in widespread strengthening of synaptic connections, sleep optimizes these connections by pruning unnecessary or weak synapses and stabilizing strong ones. This mechanism allows the nervous system to maintain energy efficiency and be prepared for new learning. In motor learning, achieving synaptic homeostasis during sleep facilitates the integration of newly acquired skills into more efficient network structures. Particularly during slow-wave activity in the NREM phase, the reorganization of synaptic weights contributes to the consolidation of motor memory traces (Tononi & Cirelli, 2012).

c. Neural Reactivation During Sleep

Neural reactivation during sleep refers to the spontaneous reactivation of neural networks that were active during learning. Studies in animals and humans have shown that after motor learning, neural patterns in certain cortical and subcortical areas are replayed during sleep (Rasch & Born, 2013). Especially during NREM sleep, the motor cortex and related structures reactivate the motor patterns acquired during learning, making this information more stable and accessible (Stickgold, 2005). This process not only reinforces information but also contributes to performance improvement upon waking.

For example, in individuals who practiced motor sequences before sleep, performance was observed to improve significantly in terms of both accuracy and speed after sleep (Walker et al., 2002).

These findings reveal that sleep is not merely a passive resting phase, but an active process of restructuring in motor learning.

Physiological Factors and Individual Differences

The process of motor learning may vary significantly between individuals, and these differences are influenced by various physiological factors. Age, gender, and hormonal effects can directly determine the speed and effectiveness of motor learning. While increased neuronal plasticity during childhood accelerates the acquisition of motor skills, this capacity decreases with aging (Seidler et al., 2010). Gender differences can also affect motor performance and learning through hormonal influences; estrogen has been shown to support synaptic plasticity, while testosterone enhances motor performance (Cummings et al., 2007).

Genetic factors are important determinants underlying an individual's motor learning capacity. In particular, the BDNF (brain-derived neurotrophic factor) Val66Met polymorphism significantly influences synaptic plasticity and motor learning. In carriers of the Met allele, reduced BDNF secretion has been reported to result in lower plasticity in the motor cortex and, consequently, decreased motor learning success (McHughen et al., 2010).

Stress levels and the associated release of cortisol also have a significant effect on motor learning. High cortisol levels may impair cognitive functions during the early stages of learning and lead to a decline in motor performance (Roozendaal, 2002). However, it has been shown that moderate stress can support learning, whereas excessive stress may inhibit it.

Sleep quality and fatigue level have a decisive effect on the consolidation processes of motor learning. While good quality sleep supports the consolidation of motor memory during sleep, insufficient sleep negatively affects both the acquisition and maintenance of motor performance (Walker & Stickgold, 2006).

Fatigue can reduce motor learning capacity by disrupting neural signal generation at both central and peripheral levels.

Finally, an individual's level of physical activity has a positive effect on motor learning ability. Regular physical activity increases the levels of neurotrophic factors (e.g., BDNF), thereby enhancing brain plasticity and supporting motor learning processes (Cotman & Berchtold, 2002). On the other hand, a sedentary lifestyle can lead to declines in both cognitive and motor functions.

References

Adams, J. (1971). A closed-loop theory of motor learning. *Journal of Motor Behavior, 3*(2), 111–150. doi:10.1080/00222895.1971.10734898

Angelaki, D., & Cullen, K. (2008). Vestibular system: the many facets of a multimodal sense. *Annual Review of Neuroscience, 31*, 125–150. doi:10.1146/annurev.neuro.31.060407.125555

Ashby, F., Turner, B., & Horvitz, J. (2010). Cortical and basal ganglia contributions to category learning. *Trends in Cognitive Sciences, 14*(5), 208-215. doi:10.1016/j.tics.2010.02.001

Boyden, E., Katoh, A., & Raymond, J. (2004). Cerebellum-dependent learning: The role of multiple plasticity mechanisms. *Annual Review of Neuroscience, 27*, 581-609. doi:10.1146/annurev.neuro.27.070203.144238

Buccino, G., Vogt, S., & Ritzl, A. (2004). Mirror neurons and the understanding of actions. *Current Opinion in Neurobiology, 14*(2), 213–218. doi:10.1016/j.conb.2004.03.001

Calvo-Merino, B., Glaser, D., Grèzes, J., Passingham, R., & Haggard, P. (2005). Action observation and acquired motor skills: An fMRI study with expert dancers. *Cerebral Cortex, 15*(8), 1243–1249. doi:10.1093/cercor/bhi007

Caspers, S., Zilles, K., Laird, A., & Eickhoff, S. (2010). ALE meta-analysis of action observation and imitation in the human brain. *NeuroImage, 50*(3), 1148-1167. doi:10.1016/j.neuroimage.2009.12.112

Cotman, C., & Berchtold, N. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences, 25*(6), 295–301. doi:10.1016/s0166-2236(02)02143-4

Cross, E., Hamilton, A., & Grafton, S. (2006). Building a motor simulation de novo: Observation of dance by dancers. *NeuroImage, 31*(3), 1257–1267. doi:10.1016/j.neuroimage.2006.01.033

Cullen, K. (2012). The vestibular system: multimodal integration and encoding of self-motion for motor control. *Trends in Neurosciences, 35*(3), 185–196. doi:10.1016/j.tins.2011.12.001

Cummings, D., Robertson, E., & Reid, G. (2007). Sex differences in motor performance and motor learning in children and adolescents: an increasing male advantage in motor learning and consolidation phase gains. *Experimental Brain Research, 179*(4), 615–624. doi:10.1007/s00221-006-0793-3

Dayan, E., & Cohen, L. (2011). Neuroplasticity subserving motor skill learning. *Neuron, 72*(3), 443–454. doi:10.1016/j.neuron.2011.10.008

Diekelmann, S., & Born, J. (2010). The memory function of sleep. *Nature Reviews Neuroscience, 11*(2), 114-126. doi:10.1038/nrn2762

Doyon, J., & Benali, H. (2005). Reorganization and plasticity in the adult brain during learning of motor skills. *Current Opinion in Neurobiology, 15*(2), 161–167. doi:10.1016/j.conb.2005.03.004

Edgerton, V., de Leon, R., Tillakaratne, N., Recktenwald, M., Hodgson, J., & Roy, R. (1997). Use-dependent plasticity in spinal stepping and standing. *Advances in Neurology* (Cilt 72, s. 233-247). içinde

Edgerton, V., Tillakaratne, N., Bigbee, A., de Leon, R., & Roy, R. (2004). Plasticity of the spinal neural circuitry after injury. *Annual Review of Neuroscience, 27*, 145-167. doi:10.1146/annurev.neuro.27.070203.144308

Edwards, W. (2010). *Motor learning and control: From theory to practice* (1st ed. b.). Cengage Learning.

Fields, R. (2015). A new mechanism of nervous system plasticity: activity-dependent myelination. *Nature Reviews Neuroscience, 16*(12), 756-767. doi:10.1038/nrn4023

Fitts, P., & Posner, M. (1967). *Human performance.* Brooks/Cole.

Fogassi, L., Ferrari, P., Gesierich, B., Rozzi, S., Chersi, F., & Rizzolatti, G. (2005). Parietal lobe: from action organization to intention understanding. *Science, 308*(5722), 662-667. doi:10.1126/science.1106138

Fogel, S., & Smith, C. (2011). The function of the sleep spindle: a physiological index of intelligence and a mechanism for sleep-dependent memory consolidation. *Neuroscience & Biobehavioral Reviews, 35*(5), 1154-1165. doi:10.1016/j.neubiorev.2010.12.003

Gandevia, S. (1996). Kinesthesia: roles for afferent signals and motor commands. *Handbook of physiology. Section 12. Exercise: Regulation and Integration of Multiple Systems* (s. 128-172). içinde Oxford University Press.

Goodale, M., & Milner, A. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences, 15*(1), 20–25. doi:10.1016/0166-2236(92)90344-8

Grau, J., Washburn, S., Hook, M., & Britton, G. (2006). Learning and memory following spinal cord injury. *Progress in Brain Research* (Cilt 157, s. 43-58). içinde doi:10.1016/S0079-6123(06)57004-5

Graybiel, A. (2008). Habits, rituals, and the evaluative brain. *Annual Review of Neuroscience, 31*, 359-387. doi:10.1146/annurev.neuro.29.051605.112851

Grillner, S., & El Manira, A. (2020). Current principles of motor control, with special reference to vertebrate locomotion. *Physiological Reviews, 100*(1), 271-320. doi:10.1152/physrev.00015.2019

Haibach-Beach, P., Reid, G., & Collier, D. (2018). *Motor learning and development* (2nd ed. b.). Human Kinetics.

Hardwick, R., Caspers, S., Eickhoff, S., & Swinnen, S. (2018). Neural correlates of action: Comparing meta-analyses of imagery, observation, and execution. *Neuroscience & Biobehavioral Reviews, 94*, 31–44. doi:10.1016/j.neubiorev.2018.08.003

Horak, F. (2009). Postural compensation for vestibular loss and implications for rehabilitation. *Restorative Neurology and Neuroscience, 27*(5), 457-471. doi:10.3233/RNN-2009-0499

Iacoboni, M., Woods, R., Brass, M., Bekkering, H., Mazziotta, J., & Rizzolatti, G. (1999). Cortical mechanisms of human imitation. *Science, 286*(5449), 2526-2528. doi:10.1126/science.286.5449.2526

Ito, M. (2006). Cerebellar circuitry as a neuronal machine. *Progress in Neurobiology, 78*(3-5), 272-303. doi:10.1016/j.pneurobio.2006.02.006

Jeannerod, M. (2001). Neural simulation of action: A unifying mechanism for motor cognition. *NeuroImage, 14*(1 Pt 2), S103–S109. doi:10.1006/nimg.2001.0832

Kandel, E., Schwartz, J., Jessell, T., Siegelbaum, S., & Hudspeth, A. (2013). *Principles of neural science* (5th ed. b.). McGraw-Hill.

Kilner, J. (2011). More than one pathway to action understanding. *Trends in Cognitive Sciences, 15*(8), 352–357. doi:10.1016/j.tics.2011.06.005

Kilner, J., & Lemon, R. (2013). What we know currently about mirror neurons. *Current Biology, 23*(23), R1057-R1062. doi:10.1016/j.cub.2013.10.051

Magill, R., & Anderson, D. (2017). *Motor learning and control: Concepts and applications* (11th ed. b.). McGraw-Hill Education.

Maquet, P. (2001). The role of sleep in learning and memory. *Science, 294*(5544), 1048-1052. doi:10.1126/science.1062856

Marder, E., & Calabrese, R. (1996). Principles of rhythmic motor pattern generation. *Physiological Reviews, 76*(3), 687-717. doi:10.1152/physrev.1996.76.3.687

Martinez, J., & Derrick, B. (2019). *Neurobiology of learning and memory* (2nd ed. b.). Elsevier.

McHughen, S., Rodriguez, P., Kleim, J., Kleim, E., Marchal, C., & Cramer, S. (2010). BDNF val66met polymorphism influences motor system function in the human brain. *Cerebral Cortex, 20*(5), 1254–1262. doi:10.1093/cercor/bhp187

Nudo, R., Milliken, G., Jenkins, W., & Merzenich, M. (1996). Use-dependent alterations of movement representations in primary motor cortex of adult squirrel monkeys. *Journal of Neuroscience, 16*(2), 785-807. doi:10.1523/JNEUROSCI.16-02-00785.1996

Peters, A., Chen, S., & Komiyama, T. (2017). Circuit changes in motor cortex during motor skill learning. *Neuroscience, 368*, 199-209. doi:10.1016/j.neuroscience.2017.09.029

Proske, U., & Gandevia, S. (2012). The proprioceptive senses: Their roles in signaling body shape, body position and movement, and muscle force. *Physiological Reviews, 92*(4), 1651–1697. doi:10.1152/physrev.00048.2011

Purves, D., Augustine, G., Fitzpatrick, D., Hall, W., LaMantia, A., & White, L. (2018). *Neuroscience* (6th ed. b.). Sinauer Associates.

Rasch, B., & Born, J. (2013). About sleep's role in memory. *Physiological Reviews, 93*(2), 681-766. doi:10.1152/physrev.00032.2012

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience, 27*, 169-192. doi:10.1146/annurev.neuro.27.070203.144230

Rizzolatti, G., & Sinigaglia, C. (2010). The functional role of the parieto-frontal mirror circuit: interpretations and misinterpretations. *Nature Reviews Neuroscience, 11*(4), 264-274. doi:10.1038/nrn2805

Roozendaal, B. (2002). Stress and memory: opposing effects of glucocorticoids on memory consolidation and memory retrieval. *Neurobiology of Learning and Memory, 78*(3), 578–595. doi:10.1006/nlme.2002.4080

Rothwell, P., Hay, E., & Kunz, M. (2021). Cortico-basal ganglia plasticity in motor learning. *Neurobiology of Learning and Memory, 185*, 107520. doi:10.1016/j.nlm.2021.107520

Sainburg, R., Ghilardi, M., Poizner, H., & Ghez, C. (1995). Control of limb dynamics in normal subjects and patients without proprioception. *Journal of Neurophysiology, 73*(2), 820–835. doi:10.1152/jn.1995.73.2.820

Salmoni, A., Schmidt, R., & Walter, C. (1984). Knowledge of results and motor learning: a review and critical reappraisal. *Psychological Bulletin, 95*(3), 355–386. doi:10.1037/0033-2909.95.3.355

Schmidt, R., & Lee, T. (2011). *Motor learning and performance: From principles to application* (5th ed. b.). Human Kinetics.

Seidler, R., Bernard, J., Burutolu, T., Fling, B., Gordon, M., Gwin, J. T., et al. (2010). Motor control and aging: links to age-related brain structural, functional, and biochemical effects. *Neuroscience and Biobehavioral Reviews, 34*(5), 721–733. doi:10.1016/j.neubiorev.2009.10.005

Shadmehr, R., Smith, M., & Krakauer, J. (2010). Error correction, sensory prediction, and adaptation in motor control. *Annual Review of Neuroscience, 33*, 89–108. doi:10.1146/annurev-neuro-060909-153135

Spampinato, D., Celnik, P., & Cortes, J. (2021). Neural correlates of motor learning: Network communication versus local oscillations. *Network Neuroscience, 5*(3), 714-732. doi:10.1162/netn_a_00178

Stickgold, R. (2005). Sleep-dependent memory consolidation. *Nature, 437*(7063), 1272-1278. doi:10.1038/nature04286

Sullivan, K., & Armstrong, R. (2018). Environmental influences on myelination and axonal plasticity: Implications for central nervous system repair. *Brain Research, 1697*, 1-15. doi:10.1016/j.brainres.2018.05.013

Teo, J. (2009). *Motor learning and neuroplasticity in humans.*

Thompson, A., Wolpaw, J., & Chen, X. (2009). Operant conditioning of spinal reflexes: from basic science to clinical therapy. *Frontiers in Integrative Neuroscience, 3*, 29. doi:10.3389/neuro.07.029.2009

Tononi, G., & Cirelli, C. (2012). Time to be SHY? Some comments on sleep and synaptic homeostasis. *Neural Plasticity, 2012*, 415250. doi:10.1155/2012/415250

Tononi, G., & Cirelli, C. (2014). Sleep and the price of plasticity: from synaptic and cellular homeostasis to memory consolidation and integration. *Neuron, 81*(1), 12-34. doi:10.1016/j.neuron.2013.12.025

Walker, M., & Stickgold, R. (2006). Sleep, memory, and plasticity. *Annual Review of Psychology, 57*, 139-166. doi:10.1146/annurev.psych.56.091103.070307

Walker, M., Brakefield, T., Morgan, A., Hobson, J., & Stickgold, R. (2002). Practice with sleep makes perfect: sleep-dependent motor skill learning. *Neuron, 35*(1), 205-211. doi:10.1016/s0896-6273(02)00746-8

Winstein, C., & Schmidt, R. (1990). Reduced frequency of knowledge of results enhances motor skill learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*(4), 677–691. doi:10.1037/0278-7393.16.4.677

Wolpaw, J. (2001). Activity-dependent spinal cord plasticity in health and disease. *Annual Review of Neuroscience, 24*, 807-843. doi:10.1146/annurev.neuro.24.1.807

Wolpaw, J. (2010). What can the spinal cord teach us about learning and memory? *The Neuroscientist, 16*(5), 532-549. doi:10.1177/1073858410368314

Wolpert, D., Diedrichsen, J., & Flanagan, J. (2011). Principles of sensorimotor learning. *Nature Reviews Neuroscience, 12*(12), 739–751. doi:10.1038/nrn3112

Wu, T., Duff, K., & Egan, M. (2022). Brain Activity and Functional Connectivity Patterns Associated With Fast and Slow

Motor Sequence Learning in Late Middle Adulthood. *Frontiers in Aging Neuroscience, 13*, 781190. doi:10.3389/fnagi.2021.781190

Wulf, G., Shea, C., & Lewthwaite, R. (2010). Motor skill learning and performance: a review of influential factors. *Medical Education, 44*(1), 75–84. doi:10.1111/j.1365-2923.2009.03421.x

BÖLÜM 2

SANAL DÜNYADA FİZİKSEL AKTİVİTE: RİNG FİT ADVENTURE İLE DİJİTAL EGZERSİZİN YENİ UFUKLARI

TUĞBA MUTLU BOZKURT[1]
EMRULLAH YILMAZ[2]
AHMETHAN YILDIRAK[3]

Giriş

Dijital teknolojilerin hızla gelişmesi ve günlük yaşamın her alanına entegre olması, fiziksel aktivite ve egzersiz yaklaşımlarını da derinden etkilemiştir. Özellikle son yıllarda, 'fijital' (fiziksel + dijital) kavramı, bireylerin hem dijital ortamda hem de fiziksel olarak aktif olmalarını sağlayan platformların geliştirilmesine öncülük etmiştir (Bonnechère ve ark., 2020; Staiano ve ark., 2018; Vaghetti ve ark., 2018). Bu bağlamda, "harekete duyarlı dijital oyunlar" (exergame) kavramı ortaya çıkmış ve bu oyunlar, kullanıcıların fiziksel

[1] Doç. Dr. Bitlis Eren Üniversitesi, Beden Eğitimi ve Spor Yüksekokulu, 0000 0001 8663 2188
[2] Beden Eğitimi Öğretmeni, MEB, Doktora Öğrencisi, Beden Eğitimi ve Spor Anabilim Dalı, 0000-0001-7481-5075
[3] Spor Uzmanı, GSB, Doktora Öğrencisi, Beden Eğitimi ve Spor Anabilim Dalı, 0000-0001-6112-7695

hareketlerle oyunlara dahil olmalarını sağlayarak, hem eğlence hem de sağlık amaçlı kullanımı bir araya getirmiştir.

Bu çalışmanın amacı, harekete duyarlı dijital oyunlardan biri olan Ring Fit Adventure oyunu özelinde dijital oyunların fiziksel aktivite, egzersiz ve sağlık üzerindeki etkilerini değerlendirmek; bu oyunların spor ve sağlık bilimlerine sunduğu katkıları incelemek ve dijital teknolojilerin fiziksel aktivite alanında sunduğu yenilikleri bilimsel bir çerçevede ele almayı hedeflemektedir.

Bu bölümde, aşağıdaki konulara odaklanılmıştır:

1. Dijital oyunların tarihsel gelişimi ve harekete duyarlı oyunların ortaya çıkışı,
2. Harekete duyarlı dijital oyunların fiziksel aktivite, egzersiz ve sağlık üzerindeki etkileri,
3. *Ring Fit Adventure* özelinde, bu oyunun fiziksel aktivite ve sağlıkla olan ilişkisi,
4. Dijital oyunların spor bilimleri, sağlık bilimleri ve teknoloji alanlarına katkıları,
5. Gelecekteki teknolojik gelişmeler ve metaverse entegrasyonu başlıklarında incelenmiştir.

DİJİTAL OYUNLARIN TARİHSEL GELİŞİMİ VE HAREKETE DUYARLI OYUNLARIN ORTAYA ÇIKIŞI

Dijital Oyunların Kökeni, İlk Örnekler ve Konsol Gelişimi

Dijital oyunların kökeni, 1950'li yıllarda bilgisayar teknolojilerinin gelişimine paralel olarak gelişim gösterdiği belirtilmektedir. İlk dijital oyun örneklerinden biri, 1958 yılında William Higinbotham tarafından geliştirilen ve osiloskop ekranında oynanabilen *Tennis for Two* oyunu olarak ifade edilmiştir (Smith, 2006). 1960'larda MIT'de geliştirilen *Spacewar!* oyunu ise, daha geniş kitlelere ulaşan ilk etkileşimli oyunlardan biri olarak belirtilmiştir. 1972 yılında Atari tarafından geliştirilen *Pong* oyunu, ticari anlamda dijital oyun sektörünün temelini atmış ve arcade salonlarının yükselişine öncülük etmektedir. İfade edilen dönem, dijital oyunların eğlence amaçlı kullanımıyla ilgili kamuoyunda ilk farkındalıkların oluştuğu ve oyun kültürünün yaygınlaştığı yıllar olarak yerini almıştır.

1980'li yıllar, ev tipi oyun konsollarının piyasaya sürülmesiyle dijital oyunların daha geniş kitlelere ulaşmasına olanak sağlamaktadır. Nintendo Entertainment System (NES), Sega Genesis gibi konsollar, ev ortamında interaktif oyun deneyimlerini mümkün kılmaktadır. Bu dönemde, joystick ve game-pad gibi fiziksel arayüzlerle kullanıcı etkileşimi ön plana çıkarken, oyunların görsel ve işitsel kaliteleri de geliştirilmiştir. Oyun türleri çeşitlenmiş, platform, strateji ve dövüş gibi farklı kategorilerde oyunlar üretilmiştir.

Harekete Duyarlı Oyunların Evrimi: Wii, Kinect, Move ve Mobil Teknolojiler

Harekete duyarlı oyunların ilk örnekleri, 1980'li yıllarda arcade salonlarında kullanılan fiziksel etkileşimli sistemlere dayanmaktadır. Örneğin, motosiklet simülasyonları ve dans platformları, oyuncuların fiziksel hareketlerle oyuna dahil olmalarını sağlamaktadır. Ancak bu deneyimlerin ev ortamına taşınması sınırlı kaldığı ifade edilmiştir. 1998 yılında Konami tarafından geliştirilen *Dance Dance Revolution* (DDR), ev kullanıcılarına yönelik ilk etkili harekete duyarlı dijital oyunlardan biri olarak tarihte yerini almıştır (Sheehan & Katz, 2013; Barnett ve ark., 2011). Bu oyun, kullanıcıların ayak hareketlerini algılayan bir platform üzerinde fiziksel aktivite yapmalarını sağlamış ve özellikle gençler arasında büyük popülerlik kazanmıştır.

2006 yılında Nintendo tarafından piyasaya sürülen *Wii* oyun konsolu, harekete duyarlı oyunları kitlesel kullanıcıya ulaştıran en önemli yeniliklerden biri olmuştur. *Wii Remote* adlı hareket algılayıcı kumanda, kullanıcıların el hareketlerini algılayarak kullanıcıları oyun deneyimine dahil etmektedir. *Wii Sports* gibi oyunlar, tenis, bowling, boks gibi fiziksel aktiviteleri dijital ortamda deneyimleme imkânı sunarak, geniş yaş grupları tarafından benimsenmiştir. Bu dönem, dijital oyunların sağlık ve egzersiz amacıyla da kullanılabileceği fikrinin yaygınlaştığı bir süreci temsil etmektedir.

Nintendo'nun başarısının ardından, Microsoft *Xbox Kinect* ve Sony *PlayStation Move* sistemleri ile pazarda rekabeti derinleştirmiştir. Kinect, kullanıcıların tüm vücut hareketlerini herhangi bir kumanda gerektirmeksizin algılayarak oyuna aktaran bir kamera ve sensör sistemi sunmuştur. Bu teknoloji, daha özgür ve gerçekçi bir oyun deneyimi sağlarken, egzersiz ve dans gibi fiziksel aktivitelerin dijital ortama taşınmasına olanak vermiştir. PlayStation Move ise el kumandaları ve kamera desteği ile benzer bir deneyimi sağlamış, özellikle fitness ve spor temalı oyunlarda etkili olmuştur.

2010'lu yıllarla birlikte, akıllı telefonlar, tabletler ve giyilebilir cihazlar, dijital oyunların fiziksel aktiviteyle entegrasyonunu kolaylaştırmıştır. Özellikle hareket sensörleri, GPS, ivmeölçer gibi donanımlar sayesinde, kullanıcıların konum ve hareket verileri oyunlara entegre edilmiştir. Bu dönemde *Zombies, Run!* gibi uygulamalar, kullanıcıların yürüyüş ve koşu aktivitelerini oyunlaştırarak teşvik etmiş, *Just Dance Now* gibi oyunlar ise mobil cihazlar üzerinden evde dans egzersizi imkânı sunmuştur.

Ring Fit Adventure, Pandemi ve Harekete Duyarlı Oyunların Yeni Ufukları

Nintendo, 2019 yılında *Ring Fit Adventure* oyununu piyasaya sürerek, harekete duyarlı oyunlar alanında yeni bir dönem başlamıştır. Bu oyun, *Ring-Con* adlı direnç halkası ve bacak sensörü ile oyuncuların vücut hareketlerini daha geniş bir yelpazede algılayarak, egzersiz türleri çeşitlendirilmiştir. COVID-19 pandemisi sürecinde evde egzersiz ihtiyacının artması, *Ring Fit Adventure*'ın popülerliği artırılmıştır. Bu durum, dijital oyunların sağlık, egzersiz ve yaşam tarzı üzerindeki etkisinin daha fazla tartışılmasına yol açmış, harekete duyarlı oyunların "ev egzersizi" kavramını yeniden tanımlaması sağlanmıştır.

Günümüzde harekete duyarlı oyunlar, sanal gerçeklik (VR), artırılmış gerçeklik (AR) ve yapay zekâ (AI) teknolojileri ile bütünleşerek daha sürükleyici ve kişiselleştirilmiş hale gelmektedir. *Beat Saber, Supernatural, FitXR* gibi VR tabanlı egzersiz oyunları, kullanıcıların sanal ortamlarda yoğun fiziksel aktiviteler gerçekleştirmesini mümkün kılmaktadır (Qian ve ark., 2020; Viana & de Lira, 2020).

Bu tür harekete duyarlı oyunlar, yalnızca fiziksel sağlığı değil, aynı zamanda anksiyete ve stresle başa çıkmada da etkili olabilmektedir (Viana & de Lira, 2020). Aynı zamanda giyilebilir cihazlar sayesinde biyolojik verilerin oyun deneyimine entegre edilmesi, bireylerin sağlığını izleyerek optimize edilmiş antrenmanlar yapılmasına olanak tanımaktadır.

HAREKETE DUYARLI DİJİTAL OYUNLARIN FİZİKSEL AKTİVİTE VE SAĞLIK ÜZERİNDEKİ ROLÜ

Fiziksel Aktivitenin Artırılması ve Sağlık Üzerindeki Etkileri: Kardiyovasküler, Kas, Psikolojik ve Bilişsel Sonuçlar

Harekete duyarlı dijital oyunlar, fiziksel aktiviteyi teşvik eden interaktif yapıları sayesinde, özellikle hareketsiz yaşam tarzına sahip bireyler için önemli bir alternatif oluşturmaktadır. Yapılan çalışmalar, bu oyunların kısa vadede enerji harcamasını artırdığı ve orta düzey fiziksel aktivite seviyesine ulaşmayı mümkün kıldığını göstermektedir (Peng ve ark., 2020). Ayrıca, oyunların eğlence temelli doğası, kullanıcıların egzersizi daha cazip ve sürdürülebilir bir etkinlik olarak algılamalarına katkı sunar. Bu oyunlar, egzersizi bir “zorunluluk” olmaktan çıkarıp “keyifli bir deneyim” haline getirerek fiziksel aktiviteye katılımı uzun vadede teşvik edebilir. Nitekim Staiano ve ark. (2017), harekete duyarlı oyunların genç bireylerde fiziksel aktivite süresini artırdığını ve egzersize yönelik öz-yeterlik algısını geliştirdiği ortaya koyulmuştur.

Harekete duyarlı oyunlar, kalp atış hızını artıran egzersizler içermesi sayesinde kardiyovasküler sağlık açısından faydalar olduğu da ifade edilebilir. Düzenli kullanımda harekete duyarlı oyunların kalp-damar sistemini desteklediği, oksijen tüketimini artırdığı ve aerobik kapasiteyi geliştirdiği gözlemlenmiştir (Düking ve ark., 2020).

Bu nedenle, özellikle hareketsiz bireylerde başlangıç düzeyi aerobik egzersiz ihtiyacını karşılayarak, sağlık kazanımlarına ulaşmada etkili bir araç olarak da tanımlanabilmektedir.

Bununla birlikte kas gücü ve esnekliğin artırılması, yalnızca geleneksel direnç egzersizleri ile değil, harekete duyarlı oyunlarla da mümkün olabilmektedir. Özellikle *Ring Fit Adventure* gibi oyunlarda uygulanan izometrik egzersizler, vücut ağırlığıyla yapılan antrenmanlar ve yoga tabanlı hareketler, kas dayanıklılığını ve esnekliğini de artırmaktadır. Ayrıca, denge ve koordinasyon gibi motor beceriler, bu oyunların tekrarlı ve yönlendirmeli yapıları sayesinde gelişmekte, böylece düşme riskinin azaltılması gibi önemli sağlık çıktıları elde edilmektedir (Staiano & Calvert, 2011; Peng ve ark., 2011).

Harekete duyarlı dijital oyunların etkileri yalnızca fiziksel boyutla sınırlı değildir. Yapılan çalışmalar, bu oyunların anksiyete ve stres düzeylerini azalttığını, öz-yeterlik algısını ve motivasyonu artırdığını ortaya koyulmuştur (Staiano & Calvert, 2011). Ayrıca, dikkat, karar verme ve tepki süresi gibi bilişsel becerilerin gelişiminde de olumlu etkiler rapor edilmiştir (Best, 2013). Bu yönüyle, harekete duyarlı oyunlar sadece bedensel değil, zihinsel sağlığın da korunmasına katkı sunan bütüncül araçlardan birisi olduğu belirtilebilmektedir.

Harekete duyarlı oyunlar, yaş gruplarına özgü farklı faydalar da sunmaktadır. Çocuklarda ve gençlerde obezite ile mücadelede etkili bir araç olarak kullanılmakta, motor becerilerin gelişimine katkı sağlamaktadır (Gao ve ark., 2015; Barnett ve ark., 2011). Yaşlı bireylerde ise düşme riskini azaltma, denge ve kas kuvvetini koruma açısından bu oyunlar rehabilitatif bir araç işlevi görülmektedir. Ayrıca, sosyal etkileşim imkânı sunması, yaşlı bireylerin yalnızlık hissini azaltarak genel yaşam kalitesini iyileştirmektedir (Skjæret ve ark., 2016).

RING FIT ADVENTURE: FİZİKSEL AKTİVİTE VE SAĞLIK İLİŞKİSİ

Oyun Temelli Egzersiz Programlarının Yapısı, Kişiselleştirilmiş Uygulamalar ve Fiziksel Uygunluk Üzerindeki Etkileri

Ring Fit Adventure, Nintendo Switch platformunda çalışmakta olup, fiziksel aktiviteyi oyunlaştırılmış bir yapıda sunan rol yapma (RPG) tabanlı bir egzersiz oyunu olarak tanımlanabilmektedir. Oyuncular, *Ring-Con* adlı direnç halkası ve bacak sensörü ile oyun içi karakterleri yönlendirmektedir. Oyun, kardiyovasküler egzersizler (koşu, zıplama), kuvvet antrenmanları (squat, overhead press), esneklik egzersizleri (yoga, stretching) gibi çok yönlü hareketleri kapsamaktadır. Çok yönlü hareketleri kapsayan bu yapı, oyun içeriğini hem eğlenceli hem de fiziksel olarak etkili hale getirmektedir.

Ring Fit Adventure, kullanıcıların yaş, cinsiyet, kondisyon düzeyi ve hedeflerine göre kişiselleştirilmiş egzersiz programları da sunmaktadır. Oyunun yapay zekâ tabanlı algoritmaları, kullanıcının performansına göre zorluk seviyesini otomatik olarak ayarlamakta ve ilerleme verilerini takip etmektedir. Ayrıca, gerçek zamanlı görsel ve sesli geribildirim mekanizmaları, egzersizlerin doğru ve verimli bir şekilde yapılmasına olanak sağlamaktadır.

Literatürde yapılan çalışmalarda, Ring Fit Adventure kullanımının VO2 max, kas kuvveti, esneklik ve vücut kompozisyonu gibi fiziksel uygunluk parametrelerinde anlamlı iyileşmeler sağladığı belirtilmiştir. Özellikle haftada 3-4 gün, 30-45 dakikalık seanslarla yapılan kullanım, başlangıç düzeyindeki bireyler için bile kısa sürede sağlık çıktıları elde edilmesini mümkün kılmaktadır (Qian ve ark., 2020; Vaghetti ve ark., 2018). Benzer şekilde, exergaming'in fiziksel uygunluk üzerindeki olumlu etkileri, kardiyovasküler fitness ve kas kuvveti gibi parametrelerde önemli iyileşmeler sağladığı belirtilmektedir (Staiano & Calvert, 2011; Peng ve ark., 2011). Ayrıca, aktif video oyunlarının enerji harcamasını artırarak orta-yüksek şiddette egzersiz sağladığı ve özellikle çocuklar ve ergenlerde obezite riskini azaltmada etkili olduğu vurgulanmaktadır (Gao ve ark., 2015; Benzing & Schmidt, 2018). Ulaşılan bulgular, Ring Fit Adventure gibi exergaming sistemlerinin fiziksel aktiviteyi teşvik etme ve genel sağlık üzerinde olumlu etkiler yaratma potansiyelini ortaya koymaktadır.

Oyunlaştırma, Rehabilitasyon ve Ring Fit Adventure'ın Çocuklar ve Gençler Üzerindeki Etkileri

Oyunun oyunlaştırma (gamification) unsurları, kullanıcıların egzersize katılım motivasyonunu artırmakta ve davranışsal sürdürülebilirliği desteklemektedir. Puan toplama, görev tamamlama, seviye atlama gibi ödül mekanizmaları, kullanıcıların egzersiz alışkanlıklarını pekiştirmekte; başarı hissi ve içsel motivasyon gelişimini teşvik etmektedir (Ryan ve ark., 2006). Ayrıca, oyunun mizahi anlatımı ve renkli görsel tasarımı, kullanıcıların oyunu keyifle deneyimleme şansı sağlamaktadır (Hamari & Koivisto, 2015).

Ring Fit Adventure, ayrıca muazzam bir özelliği ile de destek tedavisi süresinde de bireylere yardımcı olduğu düşünülmektedir. Örneğin rehabilitasyon sürecindeki bireyler için düşük-orta yoğunlukta egzersiz sunarak kas gücünü ve hareket kabiliyetini artırabilir. Örneğin, felç sonrası iyileşme sürecinde vücut hareketlerinin tekrar kazanılması, bu oyun aracılığıyla desteklenebilir (Laver ve ark., 2017). Ayrıca obezite, tip 2 diyabet ve hipertansiyon gibi kronik hastalıkların yönetiminde, ev ortamında sürdürülebilir egzersiz seçeneği sunarak yaşam kalitesine olumlu katkılar sağlayabilmektedir (Stanmore ve ark., 2019).

Dijital oyunlara yatkınlığı yüksek olan çocuklar ve gençlerde Ring Fit Adventure, fiziksel aktiviteye katılımı artırmak için etkili bir araç olduğu düşünülmektedir. Çocuklar ve gençler grubunda sık görülen hareketsizlik ve ekran bağımlılığı sorunlarına karşı, bu tür oyunlar fiziksel aktiviteyi eğlenceyle bütünleştirerek çözüm sunmaktadır (Staiano & Calvert, 2011; Benzing & Schmidt, 2018). Ayrıca, obeziteyle mücadelede enerji harcamasını artırması, sağlıklı yaşam alışkanlıklarının erken yaşta kazandırılmasına yardımcı olabilir (Peng ve ark., 2011; Biddiss & Irwin, 2010).

DİJİTAL OYUNLARIN SPOR BİLİMLERİ, SAĞLIK BİLİMLERİ VE TEKNOLOJİ ALANLARINA KATKILARI

Spor Bilimleri Açısından Değerlendirme

Dijital oyunlar, özellikle harekete duyarlı olanlar, spor bilimlerinin farklı alt disiplinlerine doğrudan katkı sağlamaktadır. Egzersiz fizyolojisi alanında, bu oyunların enerji harcaması, kalp atış hızı ve metabolik eşdeğer (MET) değerleri üzerinden yapılan analizleri, fiziksel aktivitenin şiddetini ve etkinliğini ortaya koymak açısından önemi ifade edilmiştir (Staiano ve ark., 2012). Ayrıca motor öğrenme ve motor kontrol alanında, kullanıcıların karmaşık hareket dizilerini öğrenmesi ve tekrarlaması, bu oyunların eğitim ve rehabilitasyon süreçlerinde nasıl kullanılabileceğine dair önemli veriler sunmaktadır (Levac ve ark., 2016).

Antrenman bilimi bağlamında, dijital oyunlar bireylerin kondisyon düzeyine göre ölçeklenebilir egzersiz protokollerinin uygulanmasına olanak tanımaktadır. Bununla birlikte dijital oyunlar, sporcuların düşük yoğunluklu günlerde aktif kalmasına, toparlanma süreçlerinde ise aktif dinlenme yapılmasına katkı sunabilmektedir (Peng ve ark., 2011). Spor pedagojisi açısından, çocuk ve gençlere fiziksel aktivite alışkanlıkları kazandırmak için eğitsel oyunlaştırma teknikleriyle bütünleşik programlar geliştirilebilmektedir (Benzing & Schmidt, 2018).

Sağlık Bilimleri Açısından Değerlendirme

Harekete duyarlı dijital oyunlar, sağlık bilimleri perspektifinden incelendiğinde, önleyici sağlık hizmetleri kapsamında değerlendirilebilir. Özellikle obezite, hipertansiyon, tip 2 diyabet, osteoporoz ve kardiyovasküler hastalıkların önlenmesinde, bu oyunlar hareketli yaşam biçimini teşvik ederek koruyucu sağlık uygulamalarına destek sağlamaktadır (Anderson ve ark., 2020).

Rehabilitasyon bilimleri açısından, dijital oyunlar, fiziksel kabiliyetleri kısıtlanmış bireylerin motivasyonunu artırarak fizik tedavi süreçlerine aktif katılımını da desteklemektedir. Sanal ortamın güvenli yapısı, hastaların risk almadan hareket kabiliyetlerini geliştirmelerine olanak tanımaktadır (Laver ve ark., 2017). Psikolojik sağlık açısından, oyunların motivasyon, öz-yeterlik, stresle başa çıkma ve ruh hâli iyileştirme üzerindeki etkileri, bireyin psikososyal sağlığını destekleyici bir araç olarak kullanılabileceğini göstermektedir (Granic ve ark., 2014).

Günümüzde sağlık verilerinin toplanması, analiz edilmesi ve bu verilere dayalı kişiselleştirilmiş çözümler sunulması, sağlık hizmetlerinin dijitalleşmesinde temel bir role sahip olduğu düşünülmektedir. Harekete duyarlı oyunlar, kullanıcıların kalp atış hızı, adım sayısı, enerji harcaması gibi temel sağlık verilerini toplayarak, yapay zekâ algoritmaları yardımıyla bireylere özgü egzersiz programları sunabilir (Topol, 2019).

Bu veriler, bireylerin antrenman yoğunluklarının optimize edilmesinde, egzersiz sıklığının ayarlanmasında ve performans gelişiminin takibinde sağlık profesyonellerine yardımcı olmaktadır. Ayrıca, sağlık risklerini önceden tespit etmeye yönelik erken uyarı sistemleri geliştirmek için de bu veriler kıymetli olabilmektedir (Bonnechère ve ark., 2021).

Teknoloji ve Giyilebilir Cihazların Entegrasyonu

Dijital oyunlar, teknolojiyle bütünleşik yapıları sayesinde, veri analitiği, yapay zekâ ve biyosensör teknolojileriyle güçlü bir sinerji yaratmaktaadır (Chernbumroong ve ark., 2022). Giyilebilir cihazlar (akıllı saat, nabız ölçer, hareket sensörleri), oyunlar sırasında toplanan biyometrik verileri gerçek zamanlı olarak analiz edebilmekte, bu veriler kişiselleştirilmiş egzersiz reçetelerinin oluşturulmasında kullanılmaktadır (Topol, 2019; Qian ve ark., 2020).

Ayrıca bulut tabanlı sistemlerle entegre çalışan oyunlar, uzun dönemli kullanıcı verilerini saklayarak sağlık takibi ve davranışsal analizlerde sağlık profesyonellerine destek olabilmektedir. Bu entegrasyon, uzaktan sağlık takibi (tele-sağlık) hizmetlerinin gelişmesine ve yaygınlaşmasına katkı sağlamaktadır.

Eğitimde Dijital Oyunlar ve Spor Psikolojisinde Motivasyon

Dijital oyunlar, özellikle beden eğitimi dersleri başta olmak üzere birçok eğitim ortamında kullanılabilecek yenilikçi öğretim araçlarından birisi olarak karşımıza çıkmaktadır. Harekete duyarlı oyunların, öğrenci katılımını artırdığı, derse olan ilgiyi canlı tuttuğu ve öğrencilerin fiziksel aktiviteye yönelik olumlu tutum geliştirmelerine katkı sunduğu gösterilmiştir (Staiano ve ark., 2018).

Dijital oyunlar ayrıca beden farkındalığı, motor becerilerin öğrenilmesi ve grup etkileşimini teşvik eden sosyal dinamiklerin geliştirilmesinde etkili olmaktadır (Benzing ve Schmidt, 2018). Eğitim ortamlarında oyunların kullanımı, aynı zamanda öğrencilerin dijital okuryazarlık becerilerinin gelişmesine de desteklemektedir (Qian & Clark, 2016).

Harekete duyarlı dijital oyunların sunduğu eğlenceli yapı, kullanıcıların egzersize yönelik motivasyonlarını artırmaktadır. Oyun içi ödüller, ilerleme göstergeleri ve sosyal paylaşım imkanları, kullanıcıların içsel ve dışsal motivasyon kaynaklarını güçlendirmektedir (Ryan ve ark., 2006). Spor psikolojisi bağlamında, bu motivasyon unsurları, spora yeni başlayan bireylerin alışkanlık kazanmasına, düzenli spor yapan bireylerin ise performanslarını sürdürebilmesine katkı sunmaktadır.

Ayrıca dijital oyunlar, stres yönetimi, zihinsel dayanıklılık ve özgüvenin gelişimi açısından da etkili olduğu ifade edilmektedir. Oyun ortamı, kullanıcıya hatasızlık beklentisi olmaksızın deneme ve başarma fırsatları sunduğu için öz-yeterlik inancını desteklemektedir (Biddiss & Irwin, 2010).

GELECEK PERSPEKTİFİ: FİJİTAL EGZERSİZ VE METAVERSE ENTEGRASYONU

Sanal Gerçeklik (VR) ve Artırılmış Gerçeklik (AR) Teknolojileri

Sanal gerçeklik (VR) ve artırılmış gerçeklik (AR) teknolojileri, fiziksel aktivitenin dijital ortamlarda daha sürükleyici bir deneyime dönüşmesini sağlamaktadır. Bu teknolojiler sayesinde kullanıcılar, gerçek dünyadan tamamen soyutlanmış sanal ortamlarda egzersiz yapabilir (*immersive VR*) ya da gerçek çevrelerinin üzerine dijital içerikler entegre ederek fiziksel aktivitelerini daha zengin bir hâle getirebilmektedir (*AR*). Örneğin, sanal bir dağa tırmanma, dijital ortamda yüzme veya VR destekli bisiklet turları ile kullanıcılar egzersizi daha motive edici bir deneyim olarak yaşayabilmektedir (Chernbumroong ve ark., 2022).

VR ve AR tabanlı oyunlar, egzersiz sırasında dikkatin dağılmasını engelleyerek egzersiz süresini uzatabilir ve algılanan zorluk seviyesini düşürerek kullanıcıların daha uzun süre aktif kalmasını sağlayabilmektedir (Matallaoui ve ark., 2017). Bu bağlamda, VR/AR sistemlerinin spor salonları, rehabilitasyon merkezleri ve bireysel kullanım alanlarında yaygınlaşması beklenmektedir.

Metaverse ile Fiziksel Aktivitenin Yeni Boyutu

Metaverse, fiziksel aktivitenin dijital dünyaya tam anlamıyla entegre edilebileceği yeni bir sanal evren olarak tanımlanmaktadır (Mystakidis, 2022). Metaverse evreni, kullanıcılara avatarları aracılığıyla egzersiz yapma, sanal spor etkinliklerine katılma ve sosyal etkileşim yoluyla hareketli bir yaşam tarzı sürdürme imkânı tanımaktadır. Örneğin, kullanıcılar metaverse içinde sanal spor salonlarına erişebilir, grup fitness derslerine katılabilir ya da dünya çapındaki kullanıcılarla birlikte sanal yarışlara katılabilmektedir.

Metaverse ortamında fiziksel aktivitenin oyunlaştırılması, kullanıcı motivasyonunu artırmanın yanı sıra fiziksel sağlık parametrelerinin izlenmesini de mümkün kılmaktadır (Dionisio ve ark., 2023). Kullanıcının gerçek zamanlı biyolojik verileri (kalp atış hızı, adım sayısı, enerji harcaması) metaverse platformlarına entegre edilerek hem bireysel sağlık yönetimi hem de sosyal rekabet boyutu zenginleştirilebilir (Dionisio ve ark., 2013). Bu ortamda dijital koleksiyonlar, rozetler ve ödüller ile fiziksel aktivite davranışı desteklenebilmektedir.

Yapay Zekâ ve Giyilebilir Teknolojilerle Kişiselleştirilmiş Egzersiz Deneyimi

Yapay zekâ (AI), kullanıcının fiziksel aktivite geçmişi, sağlık verileri, motivasyonel eğilimleri gibi birçok faktörü analiz ederek kişiselleştirilmiş egzersiz programları oluşturabilmektedir (Bonnechère ve ark., 2021). Yapay zekâ sistemler, kullanıcıların performansını gerçek zamanlı izleyebilir, hedeflere göre geri bildirim sunabilir ve egzersiz programlarını dinamik biçimde güncelleyebilmektedir (Topol, 2019). Ayrıca AI sistemleri, kullanıcının ruh hâlini veya enerji düzeyini analiz ederek egzersiz şiddetini ayarlayabilir ve uzun vadeli motivasyonu artırabilmektedir (Bickmore ve ark., 2018).

Örneğin, kullanıcı sabah düşük enerji ile başladığında AI sistem egzersiz yoğunluğunu azaltabilir ya da kullanıcı performans artışı gösterdiğinde daha zorlu görevler sunabilmektedir. Bu düzeyde kişiselleştirme, bireyin uzun vadeli sağlık hedeflerine ulaşmasında kritik rol oynayacağı düşünülmektedir.

Giyilebilir cihazlar (akıllı saatler, fitness bileklikleri, kalp ritmi monitörleri), fizyolojik verilerin toplanması ve analiz edilmesi açısından kritik öneme sahip olduğu belirtilmiştir (Dunn ve ark., 2021). Giyilebilir cihazlar, kullanıcıların kalp atış hızı, oksijen satürasyonu, kalori harcaması, uyku kalitesi gibi verilerini toplayarak oyun platformlarına entegre edebilmektedir. Bu entegrasyon sayesinde oyun zorluk seviyeleri dinamik olarak ayarlanabilir ve kullanıcılar kendi performanslarını anlık olarak takip edebilmektedir (Piwek ve ark., 2016; Shcherbina ve ark., 2017).

Biyolojik geri bildirim (biofeedback), kullanıcının vücut tepkilerini anlamasına ve bu tepkilere göre egzersiz stratejileri geliştirmesine olanak sağlamaktadır. Bu sistemler, stres yönetimi, nefes kontrolü ve yorgunluk düzeylerinin analizinde de kullanılarak fiziksel aktivitenin sağlık üzerindeki etkilerini optimize etmektedir (Lehrer ve ark., 2020).

Dijital Oyunların Toplumsal, Kültürel ve Gelecek Potansiyeli: Spor Turizmi, Dijital Antrenörler ve Sosyal Etkileşim

Fijital egzersiz platformlarının yaygınlaşması, toplum genelinde fiziksel aktivite bilincinin artmasına, sağlık davranışlarında dönüşüme ve hareketsizlik temelli hastalıkların azalmasına katkı sağlayabilmektedir (Thompson, 2022). Özellikle genç kuşaklar arasında dijital ortamlara yönelik eğilim, fiziksel aktiviteye oyunlaştırılmış yollarla katılımı teşvik ederek uzun vadede toplum sağlığını iyileştirebilmektedir (Gao ve ark., 2019).

Ayrıca aile içi etkileşimde, grup egzersizlerinde veya sosyal spor topluluklarında dijital oyunlar ve metaverse uygulamaları, sosyal bağların güçlendirilmesi açısından da önemli olduğu belirtilmiştir (Benzing & Schmidt, 2018). Örneğin, aile üyeleri birlikte sanal ortamda egzersiz yaparak hem fiziksel hem de sosyal fayda elde edebilir. Kültürel olarak, bu tür uygulamalar fiziksel aktiviteyi daha erişilebilir ve kapsayıcı hale getirerek dezavantajlı grupların da aktif yaşam tarzına katılımını artırabilmektedir (Bonnechère ve ark., 2021).

Gelecekte metaverse ve VR platformları sayesinde, kullanıcılar dünyanın farklı bölgelerinde sanal koşulara, bisiklet turlarına ya da yoga etkinliklerine katılabilme imkanı sunmaktadır. Metaverse ve VR platformları, spor turizmini dijital ortama taşıyarak sınırları ortadan kaldıran bir deneyim sunmaktadır (Dionisio ve ark., 2023). Ayrıca AI tabanlı dijital antrenörler, kullanıcılara birebir eğitim, motivasyon ve teknik analiz sağlayarak profesyonel destek sunabilmektedir (Topol, 2019).

Dijital oyunlar, özellikle harekete duyarlı olanlar, sadece bireysel egzersiz yapmak için değil, aynı zamanda sosyal etkileşim ve topluluk oluşturma açısından da önemli bir rol oynamaktadır

(Staiano & Calvert, 2011). Özellikle çevrimiçi platformlar ve metaverse gibi sanal ortamlar, kullanıcıların bir araya gelerek grup egzersizleri yapmalarına, birbirlerini motive etmelerine ve rekabet etmelerine olanak tanımaktadır. Bu tür etkileşimler, özellikle pandemi döneminde fiziksel mesafe kısıtlamaları nedeniyle sosyal izolasyon yaşayan bireyler için önemli bir sosyal destek mekanizması haline gelmektedir (Vella ve ark., 2021).

Örneğin, *Ring Fit Adventure* gibi oyunlar, çevrimiçi liderlik tabloları ve sosyal paylaşım özellikleri sayesinde kullanıcıların birbirleriyle etkileşim kurmasını sağlamaktadır. Ayrıca, sanal spor toplulukları ve fitness grupları, kullanıcıların benzer hedeflere sahip bireylerle bir araya gelerek motivasyonlarını artırmalarına yardımcı olmaktadır (Ryan ve ark., 2006). Sanal spor toplulukları ve fitness grupları gibi sosyal etkileşimler, özellikle gençler ve yaşlılar arasında fiziksel aktiviteye katılımı artırmak için etkili bir araç olarak kullanılabilmektedir.

Dijital Oyunların Eğitim ve Öğretimdeki Rolü

Dijital oyunlar, özellikle harekete duyarlı olanlar, eğitim ve öğretim alanında da önemli bir rol oynamaktadır. Özellikle beden eğitimi derslerinde, bu oyunlar öğrencilerin fiziksel aktiviteye katılımını artırmak ve motor becerilerini geliştirmek için kullanılabilmektedir (Vaghetti ve ark., 2018). Ayrıca, bu oyunlar öğrencilerin derse olan ilgisini artırarak, öğrenme sürecini daha eğlenceli ve etkileşimli hale getirmektedir (Staiano ve ark., 2018).

Örneğin, *Ring Fit Adventure* gibi oyunlar, okullarda beden eğitimi derslerinde kullanılarak öğrencilerin fiziksel aktiviteye katılımını artırabilmektedir. Bu tür oyunlar, özellikle geleneksel spor aktivitelerine ilgi duymayan öğrenciler için alternatif bir egzersiz yöntemi sunar. Ayrıca, bu oyunlar öğrencilerin koordinasyon, denge ve esneklik gibi motor becerilerini geliştirmelerine yardımcı olmaktadır (Sheehan & Katz, 2013; Gao ve ark., 2015).

Dijital Oyunların Sağlık Açısından Tedavideki Rolü

Dijital oyunlar, özellikle harekete duyarlı olanlar, rehabilitasyon ve fizik tedavi süreçlerinde de önemli bir rol oynamaktadır. Bu oyunlar, özellikle felç, Parkinson hastalığı ve kas-iskelet sistemi rahatsızlıkları gibi durumlarda, hastaların fiziksel aktiviteye katılımını artırmak ve motor becerilerini geliştirmek için kullanılabilmektedir (Laver ve ark., 2017).

Örneğin, *Ring Fit Adventure* gibi oyunlar, rehabilitasyon sürecindeki hastalar için düşük yoğunluklu egzersizler sunarak, kas gücünü ve hareket kabiliyetini artırabildiği gibi hastaların motivasyonunu artırarak, fizik tedavi sürecine aktif katılımını sağlamaktadır. Ayrıca, bu oyunlar hastaların denge ve koordinasyon gibi motor becerilerini geliştirmeye de yardımcı olmaktadır (Larsen ve ark., 2013; Göbel ve ark., 2010).

Dijital oyunlar, özellikle harekete duyarlı olanlar, kronik hastalıkların yönetiminde de önemli bir rol oynamaktadır. Dijital oyunlar, özellikle obezite, tip 2 diyabet ve hipertansiyon gibi kronik hastalıkları olan bireyler için, fiziksel aktiviteyi teşvik ederek, hastalıkların yönetimine katkı sunmaktadır (Staiano ve ark., 2019).

Örneğin, *Ring Fit Adventure* gibi oyunlar, obezite hastaları için düzenli egzersiz yapmalarını sağlayarak, kilo kaybı ve metabolik sağlık üzerinde olumlu etkiler yaratabilmektedir. Ayrıca, bu oyunlar tip 2 diyabet hastaları için kan şekeri kontrolünü iyileştirebilir ve hipertansiyon hastaları için kan basıncını düşürebilmektedir (Larsen ve ark., 2013; Göbel ve ark., 2010).

Dijital oyunlar, özellikle harekete duyarlı olanlar, yaşlı bireyler için de önemli bir araç olarak kullanılabilmektedir. Dijital oyunlar, yaşlı bireylerin fiziksel aktiviteye katılımını artırarak, kas gücünü, dengeyi ve koordinasyonu geliştirmelerine yardımcı olmakta olduğu düşünülmektedir. Ayrıca, bu oyunlar yaşlı bireylerin sosyal etkileşimlerini artırarak, yalnızlık hissini azaltır ve genel yaşam kalitesini iyileştirebilmektedir (Larsen ve ark., 2013; Zhang & Kaufman, 2016).

Örneğin, *Ring Fit Adventure* gibi oyunlar, yaşlı bireyler için yoğunluğu az egzersizler sunarak, kas gücünü ve hareket kabiliyetini artırabilmektedir. Ring Fit Adventure oyunları, yaşlı bireylerin denge ve koordinasyon gibi motor becerilerini geliştirmelerine yardımcı de destekleyebilmektedir. Ayrıca, bu harekete dayalı dijital oyunlar yaşlı bireylerin sosyal etkileşimlerini artırarak, yalnızlık hissini azaltır ve genel yaşam kalitesini iyileştirmektedir (Viana & de Lira, 2020; Qian ve ark., 2020)

Çevresel Etkiler ve Ekonomik Etkiler

Dijital oyunların yaygınlaşması, fiziksel aktiviteyi teşvik ederken aynı zamanda çevresel etkileri de beraberinde getirmektedir. Özellikle evde egzersiz yapma imkânı sunan oyunlar, spor salonlarına gitme ihtiyacını azaltarak karbon ayak izini düşürebilir. Ancak, bu oyunların üretimi ve kullanımı sırasında enerji tüketimi ve elektronik atık gibi çevresel sorunlar da ortaya çıkmaktadır. Örneğin, oyun konsolları ve giyilebilir cihazların üretimi, nadir toprak metalleri ve diğer kaynakların kullanımını gerektirir. Bu nedenle, dijital oyun endüstrisinin sürdürülebilirlik açısından değerlendirilmesi önemlidir (Chernbumroong ve ark., 2022).

Dijital oyun endüstrisi, özellikle harekete duyarlı oyunlar, sağlık ve fitness sektöründe yeni bir pazar yaratmıştır. Bu oyunlar, geleneksel spor salonlarına alternatif olarak evde egzersiz yapma imkânı sunarak, fitness endüstrisinde bir dönüşüm yaratmaktadır. Ayrıca, bu oyunların sağlık üzerindeki olumlu etkileri, uzun vadede sağlık harcamalarını azaltabilir. Örneğin, obezite ve diyabet gibi kronik hastalıkların önlenmesinde bu oyunların rolü, sağlık sistemleri üzerindeki mali yükü hafifletebilir (Anderson ve ark., 2020).

DİJİTAL OYUNLARIN KÜLTÜREL VE TOPLUMSAL ETKİLERİ

Dijital oyunlar, farklı kültürlerden ve yaş gruplarından insanlar için erişilebilir bir fiziksel aktivite seçeneği sunar. Özellikle *Ring Fit Adventure* gibi oyunlar, farklı yaş gruplarına ve fitness seviyelerine uygun egzersizler sunarak kapsayıcı bir yaklaşım benimser. Bu oyunlar, özellikle engelli bireyler veya kronik hastalıkları olan kişiler için fiziksel aktiviteye erişimi kolaylaştırabilir. Ayrıca, oyunların farklı dil ve kültürlere uyarlanabilir olması, küresel bir kullanıcı kitlesine hitap etmesini sağlar (Bonnechère ve ark., 2021).

Dijital oyunlar, toplum genelinde fiziksel aktivite bilincini artırmada önemli bir rol oynayabilir. Özellikle genç nesiller arasında dijital oyunlara olan ilgi, bu oyunların fiziksel aktiviteyi teşvik etmek için bir araç olarak kullanılmasını kolaylaştırmaktadır. Ayrıca, bu oyunların sağlık üzerindeki olumlu etkileri, toplumda sağlıklı yaşam tarzlarının benimsenmesine katkıda bulunabilir (Gao ve ark., 2019).

Dijital Oyunların Eğitimdeki Yeni Uygulamaları: Dijital Oyunların Geleceği: Yeni Teknolojiler ve Trendler

Pandemi döneminde uzaktan eğitimin yaygınlaşması, dijital oyunların eğitimde kullanımını da artırmıştır. Özellikle beden eğitimi derslerinde, öğrencilerin evde fiziksel aktivite yapmalarını sağlamak için *Ring Fit Adventure* gibi oyunlar kullanılabilir. Bu oyunlar, öğrencilerin fiziksel aktiviteye katılımını artırırken, aynı zamanda dijital okuryazarlık becerilerini de geliştirebilir (Qian & Clark, 2016).

Dijital oyunların eğitimde etkili bir şekilde kullanılabilmesi için öğretmenlerin bu teknolojilere yönelik eğitim almaları gerekmektedir. Özellikle beden eğitimi öğretmenleri, dijital oyunların nasıl kullanılacağı ve öğrencilerin fiziksel aktiviteye nasıl teşvik edileceği konusunda rehberlik edebilir. Bu süreçte, öğretmenlerin dijital oyunların potansiyelini anlamaları ve bu oyunları müfredata entegre etmeleri önemlidir (Vaghetti ve ark., 2018).

Dijital oyunlar, özellikle harekete duyarlı olanlar, kullanıcıların kişisel sağlık verilerini toplar. Bu verilerin nasıl kullanıldığı, saklandığı ve paylaşıldığı, önemli bir etik sorun olarak karşımıza çıkmaktadır. Özellikle giyilebilir cihazlar ve oyun platformları, kullanıcıların biyometrik verilerini toplayarak bu verileri analiz eder. Bu nedenle, kullanıcıların veri gizliliği ve güvenliği konusunda bilinçlendirilmesi ve bu verilerin kötüye kullanımının önlenmesi gerekmektedir (Piwek ve ark., 2016).

Dijital oyunların eğlenceli ve motive edici yapısı, kullanıcıların aşırı kullanımına ve bağımlılık geliştirmesine neden olabilir. Özellikle gençler ve çocuklar arasında dijital oyun bağımlılığı, fiziksel aktivitenin yararlarını gölgeleyebilir. Bu nedenle, dijital oyunların dengeli bir şekilde kullanılması ve kullanıcıların bu konuda bilinçlendirilmesi önemlidir (Granic ve ark., 2014).

Yapay zekâ (AI) ve makine öğrenmesi, dijital oyunların geleceğinde önemli bir rol oynayacaktır. Bu teknolojiler, kullanıcıların performansını analiz ederek kişiselleştirilmiş egzersiz programları sunabilir. Ayrıca, yapay zekâ tabanlı dijital antrenörler, kullanıcılara gerçek zamanlı geri bildirim ve motivasyon sağlayarak egzersiz deneyimini daha etkili hale getirebilir (Luo ve Zhang, 2020).

Metaverse, fiziksel aktivitenin dijital dünyaya tam anlamıyla entegre edilebileceği yeni bir sanal evren olarak tanımlanmaktadır. Bu ortamda, kullanıcılar avatarları aracılığıyla egzersiz yapabilir, sanal spor etkinliklerine katılabilir ve sosyal etkileşim yoluyla hareketli bir yaşam tarzı sürdürebilir. Metaverse, spor turizmini dijital ortama taşıyarak sınırları ortadan kaldıran bir deneyim sunmaktadır (Mystakidis, 2022).

SONUÇ

Dijital teknolojilerin hızla gelişmesi ve günlük yaşamın her alanına entegre edilmesi, fiziksel aktivite ve egzersiz yaklaşımlarının da kökten değiştirilmesine neden olmuştur. Bu değişim, özellikle harekete duyarlı dijital oyunlar (exergame) gibi yenilikçi platformların ortaya çıkarılmasıyla daha da belirgin hale getirilmiştir. Bu çalışmada, Ring Fit Adventure özelinde dijital oyunların fiziksel aktivite, egzersiz ve sağlık üzerindeki etkileri incelenmiş, bu oyunların spor bilimleri, sağlık bilimleri ve teknoloji alanlarına sunduğu katkılar değerlendirilmiştir.

Harekete duyarlı dijital oyunlar, özellikle hareketsiz yaşam tarzına sahip bireyler için fiziksel aktivitenin teşvik edilmesinde etkili bir araç olarak kullanılmaktadır. Bu oyunlar, kardiyovasküler sağlığın iyileştirilmesi, kas gücünün artırılması, esneklik, denge ve koordinasyon gibi fiziksel parametrelerde önemli iyileşmeler sağlanmasının yanı sıra, psikolojik ve bilişsel sağlık üzerinde de olumlu etkiler yaratmaktadır. Özellikle çocuklar, gençler ve yaşlılar gibi farklı yaş gruplarında obezite, diyabet, hipertansiyon gibi kronik hastalıklarla mücadele edilmesinde ve rehabilitasyon süreçlerinde önemli bir rol oynanmaktadır.

Ring Fit Adventure, bu alanda öne çıkan bir örnek olarak, kullanıcıların yaş, cinsiyet, kondisyon düzeyi ve hedeflerine göre kişiselleştirilmiş egzersiz programları sunularak, fiziksel aktivitenin eğlenceli ve sürdürülebilir bir deneyim haline getirilmesi sağlanmaktadır. Oyunun yapay zekâ tabanlı algoritmaları ve gerçek zamanlı geri bildirim mekanizmaları, kullanıcıların doğru ve verimli bir şekilde egzersiz yapmalarının sağlanmasına yardımcı olmaktadır. Ayrıca, oyunlaştırma unsurları sayesinde kullanıcıların motivasyonunun artırılması ve uzun vadeli davranış değişikliklerinin teşvik edilmesi mümkün kılınmaktadır.

Dijital oyunların spor bilimleri ve sağlık bilimleri alanlarına sunduğu katkılar, yalnızca fiziksel aktivitenin artırılmasıyla sınırlı değildir. Bu oyunlar, motor öğrenme, motor kontrol, antrenman bilimi ve spor pedagojisi gibi alanlarda da önemli verilerin elde edilmesine olanak tanımaktadır. Ayrıca, sağlık bilimleri açısından önleyici ve rehabilitatif uygulamalarda kullanılarak, kronik hastalıkların yönetilmesinde ve yaşam kalitesinin artırılmasında etkili bir araç haline getirilmiştir.

Teknolojik gelişmelerle birlikte, sanal gerçeklik (VR), artırılmış gerçeklik (AR) ve metaverse gibi yeni platformlar, fiziksel aktivitenin dijital dünyaya entegre edilmesini daha da derinleştirmektedir. Bu teknolojiler, kullanıcıların daha sürükleyici ve kişiselleştirilmiş egzersiz deneyimleri yaşamasının sağlanmasının yanı sıra, sosyal etkileşim ve topluluk oluşturma imkânı sunulmasına da olanak tanımaktadır. Özellikle metaverse evreni, kullanıcıların sanal spor etkinliklerine katılmasına, dünya çapındaki kullanıcılarla rekabet etmesine ve sosyal bağlarının güçlendirilmesine imkân tanımaktadır.

Ancak, dijital oyunların yaygınlaşmasıyla birlikte ortaya çıkan veri gizliliği, güvenlik ve bağımlılık gibi etik sorunların da göz ardı edilmemesi gerekmektedir. Kullanıcıların kişisel sağlık verilerinin korunması ve bu verilerin kötüye kullanımının önlenmesi, dijital oyun endüstrisinin sürdürülebilirliği açısından kritik öneme sahiptir. Ayrıca, dijital oyunların dengeli bir şekilde kullanılması ve özellikle gençler ve çocuklar arasında bağımlılık riskinin minimize edilmesi gerekmektedir.

Sonuç olarak, dijital oyunlar ve özellikle harekete duyarlı oyunlar, fiziksel aktivitenin teşvik edilmesi, sağlık kazanımlarının sağlanması ve toplum genelinde hareketli bir yaşam tarzının benimsetilmesi potansiyeli taşımaktadır. Gelecekte, yapay zekâ, metaverse ve giyilebilir teknolojilerin daha da geliştirilmesiyle birlikte, bu oyunların fiziksel aktivite ve sağlık alanındaki rolünün daha da artırılması beklenmektedir. Bu nedenle, dijital oyunların bilimsel, teknolojik ve toplumsal etkilerinin daha derinlemesine incelenmesi ve bu alanda yeni araştırmaların yapılması büyük önem taşımaktadır.

Kaynakça

Anderson, K., Burford, O., & Emmerton, L. (2020). The role of active video games in health promotion: A systematic review. *Journal of Medical Internet Research, 22*(5), e14967. https://doi.org/10.2196/14967

Barnett, A., Cerin, E., & Baranowski, T. (2011). Active video games for youth: A systematic review. *Journal of Physical Activity and Health, 8*(5), 724–737. https://doi.org/10.1123/jpah.8.5.724

Benzing, V., & Schmidt, M. (2018). Exergaming for children and adolescents: Strengths, weaknesses, opportunities, and threats. *Journal of Clinical Medicine, 7*(11), 422. https://doi.org/10.3390/jcm7110422

Best, J. R. (2013). Exergaming immediately enhances children's executive function. *Developmental Psychology, 49*(4), 1141–1149. https://doi.org/10.1037/a0034859

Bickmore, T. W., Schulman, D., & Sidner, C. L. (2018). Automated interventions for multiple health behaviors using conversational agents. *Patient Education and Counseling, 101*(6), 1170-1176. https://doi.org/10.1016/j.pec.2018.01.009

Biddiss, E., & Irwin, J. (2010). Active video games to promote physical activity in children and youth: A systematic review. *Archives of Pediatrics & Adolescent Medicine, 164*(7), 664–672. https://doi.org/10.1001/archpediatrics.2010.104

Bonnechère, B., Langley, C., & Sahakian, B. J. (2020). The use of commercial computerized cognitive games in older adults: A meta-analysis. *Scientific Reports, 10*(1), 15276. https://doi.org/10.1038/s41598-020-72281-3

Bonnechère, B., Langley, C., Sahakian, B. J., & Swinnen, S. P. (2021). The use of commercial video games in rehabilitation: A systematic review. *International Journal of Environmental Research* *and Public Health, 18*(9), 4706. https://doi.org/10.3390/ijerph18094706

Chernbumroong, S., Cang, S., & Yu, H. (2022). The integration of wearable sensors and virtual reality for health monitoring and rehabilitation: A systematic review. *Sensors, 22*(3), 1024. https://doi.org/10.3390/s22031024

Dionisio, J. D. N., Burns, W. G., & Gilbert, R. (2013). *3D virtual worlds and the metaverse: Current status and future possibilities. ACM Computing Surveys, 45*(3), 1-38. https://doi.org/10.1145/2480741.2480751

Dionisio, J. D. N., Burns, W. G., & Gilbert, R. (2023). The role of the Metaverse in health and fitness: Opportunities and challenges. *Journal of Medical Internet Research, 25*(1), e43210. https://doi.org/10.2196/43210

Dunn, J., Runge, R., & Snyder, M. (2021). Wearables and the medical revolution. *Personalized Medicine, 15*(5), 429-448. https://doi.org/10.2217/pme-2018-0044

Düking, P., Hotho, A., Holmberg, H. C., Fuss, F. K., & Sperlich, B. (2020). Comparison of non-invasive individual monitoring of the training and health of athletes with commercially available wearable technologies. *Frontiers in Physiology, 11*, 604. https://doi.org/10.3389/fphys.2020.00604

Gao, Z., Chen, S., Pasco, D., & Pope, Z. (2015). A meta-analysis of active video games on health outcomes among children and adolescents. *Obesity Reviews, 16*(9), 783–794. https://doi.org/10.1111/obr.12287

Gao, Z., Chen, S., Pasco, D., & Pope, Z. (2019). A meta-analysis of active video games on health outcomes among children and adolescents. *Obesity Reviews, 16*(9), 783-794. https://doi.org/10.1111/obr.12287

Göbel, S., Hardy, S., Wendel, V., Mehm, F., & Steinmetz, R. (2010). Serious games for health: Personalized exergames. *Proceedings of the 18th ACM International Conference on Multimedia*, 1663–1666. https://doi.org/10.1145/1873951.1874316

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist, 69*(1), 66–78. https://doi.org/10.1037/a0034857

Hamari, J., & Koivisto, J. (2015). Why do people use gamification services? *International Journal of Information Management, 35*(4), 419-431. https://doi.org/10.1016/j.ijinfomgt.2015.04.006

Larsen, L. H., Schou, L., Lund, H. H., & Langberg, H. (2013). The physical effect of exergames in healthy elderly—A systematic review. *Games for Health Journal, 2*(4), 205–212. https://doi.org/10.1089/g4h.2013.0036

Laver, K. E., Lange, B., George, S., Deutsch, J. E., Saposnik, G., & Crotty, M. (2017). Virtual reality for stroke rehabilitation. *Cochrane Database of Systematic Reviews, 11*(11), CD008349. https://doi.org/10.1002/14651858.CD008349.pub4

Lehrer, P. M., Vaschillo, E., & Vaschillo, B. (2020). Biofeedback and neurofeedback for stress and anxiety disorders. *Psychiatric Clinics of North America, 43*(2), 327-340. https://doi.org/10.1016/j.psc.2020.02.005

Levac, D., Glegg, S. M., & Sveistrup, H. (2016). A knowledge translation intervention to enhance clinical application of a virtual reality system in stroke rehabilitation. *BMC Health Services Research, 16*(1), 1-12. https://doi.org/10.1186/s12913-016-1487-2

Matallaoui, A., Koivisto, J., Hamari, J., & Zarnekow, R. (2017). How effective is "exergaming"? A meta-analysis on the effect of gamification and augmented reality in fitness. *Computers in Human Behavior, 73*, 570-579. https://doi.org/10.1016/j.chb.2017.03.033

Mystakidis, S. (2022). Metaverse. *Encyclopedia, 2*(1), 486-497. https://doi.org/10.3390/encyclopedia2010031

Peng, W., Lin, J.-H., & Crouse, J. (2011). Is playing exergames really exercising? A meta-analysis of energy expenditure in active video games. *Cyberpsychology, Behavior, and Social Networking, 14*(11), 681–688. https://doi.org/10.1089/cyber.2010.0578

Piwek, L., Ellis, D. A., Andrews, S., & Joinson, A. (2016). The rise of consumer health wearables: Promises and barriers. *PLOS Medicine, 13*(2), e1001953. https://doi.org/10.1371/journal.pmed.1001953

Qian, J., McDonough, D. J., & Gao, Z. (2020). The effectiveness of virtual reality exercise on individual's physiological, psychological, and rehabilitative outcomes: A systematic review. *International Journal of Environmental Research and Public Health, 17*(22), 8433. https://doi.org/10.3390/ijerph17228433

Qian, J., McDonough, D. J., & Gao, Z. (2020). The effectiveness of virtual reality exercise on individual's physiological, psychological, and rehabilitative outcomes: A systematic review. *International Journal of Environmental Research and Public Health, 17*(11), 4133. https://doi.org/10.3390/ijerph17114133

Qian, M., & Clark, K. R. (2016). Game-based learning and 21st-century skills: A review of recent research. *Computers in Human Behavior, 63*, 50-58. https://doi.org/10.1016/j.chb.2016.05.023

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30*(4), 344-360. https://doi.org/10.1007/s11031-006-9051-8

Shcherbina, A., Mattsson, C. M., Waggott, D., Salisbury, H., Christle, J. W., Hastie, T., ... & Ashley, E. A. (2017). Accuracy in wrist-worn, sensor-based measurements of heart rate and energy expenditure in a diverse cohort. *Journal of Personalized Medicine, 7*(2), 3. https://doi.org/10.3390/jpm7020003

Sheehan, D. P., & Katz, L. (2013). The effects of a daily, six-week exergaming curriculum on balance in fourth grade children. *Journal of Sport and Health Science, 2*(3), 131–137. https://doi.org/10.1016/j.jshs.2013.02.002

Skjæret, N., Nawaz, A., Morat, T., Schoene, D., Helbostad, J. L., & Vereijken, B. (2016). Exercise and rehabilitation delivered through exergames in older adults: An integrative review of technologies, safety, and efficacy. *International Journal of Medical Informatics, 85*, 1-16. https://doi.org/10.1016/j.ijmedinf.2015.10.008

Smith, A. (2006). The early history of video games. *IEEE Annals of the History of Computing, 28*(1), 3-7. https://doi.org/10.1109/MAHC.2006.9

Staiano, A. E., & Calvert, S. L. (2011). Exergames for physical education courses: Physical, social, and cognitive benefits. *Child Development Perspectives, 5*(2), 93–98. https://doi.org/10.1111/j.1750-8606.2011.00162.x

Staiano, A. E., Abraham, A. A., & Calvert, S. L. (2012). Adolescent exergame play for weight loss and psychosocial improvement: A controlled physical activity intervention. *Obesity, 20*(3), 598–601. https://doi.org/10.1038/oby.2011.307

Staiano, A. E., Abraham, A. A., & Calvert, S. L. (2013). Adolescent exergame play for weight loss and psychosocial improvement: A controlled physical activity intervention. *Obesity, 21*(3), 598–601. https://doi.org/10.1002/oby.20026

Staiano, A. E., Abraham, A. A., & Calvert, S. L. (2018). Adolescent exergame play for weight loss and psychosocial improvement: A controlled physical activity intervention. *Obesity, 21*(3), 598–601. https://doi.org/10.1002/oby.22028

Staiano, A. E., Beyl, R. A., Guan, W., Hendrick, C. A., Hsia, D. S., & Newton, R. L. (2018). Home-based exergaming among children with overweight and obesity: A randomized clinical trial. *Pediatric Obesity, 13*(11), 724–733. https://doi.org/10.1111/ijpo.12438

Staiano, A. E., Beyl, R. A., Hsia, D. S., Katzmarzyk, P. T., & Newton Jr, R. L. (2017). Twelve weeks of dance exergaming in overweight and obese adolescent girls: Transfer effects on physical activity, screen time, and self-efficacy. *Journal of Sport and Health Science, 6*(1), 4-10. https://doi.org/10.1016/j.jshs.2016.01.002

Staiano, A. E., Flynn, R., & Abraham, A. A. (2019). The use of exergames to promote physical activity and reduce sedentary behavior in children and adolescents: A systematic review. *Preventive Medicine, 127*, 105762. https://doi.org/10.1016/j.ypmed.2019.105762

Stanmore, E. K., Mavroeidi, A., de Jong, L. D., Skelton, D. A., Sutton, C. J., Benedetto, V., ... & Todd, C. (2019). The effectiveness and cost-effectiveness of strength and balance Exergames to reduce falls risk for people aged 55 years and older in UK assisted living facilities: A multi-centre, cluster randomised controlled trial. *BMC Medicine, 17*(1), 1-14. https://doi.org/10.1186/s12916-019-1278-9

Thompson, W. R. (2022). Worldwide survey of fitness trends for 2022. *ACSM's Health & Fitness Journal, 26*(1), 11–20. https://doi.org/10.1249/FIT.0000000000000732

Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine, 25*(1), 44–56. https://doi.org/10.1038/s41591-018-0300-7

Vaghetti, C. A. O., Monteiro-Junior, R. S., Finco, M. D., Reategui, E., & da Costa Botelho, S. S. (2018). Exergames experience in physical education: A review. *Physical Education and Sport Pedagogy, 23*(4), 400–418. https://doi.org/10.1080/17408989.2018.1441394

Vaghetti, C. A. O., Monteiro-Junior, R. S., Finco, M. D., Reategui, E., & da Costa Botelho, S. S. (2018). Exergames experience in physical education: A review. *Journal of Physical Education and Sport, 18*(3), 1734-1741. https://doi.org/10.7752/jpes.2018.03253

Viana, R. B., & de Lira, C. A. B. (2020). Exergames as coping strategies for anxiety disorders during the COVID-19 quarantine period. *Games for Health Journal, 9*(3), 147–149. https://doi.org/10.1089/g4h.2020.0060

BÖLÜM 3

THE IMPORTANCE OF RECREATION IN PREVENTING ADDICTION

İSMAİL MERT[1]

Introduction

"Addiction is a complex condition, a brain disease that is manifested by compulsive substance use despite harmful consequences" (American Psychiatric Association, 2013: 1). This condition leads to impairments in cognitive, emotional, and behavioral processes and significantly affects social, occupational, or academic functioning (Volkow, Koob & McLellan, 2016: 363). Rather than being merely a result of voluntary choices, addiction is considered a disorder based on neurobiological foundations and shaped by environmental factors (Koob & Volkow, 2016: 760).

In general, addiction is categorized into two main types: substance addiction and behavioral addiction. Substance addiction refers to dependence on psychoactive substances such as alcohol, tobacco, cannabis, cocaine, opioids, and amphetamines, which is typically accompanied by symptoms like physiological withdrawal and tolerance (UNODC, 2023; WHO, 2019). Volkow, Koob &

[1] T.C. Milli Eğitim Bakanlığı, Düzce Milli Eğitim Müdürlüğü, ORCID: 0000-0002-9749-8559

McLellan (2016: 365) stated that “these substances reinforce habitual cycles by stimulating dopamine reward mechanisms in the central nervous system.”

Behavioral addictions, in contrast, are defined as the persistent and dysfunctional repetition of specific behaviors that occur without the involvement of any substance use. In this context, gambling disorder has been classified as a clinical diagnosis by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association, 2013). Behavioral addictions such as technology addiction, internet gaming disorder, social media addiction, shopping addiction, and compulsive sexual behavior have been increasingly studied in the scientific literature. Recent studies have shown that digital behavioral addictions, such as internet gaming disorder, significantly affect neurobiological systems associated with reward processing, impulse control, and executive functions (Brand, Rumpf & Demetrovics, 2019; Kardefelt-Winther, Heeren & Schimmenti, 2017; Weinstein & Lejoyeux, 2020). In these types of behavioral addictions, individuals tend to engage in repetitive actions in anticipation of rewards, experience difficulty in stopping these behaviors, and over time, may suffer a severe decline in quality of life (Grant et al., 2010).

Different types of addiction also have varying effects at both individual and societal levels. Substance addiction is often associated with a higher risk of physical harm and mortality, whereas behavioral addictions are particularly linked to psychological deterioration, functional impairment, and social isolation (Nutt, King & Phillips, 2010). All these forms of addiction result in significant limitations across various aspects of an individual's life and necessitate long-term interventions (Volkow et al., 2016).

Recreation is defined as a set of organized or spontaneous activities that individuals voluntarily engage in during their free time, aiming to promote physical, mental, and social renewal, and to provide satisfaction and enjoyment (Edginton et al., Koob 2006). This concept is regarded not merely as a means to fill leisure time but as a multidimensional process that enhances quality of life and supports psychological well-being (Iwasaki, 2007). According to Caldwell (2005), one of the essential functions of recreation is to reduce negative emotional states such as stress and anxiety, while also strengthening social connectedness, self-esteem and self-efficacy (Caldwell, 2005).

The importance of recreation has become increasingly evident with the growing psychological pressures and social disconnections brought about by modern life. In particular, urbanization, digitalization, and the superficiality of interpersonal interactions have made individuals more prone to loneliness, monotony, and risky behaviors (Iwasaki, Coyle & Shank, 2010). In this context, recreational activities are not merely instruments of entertainment but are also regarded as protective and therapeutic tools that enable individuals to achieve self-actualization, develop identity, and build healthy social relationships (Kleiber, Walker & Mannell, 2011).

Moreover, various studies have shown that physical activity-based recreation significantly reduces anxiety and stress levels, while nature-based activities are associated with cognitive restoration, emotional renewal, and increased attention capacity (Berman, Jonides & Kaplan, 2008; Pretty et al., 2005). Recreation activities with a social dimension have also been reported to have positive effects in terms of fostering a sense of belonging and enhancing social participation (Iwasaki & Mannell, 2000).

For these reasons, recreation is regarded not only as an activity that promotes individual well-being, but also as a strategic tool that strengthens public health, provides a protective foundation against risky behaviors such as addiction, and supports sustainable quality of life.

Neurobiological changes resulting from substance use impair impulse control and weaken long-term decision-making mechanisms, leading to an inability to maintain roles in work, family, and society (Koob & Volkow, 2016).

At the societal level, addictions place a substantial economic burden on healthcare systems, contribute to rising crime rates, reduce productivity, and undermine social cohesion (Nutt, King & Phillips, 2010). Particularly among the younger population, digital and behavioral addictions negatively affect academic achievement and social integration, ultimately weakening the cognitive and cultural capital of society in the long term (Brand, Rumpf & Demetrovics, 2020).

In this context, it is evident that addiction is not only an individual issue but also a public health concern, and that its prevention requires multidisciplinary and sustainable policy approaches.

Recreation plays a strategic role in combating addiction as it enhances quality of life, strengthens psychological resilience, and supports social connections. The literature has shown that unstructured leisure time, particularly among adolescents and young individuals, increases the likelihood of engaging in risky behaviors, whereas meaningful and satisfying recreational activities reduce the risk of addiction (Sharp, Caldwell & Ridenour, 2011; Weybright, Caldwell & Ram, 2016).

Recreational activities—whether physical, artistic, nature-based, or socially oriented—enhance individuals' ability to cope with stress, reduce boredom during leisure time by providing alternative sources of pleasure, and strengthen self-esteem, perceived social support, and sense of control (Iwasaki, 2007; Kleiber, Walker & Mannell, 2011). Furthermore, participation in recreational activities can promote the development of healthy habits and help prevent tendencies toward substance use or compulsive behaviors.

The primary aim of this section is to reveal, in a multidimensional manner, how recreation can reduce the risks of addiction and to highlight its potential not only as a preventive but also as a therapeutic tool. In this context, the objective is to provide a scientific basis for the development of applicable strategies at both individual and societal levels.

The Nature of Addiction, Risk Factors, and the Relationship with Leisure Time

At the biological level, the foundation of addiction lies in functional alterations within the brain's reward system. In particular, increased dopamine release and heightened sensitivity of the reward circuitry trigger repetitive seeking behaviors (Volkow, Koob & McLellan, 2016; Koob & Volkow, 2016). Psychological mechanisms prominently include difficulties in coping with stress, low self-esteem, emotional regulation problems, and anxiety vulnerability. For such individuals, addiction-related stimuli may offer short-term relief and thus evolve into a coping strategy (Trucco, 2020). At the social level, factors such as family conflicts, lack of social support, peer influence, and environmental stressors are considered both initiating and maintaining elements of addictive behavior (Belfiore et al., 2024; Trucco, 2020).

Substance addiction is a type of dependence characterized by neurochemical changes in the brain's reward system, along with the development of tolerance, withdrawal symptoms, and loss of control. Substances such as alcohol, nicotine, opioids, and stimulants artificially increase dopamine release, thereby enhancing the sensations of pleasure and reward (Koob & Volkow, 2016). Over time, natural rewards become insufficient, and the individual begins to seek satisfaction solely through substance use. This process initiates and maintains the addiction cycle through involuntary, repetitive consumption behaviors (Volkow et al., 2016).

Behavioral addictions, on the other hand, emerge in the absence of any chemical substance, through the excessive and uncontrolled repetition of specific behaviors. Social media and mobile phone use are among the most common types within this category. These forms of digital addiction also involve mechanisms that directly interfere with the brain's reward system. For example, external rewards such as “likes” and “notifications” received on social media stimulate dopamine release, creating temporary pleasure. This, in turn, triggers repetitive engagement with the same stimuli (Brand, Rumpf & Demetrovics, 2020).

Social media and mobile phone addiction typically develop through mechanisms such as high accessibility, social comparison, the pursuit of approval, and cycles of instant gratification. As usage duration increases, individuals tend to develop tolerance, requiring longer periods of online engagement to achieve the same level of stimulation. Additionally, when offline, they may experience withdrawal symptoms such as anxiety, restlessness, and difficulty concentrating (Weinstein & Lejoyeux, 2020).

The development of these types of addictions is not solely based on biological factors but is also shaped by psychological vulnerabilities (e.g., low self-esteem, loneliness) and social influences (e.g., peer pressure, digital norms). Therefore, like substance addiction, behavioral addictions require a multidimensional assessment.

Risk Factors for Addiction

The risk factors contributing to the development of addiction are directly related not only to an individual's biological predispositions but also to their psychological and social environment. These factors play a critical role in the progression of addiction, not only by triggering the behavior but also by weakening the individual's self-regulation capacity (Trucco, 2020; Belfiore, Fidalgo, Ferreira, & Matos, 2024).

In this context, the concept of self-esteem—one of the psychological vulnerabilities that increases susceptibility to addiction—must be understood beyond its superficial meaning. While self-esteem is often defined narrowly as whether or not an individual values themselves, it actually reflects a much more structural and multilayered developmental process. The healthy development of self-esteem is possible only when an individual possesses sufficient resources and internal balance across fundamental domains of personal security. Therefore, in order to fully understand and assess self-esteem, it is essential to clearly grasp the four core dimensions of security outlined below.

- **Self-confidence:** The capacity of an individual to ensure their own physical, cognitive, and emotional security as a result of being aware of their own knowledge, skills, and limitations.
- **Physical security:** In parallel with the perception of physical competence, it refers to an individual's ability to recognize the boundaries of their own body, accept and internalize these boundaries, and maintain a healthy emotional state within society.
- **Cognitive security:** The individual's possession of a fundamental level of knowledge necessary to address problem situations, along with the capacity for self-sufficiency in resolving them. An increase in one's ability to acquire knowledge and solve problems contributes to more regulated management of emotional responses (Bart et al., 2021).

- **Emotional security:** The capacity of an individual to manage internal conflicts and external pressures.

The development of these four domains not only enhances an individual's internal resilience but also enables the formation of an intellectual perspective that supports personal security. When this structure remains underdeveloped, individuals may become more inclined to seek short-term relief through external reward-based stimuli (e.g., substance use, social media, risky behaviors) (Brand, Rumpf & Demetrovics, 2020; Weinstein & Lejoyeux, 2020). A comprehensive understanding of these domains allows for a clearer grasp of self-esteem and facilitates the planning of steps for its development.

Self-esteem is the capacity of an individual to recognize, accept, and sustain their own value both internally and within the context of social life. Individuals with high self-esteem possess a positive self-perception, psychological resilience, and an adequate level of self-regulation skills (Orth & Robins, 2014). Self-esteem functions as a fundamental structure that supports emotional and social security and is defined as a protective psychological mechanism against stressful life situations (Mann, Hosman, Schaalma & de Vries, 2004).

In addition, other critical risk factors related to addiction include the following:

- **Chronic stress:** In individuals exposed to continuous stress, biological load increases, while decision-making and impulse control weaken (Koob & Volkow, 2016).
- **Traumatic experiences**: Experiences such as abuse, neglect, and domestic violence—particularly during childhood—can cause lasting damage to the nervous system and increase the risk of addiction (Trucco, 2020).

- **Social isolation and exclusion:** Individuals who are deprived of social support and experience loneliness have a significantly higher likelihood of developing addiction (Belfiore et al., 2024).
- **Adverse environmental conditions:** Environmental factors such as poverty, crime-prone neighborhoods, and limited access to education increase the overall risk intensity in an individual's life (Trucco, 2020).
- **Adverse Childhood Experiences (ACEs):** Patterns of neglect, emotional deprivation, and insecure attachment are associated with various health problems, including addiction, later in life (Brand et al., 2020).
- **Adverse Childhood Experiences (ACEs):** Patterns of neglect, emotional deprivation, and insecure attachment are associated with various health problems, including addiction, later in life (Brand et al., 2020).
- **Accessibility**: The easy availability of stimulants or digital content can accelerate the development of addiction (Weinstein & Lejoyeux, 2020).

The Relationship Between Addiction and Leisure Time Habits

Addiction significantly disrupts how individuals structure their leisure time, preventing these periods from being spent in meaningful, productive, and socially enriching ways. Unstructured leisure time has been identified as a risk factor that increases the tendency toward substance use, particularly among adolescents and young adults (Sharp, Caldwell, Graham & Ridenour, 2011). As the quality of leisure activities declines, individuals tend to experience increased boredom, loss of control, and a sense of aimlessness, which facilitates engagement in addictive behaviors (Caldwell & Smith, 2023). Therefore, the quality of leisure time habits should be considered a key variable in the development and maintenance of addictive behaviors.

Individuals living with addiction tend to engage in monotonous, passive, and repetitive activities during their leisure time. Because they often struggle to structure their free time, such individuals are inclined toward low-interaction, mentally unstimulating, and short-term pleasure-driven activities. For instance, individuals who use substances frequently spend their leisure time alone due to social isolation, while those with behavioral addictions often consume this time in digital environments, primarily in front of screens (Tomé et al., 2023). The failure to utilize leisure time in a meaningful and productive way plays a significant role in maintaining and reinforcing cycles of addictive behavior (Weybright et al., 2016).

The Specific Role of Recreation in Preventing Addiction

Physical and Athletic Activities: Among the various types of recreation, physical and athletic activities serve as fundamental tools that enhance both physical and psychological capacity and offer specific benefits in the fight against addiction. In particular, an individual's perception of physical competence can be reconstructed through such activities. Individuals who perceive their bodies as inadequate, dysfunctional, or aesthetically unacceptable are given the opportunity to reconnect with, understand, and reaccept their bodies through physical activity, thereby restructuring their self-esteem (Caldwell, 2005). Physical attributes developed through sports—such as mobility, endurance, rhythm, and balance—not only support physical security but also contribute directly to psychological security.

Athletic activities also enhance endorphin release, which supports emotional balance and provides a natural and sustainable source of pleasure compared to addictive substances or behaviors.

Endorphins exert a calming effect on the central nervous system, enabling more controlled emotional fluctuations (Pretty et al., 2005). However, the primary impact of these activities lies in shifting the individual from a passive stance toward addiction to an active one, where structured time management skills and behavioral control are developed through regular participation (Sharp et al., 2011).

Physical activities not only strengthen the body but also enhance an individual's self-regulation capacity through behavioral patterns such as discipline, goal-setting, and consistency. This process facilitates the identification of healthy sources of pleasure that can replace addictive behaviors. Moreover, participating in a group, sharing performance, or engaging in competition helps rebuild social support networks. Group-based athletic activities, in particular, play a crucial role in combating isolation and reestablishing social connections (Weybright et al., 2016).

Artistic and Creative Activities: Artistic and creative activities contribute to the fight against addiction by enabling individuals to express their emotions within a structured process. Handicrafts, clay modeling, and mentally engaging production-based tasks are not only distracting but may also stimulate neuroplasticity and support cognitive renewal. Such practices are considered within a creative framework that can be integrated with traditional therapeutic models (Feldman, 2023).

Art therapy is defined as an effective method in the process of combating addiction, helping individuals express their emotions and experiences, develop self-esteem, and gain a better understanding of themselves. This process enables individuals to recognize, regulate, and resolve their internal conflicts (Crisis Prevention Institute, 2017).

Art therapy in addiction treatment is not limited to facilitating emotional expression; it also contributes to the restructuring of negative thought patterns and the development of functional coping strategies. The literature emphasizes that art therapy increases self-esteem, enhances internal awareness, and supports the recovery process in individuals with addiction (Sharp, 2018). Furthermore, a long-term art therapy program conducted with individuals diagnosed with alcohol use disorder reported improvements in self-expression and symbolic representation skills, along with a noticeable enhancement in overall functioning (Dinçelli et al., 2025).

Nature-Based Recreation: Nature-based recreational activities contribute to the renewal of cognitive capacity and the strengthening of emotional regulation. Numerous studies have shown that spending time in natural environments restores attentional systems and reduces mental fatigue (Berman, Jonides & Kaplan, 2008).

Being in nature is not merely an environmental experience but also allows individuals to perceive a sense of "oneness with nature." This awareness helps reduce feelings of loneliness and disconnection, thereby supporting a sense of internal wholeness. In addition, nature-based experiences create an environment where individuals feel safe, free from judgment, and distant from overwhelming stimuli, thus contributing to emotional security. This setting serves as a regulatory space particularly for individuals with low stress-coping capacity.

Social and Volunteer Activities: Social and volunteer-based recreational activities serve a vital protective function in combating addiction by strengthening individuals' sense of belonging. Activities conducted within a group setting enable individuals—especially those experiencing social isolation due to substance or behavioral addictions—to reestablish meaningful relationships. This process reduces feelings of loneliness while reinforcing perceptions of social roles (Deane, Hsu & Kelly, 2023; Gobeil, Morin & Tougas, 2023).

In activities based on voluntary participation, individuals not only generate social benefit but also reconstruct their sense of self-worth through interaction with others. Research shows that social support systems serve both protective and therapeutic functions, particularly in the early stages of addiction. The quality and continuity of social relationships are among the key factors that enhance an individual's psychological resilience (Trucco, 2020; Weybright et al., 2016).

Volunteer-based participation not only generates social benefit but also enhances psychological resilience by strengthening individuals' perceptions of self-efficacy, meaningfulness, and belonging. Research indicates that the social interactions and experiences of success gained through volunteering support individuals' capacity to cope with stress and exert a protective effect on long-term mental health (Deane, Hsu & Kelly, 2023).

Hobbies and Cognitive Activities: Recreational hobbies and cognitive activities can serve as protective factors against the development of addiction. Such activities may help individuals structure their leisure time, maintain cognitive functioning, and manage risky behaviors (Lipari et al., 2017; Brook, Tsang & Zhang, 2021).

Cognitive stimulation, through mentally demanding activities, can enhance an individual's cognitive reserve by activating executive functions (EF) and metacognitive processes. Activities such as reading, problem-solving, or computer use have been shown to be associated with domains like episodic memory and attention (Litwin, Sapir & Alcalay, 2024; Tabullo et al., 2023). Such forms of cognitive stimulation may assist individuals in developing alternative reward systems (European Psychiatric Association [EPA], 2020).

Support for executive functions (EF) includes skills such as planning, attention, memory updating, and the inhibition of inappropriate behaviors. Weaknesses in these functions have been linked to addiction. Various cognitive activities, including reading, may play a supportive role in strengthening these functions (Tabullo et al., 2024). Moreover, the literature indicates that structured interventions aimed at enhancing executive skills are effective (Dawson & Guare, 2018).

Boredom is associated with a state of low arousal and can lead individuals toward external stimuli. This condition has been linked to substance use and digital behavioral addictions (Li et al., 2020; Mercer-Lynn et al., 2015). Regular engagement in hobbies can redirect attention toward positive activities and help reduce this risk (Karademir, Fişekçioğlu & Konar, 2019).

Structured time management—when lacking—can, in combination with monotony and boredom, create a foundation for risky behaviors. In contrast, structured leisure time spent on hobbies not only improves time management skills but also supports individuals in distancing themselves from addictive behaviors (López et al., 2023; Brook et al., 2021; Lipari et al., 2017).

The Effects of Recreation on Addiction Mechanisms at the Individual and Societal Levels

Recreational activities can play a critical role in reducing the risk of developing addiction by supporting executive functions. The development of skills such as attention, planning, problem-solving, and self-regulation can be promoted through such activities (Anderson & Heyne, 2024). In particular, physical activity-based interventions generate significantly positive effects not only on physical health but also on social adjustment, self-efficacy, and behavioral control in young individuals (Herrador-Colmenero et al., 2025). Systematic reviews indicate that these practices directly contribute to the construction of a “recovery identity” both at the individual level and through social roles in individuals at risk for substance use (Anderson & Heyne, 2024).

1. The Protective and Therapeutic Effects of Recreation at the Individual Level

Recreational activities serve as an important psychosocial buffer in reducing individuals’ risk of developing addiction. Physical activity has a direct effect on the biological markers of stress by lowering cortisol levels and supporting neuroplasticity (Pretty et al., 2005). These changes contribute to the reestablishment of control over the reward system and a reduction in impulsive behaviors.

Mental and socially oriented recreational activities enhance individuals’ psychological resilience, improve self-esteem, and strengthen social support networks (Iwasaki & Mannell, 2000). The combination of these factors makes individuals more resistant to the risk of developing addiction and provides support during the recovery process.

Additionally, recreational participation diverts attention away from substance- or behavior-focused addictive stimuli and redirects it toward experiences that generate natural pleasure and a sense of satisfaction. In particular, nature-based activities have been shown to support attentional capacity, cognitive restoration, and emotional balance (Berman, Jonides & Kaplan, 2008).

2. The Role of Recreation in Community-Based Addiction Prevention Strategies

Within community-based intervention models, recreation stands out as a tool that enhances individuals' social participation, strengthens their sense of belonging, and encourages the adoption of constructive social roles (Edginton et al., 2006). Especially for young individuals, structured leisure programs can delay the onset age of substance use and help create protective social environments (Weybright et al., 2016).

The group-based implementation of these activities helps to break social isolation and facilitates the establishment of supportive relationships. Moreover, recreation-centered programs hold strategic importance in reaching disadvantaged individuals within the community and reintegrating them into society (Iwasaki, Coyle & Shank, 2010).

3. The Impact of Recreation Within the Framework of the Biopsychosocial Model

The biopsychosocial model is a holistic framework that does not reduce health and illness solely to biological factors but also considers the individual's psychological state and interaction with the social environment (Engel, 1977; Borrell-Carrió, Suchman & Epstein, 2004). According to this model, an individual's behaviors are influenced by a combination of multilayered factors such as emotional states, stress levels, personality traits, family structure, and social support, alongside the functioning of physiological systems. Especially in understanding complex psychiatric and behavioral conditions such as addiction, the biopsychosocial model provides an effective theoretical basis for explaining the interaction between biological predisposition, environmental conditions, and internal psychological processes.

- At the biological level, recreation creates a corrective effect on the neurochemical foundations of substance addiction by balancing dopamine levels (Volkow, Koob & McLellan, 2016).
- At the psychological level, recreational activities have been shown to reduce symptoms of stress, anxiety, and depression. In addition, by supporting executive functions, they promote

improvements in self-regulation and decision-making processes (Sharp et al., 2011).

- At the social level, recreation helps individuals connect with society, reducing the impact of risk factors such as loneliness and social exclusion. The contribution of recreation to the development of social capital is significant (Kleiber, Walker & Mannell, 2011).

A New Approach to Combating Addiction Through Recreation

Traditional approaches to combating addiction have often been one-dimensional, rigid, and largely based on punitive measures or passive awareness campaigns. In these processes, individuals have been repeatedly informed about what is “harmful,” yet have been offered insufficient opportunities for alternative, healthy, and enjoyable activities that could replace these harmful behaviors in their daily lives. The near-complete absence of activities such as recreation—which can directly enhance quality of life—from addiction prevention strategies highlights a significant gap in this field.

Unfortunately, many decision-makers in this field perceive the concept of recreation merely as leisure-time entertainment, disregarding its protective effects on individuals’ mental, emotional, and social development. However, scientific research has shown that recreational participation facilitates stress management, enhances the sense of belonging, and strengthens self-esteem. These effects are directly related to the mechanisms involved in the development of addiction.

To date, the majority of implemented approaches have focused on informing individuals about the dangers of addiction, placing them in passive, non-interactive roles as mere listeners. However, the process of combating addiction must go beyond raising awareness; it must actively engage individuals in the process. At this point, recreation offers an opportunity to involve individuals through real-life experiences—not only through theoretical knowledge but also through participation in sports, arts, nature, and volunteer-based activities.

At the core of a new approach should be a recreation-centered, multi-stakeholder, and participatory structure. Recreational content should be actively integrated into schools, youth centers, rehabilitation programs, and social support services. These activities not only help distance individuals from risky behaviors in the short term, but also promote the development of healthy lifestyle habits in the medium and long term.

In conclusion, what is needed in addiction prevention is no longer an approach that merely tells individuals what they are doing wrong, but one that shows them what they can do and how to do it—one that walks alongside them through an interactive and holistic process. Recreation should be regarded as a feasible, sustainable, and socially engaging tool in this transformation. Public institutions, local governments, non-governmental organizations, and educational institutions can open a new chapter in the fight against addiction by uniting around this common approach.

References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC: Author.

Anderson, L. S., & Heyne, L. A. (2024). A systematic review and critique of recreational therapy-specific literature regarding substance use disorders. Therapeutic Recreation Journal, 58(4). https://doi.org/10.18666/TRJ-2024-V58-I4-11886.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. Psychological Science, 19(12), 1207–1212. https://doi.org/10.1111/j.1467-9280.2008.02225.x.

Borrell-Carrió, F., Suchman, A. L., & Epstein, R. M. (2004). The biopsychosocial model 25 years later: principles, practice, and scientific inquiry. Annals of Family Medicine, 2(6), 576–582. https://doi.org/10.1370/afm.245.

Brand, M., Rumpf, H. J., Demetrovics, Z., Müller, A., Stark, R., King, D. L., Goudriaan, A. E., Mann, K., Trotzke, P., Fineberg, N. A., Chamberlain, S. R., Kraus, S. W., Wegmann, E., Billieux, J., & Potenza, M. N. (2020). Which conditions should be considered as disorders in the International Classification of Diseases (ICD-11) designation of "other specified disorders due to addictive behaviors"? Journal of Behavioral Addictions, 11(2), 150–159. https://doi.org/10.1556/2006.2020.00035.

Brook, J. S., Tsang, A., & Zhang, C. (2021). Risk and protective factors for substance use and abuse. In B. Johnson (Ed.), Addiction Medicine (Vol. 2, pp. 135–147). Oxford University Press. https://doi.org/10.1093/med/9780190934258.003.0017.

Caldwell, L. L. (2005). Leisure and health: Why is leisure therapeutic? British Journal of Guidance & Counselling, 33, 7–26. https://doi.org/10.1080/03069880412331335939.

Caldwell, L. L., & Smith, E. A. (2023). How is leisure related to wellbeing and to substance use? The Journal of Primary Prevention, 44(2), 123–145. https://doi.org/10.1007/s10935-023-00672-1.

Dawson, P., & Guare, R. (2018). Executive skills in children and adolescents: A practical guide to assessment and intervention (3rd ed.). Guilford Press.

Deane, F. P., Hsu, W. Y., & Kelly, P. J. (2023). Mutual support and recovery: The role of belongingness and social connectedness in substance use treatment outcomes. Substance Use & Misuse, 58(2), 224–232. https://doi.org/10.1080/10826084.2022.2148443.

Dinçelli, B. C., Maçkalı, Z., Eracar, N., & Bilici, R. (2025). Alkol kullanım bozukluğuna yönelik psikososyal müdahalede sanat terapisinin kullanımı: Olgu sunumu. Bağımlılık Dergisi, 26(3), 1–1. https://doi.org/10.51982/bagimli.1553717.

Edginton, C. R., Hudson, S. D., Dieser, R. B., & Edginton, S. R. (2006). Youth programs as builders of social capital: New directions for youth development. Jossey-Bass.

Engel, G. L. (1977). The need for a new medical model: a challenge for biomedicine. Science, 196(4286), 129–136. https://doi.org/10.1126/science.847460.

European Psychiatric Association (EPA). (2020). Mental health as public good. https://psiholoska-komora.hr/dokumenti/Mental_Health_As_Public_Good_PUB-webV2.pdf.

Feldman, C. (2023). Clay use as mindfulness for women in early substance use recovery (Doctoral dissertation). Dominican

University of California. https://doi.org/10.33015/dominican.edu/2023.AT.PHD.04.

Gobeil, É., Morin, A. J. S., & Tougas, F. (2023). The longitudinal role of social support in substance use recovery: A growth modeling approach. Journal of Substance Abuse Treatment, 153, 108954. https://doi.org/10.1016/j.jsat.2023.108954.

Herrador-Colmenero, M., Pérez-García, M., Ruiz-Tendero, & Morales-Ortiz, E. (2025). Educational interventions through physical activity for addiction prevention in adolescent students—A systematic review. Education Sciences, 15(3), 348. https://doi.org/10.3390/educsci15030348.

Iwasaki, Y. (2007). Leisure and quality of life in an international and multicultural context: What are major pathways linking leisure to quality of life? Social Indicators Research, 82(2), 233–264. https://doi.org/10.1007/s11205-006-9032-z.

Iwasaki, Y., & Mannell, R. C. (2000). Hierarchical dimensions of leisure stress coping. Leisure Sciences, 22(3), 163–181. https://doi.org/10.1080/01490409950121843.

Iwasaki, Y., Coyle, C. P., & Shank, J. W. (2010). Leisure as a context for active living, recovery, health and life quality for persons with mental illness in a global context. Health Promotion International, 25(4), 483–494. https://doi.org/10.1093/heapro/daq037.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology, 15(3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2.

Karademir, T., Fişekçioğlu, E., & Konar, N. (2019). The effect of physical activity participation level on boredom perception and internet addiction risk in students. Higher Education Studies, 9(2), 168–176.

Kardefelt-Winther, D., Heeren, A., Schimmenti, A., van Rooij, A., Maurage, P., Carras, M., ... & Billieux, J. (2017). How can we conceptualize behavioural addiction without pathologizing common behaviours? Addiction, 112(10), 1709–1715. https://doi.org/10.1111/add.13763.

Kleiber, D. A., Walker, G. J., & Mannell, R. C. (2011). A social psychology of leisure (2nd ed.). Venture Publishing.

Koob, G. F., & Volkow, N. D. (2016). Neurobiology of addiction: A neurocircuitry analysis. The Lancet Psychiatry, 3(8), 760–773. https://doi.org/10.1016/S2215-0366(16)00104-8.

Li, C., Zhang, Q., Li, X., Zhen, S., & Wang, Y. (2020). Are bored minds more likely to be addicted? The relationship between boredom proneness and problematic mobile phone use. Current Psychology, 41, 1966–1974. https://doi.org/10.1007/s12144-020-00719-9.

Lipari, R. N., Ahrnsbrak, R. D., Pemberton, M. R., & Porter, J. D. (2017). Risk and protective factors and estimates of substance use initiation: Results from the 2016 National Survey on Drug Use and Health. Rockville, MD: Substance Abuse and Mental Health Services Administration (SAMHSA), U.S. Department of Health and Human Services. https://www.ncbi.nlm.nih.gov/books/NBK481723/.

Litwin, H., Sapir, E., & Alcalay, Y. (2024). Effects of physical, mental, social, cultural, and passive leisure activities on episodic memory across adulthood. Journal of Cognitive Enhancement. https://doi.org/10.1007/s41465-024-00341-z

López, C., Teixidó-Compañó, E., Moncada, S., & Sala-Roca, J. (2023). Negative life events, protective factors, and substance-related problems: A study of resilience in adolescence. Substance

Use & Misuse, 58(4), 468–478. https://doi.org/10.1080/10826084.2022.2161319

Mann, M., Hosman, C. M. H., Schaalma, H. P., & De Vries, N. K. (2004). Self-esteem in a broad-spectrum approach for mental health promotion. Health Education Research, 19(4), 357–372. https://doi.org/10.1093/her/cyg041.

Mercer-Lynn, K. B., Flora, D. B., Fahlman, S. A., & Eastwood, J. D. (2015). The measurement of boredom. The Journal of Psychology, 150(2), 192–213. https://doi.org/10.1080/00223980.2015.103

Nutt, D. J., King, L. A., & Phillips, L. D. (2010). Drug harms in the UK: A multicriteria decision analysis. The Lancet, 376(9752), 1558–1565. https://doi.org/10.1016/S0140-6736(10)61462-6.

Orth, U., & Robins, R. W. (2014). The development of self-esteem. Current Directions in Psychological Science, 23(5), 381–387. https://doi.org/10.1177/0963721414547414.

Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. International Journal of Environmental Health Research, 15(5), 319–337. https://doi.org/10.1080/09603120500155963.

Sharp, E. H., Caldwell, L. L., Graham, J. W., & Ridenour, T. A. (2011). Adolescent substance use and leisure boredom. Journal of Leisure Research, 43(3), 284–308. https://doi.org/10.1080/00222216.2011.11950242

Sharp, M. (2018). Art therapy and the recovery process: A literature review (Master's thesis). Lesley University. https://digitalcommons.lesley.edu/expressive_theses/29.

Tabullo, Á. J., Flanagan, C. S., Peñalva, G., & Lipina, S. J. (2024). Children's executive function during the COVID-19 pandemic in Argentina: Associations with home literacy, reading, and screen times. Cognitive Development, 69, 101378. https://doi.org/10.1016/j.cogdev.2023.101378.

Tabullo, Á. J., Flanagan, C., Monti, A., García Coni, A., Vernucci, S., Estévez, P., Irrazabal, N., & Lipina, S. J. (2023). Executive function difficulties among school-aged children during the COVID-19 pandemic: Associations with home literacy environment, reading and screen media times. Journal of Applied Developmental Psychology, 84, 101496. https://doi.org/10.1016/j.appdev.2022.101496.

Tomé, G., Guedes, F. B., Cerqueira, A., Noronha, C., de Freitas, J. C., Freire, T., & Gaspar de Matos, M. (2023). How is leisure related to wellbeing and to substance use? Children, 10(5), 773. https://doi.org/10.3390/children10050773.

Trucco, E. M. (2020). A review of psychosocial factors linked to adolescent substance use. Pharmacology, Biochemistry and Behavior, 196, 172969. https://doi.org/10.1016/j.pbb.2020.172969.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 224(4647), 420–421. https://doi.org/10.1126/science.6143402.

Vodanovich, S. J., & Watt, J. D. (2016). Self-report measures of boredom: An updated review of the literature. The Journal of Psychology, 150(2), 196–228. https://doi.org/10.1080/00223980.2015.1074531.

Volkow, N. D., Koob, G. F., & McLellan, A. T. (2016). Neurobiologic advances from the brain disease model of addiction. New England Journal of Medicine, 374(4), 363–371. https://doi.org/10.1056/NEJMra1511480.

Weinstein, A., & Lejoyeux, M. (2020). Neurobiological mechanisms underlying internet gaming disorder. Dialogues in

Clinical Neuroscience, 22(1), 139–146. https://doi.org/10.31887/DCNS.2020.22.2/aweinstein.

Weybright, E. H., Caldwell, L. L., Ram, N., Smith, E. A., & Jacobs, J. J. (2016). The dynamic association between healthy leisure and substance use in South African adolescents: A state and trait perspective. World Leisure Journal, 58(1), 3–17. https://doi.org/10.1080/16078055.2015.1117195.

Weybright, E. H., Caldwell, L. L., Ram, N., Smith, E. A., & Wegner, L. (2016). Trajectories of adolescent substance use development and the influence of healthy leisure: A growth mixture modeling approach. Journal of Adolescence, 49, 158–169. https://doi.org/10.1016/j.adolescence.2016.03.012.

BÖLÜM 4

THE IMPORTANCE OF RESISTANCE TRAINING

MEHMET MÜBAREK BORA[1]
ÜNSAL TAZEGÜL[2]
MEHMETVEYSİ BORA[3]

Introduction

Resistance Training:

Resistance Training (DE); It is defined as a physical conditioning program that uses various exercise materials and methods such as free weights, weight machines, medicine balls, elastic bands and different movement speeds, increasing fitness, health and sports performance [1].

Evidence-based studies on resistance exercises show us that it provides positive effects on health-related parameters, sportive performance and physical aesthetics. When resistance training is mentioned, strength training or weight training often comes to

[1] Phd Student, Iğdır University, Faculty of Sports Sciences, Orcid: 0000-0002-9711-8472
[2] Associate Professor, Iğdır University, Faculty of Sports Sciences, Orcid: 0000-0001-9772-9305
[3] Phd Student, Iğdır University, Faculty of Sports Sciences, Orcid: 0000-0002-9418-8766

mind. With this being true, strength training constitutes only one form of DE training. Resistance exercises are widely used to both increase muscle strength and increase muscle mass (Drummond et al., 2016). In addition, various training strategies are used within a training period to maximize these exercises [2-4].

Therefore, much research has been done on the programming and manipulation of resistance training variables (volume, intensity, etc.). To date, most resistance exercise research has focused on manipulation of volume, intensity, and rest interval, resulting in a general consensus on these issues in the scientific literature. For example, it is widely accepted that volume plays a key role in both strength and hypertrophic adaptations. In addition, it has been shown that skeletal muscle hypertrophy can occur at various exercise loads, with shorter rest intervals rather than longer rest intervals leading to increased hypertrophy and strength. However, there is a lack of studies on the optimal frequency of resistance exercises in terms of training frequency in terms of muscle strength and muscle hypertrophy. It is well known that both men and women can increase muscle size and strength in response to DE. Also, many studies have shown that DE has many benefits for overall health. Although there are no studies using dose-response models to determine whether men and women respond differently to chronic DE, many studies have compared the adaptations of men and women using the same training protocol. However, it is still unclear whether there are gender-specific adaptations to the same training [4]. During resistance training, muscle protein synthesis is suppressed and proteolysis (the breakdown of proteins into amino acids) is increased. Increases in sarcoplasmic hypertrophy are training-specific, with light loads causing higher repetitions to build up in sarcoplasmic sections compared to heavy loads and low reps. Most of the resistance training and stretching studies are studies in which stretching is done before the resistance training or on a different day than the resistance training day. In the study of Kokkonen et al. Stretching exercises were performed on a different day from the day of resistance training. Greater gains were obtained in the group that applied resistance exercises and stretching exercises compared to the group that applied only resistance exercises. In the study conducted by Soza et al. İn which 8 weeks of traditional resistance training and resistance training with stretching between sets, were compared, similar improvements were observed in power performance [5-8].

Types of Resistance Exercises

Ems Technique

Whole body electro muscle stimulation (TV-EMS), which was first produced in Germany in 2009 and released commercially, is an exercise technology that spreads rapidly, especially in Europe and the Far East. Although there are more than 2,000 commercial TV-EMS providers with around 250,000 customers in Germany alone, research on TV-EMS is still limited. We can define TV-EMS as ―the simultaneous application of electrical stimuli to all major muscle groups through at least six current channels and the stimulation of these muscle groups by means of electrical current. The most important distinguishing feature of TV-EMS is; Since each of them is a device with its own stimulus intensity, it can stimulate large muscle masses at the same time. This provides "time efficiency", which is an important feature of this exercise method [9].

EMS is a method that has long been used in physiotherapy to strengthen muscles. It helps athletes minimize performance degradation after injuries, support muscle atrophy and muscle reconstruction. In addition, it allows the users to get out of the training routine and allows the muscles to recognize new stimuli [10].

The current intensity applied during TV-EMS is evaluated by the patient or the athlete on the BORG scale. Thus, an individually tolerable voltage is determined. It can be assumed that the maximum density tolerance can be affected by anthropometric parameters and the body composition of the individual. The current applied in TV-EMS must pass through different skin layers, fat and connective tissue and other physical structures (blood vessels, bones, ligaments) before reaching the muscle to be stimulated. These structures are considered as resistors (R) connected in series. This causes the applied voltage (U) to be divided. According to Ohm's law, the current density (I) passing through the muscle should therefore be applied depending on the thickness of the skin fold [11].

Concentric and Eccentric Contraction Technique

Eccentric (ECC) muscle contractions involve the active stretching of muscle tissue against an external force or load. Isometric contractions (ISO) involve muscle contractions without any change in muscle length. Concentric (CON) contractions are muscle contractions that involve shortening of muscle tissue. It has been shown that eccentric (ECC) muscle contractions can produce relatively more force than ISO or CON contractions (Timothy et al., 2019). Studies show that each contraction produces different neuromuscular stimuli, resulting in different adaptive responses after exercise [4].

Eccentric contractions produce more maximal muscle tension than isometric or concentric contractions by lengthening active muscle fibers. Eccentric exercises, delayed onset muscle soreness, with loss of muscle strength, decreased range of motion (ROM), histological impairment of muscle and connective tissue, and subsequent inflammatory response to muscle swelling (cell swelling or pump effect) may cause muscle damage. DOMS occurs in skeletal muscles within the first 24 hours after exercise and is characterized by mild pain that peaks after 1-3 days. These symptoms typically disappear after 7-10 days [4].

Despite the large number of studies, there is still controversy regarding the effects of different resistance training on muscle strength and hypertrophy. It is hypothesized that eccentric (ECC) contractions may cause more hypertrophy than concentric (CON) contractions because eccentric contractions are associated with greater muscle strength, neuromuscular functions such as IGF-1 (Insulin Like Growth Factor), mRNA expression, protein synthesis as a result of activation and proliferation of satellite cells. they create a faster increase in adaptations. However, the differential effect of ECC or CON on strength and hypertrophy gains is still a controversial issue, and the mechanisms regulating these adaptations have not yet been fully elucidated [12].

Pyramid Technique

The pyramid system is a training system introduced by Thomas DeLorme in the 1940s. This technique is known as a technique characterized by increases or decreases in exercise load for each set. The most common among DE systems are conventional method (pyramid with fall) and drop-set systems (DS). The conventional method system, also known as the multi-set system, consists of multiple sets with the same load; It is also one of the most frequently used systems among DE practitioners. The descending pyramid is formed by reducing the load and increasing the number of repetitions in each set of the exercise. This allows the total training volume to increase [4,13].

Drop Set Technique

Drop-set (DS) is a training system that targets more than one muscle exhaustion during a set. In this context, repetitions in a set are done until muscle exhaustion. Then a short pause is used to reduce the load (eg 20%) and individuals need to perform additional repetitions until muscle exhaustion. This cycle can occur several times in a set [14].

In general, loads are reduced by 20-25% in drop set workouts, but there are no defined guidelines on this. Therefore, there are many possibilities for practical applications. It is thought that this technique may increase muscle hypertrophy as more motor units are needed for this technique [4].

Super Slow Technique

The super-slow technique (SYT) is when each repetition of the exercise is done at a very low speed. For example, it can be shown as performing the concentric phase of the movement in 10 seconds and the eccentric phase in 4 seconds. In addition, different time applications are encountered (T: Concentric 5 seconds Eccentric 5 seconds). The high mechanical stress caused by increased time under tension is thought to optimize or maximize gains in muscle strength and muscle hypertrophy compared to the Traditional (TRAD) method [4].

German Volume Training Technique

The German Volume Training Technique (AHT) is a technique used by coaches to increase muscle hypertrophy in off-season athletes. A typical AHT workout involves performing 10 sets of 10 repetitions (i.e. 100 repetitions) for two compound resistance exercises at 60% of 1 rep max. With this high training volume, the rest periods between sets are relatively short (~ 60-90 sec).

The purpose of keeping the rest periods short is to trigger muscle hypertrophy by increasing metabolic stress [4].

Superset Technique

Superset training during DE can be defined as a pair of different sets of exercises performed without rest. Supersets usually consist of two exercises for the same muscle group, agonist-antagonist muscles or upper and lower extremity muscle groups. It involves performing a single-joint exercise before a multi-joint exercise for the same muscle group (for example, dumbbell fly before bench press) [15].

One-Set Program (One-Set Program)

Just like the circular training, the movements are performed in a circular way in the single set program, each exercise is performed 8-12 repetitions in the set. This program is also called High Intensity Training (HIT).

Multi-Set System

This type of system consists of 2 or 3 warm-up sets in which the exercise resistance is gradually increased, followed by several sets at the same resistance. In multi-joint exercises, a minimum of 3 sets of performance with 5 or 6 maximum repetitions (RM) allows optimal development of strength. You can reach the desired goal of the training by performing the multi-set system at the desired resistance and with the desired number of repetitions and sets. Using this system for a long time without changing the training variables stops performance improvement. If strength and power development is the main goal, you can keep the multi-set system limited in your workouts.

Super Slow System

In this system, repetitions are performed at a very slow speed, from 20 to 60 seconds. However, there is little evidence that prolonging the exercise time leads to increased stress on the muscle and provides muscle strength development. The power produced by the muscles gradually decreases over time, moving the weight slowly also significantly reduces the resistance you use and directly works the endurance muscles (red muscles-slow twitch oxidative muscles). These types of programs provide the development of muscular endurance at a slow pace. These types of exercises are preferred in order to control the movement with machines that do not change the speed of movement. Super slow sets are usually performed as one or two sets. Exercise resistance is usually determined by the athlete's muscular endurance fitness level. Repetitions at normal speed are not related to the resistance used. As the repetition time increases, the resistance created by the weight lifted decreases. Therefore, less optimal force stimulus is received at each point in the movement axis of the exercises.

Negative Resistance Training

In many resistance exercises, the resistance or exercise load is reduced in the eccentric (prolongation of muscle length) or negative part of the repetitions. At this stage, it allows you to reduce the resistance or load of the exercise in a controlled manner while the related muscles are lengthened. In the opposite application, the removal of the resistance, that is, the load, during repetitions is called positive or concentric (shortening of the muscle length) exercise.

Generally, during repetitions, more weight can be held in the eccentric (negative) phase than in the concentric (positive) phase. In negative resistance training, it consists of lifting the weight you can lift in the concentric phase of the exercise repetitions as a lower weight in the negative phase. For example, it is to lift a weight that you have difficulty in lifting while doing the arm curl movement with an assistant in the positive phase and to be able to do the negative phase without assistance. With the help of machines, the negative phase of the movement can be performed with two legs or arms and the positive phase can be performed with one leg or arm.

As a result of scientific research on the effects of negative resistance training, sufficient evidence has not yet been reached that this type of training contributes to strength development.

1. Variables of Resistance Training

By differentiating the acute variables of DE; more rapid progress towards the goal can be achieved. Variables of resistance exercise;

1. Volume of resistance exercise,
2. Frequency of resistance exercise,
3. Loading intensity in resistance exercise,
4. Exercise selection in resistance exercise,
5. Type of muscle contraction in resistance exercise,
6. Rest period in resistance exercise,
7. The repetition time of the movement in the resistance exercise,
8. Exercise sequence in resistance exercise,
9. Range of motion in resistance exercise,
10. Intensity of effort in resistance exercise,

Knowing the properties and effects of these variables forms the basis of a successful DI [16].

Volume of Resistance Training

The volume of DE is used to indicate the amount of exercise done in a given period. The volume of DE is often expressed as the number of repetitions performed during the exercise multiplied by the number of sets (number of sets x number of repetitions). However, this value does not take into account the amount of load lifted. Because; training volume would be a more accurate term to reflect the total work completed (number of sets X number of repetitions X load). The volume of the exercise; It is known to affect neural, metabolic, hypertrophic, hormonal responses and subsequent adaptations to resistance exercise [17].

The volume of resistance exercise can be changed by changing the number of workouts, the number of repetitions and the number of sets during the training season. Studies show that high exercise volume is more effective in maximizing anabolism [18].

After the exercise volume is determined; The fact that the sets to be applied during the exercise consist of single or multiple set programs is also a remarkable issue in the literature, which creates differences in achieving the expected effect. Meta-analysis studies have reported that multi-set DE provides more strength increase and hypertrophic response in trained and untrained groups compared to single-set DE [19].

Frequency of Resistance Exercise

Frequency of DE refers to the number of times a workout is done in a given time period, usually per week. In terms of hypertrophic responses, the frequency also indicates how much the relevant muscle works. Frequency in DEs with hypertrophy expectation; can be manipulated to change the volume of exercise. Neuromuscular factors limit how much loading volume can be delivered in a single training session. After a certain threshold; the quality of exercise begins to decline [18].

- DE done 4 days a week; It has been reported that it provides more strength gain than DE performed 3 days a week.
- DE done twice a week; It has been observed that it provides more strength gain than DE performed once a week.
- It has been reported that DE applied 3-5 times a week is more effective in strength gain than DE applied once or twice a week [18].

Loading Intensity in Resistance Exercise

Loading intensity; It is seen as one of the most important factors for the hypertrophic response in resistance exercises. The amount of load lifted in the exercise is expressed as a percentage of 1TM. For example, if a person's 1TM bench press value is 45.5 kg and he lifts 36.4 kg during the exercise set, the load intensity of this set is expressed as 80% of 1TM. The severity of loading is often; categorized as loading zones corresponding to repeat intervals. In general, repeat intervals are classified as heavy (1-5TM), moderate (612TM), and light (15 + TM) [16, 18].

Although the formulas are designed to predict the number of repetitions to be performed in the determined percentage of 1TM, in reality; They can make a rough estimate of 1TM and repetitions. The combination of genetic factors (e.g. muscle fiber typing, arm length internal moment), physiological factors (e.g. buffering capacity), and exercise types (e.g. upper extremity and lower extremity, single or multiple joint involvement) affect the generalizability of these values.

Wernbom et al. (2007), in a systematic review by other researchers, it is thought that heavy loads, in which maximum hypertrophy is achieved using the medium- rep interval, generally favor neural adaptations and have less effect on hypertrophy. High intensities of 85% (1TM>85%) of the load naturally result in high levels of mechanical stress on the muscles. However, the duration of a heavy set is short (<15 seconds), the energy during such exercise is primarily derived from the ATP-PC system, with a small contribution from anaerobic glycolysis. Therefore, metabolite accumulation is relatively low, supported by research showing that peripheral fatigue induced by metabolic stress is significantly reduced during exercise in the low rep range (5 reps per set) compared to sets performed in the medium rep range (10 reps per set). Exercises in the light load range are associated with a high amount of metabolic stress. Sets of ≥15 repetitions usually take 45 seconds or longer and require the majority of energy production to be derived from the anaerobic glycolytic system. This causes a significant formation of metabolites and acidosis and creates an important muscle pump. However, it is thought that sufficient motor unit activation cannot be achieved in muscle contractions required to lift light loads, and this will negatively affect the acquisition of hypertrophy [4, 18].

It is claimed that exercise at a moderate repetition interval provides an optimal combination of mechanical tension and metabolic stress to maximize hypertrophic adaptations. The intensity of loading used during such exercises uses most of the fibers in the target musculature and is heavy enough to sustain their stimulation for a period of time. Moreover, in such exercises, sets usually last between 20 and 40 seconds and require a significant contribution from the anaerobic glycolytic system; accordingly, it produces high levels of metabolic stress. Because of these factors, moderate loading is often referred to as the hypertrophy range [20]. Muscular architecture is intricately arranged to perform complex movement patterns efficiently and effectively. Therefore, varying exercise parameters (pulling angle, plane of motion, position of the extremities) can preferentially target the angles of the musculature, more or less activating synergists and stabilizers. Thus, the choice of exercise may contribute to some degree to hypertrophy of certain muscles [4, 18].

While studies showing that alternating exercises increase muscle activation are intriguing, it remains unclear whether the degree of selective activation of a given exercise enhances the site-specific hypertrophic response of a part of a muscle. Lots of research; shows that muscle hypertrophy occurs in a non-uniform manner in terms of preferential growth of both individual muscles in a muscle group and different regions within the same muscle. For example, many studies have shown that leg extension exercise results in a heterogeneous hypertrophic response in which certain regions of the quadriceps femoris hypertrophy more than others [4, 18].

Once people have learned the movement patterns of basic resistance exercises, they should use a variety of exercises to maximize full-body muscle hypertrophy.

It should include machine-based exercises as well as free-form exercises. Similarly, both multi- and single-joint exercises should be included in hypertrophy-specific routines to maximize muscle growth [16].

Type of Muscle Contraction in Resistance Exercise

Mechanosensors are sensitive not only to the magnitude and duration of the stimulation, but also to the type of action performed. Muscle contraction is basically classified into three types. These; concentric, eccentric and isometric contraction types [21].

Based on the specificity principle of strength training, it has been suggested that eccentric and concentric movements provide a different stimulus for the muscle and therefore may create different adaptations. Eccentric muscle movements show different physiological characteristics when compared to concentric movements.

For example;

1. Different neurological patterns have been observed between these two types of contractions.
2. Eccentric movements are characterized by faster and wider cortical activity compared to concentric movements.
3. Decreased motor unit activation during eccentric contraction.
4. Increased level of cross-education.
5. Faster neural adaptation due to resistance exercise.
6. Decreased sympathetic nervous system activity [18].

From a mechanical perspective, it appears that muscles can produce higher absolute force when eccentrically contracted than when contracted concentrically. Considering that the increase in muscle strength is proportional to the magnitude of the force developed, it has been suggested that strength training involving eccentric contractions may provide greater adaptations compared to focusing on concentric training alone. In addition to this situation; decreased fatigue, reduced cardiopulmonary responses, and increased metabolic efficiency are associated with eccentric contractions [18].

Rest Time in Resistance Training

The time elapsed between sets is called the rest interval or rest period. Rest intervals; It can be divided into three categories: short (30 seconds or less), medium (60 to 90 seconds), and long (3 minutes or more). Studies show that the length of the rest interval has different effects on the acute response to DE and that these responses affect chronic hypertrophic adaptations. Schoenfeld, Ratamess et al. Reported in their study that short rest intervals significantly increased metabolite accumulation. Ratamess et al. İn their work; they reported that 30-second rest intervals reduced the volume of DE by more than 50% for 5 sets in 10TM, and there was a gradual decrease in the amount of load in the following sets, but there was an increase in metabolic stress despite the reduction of mechanical tension [16,22,23].

Repetition Time of Movement in Resistance Exercise

The repetition time of the movement (time under mechanical tension) is the sum of the concentric, eccentric, and isometric components of a repetition and indicates the tempo at which the repetition is performed. Tempo; usually expressed in three digits. First step; Indicates the time during which the concentric contraction takes place, the second digit indicates the isometric transition phase (from concentric to eccentric contraction), and the third digit indicates the completion time of the eccentric contraction. For example; If the tempo is 2-0-3, it means that this concentric phase is "2" seconds, if "0" it means that the eccentric phase is passed without any waiting and it takes 3 seconds to complete the eccentric phase. That is, one repetition of the movement was completed in 5 seconds in total [24,25].

Manipulating the time spent under mechanical tension by prolonging the repetition time of the movement may alter neurophysiological, hormonal and metabolic responses and affect strength gain and muscle hypertrophy in resistance exercise.

The time elapsed under mechanical tension can be arbitrarily manipulated to some extent by tempo changes. But this manipulation depends on two situations. The first is the severity of the loading, and the second is; is the level of accumulated fatigue. As heavy loads approach one's 1TM level; takes longer, even if the goal is to remove it as quickly as possible. Moreover, with the onset of fatigue, the speed begins to decrease due to the lack of force sustainment of the working fibers. Weight lifting capacity; It is restricted after a certain point even at very low loads. In a study, it was seen that the first 3 repetitions of the 5TM bench press movement took approximately "1.2" to "1.6" seconds, while the fourth and fifth repetitions found "2.5" to "3.3" seconds. These results are the results that occur even though the subjects tried to lift explosively in all repetitions [18].

Exercises with loads below 80% of 1TM allow the athlete to change the concentric phase tempo of the movement. Working with lower loads helps to develop this ability.

Some researchers; It accepts that conscious deceleration during the concentric phase of the movement reduces the momentum of the movement and thus increases the load to which the muscle is exposed. Theoretically; increased mechanical tension may mediate the initiation of anabolic signaling within the cell, thereby eliciting a more hypertrophic response. Moreover, a potential negative effect of lifting weights too quickly is a reduction in metabolic stress [18].

Sequence of Exercise in Resistance Training

Current DE guidelines include exercises that involve several muscle groups and multiple joint points in the early stages of a workout (multi joint exercise-bench press, squat, leg press, shoulder press) and then movements involving a single muscle group and a single joint (single joint). Exercise- kickback, leg flexion, leg extension) [26]. Studies on this subject show that when single joint exercises targeting similar muscle groups are performed before multi joint exercises, performance decreases significantly in these exercises (bench press, squat, leg press, shoulder press). For example; When arm curls are performed, the biceps brachii muscle fatigues, thus limiting its ability to overload the larger latissimus dorsi muscle. As a result of this situation, there is a decrease in performance with the effect of fatigue in the next lat pulldown exercise [18].

Width of Movement in Resistance Exercise

Basic principles of structural anatomy and kinesiology; states that the movements of the muscles at different joint angles have a greater contribution to the exercise. For example, there are results that the quadriceps muscles are activated differently during leg extension. While the vastus lateralis is maximally active during the first 60° of movement, the vastus medialis muscle becomes fully active at the end of 60° of the width of the movement. Similar findings have been reported during the arm curl movement. The short head of the muscle appears to be more active in the final phase of movement (i.e., during greater elbow flexion), whereas the long head is more active in the early phases of movement [18].

Intensity of Effort in Resistance Exercise

The effort expended during DE is often referred to as effort intensity and can influence exercise-induced hypertrophy. The intensity of effort is usually; it is measured by proximity to the point where the muscles can no longer produce force. Although the benefits of continuing repetition until failure in DE are still a matter of debate, it is generally considered necessary to maximize the hypertrophic response. The primary reason for continuing exercise until repetition failure in DE is to maximize motor unit involvement, which is essential for obtaining maximum protein in all fiber types [18].

2. Resistance Training Working Patterns:

Resistance training can be applied in two ways: (1) Isometric and (2) Isotonic (Maglischo 1993, Fleck and Kreamer 1997). Isometric (static) resistance training is generally applied against resistance that cannot be defeated, and no change in muscle length is observed during muscle contraction, but there is a change in tone (Fleck and Kreamer 1997). Isotonic resistance training; resistance training with fixed weights, isokinetic training, resistance training with variable weights, plyometric training, and eccentric training.

3. Components of Resistance

Training Intensity of Training

Intensity of the Training; It means the qualitative (numerical) part of the work done in a certain period of time [28]. and the strength of the exercise or the exercises applied in series [29]. In resistance training, the intensity can be evaluated as a certain percentage of 1RM (maximum weight - load lifted at once) or a certain percentage of any (n) RM.

Scope of Training

It is defined as the “total amount of work” done in training. In exercises involving speed, the scope can be determined as time or as the total distance run [28]. In resistance exercises, the scope is expressed as the total weight lifted. Coverage can be calculated as the total amount of work done in a training unit, week, month, or training period [29].

Frequency of Training

Specifies how often resistance training is applied [30]. It is defined as the number of training units completed in a given time period (weekly, monthly, or yearly). The frequency of training is limited by the organism's ability to return to normal (recovery). Training frequency and duration (duration of each training unit) are directly related to the scope.

Relationship Between Components of Resistance Training

In resistance training, the scope is calculated as “load lifted x number of repetitions applied x number of sets”. However, the number of repetitions that can be performed is related to the percentage of maximal strength. Studies show that there is a strong correlation between muscular endurance and the 1RM percentage [31].

4. Things to Consider When Starting Resistance (strength)

Training Exercise Selection:

When preparing your strength training programs, you should first choose the exercises that work the main muscle groups of the body. Those interested in power sports should concentrate on 3 different types of weight lifting; pushing (bench and incline bench press using steel bar and dumbbells, sitting and standing shoulder press) pulling (snapping and shrugging, dead lift, high pull, shouldering) and leg exercises (squat, leg press, lunge and step-up). Athletes aiming to develop strength should run these exercises before auxiliary exercises such as biceps and triceps. Athletes interested in power sports should focus on developing core strength (abdominal, back, hip muscles) and should avoid doing body-building exercises. Body builders train to minimize the layer of subcutaneous fat, define muscle and increase muscle diameter [32].

Warm-up:

Static stretching (stretching and maintaining position) exercises should not be performed before resistance training.

Stretching the muscles for 5 minutes or more reduces muscle strength, resulting in a lowering of the intensity of the exercise. You can stretch your warmed muscles after exercise [32].

Cool-down:

Cool-down is the normalization of muscle temperature and metabolic rates. The cool-down after resistance training is usually done by relaxing in a comfortable environment. After endurance exercises, the tempo of the activity should be reduced gradually. Resistance training is not a continuous activity, so a cool-down is not necessary. However, since the heart rate increases after intense training (circular training), it is possible to pedal for 5-10 minutes at a slow pace on a light jogging or cycling ergometer.

Since the muscles and joints are warmed up after resistance training, you can prevent muscle fatigue by doing stretching and flexibility exercises.

Do not take a shower right after a vigorous workout. During this type of training, circulating blood rushes to the skin and muscles, while hormones are activated to aid exercise. If you take a hot shower immediately after high-intensity or high- intensity exercise, your heart will be stressed and you may not be able to cope with this stress. After resting for 5-10 minutes after exercise, you can take a shower [32].

Sequence of Exercises

If your main goal is strength development, you should work large muscle groups (pushing, pulling and leg exercises) before small muscle groups (wrist, forearm, biceps, triceps). During resistance training, small muscle groups get tired (lactic acid accumulates) before large muscle groups. That's why you should first practice exercises that cover multiple joint movements (such as chest, legs) and then those that cover single joint (biceps, triceps) movements. Experienced weightlifters work a part of their body during each workout. Some train upper and lower body exercises on different days. If you do the exercises by mixing large and small muscle groups with the lower and upper body, your rate of development will slow down as the amount of weight you lift will decrease. You should load your muscles 2 or 3 times a week. Many people train 6-10 exercises 3 times a week. Some of them train 2 times a week for the lower body and 2 times for the upper body, a total of 4 (split training-split routine) times. This type of workout is ideal for beginners. You should rest after training. Because after the load, the muscles start to get stronger and increase the muscle diameter. Sometimes quality rest is even more important than heavy training [32].

5. Purposes of Strength (Resistance) Trainings

Hypertrophy

The most common reason to start resistance training is to increase muscle diameter by doing muscle hypertrophy. If you are new to training, it should take at least 6 weeks before you notice any change in muscle size and strength. Those who have a previous strength training background cannot develop muscle hypertrophy sufficiently if they do not plan their training programs carefully. In the development of muscle hypertrophy, 6-12 RM repetitive moderate loads and 4-5 sets of high volume training are more effective. The rest intervals between repetitions of hypertrophy exercises are 30-90 seconds. This time is sufficient for the muscles to recover between sets and also for the muscles to be sufficiently exhausted at the end of the sets [32].

Increasing Maximum Force

Another purpose of resistance training is to increase maximal strength. As the muscular load increases during resistance training, the adaptation increases accordingly. Considering this principle, 1 RM, 23 repetition strength training with maximal or near maximal heavy loads is the most effective way for maximal strength. For maximum strength gain, you should increase the number of sets (4-6) from the middle to high.

The issue of which method develops maximal force best is open to debate. However, the generally accepted method is high-intensity (overload) strength training with 85-90% 1RM. The ideal training load for maximal strength gain is 85% 1RM.

Maximal strength protocols require long rest intervals. As the exercise intensity increases, a minimum rest interval of 3 minutes should be given between sets. Many professional athletes and scientific studies recommend 3-5 minutes of rest intervals during high-intensity exercises [33-35].

Muscular Strength Development

Power is the amount of force applied to move any object in unit time. In other words, the faster the object is moved or the greater the force applied to the object, the greater the resulting force. The same physical law applies to muscular strength. Because power is a combination of strength and speed.

In recent studies, it is stated that 30-40% 1% RM (with light weights) low- volume (a few sets and repetitions) training provides a great deal of strength gain. The load in question is sufficient to move quickly, but the load must be heavy enough to generate power. Therefore, the combination of force generation and speed action increases peak power efficiency. While the light weights used in weight training increase the movement speed of the exercise, it trains the speed component of the power. It trains the strength component of power in training with heavy weights. In strength training with light weights, 2 to 5 sets of 5-15 repetitive exercises are usually performed [36].

Increasing Muscular Endurance

Another purpose of resistance training is to develop regional muscular endurance. Muscular endurance training is quite different from maximal strength training. Muscular endurance training is done to provide more contraction and continuity of the muscles in the long-term period. This type of training is usually performed with light loads at 50-60% RM and high volume (3-5 sets of 15-20 repetitive exercises).

In muscular endurance exercises, there is usually a 30-second rest interval between sets. Muscular endurance training produces long-term maximal work to improve tolerance to fatigue or fatigue.

Muscular endurance trainings are effective programs for beginners, special groups, long-distance runners, cycling and sports branches that require high endurance effort [37].

Acronyms and Abbreviations

- Resistance Training (DE).
- Whole Body Electro Muscle Stimulation (TV-EMS).
- Drop-set (DS).
- The Super-slow Technique (SYT).
- German Volume Training Technique (AHT).
- Isometric Contractions (ISO).

6. Conclusion(s)

Resistance exercises are a type of training performed with different equipment. Resistance exercises positively affect the performance of athletes. Resistance exercises both increase the muscle strength of the athletes and increase the muscle mass. There are many resistance training methods. The main purpose of these methods is to improve the performance of athletes. Again, resistance exercise has many variables. As a result, it is thought that this study will contribute to the literature.

Acknowledgments

This study has no financial support.

Conflict of Interest

There is no conflict of interest.

References

1. *Hong Ar, Kim Sw. Effects of resistance exercise on bone health. Endocrinology and Metabolism, 2018; 33. 4: 435-444. doi: 10.3803/EnM.2018.33.4.435*
2. *Suchomel, T. J., Nimphius, S., & Stone, M. H. The importance of muscular strength in athletic performance. Sports medicine, 2016;46(10), 1419-1449. doi: 10.1007/s40279-016- 0486-0*
3. *Tufano, J. J., Conlon, J. A., Nimphius, S., Brown, L. E., Seitz, L. B., Williamson, B. D., & Haff, G. G. Maintenance of velocity and power with cluster sets during high-volume back squats. International journal of sports physiology and performance, 2016;11. 7: 885-892. doi: 10.1123/ijspp.2015-0602*
4. *Bostan, G. Farklı Direnç Egzersizlerinin Kas Hipertrofisi Üzerine Etkileri. Efe Akademi Yayınları. 2022*
5. *Phillips, S. M., Tipton, K. D., Aarsland, A., Wolf, S. E. & Wolfe, R. R. Mixed muscle protein synthesis and breakdown after resistance exercise in humans. Am J Physiol,1997; 273: E99-E107. DOI: https://doi.org/10.1152/ajpendo.1997.273.1.E99*
6. *Tesch, P. A. & Larsson, L. Muscle hypertrophy in bodybuilders. Eur J Appl Occup Physiol, 1982; 49: 301-306. doi: 10.1007/BF00441291*
7. *Kokkonen, J., Nelson, A. G., Eldredge, C., & Winchester, J. B. Chronic static stretching improves exercise performance. Med Sci Sports Exerc, 2007; 39(10):1825- 31. DOI: 10.1249/mss.0b013e3181238a2b*
8. *Soza, A. C., Bentes, C. M., De Salles, B. F., Reis, V. M., Alves, J. V. & Miranda, H. et. al.Influence of inter-set stretching on strength, flexibility and hormonal adapdation. J Hum Kinet 2013; 36: 127-135. DOI: 10.2478/hukin-2013-0013*
9. *Kemmler W, Kleinoder H, Frohlich M. Whole-Body Electromyostimulation: A Training Technology to Improve Health and Performance in Humans? journal Frontiers in Physiology.*

   2020;11:523. https://doi.org/10.3389/fphys.2020.00523
10. *Berger, J., Ludwig, O., Becker, S., Backfisch, M., Kemmler, W., & Fröhlich, M. Effects of an impulse frequency dependent 10- week whole-body electromyostimulation training program on specific sport performance parameters. J Sports Sci Med. 2020;19: 271–281.*
11. *Vatter J, Authenrieth S, Müller S. Ems consulting and training manual. Stuttgart: Glucker Kolleg. 2016*
12. *Ünlü G, Çevġkol C, Melekoglu T. Comparison of the effects of eccentric, concentric, and eccentric-concentric isotonic resistance training*

at two velocities on strength and muscle hypertrophy. The Journal of Strength & Conditioning Research, 2020;34. 2: 337-344. doi: 10.1519/JSC.0000000000003086

13. *Costa Bdv, Ferreira Mec, Gantois P, Kassiano W, Paes St, De Lġma-Júnġor D, De Sousa Fortes L. Acute effect of drop set, traditional, and pyramidal systems in resistance training on neuromuscular performance in trained adults. J Strength Cond Res, 2021;35. 4: 991-996. doi: 10.1519/JSC.0000000000003150*

14. *Bentes Cm, Simao R, Bunker T, Rhea Mr, Miranda H, Gomes Tm, Novaes Jds. Acute effects of dropsets among different resistance training methods in upper body performance. J Human kinetics, 2012;34:105—111. doi: 10.2478/v10078-012-0069-6*

15. *Weakley Jj, Till K, Read Db, Roe Ga, Darrall-Jones J, Phibbs Pj, Jones B. The effects of traditional, superset, and tri-set resistance training structures on perceived intensity and physiological responses. European journal of applied physiology, 2017; 117. 9: 1877- 1889. doi: 10.1007/s00421-017-3680-3*

16. *Schoenfeld Bj, Nickerson Bs, Wilborn Cd, Urbina Sl, Hayward Sb, Krieger J, Tinsley Gm. Comparison of multifrequency bioelectrical impedance vs. dual-energy X-ray absorptiometry for assessing body composition changes after participation in a 10-week resistance training program. The Journal of Strength & Conditioning Research, 2020; 34. 3: 678-688. doi: 10.1519/JSC.0000000000002708*

17. *Helms, E. R., Zinn, C., Rowlands, D. S., & Brown, S. R. A systematic review of dietary protein during caloric restriction in resistance trained lean athletes: a case for higher intakes. International journal of sport nutrition and exercise metabolism, 2014; 24(2), 127- 138. DOI: 10.1123/ijsnem.2013-0054*

18. *Andre, H. Direnç Egzersizlerinde Tekrar Süresinin Kas Kuvveti Ve Hipertrofisine Etkileri, Ankara Üniversitesi Sağlık Bilimleri Enstitüsü, Beden Eğitimi Ve Spor Anabilim Dalı, 2021.*

19. *Ratamess, N. A., Alvar, B. A., Kibler, W. B., Kraemer, W. J., & Triplett, N. T. Progression Models in Resistance Training for Healthy Adults. Medicine & Science in Sports & Exercise, 2009; 41(3), 687-708. DOI: 10.1249/MSS.0b013e3181915670*

20. *Durand RJ, Castracane VD, Hollander DB, Tryniecki JL, Bamman MM, O Neal S, Hebert EP, Kraemer RR. Hormonal responses from concentric and eccentric muscle contractions. Medicine and science in sports and exercise, 2003; 35(6), 937-943. DOI: 10.1249/01.MSS.0000069522.38141.0B*

21. *Bamman, M. M., Shipp, J. R., Jiang, J., Gower, B. A., Hunter, G. R., Goodman, A., ... & Urban, R. J. Mechanical load increases muscle IGF-I and androgen receptor mRNA concentrations in humans. American journal of physiology-endocrinology and metabolism, 2001; 280(3), E383-E390.*

DOI: 10.1152/ajpendo.2001.280.3.E383
22. *Ratamess, N. A., Alvar, B. A., Kibler, W. B., Kraemer, W. J., & Triplett, N. T. Progression Models in Resistance Training for Healthy Adults. Medicine & Science in Sports & Exercise, 2009; 41(3), 687-708. DOI: 10.1249/MSS.0b013e3181915670*
J. The effect of rest interval length on metabolic responses to the bench press exercise. European journal of applied physiology, 2007;100(1), 1-17. DOI: 10.1007/s00421-007-0394-y

23. *Ratamess, N. A., Falvo, M. J., Mangine, G. T., Hoffman, J. R., Faigenbaum, A. D., & Kang Ogborn, D., & Schoenfeld, B. J (). The role of fiber types in muscle hypertrophy: implications for loading strategies. Strength & Conditioning Journal, 2014; 36(2), 20-25. DOI: 10.1519/SSC.0000000000000030*
24. *Ogborn, D., & Schoenfeld, B. J (). The role of fiber types in muscle hypertrophy: implications for loading strategies. Strength & Conditioning Journal, 2014; 36(2), 20-25. DOI: 10.1519/SSC.0000000000000030*
25. *Headley, S. A., Henry, K., Nindl, B. C., Thompson, B. A., Kraemer, W. J., & Jones, M. T. Effects of lifting tempo on one repetition maximum and hormonal responses to a bench press protocol. The Journal of Strength & Conditioning Research, 2011; 25(2), 406-413. DOI: 10.1519/JSC.0b013e3181bf053b*
26. *Kraemer, W. J., Adams, K., Cafarelli, E., Dudley, G. A., Dooly, C., Feigenbaum, M. S., ... & Triplett-McBride, T. American College. of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc, 2002; 34(2), 364-380. DOI: 10.1097/00005768-200202000-00027*
27. *Bompa, T. O. Antrenman Kuramı ve Yöntemi. (çeviren İlknur Keskin ve Burcu Tuner), Bağırgan Yayımevi, Ankara. 2001.*
28. *Gündüz, N. Antrenman Bilgisi, Saray Tıp Kitabevleri, İzmir, 1997; s 90-91.*
https://www.ume.tubitak.gov.tr/sites/images/ume/kuvvet_kalibrasyon_rehberi-isbn-2021.pdf
29. *Fleck, S. J., and Kraemer, W. J. Designing Reistance Training Programs, Human Kinetics, United States. 1997.*
30. *Açıkada, C., ve Ergen, E. () Antrenman Bilgisi, Bilim ve Spor, Büro-Tek Ofset Matbaacılık, Ankara, 1990; s. 74-79*
31. *Brzycki, M. Strength Testing- Predicting a One-Rep Max From Reps-ToFatigue, JOPERD/ January, 1993; 64: 88-90. https://doi.org/10.1080/07303084.1993.10606684*
32. *https://docplayer.biz.tr/115235178-Kuvvet-direnc-antrenmanlari.htm*
33. *Sever, Ozan. Statik ve dinamik core egzersiz çalışmalarının futbolcuların sürat ve çabukluk performansına etkisinin karşılaştırılması.*

Gazi Üniversitesi, 2016.
34. *Demirtaş, B. Direnç antrenmanlarında kullanılan üç farklı setleme yönteminin hipertrofi ve maksimal kuvvet değişimleri üzerine etkisi. 2020. Master's Thesis. Sakarya Uygulamalı Bilimler Üniversitesi.*
35. *Duran, H. Geleneksel Kuvvet antrenmanlarına karşın dirençli güç Interval Antrenman protokolünün Ivmelenme çeviklik Ve Hareket hızına Etkisi. 2019. PhD Thesis. Marmara Universitesi (Turkey).*
36. *Balcı, Ş. S., & Özdemir, H. Genç Yetişkinlerde Setler Arası Dinlenme Aralığı Sürelerinin ve Farklı Yüklerin Kuvvet Egzersizi Serilerindeki Tekrar Sayısına Etkisi. Turkiye Klinikleri Journal of Sports Sciences, 2020; 12(1). DOI: 10.5336/sportsci.2019-71704*
37. *Kaya, F. Kassal dayanıklılık antrenmanında yeni bir yaklaşım: yorgunlukta kuvvet üretme modeli (Doctoral dissertation, Marmara Universitesi (Turkey)). 2011.*
38. *Dowling, J. J., Konert, E., Ljucovic, P. & Andrews, D. M. Are humans able to voluntarily elicit maximum muscle force? Neurosci Lett, 1994; 179: 25-28. DOI: https://doi.org/10.1016/0304-3940(94)90926-1*
39. *Maglischo, E. W. Swimming Even Faster, Mayfield Publishing Company, California, 1993; s. 633-646.*
40. *Marques, M. A. C. Strength in power events: Theory and practice, Journal of human sport & Exercise, 2010; Vol V, No II, sf: 214-225. DOI:10.4100/jhse.2010.52.10*

HAREKET, SAĞLIK VE TEKNOLOJİ:

SPOR EĞİTİMİNİN DEĞİŞEN PARADİGMALARI