THE EFFECTS OF COVID-19 INDUCED MOBILITY RESTRICTIONS ON PHYSICAL FITNESS IN YOUNG SOCCER PLAYERS AT DIFFERENT MATURITY AND TRAINING STATUS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY
GÜRCAN ÜNLÜ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF PHYSICAL EDUCATION AND SPORT

MARCH 2022

Approval of the thesis:

THE EFFECTS OF COVID-19 INDUCED MOBILITY RESTRICTIONS ON PHYSICAL FITNESS IN YOUNG SOCCER PLAYERS AT DIFFERENT MATURITY AND TRAINING STATUS

submitted by **GÜRCAN ÜNLÜ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Physical Education and Sports, the Graduate School of Social Sciences of Middle East Technical University** by,

Prof. Dr. Yaşar KONDAKÇI
Dean
Graduate School of Social Sciences

Assoc. Prof. Dr. Sadettin KIRAZCI
Head of Department
Department of Physical Education and Sport

Assoc. Prof. Dr. Mustafa SÖĞÜT
Supervisor
Department of Physical Education and Sport

Examining Committee Members:

Prof. Dr. Settar KOÇAK (Head of the Examining Committee)
Lokman Hekim University
Department of Physical Education and Sports

Assoc. Prof. Dr. Mustafa SÖĞÜT (Supervisor)
Middle East Technical University
Department of Physical Education and Sports

Prof. Dr. Ayşe KIN İŞLER
Hacettepe University
Department of Physical Education and Sports

Assoc. Prof. Dr. Irmak HÜRMERIÇ ALTUNSÖZ
Middle East Technical University
Department of Physical Education and Sports

Assoc. Prof. Dr. Erşan ARSLAN
Gaziosmanpaşa University
Department of Coaching Education

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Gürcan ÜNLÜ

Signature:

ABSTRACT

THE EFFECTS OF COVID-19 INDUCED MOBILITY RESTRICTIONS ON PHYSICAL FITNESS IN YOUNG SOCCER PLAYERS AT DIFFERENT MATURITY AND TRAINING STATUS

ÜNLÜ, Gürcan
Ph.D., The Department of Physical Education and Sports
Supervisor: Assoc. Prof. Dr. Mustafa SÖĞÜT

March 2022, 99 pages

The purpose of this study was to examine the 27-week COVID-19 induced mobility restrictions on physical fitness in young soccer players at different maturity and training status. The 52 participants were categorized into highly trained (HT, n=27) and recreationally trained (RT, n=25) players. HT consists of sixteen pre-PHV and eleven mid-PHV, RT consists of fifteen pre-PHV and ten mid-PHV players. After measuring anthropometrics, the following selected physical fitness tests were performed: handgrip strength (HG), dynamic balance, standing long jump (SLJ), squat jump (SJ), drop jump (DJ)-reactive strength index (RSI), countermovement jump (CMJ), acceleration (10m), speed (20m), and agility (with and without ball: ZAWB and ZAWHB). The three-way-repeated measures design [2(time: pre, post) x 2(training status: highly, recreationally trained) x 2(maturity status: pre-, mid-PHV)] was utilized to test changes in physical fitness. The results indicate that no significant 3-way interaction (time*maturity*training status), however; significant time*maturity interactions for DJ, SJ, and ZAWB and ZAWHB, and time*training status interactions for 20m and dynamic balance with a tendency for significance for CMJ and HG. Impairments for DJ, SJ, ZAWB, and ZAWHB were greater in mid-PHV players than in pre-PHV players, and impairments for RSI, 20m, SLJ, and N-Y balance were also significantly greater in HT than in RT. COVID -19 induced mobility restriction impaired physical fitness of young soccer players. Depending on the components of physical fitness, the negative effects may be more pronounced in mid-PHV players than in pre-PHV level players and more pronounced in highly trained players than in recreationally trained players.

Keywords: Detraining, Physical Activity, Adolescent, Peak Height Velocity, Children

ÖZ

KOVİD-19 HAREKET KISITLAMALARININ FARKLI OLGUNLUK VE ANTRENMAN DÜZEYLERİNDEKİ GENÇ FUTBOLCULARIN FİZİKSEL UYGUNLUKLARINA ETKİSİ

ÜNLÜ, Gürcan
Doktora, Beden Eğitimi ve Spor Bölümü
Tez Yöneticisi: Doç. Dr. Mustafa SÖĞÜT

Mart 2022, 99 sayfa

Bu çalışmanın amacı COVID-19 hareket kısıtlamalarının farklı olgunluk ve antrenman düzeylerindeki genç futbolcuların fiziksel uygunluklarına etkisini incelemektir. Çalışmanın örneklem grubunu oluşturan 27 yüksek düzeyde ve 25 rekreatif düzeyde antrenmanlı toplam 52 katılımcının zirve boy uzama hızı dönemleri (PHV) tahmin edilerek olgunluk sınıflandırmaları yapılmış, buna göre 31'inin PHV öncesi döneminde (pre-PHV) ve 21'inin PHV döneminde (mid-PHV) olduğu görülmüştür. Fiziksel uygunluk testleri önce antropometrik ölçümler, sonrasında sırasıyla; kavrama kuvveti, Y-denge, durarak uzun atlama, dikey sıçramalar (skuat sıçrama, drop sıçrama-reaktif kuvvet indeksi ve aktif sıçrama), hızlanma (10m), hız (20m), zikzak çeviklik(toplu-topsuz) ile gerçekleştirilmiştir. Fiziksel uygunluk parametrelerindeki değişimlerin karşılaştırılması için üç yönlü tekrarlanan ölçüm tasarımı [2 (zaman: öntest-sontest) x 2 (antrenman düzeyi: yüksek-rekreatif) x 2 (olgunluk durumu: pre-PHV-mid-PHV)] kurulmuş, anlamlı etkileşimlerdeki farklar etki büyüklüklerine göre değerlendirilmiştir. Çalışma sonuçlarına göre; üç yönlü etkileşimler tüm parametreler için anlamsızken; anlamlı zaman*olgunluk etkileşimlerinin raporlandığı drop sıçrama(d=0.10), skuat sıçrama(d=0.18), toplu ve topsuz zikzak çeviklik(d=0.21, d=0.16) performanslarında azalmaların mid-PHV grupta daha fazla olduğu ve yine anlamlı zaman*antrenman durumu etkileşimlerinin bulunduğu reaktif kuvvet indeksi (d=0.11), durarak uzun atlama (d=0.08), 20m sürat (d=0.12) ve N-Y denge (d=0.09) performanslarında yüksek antrenmanlı oyunculardaki performans kayıplarının daha fazla olduğu görülmüştür. Çalışmanın sonuçları fiziksel uygunluğun tüm bileşenleriyle COVID-19 kısıtlamalarından etkilendiğini, patlayıcı güç gerektiren performanslardaki kayıpların yüksek düzeyde antrenmanlı futbolcularda, sürat ve dinamik denge performans kayıplarının ise adölesan futbolcularda daha fazla olabileceğini göstermektedir.

Anahtar Kelimeler: Antrenmansızlık, Fiziksel Aktivite, Adölesan, Zirve Boy Hızı, Çocuklar

To my family…

ACKNOWLEDGMENTS

First and foremost, I would like to express my sincere gratitude to my thesis advisor, Assoc. Prof. Dr. Mustafa Söğüt for his empathy and motivation, and to my former supervisor, Prof. Dr. Settar Koçak, for his support during my doctoral process. They have contributed significantly to my academic progress by providing me with many opportunities for research and practice. I would also like to thank the members of my committee Prof. Dr. Ayşe Kin İşler, Assoc. Prof. Dr. Irmak Hürmeriç Altunsöz, and Assoc. Prof. Dr. Erşan Arslan for their insightful comments, invaluable suggestions, and constructive criticisms.

My sincere thanks also go to Prof. Dr. David G. Behm (Memorial University of Newfoundland), who mentored me, provided invaluable comments on the statistical analysis, and reviewed the initial draft of this study, and to Professor Urs Granacher (University of Potsdam) who provided me with important tools.

Special thanks to the children and their parents who participated in the study, track and field coaches of the Ankara-Altınordu Soccer Schools, who helped in data collection process.

I thank my fellow colleagues and friends from the department of physical education and sports: Dr. Tolga Tek, Dr. Betül Coşkun, Dr. Can Özgider, Dr. Tuba Yazıcı, Dr. Ahmet Yapar, Alper Yıldız, Serap Usta Sarıkaya, Nehir Kavi Şimşek, Ayşegül Aksoy and Tuncay Anıl and Özlem Haydaroğlu.

I would like to thank my wife Gamze for her support and great love. She has kept me going, and without her contribution, this achievement would not have been possible.

TABLE OF CONTENTS

PLAGIARISM iii
ABSTRACT iv
ÖZ vi
DEDICATION viii
ACKNOWLEDGMENTS ix
TABLE OF CONTENTS x
LIST OF TABLES xiii
LIST OF FIGURES xiv
LIST OF ABBREVIATIONS xv
CHAPTERS
1. INTRODUCTION 1
  1.1. Background of the Study 1
  1.2. Purpose of the Study 3
  1.3. Significance of the Study 4
  1.4. Definition of Terms 5
2. LITERATURE REVIEW 7
  2.1. COVID-19 Induced Mobility Restrictions 8
    2.1.1. Physical Inactivity 9
    2.1.2. Detraining 13
  2.2. Physical Fitness 16
    2.2.1. Health-Related Physical Fitness 17
    2.2.2. Skill-Related Physical Fitness 19

2.2.3. Rationale of Physical Fitness Assessments 20
2.2.4. Influence of Maturation on Physical Fitness Adaptations to Detraining 21
2.2.5. Influence of Training Status on Physical Fitness Adaptations to Detraining 23
2.3. Impacts of COVID-19 Induced Mobility Restrictions on Physical Fitness 24
3. METHODS 27
3.1. Experimental Approach to the Problem 27
3.2. Participants 30
3.3. Measurements and Data Collection Procedures 31
3.3.1. Anthropometric Measurements 32
3.3.2. Handgrip Strength 32
3.3.3. Jumps 33
3.3.4. Acceleration and Maximal Running Velocity 34
3.3.5. Agility 34
3.3.6. Dynamic Balance 35
3.3.7. Physical Activity 36
3.3.8. Training Status 37
3.3.9. Maturity Status 37
3.4. Statistical Analysis 38
4. RESULTS 39
4.1. Descriptive Statistics 39
4.2. Changes in Physical Fitness Parameters 40
4.3. Comparisons of the Changes in Physical Fitness Parameters 43
5. DISCUSSION 46
5.1. Effects of Training Status on Detraining-Induced Physical Fitness Adaptations 55

5.2. Effects of Maturity Status on Detraining-Induced Physical Fitness Adaptations 57

5.3. Discussion of Methods 59

5.3.1. Maturity Assessment 59

5.3.2. The Rationale of Measuring Physical Activity Level: Controlled Detraining Level 60

5.3.3. Evaluation of Training Status 61

5.4. Practical Implications 62

5.5. Limitations and Recommendations 63

5.6. Conclusion 65

REFERENCES 66

APPENDICES

A. ETHICAL COMMITTEE APPROVAL 80

B. CURRICULUM VITAE 81

C. TURKISH SUMMARY / TÜRKÇE ÖZET 86

D. THESIS PERMISSION FORM / TEZ İZİN FORMU 99

LIST OF TABLES

Table 1. Intraclass Correlation Coefficients 29

Table 2. Characteristics of the Participants 39

Table 3. Physical Activity Levels Before and During Lockdown Period 40

Table 4. Changes in the Selected Physical Fitness Variables of Highly Trained Soccer Players at Pre-PHV 41

Table 5. Changes in the Selected Physical Fitness Variables of Recreationally Trained Soccer Players at Pre-PHV 41

Table 6. Changes in the Selected Physical Fitness Variables of Highly Trained Soccer Players at Mid-PHV 42

Table 7. Changes in the Selected Physical Fitness Variables of Recreationally Trained Soccer Players at Mid-PHV 43

Table 8. P-Values for Interactions and Main Effects 44

Table 9. Delta Values and Effect Sizes for Significant Parameters 53

LIST OF FIGURES

Figure 1. The Health- and Performance-Related Consequenses of COVID-19-Induced Mobility Restrictions 8
Figure 2. Study Overview 28
Figure 3. Average Total Weekly Training Volume(Hours) Before the COVID-19 Lockdown 30
Figure 4. Zigzag Agility Run Dimensions and Completion Route 35

LIST OF ABBREVIATIONS

PHV	Peak Height Velocity
BMI	Body mass index
HG	Absolute values of handgrip strength
RHG	Relative values of handgrip strength
SLJ	Standing Long Jump
CMJ	Countermovement jump
SJ	Squat Jump
DJ	Drop Jump
RSI	Reactive Strength Index
ZAWB	Zigzag Agility with ball
ZAWHB	Zigzag Agility without ball

CHAPTER 1

INTRODUCTION

1.1. Background of the Study

Coronavirus disease (COVID -19), officially declared as a pandemic by the World Health Organization, has caused great social and economic damage around the world, and with no drug or vaccine to completely eradicate the disease, countries continue to fight it with various measures. As of December 2021, this pandemic has infected more than three hundred million people and caused approximately five million virus-related deaths worldwide(*WHO Coronavirus (COVID-19) Dashboard*, n.d.). In response to this unique situation that arose, governments worldwide, including that of Turkey, have taken public health measures to contain the spread of this virus, including home quarantine, social distancing (to limit proximity to other people), enforced closures, limitations on the places where people congregate (e.g., schools, shops, weddings, funerals, celebrations recreational facilities), and restriction of interstate and international travels (Tayech et al., 2020). Furthermore, people who may have been exposed to COVID-19 are quarantined. Quarantine is the separation and restriction of movement of people who may have been exposed to a contagious disease to determine if they are unwell and thus reduce the risk of infecting others. It is distinct from isolation, which involves separating people who have been diagnosed with a contagious disease from people who are not ill. However; the two terms are often used interchangeably, especially in communication with the public (Brooks et al., 2020). These quarantine and social distancing measures are intended to protect people from the virus. They have been shown to play a critical role in protecting people who are at higher risk for severe illnesses caused by COVID -19 (Zhou et al., 2020). As more governments impose nationwide quarantines or consider various forms of lockdown to prevent the spread of novel coronavirus, a major human health problem has emerged - diseases caused by lack of movement.

Physical inactivity, already a growing public health problem in the last 50 years before the pandemic, is even more difficult to combat under pandemic conditions. Efforts, especially in developed countries, to increase people's levels of physical activity have now been replaced by the fight against the COVID -19 virus. In fact, the restrictions imposed by this war confined people to their homes, and the sedentary lifestyle began to take on a life of its own more than ever. Especially in the early stages of the pandemic, with a virus whose dangerousness cannot be accurately predicted, physical inactivity completely ceased to be a priority in this state of panic. Studies from different countries showing the decline in physical activity due to pandemics confirm the seriousness of this situation (Andreato et al., 2020; Castañeda-Babarro et al., 2020; Kaur et al., 2020; Lesser & Nienhuis, 2020; Maugeri et al., 2020; Musselwhite et al., 2021; Pinto et al., 2020; J. F. Sallis et al., 2020; Tison et al., 2020; Tornaghi et al., 2020). In addition to the negative long-term health effects of this reduction in physical activity levels, it can also be detrimental in the fight against COVID -19. This is because in the case of infection with coronavirus, the immune system, which is crucial for the healing process, is also weakened by physical inactivity (cite). Given this sensitivity, one may wonder how effective the mobility restrictions that lead to physical inactivity are in the fight against COVID -19. In addition to the health concerns associated with physical inactivity, the current situation also negatively affects athletes' training, consequently they faced performance derogation. Several sporting events have been canceled and/or postponed and hundreds of thousands of amateur and professional athletes around the world have abruptly been forced to train at home. As a result, athletes faced unprecedented and relatively long-term reductions or cessations in their training routines, as well as significant reductions in their daily physical activities. Such changes can lead to a significant decrease in the quantity and a decrease in the quality of training stimuli, exposing athletes to some potential level of detraining(Girardi et al., 2020). Athletes who can only find training opportunities at home in the pandemic COVID -19 can maintain their performance to some degree with this type of activity (de Oliveira Neto et al., 2020; Tayech et al., 2020).

However, especially in the early stages of the pandemic, the psychological and environmental conditions were not conducive to even these home exercises. Therefore, most athletes were exposed to complete detraining by remaining physically inactive during this period. In light of the literature reviewed above, it can be claimed that this pandemic resulted in two important problems; detraining-induced impairments in physical performance, and physical inactivity-induced health concerns.

1.2. Purpose of the Study

The detrimental effects of COVID -19 induced mobility restrictions on physical activity levels are confirmed by several studies in different countries such as Spain, Canada, Italy, Australia, Germany, Iran and Latin America (Akbari et al., 2021; Giustino et al., 2020; Lesser & Nienhuis, 2020; Ruíz-Roso et al., 2020; Schmidt et al., 2020; Stockwell et al., 2021). Based on the fact that these movement restrictions leading to physical inactivity are also implemented in Turkey, it would not be wrong to predict that the decline in physical activity in Turkey is at a similar level as in these countries. To support this prediction and independently of the main research questions of the study, a physical activity questionnaire was conducted to determine the changes of physical activity levels of the participants during the COVID -19 lockdown. This intervention was also intended to control for "detraining level," which is the level of physical activity during detraining that plays a moderator role in the training- and detraining-induced physiological adaptations. In keeping with the main research questions, the primary objective of the study is to investigate the effects of COVID -19 induced mobility restrictions leading to physical inactivity on physical fitness in young soccer players. This was the point of departure for the present study, which aimed to demonstrate the changes in physical fitness, an indicator of overall health and one of the most important determinants of sports performance in young soccer players who remained inactive due to COVID -19 induced mobility restrictions. Lastly, it was aimed to examine the whether there are effects of maturity and training status on these COVID-19 induced physical fitness adaptations.

1.3. Significance of the Study

To date, numerous studies have shown that physical activity, exercise, and sport are key elements for a healthy lifestyle at all ages (Mannino et al., 2019a). In the face of these facts, the COVID-19 pandemic has negatively affected these health and athletic performance-related activities worldwide through widespread mobility restrictions (Kaur et al., 2020). People whose access to physical activities was restricted have been condemned to a sedentary lifestyle, and athletes have not been adequately trained. Because physical fitness that constitute the dependent variables of this study can also be regarded as an indicator of physical health (Knapik et al., 2019; Ortega et al., 2008), the study's findings indirectly analyze the effects of COVID-19-related physical inactivity on health and thus are very important.

It has been recently observed that physical inactivity may also be linked to more severe Covid-19 infections and a higher risk of death due to the virus (R. Sallis et al., 2021). As the population of this study consists of physically inactive individuals, it is thought that physical fitness changes that may provide insights into overall health will contribute to the relevant literature. However, the study does not offer an examination of the outcomes of COVID-19. It was also stated that handgrip strength, measured in the study as a physical fitness test, may also be considered as an indicator for the immune system in addition to overall health (L. Smith et al., 2019). Within this context, it is thought that the findings of this study can serve as guidance for future studies that will analyze the risk factors for severe COVID-19 outcomes.

In addition to the sudden changes in physical activity and exercise routines, sporting events were also affected in different ways. In the first period of the epidemic, when all possibilities for exercising were limited and the outcomes of this epidemic could not be predicted even by experts, it was also psychologically not favorable to do sports at home. The cessation of all sports activities was not only a health problem, but also led to performance losses due to the "detraining syndrome" in elite athletes. Considering that even short periods of detraining can lead to significant performance losses (Arnason et al., 2004; Edwards et al., 2003; Franchini et al., 2005), it is not difficult to predict that long-term restrictions can lead to meaningful performance losses. In this context, it is believed that study results obtained with measures of physical fitness, including various performance tests, can make an important contribution to studies addressing detraining-induced performance losses.

Another contribution to the literature on “detraining syndrome” is that the study analyzes the physical fitness changes by considering potential moderators such as gender, age, maturation status, training status. While numerous studies have revealed different mechanisms for these factors, they have generally not been examined together, precluding an investigation of the possible interaction of these elements. Therefore, there are insufficient data for assessing the influence of such modifiers. Despite the fact that detraining-induced performance losses may differ depending on various factors (Bosquet et al., 2013), the relevant studies were conducted without considering one or multiple of these factors. In addition to age-related differences, the maturation, which is another critical determinant, affects both performance improvement in training and performance losses that occur due to interruptions in training (Goswami et al., 2014). It is thought that classifications will be made based on maturation status, which will lead to more comprehensive findings. It is also considered that, in addition to maturation, previous training status is also one of the moderators that affect performance (Bosquet et al., 2013). To the best of our knowledge, no study analyzes physical fitness changes by considering both training status and maturation status. The current research purposed to bridge this gap by investigating the effects of maturation and training status on detraining induced physical fitness adaptations. And to the best of the researcher's knowledge, no study has been conducted on the physical fitness responses to detraining in children by considering the moderators that may have meaningful effects on physical fitness.

1.4. Definition of Terms

This section contained operationally defined terms in the current dissertation. These terms were arranged alphabetically and conceptual terms were defined lexically.

COVID-19 induced mobility restrictions: These restrictions include both incentives that encourage working from home, facilitated by the expansion of online resources that allow meetings, classes, and shopping, and sanctions such as orders to stay home, travel restrictions, and the closure of stores, offices, and public transportation.

Detraining: This is the situation in which athletes take a break from training for various reasons. Although these reasons are usually due to sports injuries in elite athletes, there may also be reasons for a break in training, such as loss of motivation or a post-season breakout.

Detraining level: The state in which the body shows different physiological responses during detraining, depending on how active it is. The situation when the body spends the period of detraining with complete inactivity (e.g., bedridden diseases) and physical activity (various exercises, jogging, or high physical activity) and creates different physiological adaptations (partial detraining - complete detraining).

Physical fitness: A set of attributes that people have or achieve that relate to their ability to engage in physical activity (Caspersen et al., 1985). Some of these attributes may describe health-related physical fitness, while others may describe more skill-related physical fitness. In this study, the combination of all health-related components except cardiorespiratory endurance and some skill-related components (considering the performance requirements of soccer) is understood as "physical fitness".

Training status: Athletes in a sport differ from each other depending on their previous training background. These differences often determine their level (e.g., elite-subelite-amateur) and also identify their training status (competitive, recreational, or inactive levels).

CHAPTER 2

LITERATURE REVIEW

On the basis of the effects of COVID -19 induced Mobility restrictions, which is the independent variable of the study, on physical fitness is the effect of "physical inactivity" and "detraining" states. In this context, the first part of this chapter presented the content of COVID -19 induced Mobility restrictions and its role in detraining and physical activity. Reviewing this literature, it is clear that the concept of physical activity is related to general health and the concept of detraining is mostly related to sports performance impairments. At this point, the second part of the study was created with the physical fitness literature, which is an indicator of overall health and includes sport-specific performance components. The factors of "maturation" and "training condition", which are moderators in the study content and may influence detraining-induced impairments in physical fitness, are presented in the last section of this chapter. Figure 1 illustrates the states of detraining and physical inactivity of these restrictions and shows that physical fitness adaptations can change depending on maturity and training status.

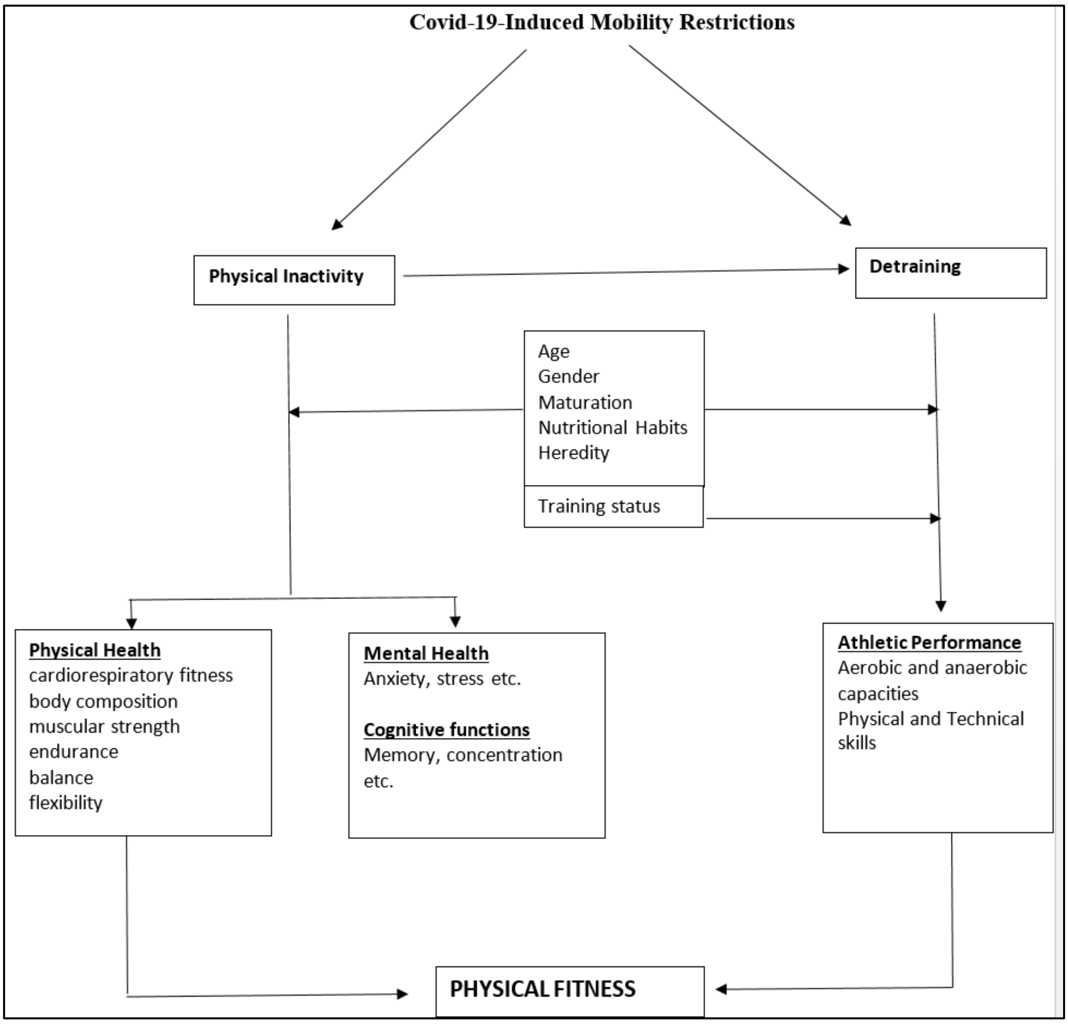

Figure 1. The Health- and Performance-Related Consequenses of COVID-19-Induced Mobility Restrictions

2.1. COVID-19 Induced Mobility Restrictions

Since the effective drugs or vaccines had not been developed, authorities worldwide had adopted different strategies in an attempt to curb the spread of the COVID -19 virus, such as lockdowns, home confinement, and other restrictive measures, meaning a large number of people are required to remain at home. While it is recognized by all authorities that these measures are effective in preventing the spread of the virus, it is also recognized that many of them are measures that open the door to physical inactivity associated with health problems. Mobility restrictions caused by COVID-19 affected not only the level of physical activity levels, but also the training routines of athletes. Athletes who increased their physical performance through systematic training were forced to abandon their training due to canceled sporting events and mobility restrictions. Considering that induced physiological adaptations are formed as a result of prolonged training, maintaining the achieved level or further improvement requires intensive training stimuli (Nugroho & Or, 2005). In the absence of sufficient training stimuli, the athlete is exposed to functional and even psychological disorders, and "detraining syndrome" which is reduction in the state of training.

2.1.1. Physical Inactivity

Physical inactivity is a term used to describe people who do not regularly perform physical activity at recommended levels (Damian et al., 2018). Insufficient levels of physical activity (150 minutes of moderate PA per week) in daily life cause major health problems and it is a widely held view that physical inactivity is one of the most significant public health problems of the 21st century (Blair, 2009). Before the current pandemic, there was a growing global effort to address this problem and take the lead in combating the pandemic of physical inactivity. Physical inactivity, already considered a growing public health problem in the pre-pandemic era, is even more difficult to combat under pandemic conditions. Efforts, especially in developed countries, to increase people's levels of physical activity have now been replaced by the fight against the COVID -19 virus. In fact, the restrictions brought about by this war confined people to their homes, and the sedentary lifestyle began to take on a life of its own more than ever before. Especially in the early stages of the pandemic, with a virus whose dangerousness cannot be accurately predicted, physical inactivity completely ceased to be a priority in this state of panic. And the current situation has exacerbated this problem more burdensome, especially for children who spend their leisure time indoors, use electronic entertainment media, and spend more time sitting and less time being physically active than they did a decade ago (Fedewa & Ahn, 2011). Theoretically, the prioritization of public health interventions is determined primarily by three factors: the prevalence and trends of a health disorder, the magnitude of risk associated with exposure to that disorder, and the evidence for effective prevention and control. On the other hand, an important health problem has emerged - physical inactivity. Moreover, physical activity is more important for children at a critical stage of physical, mental, and cognitive development, making the health risks associated with physical inactivity in children even more dramatic. Before this pandemic, there was a substantial body of literature quantifying and qualifying the role of physical inactivity as a risk factor and global interest and efforts to increase physical activity levels in children.

Medical authorities and other health administrators have suggested that residential mobility restriction, including limiting recreational activities and prohibiting sports, is necessary to prevent the spread of the virus (Oh et al., 2021). The rationale of this public health measure is that restricting normal activities reduces the number, duration, and closeness of interpersonal contacts and thus the potential for virus transmission. While these measures curb the spread of the disease, it is certain that they open the door to physical inactivity causing serious health problems. Physical inactivity was a growing health problem even before COVID -19. Many different institutions and organizations made serious efforts to prevent this problem. However, the current pandemic has put additional obstacles in the way of these efforts, and the decline in physical activity has taken on even more dramatic proportions. Even school-based physical education programs which is ideal for providing students with safe and sequential activities that maintain and improve physical fitness is limited (Faigenbaum et al., 2013).

The decreases in physical activity and the increase in sedentary behavior have been documented by several countries, including Spain, Canada, Italy, Australia, Germany, and Latin America (Giustino et al., 2020; Lesser & Nienhuis, 2020; Ng et al., 2020; Ruíz-Roso et al., 2020; Schmidt et al., 2020; Stockwell et al., 2021). Given similar public health measures such as the closure of recreational facilities, the closure of city parks and playgrounds, and the cancellation of all sports following the introduction of COVID -19 in Turkey, it would be expected that the physical activity behavior of the Turkish population would change. And it is inevitable that this change, which takes place in a negative sense, can cause health problems and lead to detraining syndrome, which can also lead to irreparable performance losses in athletes and leave permanent psychological and physiological effects (Musselwhite et al., 2021). Given this alarming scenario, people should protect from these health risks caused by lack of exercise, and athletes should at least be avoided detraining-induced performance loss by doing exercises at home. In that sense, A. Hammami et al., (2020) have provided valuable guidelines for children and adolescents for optimal health outcomes. In their study, the exercise volumes and intensities of home-based bodyweight exercises performed such as squats, push-ups, walking lunges, planks, jumping jacks, and sit-ups vary significantly depending on the physical level of the children. On the other hand, it should be questioned that these proposals can partially act as a preventative and that the conditions are unfavorable in terms of applicability. Prolonged stays at home due to COVID-19 induced mobility restrictions can reinforce behaviors that lead to inactivity, which can lead to a sedentary lifestyle known to lead to several chronic health conditions (K. Y. Chen et al., 2012). On the other hand, athletes cannot maintain their performance level because this situation led to an insufficient training stimulus, as well (Mujika & Padilla, 2000).

Since the seminal work of Morris and colleagues in the 1950s (Warburton et al., 2006), numerous studies have shown that sedentary lifestyles pose a significant public health challenge and that the human cost of this is unacceptable (Bull et al., 2020; Damian et al., 2018; Mannino et al., 2019b; Maugeri et al., 2020; R. Sallis et al., 2021). Previous studies have shown that insufficient physical activity increases the risk of cardiovascular disease and various other conditions, including obesity, all types of cancer, diabetes mellitus, obesity, hypertension, and bone disease such as osteoporosis and osteoarthritis (Warburton et al., 2006). In addition to these physical health problems, significant psychological health problems also occur with decreasing physical activity, such as reduced functional status, psychiatric morbidity, emotional well-being, and depressive disorders (Galper et al., 2006).

As a modifiable component of energy expenditure, physical activity can influence energy balance. However, the overall effect of physical activity on total energy expenditure goes beyond the energy expenditure caused by physical activity. Increases in resting metabolic rate and thermogenesis can also be observed in the absence of physical activity. In addition, physical activity can positively affect body composition by decreasing fat mass and increasing lean mass (L. Miles, 2007). From a detailed physiological perspective, physical activity can decrease resting blood pressure and increase the capacity of coronary arteries to transport blood, and improve glucose metabolism. There are also beneficial changes in the lining of blood vessels that help control the distribution of blood throughout the body. Regular physical activity can also positively affect the body's ability to form and break down blood clots and favorably alter the lipid profile in plasma (McArdle et al., 2010).

As evidence has accumulated that excessive sedentary behavior is associated with adverse health outcomes (Akbari et al., 2021), public health strategies have been developed and continuously improved to reduce sedentary behavior and increase physical activity in all age groups. Recent meta-analyses provide ample evidence of the effects of physical activity on physical health (obesity, mortality related to cardiovascular disease and cancer), mental health such as depression, anxiety, self-esteem (Maugeri et al., 2020), cognitive functions such as memory and concentration and report that even relatively minor modifications, such as promoting active forms of transportation, have potential benefits in various diseases.

Health concerns related to physical inactivity mentioned above are clear, but for children, it means more (Chaddock- Heyman et al., 2014). In childhood, physical activity is vital for maintaining energy balance and promoting bone strength, which reduces the risk of severe chronic disease later in life (L. Miles, 2007). Because motor development in childhood is closely related to growth and cognitive development, it may be critical for later academic achievement (Kantomaa et al., 2013). In this sense, this pandemic, which is often accompanied by physical inactivity, is likely to trigger physical, mental, and cognitive problems in some children and adolescents.

Since physical activity and exercise are crucial elements in strengthening the immune system, limiting these elements may mean increasing the likelihood of a severe course of Covid-19. Indeed, this idea is beginning to be supported by recent studies examining the relationship between exercising and the severe course of COVID-19. (R. Sallis et al., 2021) studied 48440 adult patients in the US with confirmed COVID-19 infection and reported that even irregular physical activity lowered the chances for a severe course of COVID-19 compared to people who did not exercise. During exercise, pro-inflammatory and anti-inflammatory cytokines are released, lymphocyte circulation increases, and cell recruitment and consequently positive immunological adaptations occur (da Silveira et al., 2021). These are the main ways in which it is thought to reduce the risk COVID -19 of serious illness or to manage or minimize its serious effects.

2.1.2. Detraining

Detraining can be defined as a partial reduction or total interruption in training loads in response to an insufficient training stimulus, leading to a series of physical and physiological adaptations (Mujika & Padilla, 2000). Detraining may occur as a result of an injury, illness, or postseason break or as a function of the phases of the annual planning of training, with some can result in partial reduction or with total interruption in training loads. Moreover, these two situations have not similar aspect in terms of physical fitness related performance alterations. In complete interruption, the daily muscular activation of the athlete is largely lost, while in partial detraining, the daily muscular activation is somewhat interrupted. Partial detraining can increase subsequent sensitivity to training stress, making time off a potentially useful tool to help break through plateaus in the coming year.

Detraining syndrome is caused by an inadequate training stimulus and can occur due to a partial or complete loss of training (Mujika & Padilla, 2000). The principle of reversibility of training states that regular physical training leads to various physiological adaptations that improve athletic performance, whereas a disruption or significant reduction in training causes a partial or complete reversal of these adaptations and impairs athletic performance. In such a process, athletes often experience interruptions in the training process and competitive programs due to illness, injury, a post-season break, or other reasons that result in a reduction or cessation of their usual level of physical activity. Today, COVID -19 based detraining has taken place as a new reason in addition to the aforementioned reasons. As all sports activities come to a sudden and unexpected halt due to the current situation (COVID 19), this issue of detraining has come to the forefront again today. This pandemic has forced amateur and professional athletes worldwide to suspend their training sessions. Although an important exception was made that allows athletes to practice sports and engage in outdoor physical activity provided that an interpersonal distance of at least 1 m could be maintained after a certain period, this concession came too late to maintain physical fitness in the pre-COVID-19 eras. Due to this unique situation that constitutes detraining syndrome, athletes are confronted with impaired performance (D. D. Cohen et al., 2020) and increased risk of injuries such as ligament rupture and muscle injuries (Sarto et al., 2020). When we consider the issue from this detraining content, it can also be considered the fact that detraining induced physiological or performance adaptations may also differ according to some external factors such as type and duration of detraining, as well as the factors of maturation and training status (Bosquet et al., 2013). Duration of detraining refers to days in untrained and can be divided into seven categories: < 7 days, 8 to 14 days, 15 to 28 days, 29 to 56 days, 57 to 112 days, 113 to 224 days, and > 224 days (Bosquet et al., 2013). Data from several studies suggest that even a short-term detraining period can negatively affect athletic performances (McArdle et al., 2010). On the other hand, some researchers have drawn attention to the paradox in maintaining some physical fitness components from 4 to 32 week detraining period in young subjects (Pereira et al., 2020). In fact, these contradictory findings might be explained by the effects of other moderators such as sporting level, age and maturation (Mujika & Padilla, 2000). With considering short-term studies separately, the level of evidence is limited, with some studies demonstrating no changes or even increases in a certain strength, speed, and power qualities after periods of inactivity (Hortobágyi et al., 1993; Irineu Loturco et al., 2015; Pritchard et al., 2018; Toraman, 2005). Concerning long-term studies, sporting level, another factor of detraining-induced alterations, moderates the changes (Mujika & Padilla, 2000). With concerning these contradictory findings, it is thought that the effects of short- and long-term detraining should be handled by considering other moderators. Moreover, detraining induced-physiological adaptations can also be considered for better understanding.

From a physiological viewpoint, cardiorespiratory and neuromuscular adaptations are essential in various sports, with significant decreases (e.g., 4-14% of maximal oxygen uptake) following a short-term (< 4 weeks) interruption of training (Mujika & Padilla, 2000). In parallel, most of the studies to date have that short term detraining period (less than four weeks) causes decreases in physical performance (Melchiorri et al., 2014; Thomassen et al., 2010). Moreover, several studies are reporting even a week of training affects speed performance(Joo, 2016)(Burgomaster et al., 2007; Yoshida et al., 2005). On the contrary, there is also evidence of maintenance of training-induced gains in physical fitness achieved by exercise can be maintained. (Faigenbaum et al., 1996) showed that the vertical jumping performance of children could be preserved entirely for eight weeks. There are also other studies that show that there is no decrease in performance in children when they perform different exercises with a certain training intensity(Santos & Janeira, 2009a). The results of these studies show that moderate or vigorous physical activities during the detraining phase, which can be called "*detraining level"*, can influence the changes in physical fitness(Bosquet et al., 2013; Tayech et al., 2020). In this sense, it is needed to highlight the importance of detraining level differentiation.

From a scientific perspective, very little discussion has been given to detraining level, which most likely affects detraining-induced physical fitness changes. (Bosquet et al., 2013) stated that an important consideration in evaluating the effects of exercise interruption on physical fitness is the dose of physical activity maintained by participants for the duration of the exercise interruption. In parallel, (Zacca et al., 2019) indicated that maintaining physical activity level, or undertaking mainly moderate and vigorous activities, despite the cessation of training can minimize the detraining-induced athletic performance losses. From a physiological point of view, (Liu et al., 2008) revealed that hormonal and psychological adaptations after maintaining partial training activity (maintaining 50% of exercise training volume) can be different than totally detrained conditions(complete loss of training). This evidence underpins the idea that physical fitness can be maintained with different types of exercises. (Santos & Janeira, 2009a) revealed that it is possible to retain some athletic performances related to strength and power with a continuation of sport-specific training. (DeRenne, Hetzler, Buxton, & Ho, 1996)supported this finding and reported that the application of sport-specific training once a week during the competitive season was adequate to maintain strength levels.

COVID19 induced detraining can be a partial reduction or a complete interruption, similar to other detraining reasons such as illness, a post-season break, or sport injuries. The fact that even outdoor sports facilities are closed may only provide athletes with the option to train at home. Providing this option can result in maintaining physical fitness with the effects of a partial loss of training. However, in some cases, it is not even possible to perform these exercises. In such situations, physical fitness components can be affected more dramatically. On the hand, these changes would be influenced by numerous physiological (e.g., cardiorespiratory, metabolic, neural, thermoregulatory) and psychological attributes (e.g., mood, motivation, perception of effort).

2.2. Physical Fitness

Physical fitness and physical activity are sometimes used interchangeably, which is not always appropriate, and therefore, meanings should be distinguished. Physical activity is a behavior that includes any body movement caused by skeletal muscle contraction that increases energy expenditure above a baseline level. On the other hand, the term physical fitness has several meanings, including health-related components or skill-related components. In general, this term refers to specific abilities to efficiently perform physical tasks associated with moderate to vigorous physical activity. From the physiological point of view, physical fitness is the capability of the heart, lungs, blood vessels, and muscles to perform at optimal efficiency (Getchell, 1979). It affects human ability to function and be physically active and, at poor levels, is a strong indicator of various health outcomes. For individuals, the key for health seems to be the body's efficiency, and health-related physical fitness may reflect this efficiency, providing a potential indication of physical health status (Knapik et al., 2019; Ortega et al., 2008). Although these terms of physical activity and physical fitness, have different meanings, there is a relatively strong connection between these concepts. Low quality of physical activity can affect physical fitness negatively and, in parallel, worsen the health status of children. In addition to its impact on health, physical fitness can be characterized as encompassing various types of muscular strength, speed, agility, balance, and reaction. This group of abilities is referred to as skill-related physical fitness.

These components are also related to the performance of specific tasks sports practice. Additionally, there are other physical fitness components such as balance, coordination, reaction time and high intensity performances including power, speed and agility, that are called skill-related physical fitness (Medicine, 2013b). In fact, these elements vary in the performance requirements of sports. For instance, soccer is a physically demanding contact sport involving high-intensity activities such as sprinting, jumping, and tackling and typical senior soccer match is 90 minutes in duration, with frequent intense bouts of these activities and short recovery bouts These performance requirements can vary by sport, as can the sporting level of athletes in the same sport. Elite players perform 500-600 m of high-speed running (19.8–25,2 km/h) and 180-200 m of sprinting (>25,2 km/h) during a typical game. On the other hand, the total covered distances, a part of cardiovascular fitness, depends on team success in soccer (Joo, 2018). In this sense, there is no single variable measures physical fitness, which is a composite factor varying with soccer due to including intricate blend of aerobic and anaerobic performances.

2.2.1. Health-Related Physical Fitness

Health-related fitness is often characterized as lifetime activity and used to assess people who are not interested in high-intensity activities (Medicine, 2013a) and consists of five measurable components including body composition, cardiovascular endurance, muscular strength, muscular endurance, flexibility.

Several studies have confirmed that body composition, which refers to the relative amount of water, bone, muscle, and fat in the body, is associated with many health problems such as the risk of obesity, cardiovascular disease, and diabetes. The impact of low cardiorespiratory fitness on mortality varies with other conventional health indicators such as body weight, blood pressure, cholesterol levels, and smoking (Artero et al., 2011). The gold standard measure of this component is maximal oxygen uptake ($\dot{V}O2max$) tests; however, assessments of cardiorespiratory fitness using physical fitness tests are relatively easy to obtain and can routinely be gathered (Jurca et al., 2005). Researchers usually prefer 20-m shuttle run as a physical fitness component (Rtero et al., 2011). The VO2max can then be estimated from the data gathered from the frequency distribution of measured distances.

Musculoskeletal fitness requires that a given muscle or muscle group is capable of generating force, resisting repeated contractions over an extended period of time or sustaining a maximal voluntary contraction over an extended period of time (muscular endurance), and performing a maximal, dynamic contraction of a single muscle or muscle group(power) in a short period of time (Artero et al., 2011). Scientific evidence showed that there are strong relationships between musculoskeletal fitness and health outcomes. The handgrip strength and standing long jump tests are most often used to measure and assess this component. These tests can consider as alternative tests that have not yet been shown to be related to health but are valid, reliable, and feasible; however, it can be not appropriate to interpret as a health context until their relationships with health outcomes have been established more firmly in youth (Pillsbury et al., 2013). Assessment of musculoskeletal fitness should also include flexibility, defined as intrinsic properties of body tissues that determine the maximal joint range of motion without causing injury (Nuzzo, 2020). It is classified as an important component of physical fitness (Corbin & Noble, 1980) and may be linked to various health outcomes such as back pain, injury prevention, and posture (Pillsbury et al., 2013). There are several flexibility tests such as shoulder stretch (also called the zipper test), trunk lift, and sit-and-reach test, which is most commonly used to assess low-back and hip flexibility.

In order to assess general health-related physical fitness, there are more than fifteen test batteries such as 'Eurofit,' 'FitnessGram,' and 'Alpha-fit' worldwide (Kolimechkov, 2017). A general principle in physical fitness testing is that one test is considered the gold standard, that is, it is considered the definitive or true measure. Although the gold standard test is a criterion test, it is not always possible for a variety of reasons. These include the need for expensive equipment, trained experts, a large time commitment, and increased risk to the test subject.

2.2.2. Skill-Related Physical Fitness

Health-related physical fitness components that enable a person to become physically healthy is also linked to athletic performance in sports. On the other hand, there are performance related component of physical fitness such as speed, agility, maximum power or strength, and motor or cognitive skills such as balance, reaction time, and coordination. People who are sedentary do not have the same level of these performances as athletes. They have high body mass index, low muscle strength, and low cardiopulmonary fitness (McArdle et al., 2010). Although the combination of health-related and skill-related aspects of physical fitness is imperative in shaping individuals in sport (Kariyawasam et al., 2019), these differences are more specific to the skill-related components than to the health-related components as they relate to exercises. Moreover, skill-related physical fitness performances are quite poor compared to that of sedentary athletes, such as balance, strength, and speed.

Test battery selection for assessing skill-related physical fitness related to sports or occupational performance is determined by specific sports requirements. Previous studies investigating anthropometric and physiological attributes of various athlete groups have demonstrated that a battery of field-based tests can distinguish different sports. While only a few components were required for some sports, specific components can be selected (performance-derived) for some competitive sports like soccer characterized by intensive and repetitive anaerobic efforts such as sprints, jumping, accelerations and decelerations, and technical skills such as shooting, passing, ball control, dribbling, and application to innumerable situations (Bloomfield et al., 2007). Creating a test battery considering this demand can also be called performance-related physical fitness. It refers to those components of fitness that are necessary for optimal work or sports performance.

2.2.3. Rationale of Physical Fitness Assessments

Physical fitness refers to the ability of body systems to work together efficiently to allow to be healthy and perform daily living activities (Caspersen et al., 1985). Indeed, this definition can explain the health-related identifications such as being fit and being healthy. Due to the high cost, the need for specialists, and the time involved, it is very difficult to measure a person's health with medical examinations. Physical fitness tests are relatively inexpensive and easy to use methods compared to these applications. Therefore, it would not be wrong to say that evaluating a person's health status through physical fitness measurements is the best method. In this parallel, scientific studies focusing on the benefits of physical fitness on health have used physical fitness assessments. As practical implication, physical fitness testing is also an important tool for monitoring training-induced adaptations and evaluating the level of physical performance at athletes.

The assessment of physical fitness is a necessity in scientific studies to observe the health effects of physical activity. On the other hand, physical fitness can be considered as an integrated measure of most body functions, such as skeletal-muscular, cardiorespiratory, psychoneurological, and endocrine-metabolic functions involved in performing daily physical activities and/or exercises (Ortega et al., 2008). That is, when physical fitness is tested, the functional status of all these systems is being checked. In view of these facts, fitness tests are important tools that indicate the state of health in practical ways. Assessing children's physical fitness has become even more critical with the growing awareness of the relationship between physical activity, health, and physical development (Hallal et al., 2003). And, assessments of physical fitness are also important to athletes or their coaches in the way that it provides performance evaluations. Scientific literature has firmly established that there are meaningful differences between elite and non-elite or amateur athletes in all these parameters of physical fitness (Franchini et al., 2005). These evaluations using physical fitness testing not only guide the design of training programs for athletes, but also provide benefits by showing performance losses at different rates in the detraining process. In this way, it becomes easier to design a retraining program following a detraining period according to performance requirements of the athletes. However, "maturation" and "training status" factors, which play an important role in both training-induced and detraining-induced physiological adaptations, should be taken into account for assessing physical fitness.

2.2.4. Influence of Maturation on Physical Fitness Adaptations to Detraining

It has been well documented that training- or detraining-induced physiological adaptations may vary by gender, age, maturation and sporting level. The previous studies have shown that detraining-induced changes can also be more dramatic in older people for strength and power outputs when compared with young individuals (Bosquet et al., 2013). In young individuals, this situation was markedly different. Since age-related muscle weakness (also defined as dynapenia) and decreased maximal oxygen consumption rate (VO2 max) occur in the elderly (> 65 years old), impairments in general functional abilities are observed after only one week (Leitão et al., 2019; Manini & Clark, 2012). Within a given population of chronological age, some children may have an advantage or disadvantage based on their maturity status, independent of other external or internal factors (Mota et al., 2002). Specifically, greater height and mass (usually to a fat-free mass) based on maturation scales lead to the desired successful physical performance in sports that require strength, speed, and endurance (Moran et al., 2017; Philippaerts et al., 2006; Schorer et al., 2009). In addition to maturity-related physical fitness differences, maturation seems to also play a determinant role in the physical fitness adaptations to training or detraining (Romero et al., 2021). Considering the fact that COVID-19 induced mobility restrictions induced physical fitness adaptations can also be explained by detraining-induced physical fitness adaptations, the literature on detraining should also be addressed to understand this maturity related physiological adaptations.

When strength and power performances can be maintained from 4 to 32 week detraining period in young subjects, skill-related physical fitness can be impaired in a week (Faigenbaum et al., 2013).

Child athletes require a higher volume of training than non-athletes' counterparts to maintain the current level of performance. Furthermore, training recommendations are tailored to the needs of athletes according to sport-specific performance requirements. Otherwise, athletes faced with an unprecedented and relatively long-term reduction or cessation of their training (detraining syndrome) will inevitably experience a decline in performance (Andreato et al., 2020). The assessment of performance changes in child athletes following the temporary or permanent reduction or withdrawal of a training stimulus is complicated by concurrent growth-related increases during the same period (Faigenbaum et al., 2013). Santos & Janeira, (2009) demonstrated the adverse effects of a 16-week training period and reduced training following a 10-week strength and conditioning program on explosive strength in adolescent male basketball players. Because weight-bearing and strenuous activities such as running or skipping are most effective at increasing bone strength in children (L. Miles, 2007), athletic children who engage in high-intensity training are likely to have incredible health benefits. Therefore, the loss of physical fitness may be even more dramatic when such training is discontinued.

Evidence demonstrated that maturation related physiological changes (e.g., hormonal alterations, changes in height, central nervous system myelinization) during growth have a positive effect on the transference of resistance training gains to motor skill performance (Behringer et al., 2010, 2011) and may promote different types of adaptation depending on maturity level, assessing strength, power, speed, and the force-velocity relationship (F-v) may provide greater insight into how maturity level alters the effects of strength training (Moran et al., 2017). Behringer, Vom Heede, Matthews, & Mester, (2011) indicated that adolescents might be able to make greater adaptations concerning muscular strength, the transference of resistance training gains to motor skill performance may more be pronounced in children. On the other hand, assessing detraining-induced physical fitness changes in children after a detraining period is a more complicated issue because of existing individual differences in terms of maturation-related morphological and neural changes. Tsolakis, Vagenas, & Dessypris, (2004) revealed that post training hormonal gains in preadolescent males were preserved, but significant strength decreases were found at the end of an 8-week detraining period. Since strength training stimulates the anabolic and androgenic activities that are different in adolescents (Tsolakis et al., 2000), maturational differences may also have different aspects on strength and power performances following cessation of strength training (Meylan et al., 2014). Santos & Janeira, (2009) stated with supporting this charge that maintenance of some physical fitness components may be attributed to physical growth in adolescents. However, there is still no consensus in the current literature that how effects of detraining on physical fitness components of children because it has not been extensively studied. The majority of previous studies investigating detrained-induced physical fitness adaptations in children have not considered an important issue that the question of a maturation specificity in response to detraining. At the same time, the evidence is quite clear that more mature children can carry high performance out than less grown children (Philippaerts et al., 2006). Since only a few studies have focused on this topic that reported conflicting results, the precise nature of the detraining-induced performance and physiological alterations that occur during the detraining period according to maturation status remains uncertain for now.

2.2.5. Influence of Training Status on Physical Fitness Adaptations to Detraining

Another critical issue when assessing the impacts of detraining on physical fitness components is training status (sporting level), which refers to previous training experiences, directly determines the type of adaptations that subtends strength gains and probably the speed of reversibility (Bosquet et al., 2013). Since elite athletes have greater weekly training volume, including high-intensity sessions, they exhibit greater physical capabilities than recreationally trained athletes(Edwards et al., 2003; D. J. Smith, 2003). Furthermore, trained induced physical performance changes of highly trained athletes are much more limited than untrained or recreationally trained individuals (Ahtiainen et al., 2003). And yet, it's not farfetched to think that there may be detraining-induced differences according to their previous training history. There are interesting findings on this topic, with making classification by training status such as elite-sub-elite-amateur or highly trained-moderate trained-recreationally trained. One thought that came to the fore was reductions in strength-power performances in athletes depends on training backgrounds after long-term detraining. Bosquet et al., (2013) reported a more considerable decrease in maximal force and maximal power of previously inactive people than recreational athletes, but non-significant differences compared with competitive athletes. These results were attributed to the complexity of the training stimulus and its corollary the adaptation process in that study.

With a physiological view, (Mujika & Padilla, 2000) demonstrated that short-term cardiorespiratory detraining in highly trained athletes is characterized by rapid declines in maximal oxygen uptake (V O2max) and blood volume (VO2max declines are significant in highly trained athletes but less so in recently trained individuals). It is also stated in that study that some characteristics of detraining are not necessarily identical in highly trained athletes with a multi-year training background who wish to improve their athletic performance and in recently trained but previously sedentary or moderately active individuals who are engaged in a program of physical activity that is usually for either health-related or research purposes.

2.3. Impacts of COVID-19 Induced Mobility Restrictions on Physical Fitness

The impact of the COVID -19 lockdown on physical activity, made clear in the previous chapter, means that physical fitness profiles are also affected by this lockdown, considering that these two concepts are interrelated. In parallel, physical fitness, including various aspects of human performance such as speed, balance, agility, coordination, reaction time, muscle strength and power, cardiorespiratory endurance, flexibility, and body composition, may predict levels of physical activity during the COVID -19 pandemic (Tsoukos & Bogdanis, 2022). However, there are few studies that examine the effects of COVID -19 Lockdown on physical fitness and present data from physical fitness testing. Sunda et al., (2021) showed negative effects of the COVID-19 lockdown on muscular fitness in adolescents aged 15–17 years. Guessogo et al., (2021) showed that COVID-19 semi lockdown resulted in impaired strength (43.1%), speed (55%), and endurance (78%). Spyrou et al., (2021) showed that sprint and specific countermovement jump variables were significantly affected by long-term reduced training, whereas vertical jump height and horizontal jump distance and body composition were not. Salazar et al., (2020) reported that all components of physical fitness were negatively affected by COVID -19 lockdown with moderate to substantial effects in elite youth basketball players. The reasons for the contradictory findings in these studies may be attributed to the duration and content of the COVID-19 lockdown and population differences regarding maturity and training status as mentioned in previous chapters. In fact, studying the effects of the COVID -19 lockdown means studying the effects of physical inactivity or the effects of detraining for athletes. In this context, it is reasonable to see differences in changes in physical fitness as different physiological adaptations occur depending on the duration and content of detraining, described in the relevant literature as detraining duration and detraining level.

Furthermore, the extent of the effects may vary depending on age, gender, maturity level, and training status. To the best of the author's knowledge, few studies on soccer players and even limited evidence on child athletes. Grazioli et al (2020) reported impairments in countermovement jump, acceleration, and running performances, with non-significant changes in eccentric hamstring strength, squat jump height, and cardiorespiratory fitness in professional soccer players (26.3± 5.6 years old) in response to 63 days-COVID -19 lockdown. In contrast, Demir et al., (2021) reported adverse effects on eccentric hamstring strength after short-term COVID -19 lockdown in professional male soccer players (24.9± 4.8 years old). Considering the literature on physical fitness, detraining, and physical activity, it was hypothesized that COVID -19 induced mobility restrictions would harm all soccer players. In addition, more significant impairments were expected in highly trained players compared with recreationally trained players. The impairment of physical fitness is expected to be much higher in athletes than in non-athletes due to the principle of super-compensation (McArdle et al., 2010). Following the same direction, athletes are expected to have different levels of physical fitness impairment depending on their training status. It is also possible to evaluate physical inactivity in a detraining concept because athletes cannot have insufficient physical activity levels as long as they have certain levels of training volumes. It was challenging to hypothesize unequivocally about maturation-related adaptations in physical fitness because there may be several physiological advantages and disadvantages that influence these adaptations. Although it is the first logic that comes to mind, the detraining-induced performance losses in children at puberty might be more limited than in children before puberty because there are more growth-related natural developments in physical fitness; one might also expect to see less performance decline in children during prepuberty, since the development of physical fitness during this period is due to neural adaptations, whereas a combination of neural and hormonal adaptations occurs during puberty (Lloyd & Oliver, 2012).

CHAPTER 3

METHODS

3.1. Experimental Approach to the Problem

A repeated measures design was utilized to test physical fitness changes in response to 27-week periods of COVID-19 induced mobility restrictions.

The study design was created by determining the factors that could affect the changes in the parameters of physical fitness, which are the study's dependent variables. In this sense, maturity and training status were included as independent variables, and age, gender, and sport-related characteristics were controlled for based on the selection criteria. Detraining duration and detraining level as another important moderators were also considered.

Because the duration of detraining was the same for all participants (27 weeks), there was no need for intervention. However, physical inactivity was set as an inclusion criterion to control for the effects of detraining level, which is another crucial moderator of physiological adaptations to detraining. It was considered to be appropriate to apply questionnaires regarding on physical activity and detraining conditions. The data gathered from these questionnaires were used to reveal detraining and physical inactivity effects of the mobility restrictions which were included as independent variables of this study. Hence, it was thought that more homogeneous groups would be created with excluding data owned by those who are physically active during the lockdown. It was planned to exclude some data from participants who were physically active during the lockdown period; however, there was no problem in terms of the level of physical activity during the pre-lockdown period.

Since it was not known how long the COVID-19 related mobility restrictions would last, no specific detraining period was included in the study design. Second measurements were taken on the first day of return from long-term detraining (27 weeks later). An overview of the study design is provided in Figure 2. and details of the test procedures and instruments are described below.

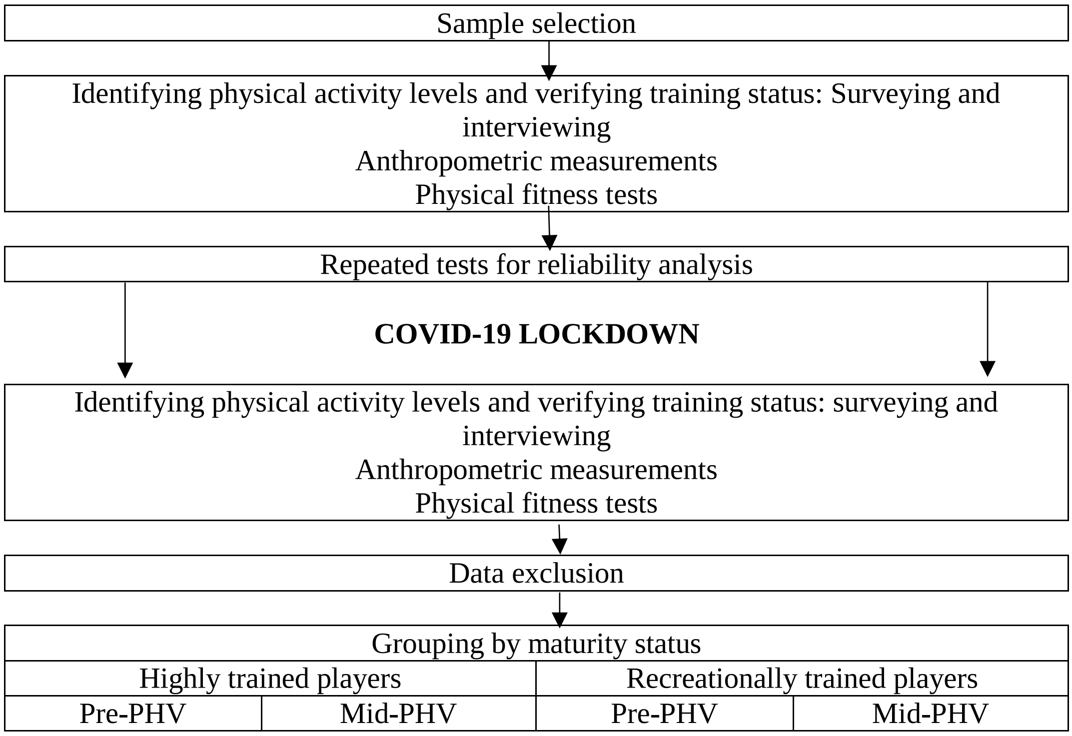

Figure 2. Study Overview

After surveying and interviewing the children with their parents to determine their current activity level and previous exercise level, the plan was to collect anthropometric data and then measure the following selected physical fitness tests (dependent variables): Handgrip strength (HG), dynamic balance (Y balance test), countermovement jump (CMJ), squat jump (SJ), drop jump (DJ), sprinting (acceleration: 10-m run, speed: 20-m run), zigzag agility (without ball: ZAWHB, with ball: ZAWB) in their last training before COVID -19 suspension.

In keeping with secondary research questions of the study, grouping was carried out according to training status and maturity status to provide initial assessments before the first tests. Afterwards, participants were asked to repeat the selected tests after one week to analyze reliability, and the majority of them participated in these measurements. Test-retest reliability was good to excellent for each test, and the ICC ranged from 0.72 to 0.99. (Table1).

Table 1
Intraclass Correlation Coefficients (ICCs)

	Session 1	**Session 2**	**ICCs (%95 CI)**
HG (Kg)	20.09 (5.95)	20.44 (6.13)	0.975 (0.957-0.985)
R-HG (Kg/BMI)	1.07(0.3)	1.08 (0.3)	0.982 (0.969-0.990)
10m (s)	2.55 (0.26)	2.54 (0.25)	0.988 (0.978-0.993)
20m(s)	3.83 (0.37)	3.82 (0.36)	0.989 (0.980-0.993)
SLJ (cm)	152.5 (22.6)	153.2 (22.7)	0.983 (0.971-0.990)
DJ (cm)	20.87 (4.7)	20.83 (5.47)	0.772 (0.634-862)
RSI (mm/ms)	0.74 (0.25)	0.75 (0.27)	0.966 (0.941-980)
SJ (cm)	19.79 (4.09)	20.27 (5.11)	0.722 (0.561-0.830)
CMJ (cm)	24.22 (5.92)	24.67 (6.69)	0.853 (0.757-0.913)
ZAWB (s)	10.52 (1.33)	10.53 (1.32)	0.996 (0.994-0.998)
ZAWHB(s)	8.18 (0.76)	8.20 (0.77)	0.989 (0.981-0.994)
Normalized Y-Balance (%)	100.6 (8.3)	101.8 (8.2)	0.753 (0.606-0.850)

Legend: HG= Handgrip Strength, R-HG= Relative Handgrip Strength, 10m= Acceleration 20m= Running velocity, SLJ=Standing long jump, DJ=Drop jump, RSI= Reactive Strength Index, SJ= Squat Jump, CMJ= Countermovement Jump, ZAWB= Zigzag agility with the ball, ZAWHB= Zigzag agility without the ball

The sample size was sufficiently large at pre-test (n=142), but dropped to 52 subjects at the end of post-test following reasons; the majority of recreational players withdrew from the study due to health concerns (n=28) and lack of interest (n=18), and more than half of the population had various home-based training programs (n=30), seven subjects who were outside the identified PHV ranges (three subjects had maturity offset values higher than 0.6 years, and four were in a borderline range between pre- and mean PHV values), four participants who had high weekly physical activity levels (> 2500 MET×week), three were actively involved in several sports such as swimming and tennis. Because COVID -19 induced mobility restrictions lasted longer than expected, a critical detail related to maturational transitions occurred. The remaining 52 subjects who completed all study aspects included 27 highly trained (n = 16 pre-PHV and n = 11 mid-PHV) and 25 recreationally active players (n = 15 pre-PHV and n = 10 mid-PHV); therefore, data from the majority of participants were excluded from the study. Training volumes based on maturity and training status are presented in figure 3.

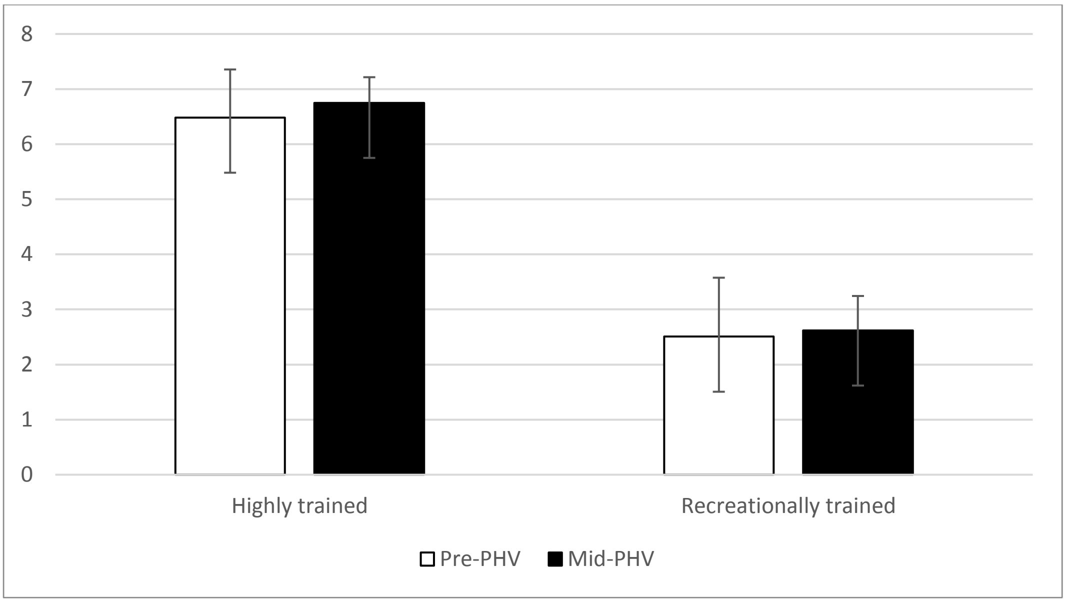

Figure 3. Average Total Weekly Training Volume (Hours) Before the COVID-19 Lockdown

3.2. Participants

Sixty-three (63) highly trained young soccer players contracted to the U11, U12, U13, and U14 teams of a local feeder club of a professional team in Turkey and 79 recreationally trained soccer players aged 10-14 years from the local soccer schools of this team volunteered to participate in this study. These age groups (10-14 years) were preferred because it is in these age groups that the differences between pre-PHV and mid-PHV are apparent (Figueiredo et al., 2009). Both highly trained and recreationally trained players had at least two years of experience with systematic soccer training, while their training backgrounds differed in terms of training volume. Highly trained players had 4-6 training sessions weekly that included high-intensity physical efforts (strength and power training), technical and tactical practices, and soccer-specific skills such as passing, shooting, and dribbling, whereas recreational soccer players had 2-3 training sessions weekly that included only soccer-specific skills at moderate or low training intensity. The differences in training volumes between these two populations were described in detail in section 3.3.9.

3.3. Measurements and Data Collection Procedures

The study was approved by the Middle East Technical University Human Subjects Ethics Committee (258-ODTU-2020/28620816). Participants and their parents granted consent to partake with received information about study content on the first page of the questionnaire without providing any sensitive personal data such as name, ID number, and awareness that their knowledge and answers are used in scientific studies.

Before measuring physical fitness, training status was determined using data obtained from participants' records in the club's player monitoring system. The data were verified using a semi-structured interview with five open-ended questions as detailed in section 3.4.9. After obtaining anthropometrics, maturity offset prediction equations derived from some physical features, including age, height, leg length, and sitting height, as denoted by years to and from PHV was used.

Laboratory methods can objectively and accurately measure physical fitness. However, due to limitations such as lack of time qualified specific and costly instruments, this is not as common as an alternative to field-based fitness testing (Kolimechkov, 2017). Considering this fact, field-based tests, which are an available alternative for measuring fitness components, were chosen in this study.

As a musculoskeletal fitness, handgrip strength and different types of jumps were selected. These tests reliable and valid measures (Artero et al., 2011), are the most commonly used field-based tests for measuring musculoskeletal fitness in all populations with high correlation to gold standard laboratory measurement methods (Ruiz et al., 2011). To select appropriate motor fitness tests, soccer-specific performance demands were identified by considering the literature on this topic. The literature indicates that competitive sports such as soccer, which are characterized by intense and repetitive anaerobic efforts such as sprinting, jumping, accelerating, and decelerating, and technical skills such as shooting, passing, ball control, and dribbling, may require numerous components of physical fitness, whereas other sports require few of these components. With this in mind, some skill-related tests were added to the selected health-related components of physical fitness in this study, including technical skills, jumping, and agility. It is thought that the changes in dynamic balance and agility associated with soccer performance can provide more meaningful information about physical fitness. Y-balance test, a reliable and valid method for assessing dynamic balance (Butler et al., 2012). Zig-zag agility, which includes acceleration and deceleration performances and can also evaluate important technical skills such as dribbling with the ball, were selected as motor fitness components.

3.3.1. Anthropometric Measurements

Body mass (kg) was measured with a bio-impedance scale (Tanita® BC-418MA, Tanita Corp., Tokyo, Japan) with an accuracy of 100 g (0.1 kg), while standing height (cm) and sitting height (cm) was measured with a portable stadiometer (SECA 217, Hamburg, Germany) with an accuracy of 0.1 cm. Subjects were positioned in an upright sitting position at head level, and the distance between the top of the head and the sitting surface was measured. Leg length was calculated by subtracting this value from standing height. Body mass index (BMI) was also calculated as body mass in kilograms divided by standing height squared in meters.

3.3.2. Handgrip Strength

Isometric handgrip dynamometer (Takei Digital Grip Strength Dynamometer Model T.K.K.5401, Takei Scientific Instruments Co., Ltd., Tokyo) was used to measure participants' muscular strength. This device has a load limit between 0 and 100 kgf, digital display, minimum reading of 0.5 kgf, rectified adjustable, complacent handle, and a force transducer (Amaral et al., 2012)**.** Handles of the dynamometer were set according to hand and finger sizes for each participant. Then participants performed three maximal isometric efforts for six seconds in a standing position with the arm extended straight down to the side unless the participant was physically limited. Each hand was tested three times with one-minute rest, and the sum of the largest values from each hand (in kilograms) recorded absolute Handgrip strength. Relative

Handgrip strength was also calculated as absolute grip strength divided by BMI as previously recommended (Lawman et al., 2016).

3.3.3. Jumps

The standing long jump test mirrored previous studies (R. Hammami, Granacher, et al., 2016a). Subjects were asked to jump forward with unrestricted arm movements after standing stationary with the toes aligned level with the start line. The instructor measured the jumped distance between the start line and landing position using a measure of metal in centimeters. Each participant performed three jumps, and the best score was recorded.

Three different vertical jump tests (countermovement jump, drop jump, and squat jump) were performed using the Optojump™ photocell system (Microgate, Bolzano, Italy), which is valid and reliable (ICCs ranging from 0.982 to 0.989) to estimate jump height (Glatthorn et al., 2011). In this system, jump heights were estimated from flight time calculated as the time between take-off and subsequent landing. Each session was planned as follows: (a) warm-up, (b) CMJ, (c) SJ (d) DJ. All tests were conducted in random order with no more than three trials (1-minute rest after each trial) on a soccer field (synthetic grass) and with a passive recovery period of no less than two minutes. In the CMJ, participants were asked to jump as high as possible with a quick preparatory eccentric downward movement while placing their hands on their hips to reduce lateral and horizontal movements in the test, to avoid any effect of arm movements on vertical jumps, and to prevent coordination from appearing as a confounding parameter in the evaluation of neuromuscular performance of the leg extensors (R. Hammami, Chaouachi, et al., 2016a). Similarly, subjects performed the SJ from a standing position, bent their knees to 90^0, paused for 3 seconds, and then jumped as high as possible, trying to avoid any knee or trunk countermovement. Instead of individual heights, 30-cm boxes were set for all subjects because, after reviewing studies on this topic, this height was considered most suitable for inducing fast and powerful drop-jump performances during reactive strength training for athlete children (Prieske et al., 2019). Subjects were instructed to place their hands on their hips and jump off the jump boxes with their front leg extended to prevent an initial upward thrust and to achieve a 30-cm drop height (Power et al., 2004). Subjects were encouraged to aim for maximum height and minimum ground contact time during all jumps. In order to assess explosive strength (can be called power), Reactive Strength Index (RSI) was calculated using the time spent on the ground after dropping from the box and the jump height achieved (computed as Height (in m) / Contact T.).

3.3.4. Acceleration and Maximal Running Velocity

An electronic timing system (Smart speed, Fusion Sport, Australia) measured 10-m acceleration and 20-m flying times with previously established methods (R. Hammami, Granacher, et al., 2016a). Three timing gates were positioned at 0-m, 10-m, and 20-m and were set at a 0.8-m height for each gate. The start stance was marked just 20-cm behind the first timing gate. The participants were instructed to step on the marker behind the start line and keep running until they reached the last marker placed 5-m after the last timing gate. After 2 minutes of recovery time, they repeated the same procedure twice more. Best values (shortest scores) for each distance of three performances were recorded.

3.3.5. Agility

The zigzag agility tests at two different forms (with and without the ball) has been used to assess agility. This test can be used to test the ability to change of direction, acceleration, and deceleration. In addition, by performing this test with the ball, other football-specific technical skills such as dribbling and ball control can be assessed (Köklü et al., 2015).

This test begins with a straight 5-m acceleration followed by three linear 5-m sprints after changing directions at 100^0 angles. Participants wore their soccer shoes and started independently without visual or auditory stimuli on a synthetic grass pitch. Time was measured using electronic timers (Smart Speed, Fusion Sport, Australia).

The timing gates were located 0.8 m above the ground, and participants started running 20 cm (30 cm when zigzagging with the ball) behind the starting line. There was 15.32 m between the start and finish gates, and the total distance covered was 20 m for each subject (Figure 4). Participants were not instructed on effective movement techniques. They were simply required to complete the course as quickly as possible and place their preferred foot forward while standing (Lockie et al., 2013). In the zigzag agility test with ball, there was no criterion such as the number of times the ball was touched or foot preference. After three successful trials with 2 minutes rest, the best performances were recorded.

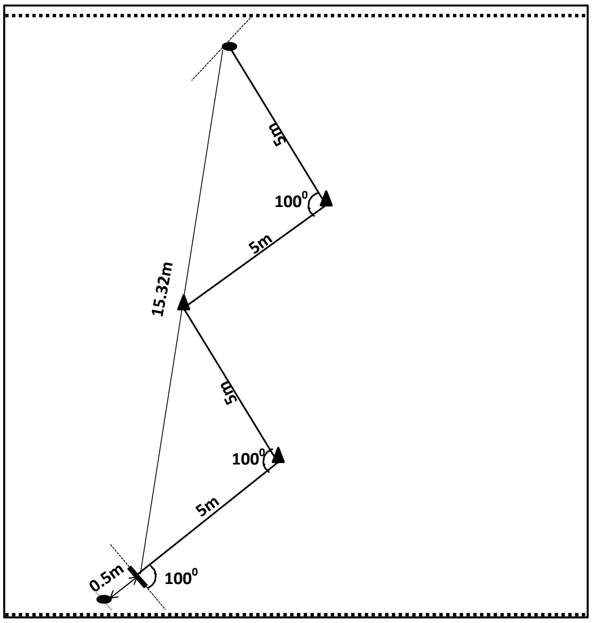

Figure 4. Zigzag Agility Run Dimensions and Completion Route

3.3.6. Dynamic Balance

To assess dynamic balance ability, the Y-balance test was performed in which three excursions (i.e., anterior, posteromedial, posterolateral) were made with the contralateral leg while maintaining balance in a single-leg stance (Plisky et al., 2006). This test showed high reliability (intraclass correlation coefficients: 0.71 - 0.88) in terms of isometric hip strength and dynamic stability (Read et al., 2019).

The two posterior lines extended from the center of the grid where participants were positioned at 135° to the anterior line and 45° between the two anterior lines. The instructor demonstrated the procedure before the test, and then participants performed three trials in all directions without shoes. The participant performed a reach in the three different directions with the non-dominant leg while maintaining a single-leg stance. The heel of the supporting foot had to touch the ground, both hands had to be placed on the hips during the test, the participant had to touch the measuring tape at the longest possible point possible, and the participant recovered to return to a one-legged stance position for at least 2 seconds to perform a proper test attempt. Trials were invalid or repeated if participants failed to touch the line (2), moved their standing foot off center of the grid (3), lost balance at any point during the trial (4), failed to maintain the start and return position for 1 second, or (5) received assistance from the reaching foot by sitting up (R. Hammami, Granacher, et al., 2016b). To standardize differences in reach distances due to leg length, normalized values were calculated by dividing each reach distance by the leg length of the subjects and then multiplying by 100 for each direction to obtain these normalized values, and the average of these three values was considered.

3.3.7. Physical Activity

The literature shows that more than 30 methods have been used to measure physical activity levels, with the majority of them have opted to use self-reported (subjective) measures such as diaries, physical activity logs, recall surveys, and questionnaires due to feasibility and cost constraints (Laporte et al., 1985). Insight into the several constraints such as feasibility and cost, growing interest, and measurement difficulties have stimulated the development of a standardized questionnaire to assess physical activity in various populations (Hallal et al., 2003). The International Physical Activity Questionnaire (IPAQ; www.ipaq.ki. SE) was therefore developed by researchers from several countries with the support of the World Health Organization and the Centers for Disease Control. Several versions of the questionnaire have been produced, differing in the number of questions (long or short), the period of collection (usual week or last seven days) and the method of use (self-administered, telephone, or face-to-face interview). This method has been relied upon heavily in Turkish studies and surveys conducted to date (Saglam et al., 2010).

All participants completed the Turkish version of IPAQ-SF before pretest and posttest, as previously described by Saglam et al., (2010). Based on IPAQ-SF, physical activity was classified into three categories: vigorous activity, moderate activity, and walking. From the time spent (in minutes) for each of the above physical activities, utilized MET for the physical activity was estimated by multiplying MET with time spent. Similarly, MET utilized for a particular week was calculated by multiplying with the number of days the following physical activity was performed. Thus, MET-min/wk was estimated using the following MET values: walking –3.3 METs; moderate activity–4.0METs and vigorous activity–8.0 MET. Furthermore, outcomes were classified into three categories: inactive (<700 MET×week), moderately active (700–2500 MET × week), and active (>2500 MET×week), according to the scoring system provided by IPAQ (Craig et al., 2003).

3.3.8. Training Status

Training volumes were tabulated with the data obtained from the players through the interviews and data gathered from the club's players' monitoring system and reported as hours of training (training loads and intensities were not considered) in the last six months on average. In a semi-structured interview, the subjects were asked 1) How many years have you been training? 2) How many days per week have you trained in the last six months? 3) How many days have you not trained in the last six months? 4) What is the average length of your training session? 5) How many competitions do you compete in per year? Training periodization plans were obtained to verify the interview data from their coaches.

3.3.9. Maturity Status

To predict maturity status, chronological age (on the testing day) and anthropometrics (height, body mass, sitting height) were entered into equation of Mirwald, Baxter-Jones, Bailey, & Beunen, (2002). In this equation, the maturity offset is calculated as follows: -9.236 + (0.0002708 * Leg Length * Sitting Height) + (-0.001663 * Age * Leg Length) + (0.007216 * Age* Sitting Height) + (0.02292 * Weight by Height Ratio). This equation predicting maturity offset with using anthropometric variables within an error of ±1 year and 95% of the time, has been used in a number of studies (Kozieł & Malina, 2018). To reduce the risk of participants being allocated to the wrong group based on an error of measurement (approx. ± six months) associated with the utilized method (Moran et al., 2018), narrower PHV ranges (pre-PHV = ≥−4.2 and <−1.5, mid-PHV = ≥−1.0 and<+0.6 years from PHV) were utilized as previously recommended by (Mirwald et al., 2002). Subsequently, participants were divided into pre-PHV (highly trained: n= 16; recreationally trained: n = 15) and mid-PHV (highly trained: n= 11; recreationally trained: n = 10). There were 0.8 years between the most mature subject of the pre-PHV groups and the least mature subject of the mid-PHV groups.

3.4. Statistical Analysis

Before the main analysis, intraclass correlation coefficient (ICC) with a two-way mixed model was performed to reveal the level of reliability for each physical fitness parameter by the majority of the whole sample (n= 92, data gathered from the pre-test scores and six days after - Table 1.). Between-group differences for highly and recreationally trained children of the same maturity status were computed in separate analyses using independent sample t-tests. For this analysis, the normality of data was confirmed using the Shapiro Wilk test. Because the assumptions of homogeneity of variances and normality were violated for the physical activity level parameter, a Wilcoxon signed rank test was performed to show the differences between pretest and posttest. Comparisons of the changes in each physical fitness variable were analyzed using 2 (time: pre, post) x 2(training status: highly, recreationally trained) x 2 (maturity status: pre-, mid-PHV) repeated measures ANOVA. Mauchly's statistics were performed, and Greenhouse– Geisser adjustments were considered when the sphericity assumption was violated. Bonferroni or Games-Howell post hoc was chosen when equal variance was or was not assumed respectively. Calculation and interpretation of effect size (as trivial (< 0.2), small (0.2-0.5), moderate (0.5-0.8), and large (> 0.8)) was based on Cohen's d statistical classification (Cohen, 1988). Analyses were computed using SPSS Version 24 (SPSS Inc., Chicago, IL, USA), with statistical significance set at an alpha level of $p < 0.05$.

CHAPTER 4

RESULTS

In this chapter, initially, descriptive statistics of the anthropometrics were included. Afterwards, the changes in selected parameters of physical fitness were reported for each group separately. Then, the significances for 3-way and 2-way interaction effects as well as for main effects were presented to show comparisons of changes according to maturity and training status. Finally, significant differences from the results of the 2 x 2 x 2 (time x training status x maturity) repeated measures ANOVAs were interpreted with effect sizes.

4.1. Descriptive Statistics

Descriptive statistics for anthropometrics including age, maturity off set, height, body mass, body mass index, sitting height, and leg length, are shown in Table 2 as mean ± SD. The values of MET, describing the level of physical activity, were reported as mean with 95% confidence intervals in Table 3.

Table 2
Characteristics of the Participants

	Pre-PHV (n=31)			**Mid-PHV (n=21)**		
Variables	Highly trained (n=16)	Recreationally trained (n=15)	p	Highly trained (n=11)	Recreationally trained (n=10)	p
Age (y)	10.66±1.1	10.04±1.1	0.09	13.81±1.2	12.94±0.8	0.08
MO (y)	-2.98±0.58	-3.14±0.74	0.51	-0.32±0.68	-0.71±0.56	0.16
Height(cm)	136.19±6.18	136.94±7.98	0.77	160.45±12.32	155.1±8.6	0.26
BM (kg)	29.80±4.34	33.42±6.57	0.09	48.79±8.23	47.09±9.42	0.56
BMI (kg.m^{-2})	15.25±1.63	16.87±2.22	**0.03**	17.78±1.95	18.40±2.75	0.66
SH (cm)	73.13±2.70	73.93±3.10	0.45	82.75±4.62	83.10±1.91	0.97
LL (cm)	63.07±4.29	63.00±5.44	0.97	77.40±8.64	71.95±7.09	0.13

Legend: MO= Maturity off set; BM= body mass; BMI= body mass index, SH=sitting height, LL: leg length

The significant difference in BMI between highly trained and recreationally trained players was ignored because the effect size was trivial (d=0.09) and the BMI values for both groups were within the normal range corresponding to the population to which they belong (Neyzi et al., 2015).

Table 3
Physical Activity Levels Before and During Lockdown Period

Physical activity	**Training status**	**Before lockdown (MET-min/week)[a]**	**During lockdown (MET-min/week)[a]**	**Change (%)**
Vigorous	HT (n=27)	2469.1 (2286.4-2649.9)	281.5 (233.1-329.9)	-88.6*
	RT (N=25)	1008.0 (913.6-1102.3)	19.2 (-8.23-46.6)	-98.1*
Moderate	HT (n=27)	2256.3(2009.7-2502.9)	300.7 (240.8-360.7)	-86.7*
	RT (N=25)	1694.4 (1567.6-1821.1)	91.2 (63.4-119.0)	-94.6*
Walking	HT (n=27)	3773.0(3419.8-4126.2)	699.7 (592.1-807.3)	-81.4*
	RT (N=25)	3557.4 (3431.3-3683.5)	679.1 (552.3-806.0)	-80.9*
Total	HT (n=27)	8497.4 (8025.1-8969.1)	1281.9 (1145.2-1418.7)	-84.9*
	RT (N=25)	6259.8 (6063.9-6455.7)	789.5 (653.3-925.8)	-87.3*

Legend: HT= Previously Highly trained participants, RT= Previously recreationally trained participants, [a]= Expressed in Mean (95% Confidence Interval), * = $p<0.001$-Wilcoxon Signed Rank test

About 85% of physical activity was decreased in participants during the lockdown period when compared to before the lockdown values (Table 1). Since the questionnaires did not contain any personal information and the maturity groups of the participants were only determined after the survey applications, the categorization was only done according to the training status (as highly trained and recreationally trained individuals), whereas a classification according to the maturity level was not possible.

4.2. Changes in Physical Fitness Parameters

Instead of mean differences, percent changes were reported to provide an initial assessment of the components that stood out by the magnitude of change. In addition to percent changes, P and F values, confidence intervals, and effect sizes (Cohen's d) were also provided to allow more informative interpretations.

Table 4

Changes in the Selected Physical Fitness Variables of Highly Trained Soccer Players at Pre-PHV

Variables	Pre	Post	Δ (%)	CI (%95)	F	p	ES
HG (kg)	15.85±3.37	16.35±3.48	3.18	-0.25 to 1.26	2.04	0.17	0.12
RHG (kg/BMI)	1.04±0.20	0.96±0.23	-7.69	-0.14 to 0.02	7.16	**0.02**	0.32
RSI (mm/ms)	0.95±0.24	0.81±0.24	-14.81	-0.18 to -0.11	78.8	**0.00**	0.84
10m(s)	2.44±0.13	2.53±0.17	3.68	0.04 to 0.13	14.00	**0.00**	0.48
20m(s)	3.74±0.20	3.82±0.24	2.13	0.03 to 0.14	9.39	**0.01**	0.39
DJ (cm)	20.62±3.12	20.79±3.68	0.85	-1.56 to 1.91	0.46	0.83	0.00
CMJ (cm)	24.79±4.02	23.66±4.55	-4.5	-2.44 to 0.17	3.42	0.08	0.19
SJ (cm)	19.98±2.63	20.27±3.06	1.47	-0.43 to 1.02	0.74	0.40	0.05
SLJ (cm)	151.50±18.24	147.37±16.08	-2.72	0.30 to 7.95	5.29	**0.04**	0.26
ZAWHB (s)	7.90±0.50	7.99±0.46	1.13	0.00 to 0.17	4.60	**0.05**	0.23
ZAWB (s)	9.54±0.81	10.11±0.86	5.97	0.43 to 0.72	69.26	**0.00**	0.82
Y Balance (cm)	67.87±5.11	66.67±4.67	-1.16	-2.74 to 0.34	2.78	0.12	0.16
N-Y Balance (%)	107.81±7.32	103.92±6.63	-3.61	-5.59 to 2.19	23.7	**0.00**	0.61

Legends: Δ= percentile change; CI= confident intervals; ES= Effect size; HG= Handgrip strength; RHG= Relative handgrip strength; RSI= Reactive Strength Index; 10m= 10m acceleration time; 20m= 20m running velocity; DJ= Drop jump; CMJ= Countermovement Jump; SJ= Squat Jump; SLJ= standing long jump; ZAWHB= zigzag ability without the ball; ZAWB= zigzag ability with the ball; CS-Y Balance= composite score of Y-balance; N-Y Balance= normalized values of Y-balance

In the highly trained pre- PHV group, there were significant decreases in performance in RHG, RSI, 10m, 20m, SLJ, ZAWB, and N-Y Balance, ranging from small to large, and a tendency for a significant loss in performance in "ZAWHB" (F= 4.60, p= 0.051). The changes in HG, DJ, CMJ, SJ, and CS -Y balance was not significant (p > 0.05). While the large effects were observed in RSI and ZAWB, only moderate change was observed in N-Y balance (ES = 0.61 [-5.59-2.19], F = 23.70 [p =0.001]). The ES for other significant changes (RHG, 10m, 20m, and SLJ) were low.

Table 5

Changes in the Selected Physical Fitness Variables of Recreationally Trained Soccer Players at Pre-PHV

Variables	Pre	Post	Δ (%)	CI (%95)	F	p	ES
HG (kg)	16.13±2.52	16.95±3.39	0.51	-0.48 to 1.68	4.10	0.06	0.23
RHG (kg/BMI)	0.96±0.19	0.88±0.21	-8.33	-0.14 to -0.03	10.94	**0.01**	0.44
RSI (mm/ms)	0.62±0.20	0.57±0.18	-8.06	-0.10 to -0.00	5.49	**0.03**	0.28
10m (s)	2.71±0.25	2.78±0.27	2.58	-0.01 to 0.15	3.60	0.07	0.20
20m(s)	4.09±0.38	4.15±0.41	1.46	-0.03 to 0.15	2.15	0.17	0.13
DJ (cm)	17.67±4.23	18.33±3.97	3.74	-0.05 to 1.37	4.02	0.07	0.22
CMJ (cm)	20.90±5.60	21.01±5.90	0.05	-0.55 to 0.77	0.12	0.73	0.01
SJ (cm)	16.71±3.06	16.63±3.15	0.05	-0.09 to 0.07	0.56	0.82	0.00
SLJ (cm)	136.60±19.72	135.67±19.82	-0.68	-7.25 to 5.38	0.10	0.76	0.01
ZAWHB (s)	8.69±0.52	8.84±0.69	1.72	0.22 to 0.28	6.20	**0.03**	0.31
ZAWB (s)	10.75±1.21	11.44±1.28	6.42	0.51 to 0.88	66.68	**0.00**	0.83
Y Balance (cm)	62.69±6.93	62.96±6.95	0.43	-0.46 to 1.00	0.61	0.45	0.04
N-Y Balance (%)	99.67±9.10	97.24±8.45	2.44	-3.59 to -1.26	19.9	**0.00**	0.59

Legends: Legends: Δ= percentile change; CI= confident intervals; ES= Effect size; HG= Handgrip strength; RHG= Relative handgrip strength; RSI= Reactive Strength Index; 10m= 10m acceleration time; 20m= 20m running velocity; DJ= Drop jump; CMJ= Countermovement Jump; SJ= Squat Jump; SLJ= standing long jump; ZAWHB= zigzag ability without the ball; ZAWB= zigzag ability with the ball; Y-Balance= composite score of Y-balance; N-Y Balance= normalized values of Y-balance

With the exception of acceleration and maximal running speed (10m and 20 m runs), the parameters with significant impairments (RHG, RSI, SLJ, ZAWB, ZAWHB, and N-Y balance) and nonsignificant changes (HG, DJ, CMJ, SJ, and CS -Y balance) in the pre-PHV recreationally trained players were almost identical to those in the pre-PHV highly trained players. Differently, the effect size for the decrease in RSI in the pre-PHV recreationally trained players was small (d=0.28), whereas the effect in the pre-PHV highly trained players was large (d=0.84). While a large effect was found only for ZAWB impairments, the moderate effect was only for N-Y balance decrease, and for all other variables where significant impairments were found, the effect size was small in pre-PHV recreationally trained players.

Table 6

Changes in the Selected Physical Fitness Variables of Highly Trained Soccer Players at Mid-PHV

Variables	**Pre**	**Post**	**Δ (%)**	**CI (%95)**	**F**	**p**	**ES**
HG (kg)	28.16±7.27	26.99±4.97	-4.15	-3.40 to 1.07	1.35	0.27	0.12
RHG (kg/BMI)	1.59±0.45	1.42±0.31	-11.19	-0.31 to 0.05	9.81	**0.01**	0.50
RSI (mm/ms)	1.15±0.06	1.00±0.05	-15.01	-0.22 to 0.08	25.55	**0.00**	0.72
10m (s)	2.17±0.13	2.29±0.15	5.53	0.08 to 0.16	42.73	**0.00**	0.81
20m(s)	3.27±0.13	3.45±0.15	5.50	0.12 to 0.23	47.55	**0.00**	0.83
DJ (cm)	26.80±5.14	24.72±4.56	-7.76	-4.10 to -0.07	5.30	**0.04**	0.35
CMJ (cm)	31.75±5.17	29.74±4.94	-6.33	-4.05 to 0.03	4.85	**0.05**	0.33
SJ (cm)	25.71±3.34	23.77±3.43	-7.62	-3.39 to -0.48	8.79	**0.01**	0.47
SLJ (cm)	184.36±14.88	177.09±12.23	-3.96	-10.95 to -3.59	19.38	**0.00**	0.66
ZAWHB (s)	6.94 ±0.63	7.35±0.55	5.91	0.17 to 0.65	14.27	**0.00**	0.59
ZAWB (s)	8.35±0.97	9.23±1.25	10.53	0.67 to 1.09	85.90	**0.00**	0.90
Y Balance (cm)	83.67±8.41	83.48±7.91	-0.02	-1.32 to 0.95	0.13	0.72	0.01
N-Y Balance (%)	108.63±9.96	104.63±8.44	-3.68	-5.44 to -2.46	33.52	**0.00**	0.77

Legends: Legends: Δ= percentile change; CI= confident intervals; ES= Effect size; HG= Handgrip strength; RHG= Relative handgrip strength; RSI= Reactive Strength Index; 10m= 10m acceleration time; 20m= 20m running velocity; DJ= Drop jump; CMJ= Countermovement Jump; SJ= Squat Jump; SLJ= standing long jump; ZAWHB= zigzag ability without the ball; ZAWB= zigzag ability with the ball;Y Balance= composite scores of Y-balance; N-Y Balance= normalized values of Y-balance

Significant impairments were observed in all musculoskeletal and motor fitness variables in mid-PHV-highly trained soccer players (except for CS -Y balance and HG). Impairments for ZAWB, 10m acceleration, and 20m maximal running velocity had large effects, small effects for vertical jump heights (DJ, CMJ, and SJ), and moderate effects for other significant parameters (RHG, RSI, SLJ, ZAWHB, and N-Y balance.

Table 7

Changes in the Selected Physical Fitness Variables of Recreationally Trained Soccer Players at Mid-PHV

Variables	Pre	Post	Δ (%)	CI (%95)	F	p	ES
HG (kg)	22.66±4.81	23.23±4.94	2.52	0.11 to 1.03	7.73	**0.02**	0.46
RHG (kg/BMI)	1.24±0.24	1.16 ±0.24	-6.45	-0.12 to -0.03	17.08	**0.00**	0.66
RSI (mm/ms)	0.75±0.20	0.62±0.20	-17.30	-0.21 to -0.04	11.86	**0.01**	0.57
10m (s)	2.49±0.13	2.52±0.14	1.20	-0.01 to 0.07	3.92	0.08	0.30
20m(s)	3.78±0.21	3.80±0.23	0.53	-0.05 to 0.09	0.40	0.54	0.04
DJ (cm)	20.73±4.53	20.57±5.10	-0.77	-1.27 to 0.95	0.10	0.75	0.01
CMJ (cm)	24.68±5.12	23.90±5.29	-3.16	-2.42 to 0.87	1.15	0.31	0.11
SJ (cm)	20.59±4.00	19.42±3.75	-5.68	-2.94 to 0.60	2.25	0.17	0.20
SLJ (cm)	159.20±16.60	159.10±19.76	-0.04	-4.01 to 4.21	0.00	0.96	0.00
ZAWHB (s)	8.15±0.55	8.41±0.39	3.19	0.08 to 0.44	10.58	**0.01**	0.54
ZAWB (s)	10.12±0.45	11.19±0.47	10.57	0.77 to 1.37	65.03	**0.00**	0.88
Y Balance (cm)	70.60±6.20	69.53±5.81	-1.52	-4.36 to 2.23	0.54	0.48	0.06
N-Y Balance (%)	98.37±6.04	96.08±6.61	-2.32	-4.14 to -0.44	7.82	**0.02**	0.50

Legends: Δ= Legends: Δ= percentile change; CI= confident intervals; ES= Effect size; HG= Handgrip strength; RHG= Relative handgrip strength; RSI= Reactive Strength Index; 10m= 10m acceleration time; 20m= 20m running velocity; DJ= Drop jump; CMJ= Countermovement Jump; SJ= Squat Jump; SLJ= standing long jump; ZAWHB= zigzag ability without the ball; ZAWB= zigzag ability with the ball;Y Balance= composite scores of Y-balance; N-Y Balance= normalized values of Y-balance

The changes in the two running tests (10m acceleration and 20m running velocity) and the three vertical jump performances were not significant ($p > 0.05$). Regarding handgrip strength, there was a positive significant effect with a small effect size (< 0.50) for the absolute values, while there was a significant decrease with a medium effect for the relative values. The adverse effects for RSI and ZAWHB were moderate, and a large effect was found only for ZAWB (> 0.80).

4.3. Comparisons of the Changes in Physical Fitness Parameters

In addition to within-group analysis, comparisons of the changes (between-group differences) were also performed for each dependent variable. P-values are presented for 3-way and 2-way interaction effects and for the main effects in table 9.

Table 8
P-Values for Interactions and Main Effects

	Time x training status x maturity	Time x training status	Time x maturity	Maturity x training status	Time	Training status	Maturity status
HG (kgf)	0.197	0.067	0.086	**0.039**	0.509	0.087	**0.001**
RHG(kg/BMI)	0.128	0.180	0.212	0.128	**0.001**	**0.010**	**0.001**
RSI (mm/ms)	0.168	**0.033**	0.094	0.325	**0.001**	**0.001**	**0.015**
10m (s)	0.212	0.083	0.974	0.909	**0.001**	**0.001**	**0.001**
20m(s)	0.060	**0.012**	0.470	0.543	**0.001**	**0.001**	**0.001**
DJ (cm)	0.309	0.091	**0.033**	0.297	0.319	**0.001**	**0.001**
CMJ (cm)	0.996	0.061	0.177	0.262	**0.005**	**0.001**	**0.001**
SJ (cm)	0.269	0.708	**0.002**	0.471	**0.007**	**0.001**	**0.001**
SLJ (cm)	0.392	**0.029**	0.618	0.395	**0.010**	**0.001**	**0.001**
ZAWHB (s)	0.144	0.569	**0.004**	0.291	**0.001**	**0.001**	**0.001**
ZAWB (s)	0.723	0.108	**0.001**	0.282	**0.001**	**0.001**	**0.010**
CS-Y Balance	0.140	0.710	0.840	**0.015**	0.170	**0.001**	**0.001**
N-Y Balance	0.869	**0.037**	0.988	0.655	**0.001**	**0.001**	0.919

Legend: HG= Handgrip Strength, R-HG= Relative Handgrip Strength, 10m= Acceleration 20m= Running velocity, SLJ=Standing long jump, DJ=Drop jump, RSI= Reactive Strength Index, SJ= Squat Jump, CMJ= Countermovement Jump, ZAWB= Zigzag agility with the ball, ZAWHB= Zigzag agility without the ball

The main time effects were significant for the all-selected physical fitness variables, except for HG, DJ, and CS -Y balance. The other main effects for maturity and training status were also significant, except for HG for training status and N-Y balance for maturity. With the exception of N-Y balance, mid-PHV players performed better than pre-PHV players on all selected physical fitness variables. Similarly, highly trained athletes performed better on all physical performance variables except HG.

Although a trend was noted for the "time x Training status x maturity" interaction for 20m running speed ($p = 0.060$), analyses revealed no significant 3-way interaction effect (time-by-training status-by maturity) for any physical fitness variable. However, it should also be noted that a dramatic decrease in this performance was observed only in the mid-PHV highly trained group with a large effect ($d > 0.80$).

A significant interaction effect "time x training status" was found for 20m ($d=0.12$), RSI ($d=0.11$), SLJ ($d=0.08$) and N-Y balance ($d=0.09$), and a tendency for significance for CMJ and HG. As can be seen in Tables 7-10, N-Y Balance values decreased significantly in all groups. Although the impairments in both the highly trained and recreationally trained cohorts had moderate effect size for N-Y balance

(Δ -3.64%, p < 0.001, d=0.67 and Δ -2.39%, p < 0.001, d=0.53, respectively), the highly trained cohorts had a greater reduction than the recreationally trained players with a trivial effect size (d=0.09). While there were no significant changes in the two recreationally trained groups, significant increases in 20m running time were found in both highly trained groups. Whereas this detrimental effect on performance was small in the pre-PHV trained group (d < 0.50), the effect was large in the highly trained group (d > 0.80). And, the detrimental effect was significantly greater in highly trained players than in recreationally trained players for 20m running performance.

"Time x maturity" interactions for DJ (d=0.10), SJ (d=0.18), and both agility tests (ZAWB (d=0.21) and ZAWHB (d=0.16)) were significant (p<0.05). As evident in within-group analysis detailed in tables 7-10, significant changes in SJ and DJ were reported only for highly trained mid-PHV soccer players. Regardless of maturation, SJ change was not significant in the pre-PHV cohort (Δ 2.13%, p=0.36, d=0.03), whereas a significant reduction was reported for the mid-PHV cohort (Δ-4.88%, p=0.05, d=0.17). Similarly, the change in DJ was not significant in the pre-PHV cohort (Δ0.06%, p=0.66, d=0.01), while a significant decrease was seen in the mid-PHV cohort (Δ-6.75%, p=0.01, d=0.33). Regarding agility tests, ZAWHB time increased significantly in both the pre-PHV and mid-PHV cohorts (p <0.01), but impairments in mid-PHV players was greater than pre-PHV players. Moreover, the effect size was moderate in the mid-PHV players (d=0.55) whereas small in the pre-PHV (d=0.26). In the ZAWB time, significant decreases were reported for both maturity level with large effect sizes (pre-PHV=0.82 mid-PHV cohorts = 0.88), however impairment in mid-PHV cohort was greater than pre-PHV cohort with a small effect (d=0.21).

CHAPTER 5

DISCUSSION

The first hypothesis of the present study was that COVID -19 induced mobility restrictions cause impairments in all components of physical fitness because they cause both physical inactivity and detraining state. The results of the study supported this hypothesis, with significant main time effects found for each physical fitness component. Second, the adverse effects related to the skill-related components were also expected to vary with the maturity or training status of the selected population. Before discussing these important findings showing that both moderators may play a role in the changes in physical fitness induced by detraining in children, it is necessary to understand the framework of COVID -19 induced mobility restrictions that may explain the effects on physical activity and detraining conditions. The study research questions were based on the effects of COVID -19 induced mobility restrictions that form the basis of physical activity levels and detraining conditions in the literature (see Section 2.1.1.), and these effects were withheld in the first part of the discussion section to provide informative background. Next, the main findings of the current study that some aspects of musculoskeletal or motor fitness are impaired in response to COVID -19 lockdown are contextualized with the literature. In keeping with secondary research questions of the study created on the basis of the changes in physical fitness after a detraining period may vary depending on the several factors such as the duration of the period (short or long term detraining), level of detraining (partial detraining - insufficient training or complete detraining), training status (sporting level or fitness level), gender, age and maturity level (Bosquet et al., 2013; Joo, 2018; Mujika & Padilla, 2000), the covariance effects of maturity and training status are separately placed in the context of the literature as selected moderators of the study. To the best of the author's knowledge, there is no study that examines a comparison of the effects of these two moderators on detraining induced physical attributes. Most of these studies conducted generally controlled for training status- that is, they created the same populations on this factor and examined the effects of detraining on physical fitness according to the maturation factor. Changes in physical fitness brought on by detraining are explained as the result of physiological adaptations such as a training-induced change. To better understand the physiological mechanisms underlying the changes in physical fitness caused by maturity or training status, this section also considers the literature on exercise-induced physiological changes. Thus, it is believed that the results of a limited number of studies examining detraining-induced changes in physical fitness as a function of maturity or training state can be supported. Finally, it was deemed necessary to discuss the methods of the study, as it included several unique interventions. The limitations of maturity assessments reported in previous studies, the methods used to determine training status in the current, and the rationale for measuring physical activity levels are discussed.

Although COVID -19 induced mobility restriction was defined as the independent variable of this study, it can be considered when establishing a cause-effect relationship, as the impact of physical inactivity and detraining conditions caused by these restrictions on physical fitness. In this context, it was considered that the relationships between mobility restrictions and physical inactivity and detraining should be explained before discussing the study findings.

In this study, the physical activity levels of the participants were revealed by surveyed before and after COVID-19 lockdown. In this study, participants' physical activity levels were assessed before and after blocking COVID -19. The necessity of this application can be questioned, but one could assume that a design that does not include an intervention related to physical activity, i.e., that assumes that all participants are physically inactive, can bring about some limitations such as ignoring participants who succeed to stay physically active during the lockdown. Indeed, studies from different countries have shown that COVID -19 induced mobility limitations reduced physical activity levels, and it could be assumed that there were similar effects because similar limitations were applied in the country where the current study was conducted (Turkey). However, it was also assumed that the disclosure of physical activity level may help to find out some exceptional situations, such as players who had remained physically active in different ways to stop participating.

Apart from the assessment that the effects of COVID -19 induced mobility limitations on physical inactivity, some studies have clearly demonstrated this. Castañeda-Babarro, Arbillaga-Etxarri, Gutiérrez-Santamaría, & Coca, (2020) reported that the mobility restrictions caused by COVID -19 negatively affect the sedentary time of people of all ages in Spain. Maugeri et al., (2020) showed that the outbreak of COVID -19 in Italy led to a decline in physical activity in all age groups. Similarly, Tornaghi et al., (2020) revealed declining physical activity levels due to the outbreak of COVID -19 in the inactive or moderately active young population in Italy. Lesser & Nienhuis, (2020) reported that physically active and inactive Canadians were differentially affected by public health interventions, including mobility restrictions. Tison et al., (2020) showed that during the pandemic COVID -19, there was a rapid decline in step counts worldwide, with regional variability. From these studies, COVID -19 induced mobility limitations lead to physical inactivity. However, it was predicted that some of these athletes from the current study would have high levels of physical activity that could play a protective role in physical fitness by performing various exercises to protect their performance during lockdown despite the obstacles of the COVID -19 process. The physical activity level questionnaire was used in this direction, although it contains some limitations (see Section 5.3.2). According to the results of this questionnaire, only those who remained physically inactive were included in the study.

Since the mobility limitations that are the independent variable of this study can actually be indirectly explained by the effects of physical inactivity, the decline in the level of physical activity was the first to be noted in the study. Moreover, this is an issue that needs to be taken more seriously in the context of detraining syndrome in athletes. While aborted sports competitions and training sessions put athletes into the detraining process that leads to severe performance losses, the physical inactivity of this process can make these losses even more dramatic. An important question when evaluating the effects of detraining on physical fitness is the level of physical activity maintained by athletes during this period. With concerning these specific conditions, it can be said that this pandemic is causing mobility restrictions, which include the prohibition of athletic activities, leading to the detraining syndrome often studied in the literature. Notwithstanding, it appears that existing scenarios of detraining, which can be also described as reasons for detraining syndrome such as illness, injury, travel, loss of motivation, or postseason break in competitive athletes, do not completely describe the unprecedented conditions of COVID-19. Since players had to stay home, there may be different psychological consequences during a pandemic compared to a normal vacation (i.e., the stressful time versus the leisure period), in addition to the physical impairments. Furthermore, COVID -19 induced mobility restrictions had been longer than a typical traditional offseason, and the requirement to stay home precludes players from particularly sport-specific training such as playing soccer. Furthermore, in this study, it is difficult to define the level of detraining caused by these COVID -19 induced mobility impairments. Although it could be incorrect to consider this detraining condition as a complete classification as totally inactive (bedridden patient), a classification beyond the partial detraining assessment was needed because they had the worst physical inactivity levels than usual (Table 2.). The cessation of all sports activities and even the imposition of curfews prevented the athletes from performing individual exercises in addition to their regular training and did not allow any exercise routine other than exercises at home. These home-based exercises during this period can be beneficial to avoid physical fitness decreases in part because of maintaining physical activity levels in the period before COVID -19 (Bosquet et al., 2013; Chaabene, Prieske, Herz, Moran, Höhne, Kliegl, Ramirez-Campillo, Behm, Hortobagyi, et al., 2021; A. Hammami et al., 2020; Sarto et al., 2020; Villaseca-Vicuña et al., 2021). Losses in athletic performance would be unavoidable, however, because these exercises do not contain sufficient training stimulus (Bosquet et al., 2013; Mujika & Padilla, 2000). Furthermore, it would not be possible to assume the required performance increases in young athletes who have the goal of reaching the elite level if they have such insufficient training time. Because the performance development of athletes depends on high-intensity activities that fully meet their sport-specific performance requirements (McArdle et al., 2010). The last point to consider is the content and applicability of home-based training. The scientific studies that address this issue showhat home exercise programs generally include exercises with strength content (Chaabene, Prieske, Herz, Moran, Höhne, Kliegl, Ramirez-Campillo, Behm, Hortobágyi, et al., 2021; A. Hammami et al., 2020). In the home environment, there are many limitations when it comes to training flexibility, balance, and other sport-specific skills that can be performed outside of the strength domain. For the first phases of the COVID -19 period, when the severity is not fully understood and no explanatory information can be given, even the efficiency of home exercises should be questioned, because the precautions are stringent (the masks are almost never removed) and the psychological conditions are not suitable for sports in such panic and anxiety. Participants who managed to exercise during the COVID-19 lockdown despite the above obstacles were identified through a physical activity survey and a semi-structured interview and were excluded from the study.

Regardless of the main research question of the study, more mature players showed better performances in all skill-related physical fitness components (significant main effect of maturity, $p < 0.05$), as expected before the study. Moreover, highly trained players were better than recreationally trained players in all physical fitness performances except for handgrip strength (a trend toward significance, $p < 0.10$). Literature reports that mature young athletes perform better physically compared to their less mature peers and that high level athletes perform better than lower-level players (Buchheit & Mendez-Villanueva, 2014; Guimarães et al., 2019; Lloyd et al., 2014; Malina et al., 2004; Meyers, 2016; Moran et al., 2017; Patel et al., 2019; Romero et al., 2021).

The main finding of the current study was that 27-week detraining due to COVID -19 mobility limitations negatively affected physical fitness in all young soccer players. Although no significant main effect for time was found in drop jump heights, a statistically significant decrease was reported in the reactive strength index obtained with this drop jump performance. And it is reasonable to consider the 27-week changes in dynamic balance values as normalized values that show significant decreases, rather than composite values that are not significant. Similarly, adverse effects on handgrip strength were observed by decreasing relative handgrip strength normalized with BMI values, although it was not significant for absolute values. An interesting finding of the current study is the significant or trended increase in handgrip strength in terms of absolute values in both recreationally trained groups (pre-PHV and mid-PHV). Considering this result along with the finding of a trended interaction of time x training condition (p=0.67) in the study, this indicates that the contribution of physical development to handgrip strength may be identical to the contribution of soccer-specific training at the recreational level over 27 weeks. Since this is a finding outside of the research question, the literature on this topic was not discussed. Nevertheless, the non-significant training status-related differences in hand strength in terms of absolute values (p=0.067 for training status x time) in the study are not as meaningful as the relative values which had significant differences in this finding, as they were obtained by completely neglecting the weight differences.

With conclusions showing relative handgrip strength differences in mind, it would not be incorrect to say for current study findings that muscular strength which is a important component of physical fitness declined when considering the growth-related strength increases. In fact, it was predicted that growth-related physical developments might limit some performance losses, it was also expected that detraining, where significant performance losses can be seen even in a few weeks (McArdle et al., 2010), would result in much more dramatic losses over such a long-term period of detraining (27-week) than the reported rates. However, there are several studies suggesting that growth-related physical development may play a confounding role in adaptation and may reduce the decline in strength after a period of training cessation (Bosquet et al., 2013; Meylan et al., 2014). Indeed, there were some other signs in the results of the current study that show the contribution of physical development to performance-related physical fitness. For example, the values of dynamic balance did not change when the composite values were considered, but significant decreases were found in the normalized values. This finding, which shows that the values of Y- balance obtained in the last tests are almost equal to those obtained in the first tests, despite an advantage due to the increase in leg length, explains that dynamic balance actually deteriorated relatively. On the other hand, there are some studies that show that some performance can be maintained after long-term detraining (Kubo et al., 2010; Santos & Janeira, 2009b).

Kubo et al., (2010) showed that strength gains after three months of strength training were maintained even after two months of detraining. In their study, the retention of strength losses is explained by different physiological adaptations, as it could not be possible to mention growth-related physical performance increases due to the ages of the participants (non-adolescent subjects). In addition to unchanged strength and power performances, the neuronal activation levels did also not change, but muscle atrophy occurred. The results of that study show that in this regard, neural physical adaptations are more effective than hypertrophic adaptations in maintaining detraining-induced fitness performance. with concerning those results, it can be assumed that the detraining-induced performance decrements in the participants of the current study can be considered as the expected level since the subjects that make up the study population are in puberty (puberty related developments in the neural system). This view can be supported by the study conducted by Santos & Janeira (2009b), which showed strength and strength gains can be maintained even up to 16 weeks in athlete adolescents. Similar to the current study findings, Spyrou et al., (2021) reported that the 70 days of COVID-19 induced reduced training did not show a significant change in vertical jump height and horizontal jump distances.

In fact, it is also reasonable to think that strength gains can occur following short periods of detraining after a period of training with high-intensity activities (McArdle et al., 2010), as this allows for full recovery (supercompensation effect). At this point, there may have been some increase in performance after the first measurements in the study, where participants continued their regular training, which may have compensated for some of the decrease in performance caused by detraining that was observed in the second measurements. Moreover, it may be legitimate to consider the effect sizes for some physical fitness variables to be dramatic, considering that they would have been exempt from training-induced performance gains because they had not exercised regularly during this period, which can be considered to be 27 weeks long. In these age groups, severe increases in athletic performance can be expected in a short period of 4 weeks with regular complex training (Freitas et al., 2017). In addition to this situation, it should be taken into account that the highly trained athletes in the current study had performed high-intensity specialized training to increase their sprinting and agility performance on certain days of the week before the COVID-19 lockdown. On the other hand, statistically significant improvements in children's sprint and agility performance can be expected both before and during PHV, even over an 8-week period (Moran et al., 2018). Based on this information, it can be predicted that the participants would have achieved a 5-15% improvement in their athletic performance if they had not imposed COVID -19 induced detraining and had continued their regular training for 27 weeks. Considering this fact that the participants were exempt from this expected training-induced performance development after such a long period of time and are not even able to maintain their performance level, impairs can be evaluated as dramatic.

The other main objective of the current study was to investigate the extent to which maturation and training status influence detraining-induced changes in physical fitness in young soccer players. In addition to grouping these factors separately, grouping together by utilizing a 3-way repeated measure design. Although Mid- PHV-highly trained group is the only one in which significant decreases were observed for each component of physical fitness (Table 9), the statistical analysis failed to detect a 3-way interaction for any variable, meaning that it cannot express that decreases in physical fitness are greater in Mid-PHV-highly trained soccer players than in mid- PHV recreational training soccer players or any pre-PHV soccer players at both training status. However, also considering the fact that the highest effect sizes are also reported in this group, except for two parameters (RSI and RHG), it is difficult to clearly express that the deteriorations in physical fitness in mid-PHV highly trained players are similar to those in other players (Table 9).

Table 9
Delta Values and Effect Sizes for Significant Parameters

	Highly trained cohort		**Recreationally trained cohort**	
	Pre-PHV	Mid- PHV	Pre-PHV	Mid- PHV
HG (kg)	-	-	-	Δ 2.52% (0.46)
RHG (kg/BMI)	Δ-7.69% (0.32)	Δ-11.19% (0.50)	Δ-7.69% (0.44)	Δ -6.45 (0.66)
RSI (mm/ms)	Δ-14.81% (0.84)	Δ-15.01% (0.72)	Δ-14.81% (0.28)	Δ -17.30 (0.57)
10m(s)	Δ3.68% (0.48)	Δ5.53% (0.81)	Δ3.68 % (0.20)	-
20m(s)	Δ2.13% (0.39)	Δ5.50% (0.83)	-	-
DJ (cm)	-	Δ-7.76% (0.35)	-	-
CMJ (cm)	-	Δ-6.33% (0.33)	-	-
SJ (cm)	-	Δ-7.62% (0.47)	-	-
SLJ (cm)	Δ-2.72% (0.26)	Δ-3.96% (0.66)	-	-
ZAWHB (s)	Δ1.13% (0.23)	Δ5.91% (0.59)	Δ1.13% (0.31)	Δ3.19 (0.54)
ZAWB (s)	Δ5.97 % (0.82)	Δ10.53% (0.90)	Δ5.97% (0.83)	Δ10.57 (0.88)
Y Balance	-	-	-	-
N-Y Balance	Δ-3.61% (0.61)	Δ-3.68% (0.77)	Δ-3.61% (0.59)	Δ-2.32 (0.50)

Legend: HG= Handgrip Strength, R-HG= Relative Handgrip Strength, 10m= Acceleration 20m= Running velocity, SLJ=Standing long jump, DJ=Drop jump, RSI= Reactive Strength Index, SJ= Squat Jump, CMJ= Countermovement Jump, ZAWB= Zigzag agility with the ball, ZAWHB= Zigzag agility without the ball

The absolute value of handgrip strength and the composite values of Y-balance are strongly growth-dependent (positive effects of body mass on handgrip strength, and positive effects of leg length on Y-balance), so these variables cannot represent changes in physical fitness as well as the relative values of handgrip strength or the normalized values of Y-balance. In relation to this, it can be concluded that the group with high trained and medium PHV was the only group in which a significant decrease in all components of physical fitness was observed.

Significant 2-way interactions with respect to time x maturity and time x training status were also reported for some variables in this study. While maturity-related differences were observed in changes in drop-jump and squat jump heights and agility times (with and without ball), training status-related differences were also observed in changes in reactive strength index, 20-m running velocity, standing long jump, and dynamic balance (Y-balance). Because there is no physical fitness variable for which a significant interaction for either time x maturity and time x training status has been observed, and 3-way interactions are meaningless for all dependent variables, the literature on the effect of maturity or training status on detraining-induced changes in physical fitness is discussed separately.

The different significances and effect sizes in the variables of 10m acceleration and 20m running velocity in the study results should not be considered contradictory results, assuming that these two performances are in similar form. Previous studies have shown that there are some differences between 10m acceleration and 20m running velocity with respect to acute physiological responses(Lloyd et al., 2016). While 10m acceleration performance is indicative of slower stretch-shortening cycle activity (Bret et al., 2002), 20m maximal running velocity typically utilizes faster-stretch-shortening cycle actions (Lloyd et al., 2011). Bret et al., (2002) found that leg stiffness plays a key role in the second phase of maximal running performance and that jumping performance, termed "explosive strength," is more related to the acceleration phase than running performance over longer distances. Based on this information, one might also expect from the results of the current study that changes in 10m acceleration would resemble jumping performance, while changes in 20m running performance would resemble the reactive strength index (Lloyd et al., 2016). However, it cannot be said that the results of the study exactly match this expectation. A significant difference in jumping performance was found only in the highly trained mid-PHV group, whereas changes in 10m acceleration performance were significant in all groups except the recreationally trained mid-PHV group. In addition, significant changes in jumping performance were found in the highly trained Mid-PHV group. While the effect sizes were small, the significant changes in 10m acceleration performance were large. However, it should not be ignored that the main time effects were as significant as the changes in 10m acceleration performance for squat jump and countermovement jump performances. The 20m running speed and reactive strength index, which have similar physical characteristics, also showed significant time effects.

5.1. Effects of Training Status on Detraining-Induced Physical Fitness Adaptations

In the study, it was found that performance decrements in Reactive strength index, 20m running speed, standing long jump and normalized Y-Balance were higher in highly trained players than in recreational players after COVID -19 induced mobility restrictions. On the other hand, there is no variable for which performance impairments are greater in recreational athletes compared to highly trained athletes. Furthermore, effect sizes were more remarkable in highly trained players compared to recreationally trained players for all variables. With respect to these results, although it cannot be said that physical fitness losses are higher in highly trained athletes than in recreational athletes, it can be claimed that highly trained athletes may have been more affected by musculoskeletal attrition because the variables for which a significant time x training status-interaction was found were high-intensity performances requiring explosive power. It can also be supported by the literature that detraining-induced musculoskeletal performance losses in highly trained athletes can be higher than in recreationally trained athletes. Previous studies have shown that in contrast to reduced physical fitness after a short-term training cessation in elite athletes, these effects are controversial in recreationally trained or the untrained athletes (Izquierdo et al., 2007; Koundourakis et al., 2014; Mujika & Padilla, 2000). Indeed, this training status-related differences in the decline of physical performance can be explained more clearly by training- or detrained induced physiological alterations. Evidence from physiological studies on this topic has shown that the morphological changes in highly trained (elite) athletes are more dramatic than in their less trained counterparts. For instance, muscle atrophy, which causes a decrease in muscular strength, is more accelerated in elite athletes after a detraining period (M. P. Miles et al., 2005). Regarding cardiorespiratory adaptations, detraining in highly trained athletes is also characterized by a rapid decrease in maximal oxygen uptake (VO2max) and blood volume (Mujika & Padilla, 2000).

In the light of the above information, differential physiological adaptations following a period of detraining depending on the training status, and the studies reporting differential rates of performance decline following a period of detraining depending on training status, it is reasonable to assume that components of physical fitness disappear more rapidly in highly trained individuals than in recreationally trained individuals. McArdle et al., (2010) emphasized this fact by stating that in highly trained athletes, even the positive effects of many years of training are temporary and reversible. Considering that highly trained athletes have no privilege in terms of detraining-induced physical performance losses, they may fall to the same level as less trained counterparts at a given time; it is evident that the amount of detraining-induced total performance losses is higher for them because their pre-detraining performances are higher. In line with this assertion, the present study reported larger decreases in drop jump, squat jump, and agility (with and without the ball) in highly trained soccer players when compared with recreational players. Surprisingly, we found no training status-related differences for other musculoskeletal or motor fitness components. Since no component of physical fitness of selected parameters showed that recreational athletes had greater performance losses, it can be said that the results of the current study support the hypothesis that physical fitness losses are greater in highly trained individuals than in recreational athletes.

5.2. Effects of Maturity Status on Detraining-Induced Physical Fitness Adaptations

The findings of the current study demonstrated that physical fitness changes in some aspects may be induced by a natural development, which is dependent on maturity status. The current study findings reported that the mid-PHV cohort had greater loss of drop jump, squat jump, and agility (with and without ball) performances than the pre-PHV cohort after the 27-week detraining period, with non-significant 2-way interactions for time x maturity were reported for other variables. Regarding the differences between maturity status in the changes in physical fitness caused by detraining, it was expected that the impairment of physical fitness would be more tolerable in the players at mid-PHV because during this period physical development, which is an important contributor to strength and power, is accelerated. Despite the fact that this opinion can be supported by some studies (Meylan et al., 2014), mid-PHV players underwent greater detraining-induced decays in force-dependent variables of physical fitness, including drop jump, squat jump, and agility (with and without the ball), than pre-PHV players in the current study. One reason for this discrepancy may be explained that greater neural adaptation related to natural development, which may form physiological advantages for maintaining strength performance, is observed during this period compared to hormonal factors, compared to children in the middle of PHV (Lloyd & Oliver, 2012). The nonsignificant differences in changes in handgrip strength between pre-PHV and mid-PHV players, in contrast to the force-dependent variables, may be attributed to adaptations dominating hormonal and hypertrophic responses in the mid-PHV period (Lloyd & Oliver, 2012), and these adaptations may have compensated for the decline in strength performance in mid-PHV players. Meylan et al. (2014) examined the effect of maturation on adaptations to strength training and detraining and reported more loss of strength and power in pre-PHV children. However, their study addresses the detraining effect of different maturity groups following the cessation of a strength training program, whereas the current study does not include a training intervention.

Moreover, the period of detraining in their study was relatively short (eight weeks) compared to that of the current study. Indeed, this situation related to the duration of detraining could explain these contradictory results. Bosquet et al., (2013) showed that the changes in power induced by detraining may be similar in the initial phases, while after 16 weeks of inactivity, dissociation occurred as maximum strength continued to decrease while maximum power remained the same.

Since there are a limited number of studies on the physiological or performance responses induced by detraining, no firm conclusions can be drawn. Nevertheless, numerous studies on training-induced physiological or performance-related adaptations can help make deductions by understanding different maturational physiological adaptations in response to the same interventions. Based on the evidence to date from the relevant literature on this topic, training-induced performance gains appear to be greater in pre-PHV adolescents than in mid-PHV or post-PHV adolescents (D. D. Cohen et al., 2020; Moran et al., 2017, 2018). This difference in the rate of physical performance development may be attributed to their age-related training background. In almost all the studies mentioned above, the age of children before PHV is chronologically younger. Considering that the starting ages for sport are similar, it is reasonable to assume that pre-PHV athletes have a lower lifetime training volume than more mature athletes and are therefore still far from their peak performance. In other words, it can be logical to expect pre-PHV athletes who are most likely to not far their peak performance to show more rapid improvement. This is because the training-induced physical performance increases are rapid and extensive in the initial phase of training due to the greater contribution of the nervous system, while they are limited in the later stages (McArdle et al., 2010). Conversely, training-induced performance decrements can be expected to be more limited in pre-PHV athletes, assuming that they are generally further from peak performance, suggesting that training-induced physical performance increases are larger in pre-PHV athletes. Although the subjects in the study were similar in terms of training status, it was not known how far they are from their peak performance which is a determinant for physical performance development rates. The final and less likely reason why more declines in physical fitness are observed in athletes in the mid-PHV is that developmental spurts are greater in this period than in the pre-PHV period (Malina et al., 2004), and the sudden anthropometric developments associated with these developments may have led to dysfunction in some motor fitness-related skills. Since the way in which the human body physiologically adapted to rapid physical growth is a complicated issue that has not yet been clearly clarified, it is challenging to make certain summary, detraining-induced performance impairment in athletes with intermediate PHV might be higher than in athletes before PHV in some aspects of performance-related physical fitness, but there are insufficient studies to support these findings. In addition, among the selected components of physical fitness, there were several variables that did not show significant differences according to maturity level. Accelerated physical development in the puberty phase can play a confounding role in physiological adaptations triggered by detraining, which can lead to significant losses in physical fitness.

5.3. Discussion of Methods

The assessment of maturity may have some drawbacks, such as the stages of maturity, which may change with such an extended follow-up. In addition, although the dependent variable of the study was COVID -19 induced mobility restriction, the situations thought to underlie the adaptations in physical fitness that are the dependent variable are physical inactivity and detraining situations. In this context, since it would not be appropriate to evaluate those who are subject to mobility restrictions and remain physically active and those who remain physically inactive in the same sample, an intervention was applied to determine the level of physical activity. In conclusion, the limitations of the method to verify the training status of athletes should be addressed.

5.3.1. Maturity Assessment

The literature showing significant effects of maturity level on physical performances in children of similar chronological age, and the literature reporting that changes in these performances after a given training period may also vary according to maturity level, indicate that studies aiming to investigate physical fitness in adolescents should consider the maturity factor in order to obtain comprehensive results. Although it is well documented that maturation can refer to an adolescent as a subset of individuals whose biological characteristics distinguish them from the broader population of peers, the majority of previous studies have not applied an intervention to this fact because of the difficulty of measurement and high cost (MRI or radiographs of the human skeleton), and have considered it in the context of other limitations such as genetic differences (uncontrollable variable). With the recent emergence of maturity prediction equations based on anthropometric body measurements, researchers are addressing the role of this critical moderator of physical performance. The most widely used of these equations is the method developed by Mirwald et al., (2002). Although this method has some limitations, especially for samples covering a wide range of chronological ages, it is often considered in the literature that a reliable, non-invasive, and practical solution for measuring biological maturity is a more accurate method than completely ignoring the maturation factor. In light of the literature mentioned above, the current study aimed to reveal the effect of COVID-19 induced mobility restrictions on physical fitness by considering this role of maturity. Instead of recommended PHV value ranges, narrower ranges (pre-PHV = ≥ -4.2 and < -1.5, mid-PHV = ≥ -1.0 and $< +0.6$ years from PHV) were used for maturation classification to exclude data from subjects who could be counted in both maturation periods due to long-term detraining (subjects are assumed to be in the same maturation status throughout this period). were utilized. There were 0.8 years between the most mature subject of the pre-PHV groups and the least mature subject of the mid-PHV groups. The mean chronological age of pre-PHV and mid-PHV soccer players in the current study sample was similar to values in previous studies conducted with similar populations (Figueiredo et al., 2009).

5.3.2. The Rationale of Measuring Physical Activity Level: Controlled Detraining Level

Detraining level is a factor that is difficult to control in scientific studies aiming to reveal the detraining-induced physiological or physical performance adaptations. Most studies have considered this factor as a limitation rather than including it as a covariate. However, this moderator has a fairly determinant effect, and ignoring its effect is an important limitation for studies that consider detraining as an independent variable. The more difficult it is to ignore this moderator, the more difficult it is to build a population or apply an intervention according to this moderator. For example, it is likely to be very difficult to obtain a sufficient number of samples when creating a research design that aims to examine injury-related detraining effects while considering similar content and similar injury durations. Alternatively, in studies designed to examine post-season performance losses, because it will not be possible to force athletes to be inactive during the post-training period, there will be differential performance losses due to individual training, resulting in the effects of post-training not being fully captured. While high levels of physical activity during retraining can partially reduce the performance losses caused by retraining, complete inactivity (bedridden disability) can lead to dramatic performance losses. Although this study was designed to examine the effects of COVID -19 induced mobility impairments, it was considered inappropriate to include in the same evaluation those who managed to remain physically active during this period and those who were completely inactive or engaged in individual training. In that sense, it was considered necessary to ensure homogeneity of physical activity level for the period of this current unique detraining situation (COVID -19 Detraining) and to check heterogeneity in relation to the period prior to COVID -19 (high physical activity level in highly trained players due to high training volume). Even if the players had not been instructed to train during the COVID -19 suspension, it was noted that some reported regular participation in regular conditioning or multiple sports, and some remained physically active in various ways. These all-specific conditions during detraining can be largely successful in maintaining performance-based physical fitness. With this in mind, it was thought that it would be helpful to determine the physical activity levels that are useful as criteria for these conditions in this study.

5.3.3. Evaluation of Training Status

In addition to maturity, training status directly determines the type of adaptations underlying performance gains and detraining induced physical performances

(Bosquet et al., 2013). Controlling the effects of this moderator can be easy, unlike the impact of the maturity factor which requiring additional measurements or evaluations. For example, one can claim that group homogeneity is achieved by including players from the same football team or teams from the same division (elite-sub-elite-amateur) in a research design. However, if the goal is to detect training status-related differences in training- or detraining-induced physiological adaptations (as in the present study), some intervention should be performed to make classifications with respect to training status. At this point, data on the training background of the players were obtained from club records. These data were verified against the data obtained from the semi-structured interview with the coaches and the players themselves.

The reason for these interventions is to avoid misclassification that may result from some exceptional circumstances. For example, an athlete who has taken a break from football in the recent past for personal reasons may be excluded from the study, even though he was a player on the same team with other participants.

5.4. Practical Implications

The results of the present study demonstrate the detrimental effects of long-term detraining with significant decreases in the components of physical fitness after 27-week COVID -19 induced mobility restrictions on physical fitness. Depending on the growth-related physical development advantages, it can be misleading if some components of physical fitness decrease were not-dramatically levels. Strength and conditioning coaches should address these declines dramatically because when you consider that athletes at this age if they continued their regular training instead of remaining untrained, were also exempt from improvements in the expected 5-15% range, it's pretty striking. After a detraining period, trainers should also consider growth-related natural physical developments to set performance goals when designing a retraining program.

Even though all selected physical fitness components of this study are important determinants of match-winning actions in soccer, it is also notable that zigzag agility with the ball may be considered more remarkable for detraining induced physical fitness losses. Because the development of this performance is highly dependent on soccer-specific practices, evaluating performance decrements in this performance separately from other performances may provide more meaningful insights.

5.5. Limitations and Recommendations

This study attempted to compare the changes in physical fitness induced by detraining according to maturity and training status by partially removing or controlling or minimizing the effect of other moderators but ignoring the impact of some other important factors. It was not possible to control for the effects of other factors, such as psychological factors, sleep patterns, dietary habits, and physiological considerations, which are critical to both training-induced and detraining-induced physiological adaptations. Considering that the COVID -19 epidemic, specifically related to human life, tests the ability to cope with stressful and anxious situations that affect physical performance in humans and even in athletes, it might be advisable to consider this topic for further studies, but in particular, controlling physiological benefits by measuring muscle fiber type, muscle cross-sectional area, muscle architecture, or neural gating of muscles is a very, very difficult application.

Eliciting the level of physical activity to control for the effect of detraining level is a unique approach for this type of study, but the fact that these questionnaires include questions for the last week, assuming that they represent the level of COVID -19 lockdown, can be taken into account. Although individuals with different physical activity routines were identified and eliminated in the semi-structured interview conducted prior to these surveys, this point should still be noted as a limitation. However, it is certain that a design without any intervention would have been realized with an even greater limitation.

Soccer is a sport with position-specific requirements, so there could be meaningful differences in terms of players' playing positions(di Salvo et al., 2007; Martinez-Santos et al., 2016). However, the scope of this study was not included because a specific determination of playing position is not usually applied by clubs for child athletes in these age categories and the sample size is not large sufficient to make such a classification.

These components of physical fitness were selected because balance, strength, and other high-intensity efforts such as sprinting, agility, and explosive power are characterized by soccer-specific training responses. While the zigzag test without a ball only assesses agility from changes in direction, ball control and dribbling skills are also required for performing it with a ball. Sporiš et al., (2011) indicated that this agility performance without a ball is much more strongly related to other power performances such as speed, jumping power, and quickness than the performance with a ball. The findings of the present study showed that highly trained adolescents exhibited more dramatic percentage changes in zigzag agility with the ball in comparison with the recreationally trained ones, while there were no meaningful differences in these changes in terms of maturational differences. Chronic increases in each of these selected physical fitness tests are expected with soccer-specific training, and dramatic losses in these components are thought to be more evident after detraining period. No cardiorespiratory fitness test was included in the study because the measurement of cardiorespiratory fitness in children has some limitations (Mayorga-Vega et al., 2015) and applying a maximum cardiac workload, such as a 20-m shuttle run, after a long-term detraining period cannot be a healthy approach.

In the tests performed consecutively, it was predicted that there would be no performance losses due to fatigue when sufficient rest intervals were given (Martinez-Santos et al., 2016). However, this viewpoint was questioned by second measurements conducted for reliability analysis. Further studies should still pay attention to this point.

5.6. Conclusion

These results indicate that the 27-week detraining caused by COVID -19 induced mobility limitations adversely affects all components of physical fitness and that these adverse effects could be influenced by maturation or training status. Although the decreases in all components of physical fitness were significant, the effect sizes for some components were smaller than expected for such a long period of detraining (27 weeks). This result shows in detail that 27 weeks of physical development can significantly contribute to physical fitness. No significant 3-way interaction (time x maturity x training status) was found in the study. However, considering that the highly trained players at mid-PHV is the only group in which a significant decline was observed for each component of physical fitness (Table 12), and that the highest effect sizes are also reported in this group (with the exception of 2 parameters: RSI and RHG), it cannot be unequivocally said that the deterioration of physical fitness in this population is similar to that in other players. Nevertheless, it can be said that 2-way interactions provide more explainable conclusions in the current study. The detraining period caused by mobility restrictions had greater negative effects on some aspects of performance-related physical fitness (drop and squat jump heights and agility times (with and without the ball)) in players with -middle PHV than in players before PHV. On the other hand, this period had greater negative effects on some aspects of performance-related physical fitness (reactive strength index, 20-m running velocity, standing long jump, and dynamic balance) in highly trained players, regardless of maturity status.

REFERENCES

Ahtiainen, J. P., Pakarinen, A., Alen, M., Kraemer, W. J., & Häkkinen, K. (2003). Muscle hypertrophy, hormonal adaptations and strength development during strength training in strength-trained and untrained men. *European Journal of Applied Physiology*, *89*(6), 555–563.

Akbari, H. A., Pourabbas, M., Yoosefi, M., Briki, W., Attaran, S., Mansoor, H., Moalla, W., Damak, M., Dergaa, I., & Teixeira, A. L. (2021). How physical activity behavior affected well-being, anxiety and sleep quality during COVID-19 restrictions in Iran. *Eur Rev Med Pharmacol Sci*, *25*(24), 7847–7857.

Amaral, J. F., Mancini, M., & Novo Júnior, J. M. (2012). Comparison of three hand dynamometers in relation to the accuracy and precision of the measurements. *Brazilian Journal of Physical Therapy*, *16*(3), 216–224.

Andreato, L. v, Coimbra, D. R., & Andrade, A. (2020). Challenges to athletes during the home confinement caused by the COVID-19 pandemic. *Strength and Conditioning Journal*.

Arnason, A., Sigurdsson, S. B., Gudmundsson, A., Holme, I., Engebretsen, L., & Bahr, R. (2004). Physical fitness, injuries, and team performance in soccer. *Medicine & Science in Sports & Exercise*, *36*(2), 278–285.

Artero, E. G., Espana-Romero, V., Castro-Pinero, J., Ortega, F. B., Suni, J., Castillo-Garzon, M. J., & Ruiz, J. R. (2011). Reliability of field-based fitness tests in youth. *International Journal of Sports Medicine*, *32*(03), 159–169.

Behringer, M., Vom Heede, A., Matthews, M., & Mester, J. (2011). Effects of strength training on motor performance skills in children and adolescents: a meta-analysis. *Pediatric Exercise Science*, *23*(2), 186–206.

Behringer, M., vom Heede, A., Yue, Z., & Mester, J. (2010). Effects of resistance training in children and adolescents: a meta-analysis. *Pediatrics*, *126*(5), e1199–e1210.

Blair, S. N. (2009). Physical inactivity: the biggest public health problem of the 21st century. *British Journal of Sports Medicine*, *43*(1), 1–2.

Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. *Journal of Sports Science & Medicine*, *6*(1), 63.

Bosquet, L., Berryman, N., Dupuy, O., Mekary, S., Arvisais, D., Bherer, L., & Mujika, I. (2013). Effect of training cessation on muscular performance: A meta- analysis. *Scandinavian Journal of Medicine & Science in Sports*, *23*(3), e140–e149.

Bret, C., Rahmani, A., Dufour, A.-B., Messonnier, L., & Lacour, J. R. (2002). Leg strength and stiffness as ability factors in 100 m sprint running. *Journal of Sports Medicine and Physical Fitness*, *42*(3), 274.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet*, *395*(10227), 912–920.

Buchheit, M., & Mendez-Villanueva, A. (2014). Effects of age, maturity and body dimensions on match running performance in highly trained under-15 soccer players. *Journal of Sports Sciences*, *32*(13), 1271–1278.

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., & Chou, R. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, *54*(24), 1451–1462.

Burgomaster, K. A., Cermak, N. M., Phillips, S. M., Benton, C. R., Bonen, A., & Gibala, M. J. (2007). Divergent response of metabolite transport proteins in human skeletal muscle after sprint interval training and detraining. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *292*(5), R1970–R1976.

Butler, R. J., Southers, C., Gorman, P. P., Kiesel, K. B., & Plisky, P. J. (2012). Differences in soccer players' dynamic balance across levels of competition. *Journal of Athletic Training*, *47*(6), 616–620.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126.

Castañeda-Babarro, A., Arbillaga-Etxarri, A., Gutiérrez-Santamaría, B., & Coca, A. (2020). Physical activity change during COVID-19 confinement. *International Journal of Environmental Research and Public Health*, *17*(18), 6878.

Chaabene, H., Prieske, O., Herz, M., Moran, J., Höhne, J., Kliegl, R., Ramirez-Campillo, R., Behm, D. G., Hortobagyi, T., & Granacher, U. (2021). Home-based exercise programmes improve physical fitness of healthy older adults: a PRISMA-compliant systematic review and meta-analysis with relevance for COVID-19. *Ageing Research Reviews*, 101265.

Chaabene, H., Prieske, O., Herz, M., Moran, J., Höhne, J., Kliegl, R., Ramirez-Campillo, R., Behm, D. G., Hortobágyi, T., & Granacher, U. (2021). Home-based exercise programmes improve physical fitness of healthy older adults: A PRISMA-compliant systematic review and meta-analysis with relevance for COVID-19. *Ageing Research Reviews*, 101265.

Cohen, D. D., Restrepo, A., Richter, C., Harry, J. R., Franchi, M. v, Restrepo, C., Poletto, R., & Taberner, M. (2020). Detraining of specific neuromuscular qualities in elite footballers during COVID-19 quarantine. *Science and Medicine in Football*, 1–6.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences Lawrence Earlbaum Associates. *Hillsdale, NJ*, 20–26.

Corbin, C. B., & Noble, L. (1980). Flexibility: A major component of physical fitness. *Journal of Physical Education and Recreation*, *51*(6), 23–60.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U. L. F., Yngve, A., & Sallis, J. F. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, *35*(8), 1381–1395.

da Silveira, M. P., da Silva Fagundes, K. K., Bizuti, M. R., Starck, É., Rossi, R. C., & e Silva, D. T. de R. (2021). Physical exercise as a tool to help the immune system against COVID-19: an integrative review of the current literature. *Clinical and Experimental Medicine*, *21*(1), 15–28.

Damian, M., Oltean, A., & Damian, C. (2018). The Impact of Sedentary Behavior on Health and the Need for Physical Activity in Children and Adolescents. *Romanian Journal for Multidimensional Education/Revista Romaneasca Pentru Educatie Multidimensionala*, *10*(1).

de Oliveira Neto, L., Elsangedy, H. M., de Oliveira Tavares, V. D., Teixeira, C. V. L. S., Behm, D. G., & da Silva-Grigoletto, M. E. (2020). # TrainingInHome-Home-based training during COVID-19 (SARS-COV2) pandemic: physical exercise and behavior-based approach. *Revista Brasileira de Fisiologia Do Exercí Cio*, *19*(2), 9–19.

DeMet, T., & Wahl-Alexander, Z. (2019). Integrating Skill-Related Components of Fitness into Physical Education. *Strategies*, *32*(5), 10–17.

Demir, C., Subasi, B., & Harput, G. (2021). Effects of the COVID-19 confinement period on hip strength, flexibility and muscle injury rate in professional soccer players. *The Physician and Sportsmedicine*, 1–8.

DeRenne, C., Hetzler, R. K., Buxton, B. P., & Ho, K. W. (1996). Effects of training frequency on strength maintenance in pubescent baseball players. *The Journal of Strength & Conditioning Research*, *10*(1), 8–14.

di Salvo, V., Baron, R., Tschan, H., Montero, F. J. C., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, *28*(03), 222–227.

Edwards, A. M., Macfadyen, A. M., & Clark, N. (2003). Test performance indicators from a single soccer specific fitness test differentiate between highly trained and recreationally active soccer players. *Journal of Sports Medicine and Physical Fitness*, *43*(1), 14–20.

Faigenbaum, A. D., Farrell, A. C., Fabiano, M., Radler, T. A., Naclerio, F., Ratamess, N. A., Kang, J., & Myer, G. D. (2013). Effects of detraining on fitness performance in 7-year-old children. *The Journal of Strength & Conditioning Research*, *27*(2), 323–330.

Faigenbaum, A. D., Westcott, W. L., Micheli, L. J., Outerbridge, A. R., Long, C. J., LaRosa-Loud, R., & Zaichkowsky, L. D. (1996). The effects of strength training and detraining on children. *Journal of Strength and Conditioning Research*, *10*, 109–114.

Fedewa, A. L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: a meta-analysis. *Research Quarterly for Exercise and Sport*, *82*(3), 521–535.

Figueiredo, A. J., Gonçalves, C. E., Coelho E Silva, M. J., & Malina, R. M. (2009). Youth soccer players, 11–14 years: maturity, size, function, skill and goal orientation. *Annals of Human Biology*, *36*(1), 60–73.

Franchini, E., Takito, M. Y., Kiss, M., & Strerkowicz, S. (2005). Physical fitness and anthropometrical differences between elite and non-elite judo players. *Biology of Sport*, *22*(4), 315.

Freitas, T. T., Martinez-Rodriguez, A., Calleja-González, J., & Alcaraz, P. E. (2017). Short-term adaptations following Complex Training in team-sports: A meta-analysis. *PLoS One*, *12*(6), e0180223.

Galper, D. I., Trivedi, M. H., Barlow, C. E., Dunn, A. L., & Kampert, J. B. (2006). Inverse association between physical inactivity and mental health in men and women. *Medicine & Science in Sports & Exercise*, *38*(1), 173–178.

Getchell, B. (1979). *Physical fitness: A way of life*.

Girardi, M., Casolo, A., Nuccio, S., Gattoni, C., & Capelli, C. (2020). Detraining effects prevention: A new rising challenge for athletes. *Frontiers in Physiology*, *11*.

Giustino, V., Parroco, A. M., Gennaro, A., Musumeci, G., Palma, A., & Battaglia, G. (2020). Physical activity levels and related energy expenditure during COVID-19 quarantine among the Sicilian active population: a cross-sectional online survey study. *Sustainability*, *12*(11), 4356.

Glatthorn, J. F., Gouge, S., Nussbaumer, S., Stauffacher, S., Impellizzeri, F. M., & Maffiuletti, N. A. (2011). Validity and reliability of Optojump photoelectric cells for estimating vertical jump height. *The Journal of Strength & Conditioning Research*, *25*(2), 556–560.

Goswami, B., Roy, A. S., Dalui, R., & Bandyopadhyay, A. (2014). Impact of pubertal growth on physical fitness. *Am J Sport Sci Med*, *2*(5A), 34–39.

Grazioli, R., Loturco, I., Baroni, B. M., Oliveira, G. S., Saciura, V., Vanoni, E., Dias, R., Veeck, F., Pinto, R. S., & Cadore, E. L. (2020). Coronavirus disease-19 quarantine is more detrimental than traditional off-season on physical conditioning of professional soccer players. *The Journal of Strength & Conditioning Research*, *34*(12), 3316–3320.

Guessogo, W. R., Bika-Lele, E. C., Mban-Bian, W., Mandjek, A. R. D., Temfemo, A., Mandengue, S. H., & Assomo-Ndemba, P. B. (2021). Impact of Covid-19 Semi-lockdown on Sports and Physical Activity Behaviors of Cameroonian Elite Volleyball Players: A Cross-sectional Study. *Electronic Physician*, *13*(1).

Guimarães, E., Ramos, A., Janeira, M. A., Baxter-Jones, A. D. G., & Maia, J. (2019). How does biological maturation and training experience impact the physical and technical performance of 11–14-year-old male basketball players? *Sports*, *7*(12), 243.

Hallal, P. C., Victora, C. G., Wells, J. C. K., & Lima, R. da C. (2003). Physical inactivity: prevalence and associated variables in Brazilian adults. *Medicine and Science in Sports and Exercise*, *35*(11), 1894–1900.

Hammami, A., Harrabi, B., Mohr, M., & Krustrup, P. (2020). Physical activity and coronavirus disease 2019 (COVID-19): specific recommendations for home-based physical training. *Managing Sport and Leisure*, 1–6.

Hammami, R., Chaouachi, A., Makhlouf, I., Granacher, U., & Behm, D. G. (2016b). Associations between balance and muscle strength, power performance in male youth athletes of different maturity status. *Pediatric Exercise Science*, *28*(4), 521–534.

Hammami, R., Granacher, U., Makhlouf, I., Behm, D. G., & Chaouachi, A. (2016). Sequencing effects of balance and plyometric training on physical performance in youth soccer athletes. *The Journal of Strength & Conditioning Research*, *30*(12), 3278–3289.

Hortobágyi, T., Houmard, J. A., Stevenson, J. R., Fraser, D. D., Johns, R. A., & Israel, R. G. (1993). The effects of detraining on power athletes. *Medicine and Science in Sports and Exercise*, *25*(8), 929–935.

Irıneu Loturco, L. A. P., Kobal, H., Kıtamura, K., Abad, C. C. C. A. L., & Nakamura, F. Y. (2015). Effects of detraining on neuromuscular performance in a selected group of elite women pole-vaulters: A case study. *J Sports Med Phys Fitness*.

Izquierdo, M., Ibañez, J., González-Badillo, J. J., Ratamess, N. A., Kraemer, W. J., Häkkinen, K., Bonnabau, H., Granados, C., French, D. N., & Gorostiaga, E. M. (2007). Detraining and tapering effects on hormonal responses and strength performance. *The Journal of Strength & Conditioning Research*, *21*(3), 768–775.

Joo, C. H. (2016). The effects of short-term detraining on exercise performance in soccer players. *Journal of Exercise Rehabilitation*, *12*(1), 54.

Joo, C. H. (2018). The effects of short term detraining and retraining on physical fitness in elite soccer players. *PloS One*, *13*(5), e0196212.

Jurca, R., Jackson, A. S., LaMonte, M. J., Morrow Jr, J. R., Blair, S. N., Wareham, N. J., Haskell, W. L., van Mechelen, W., Church, T. S., & Jakicic, J. M. (2005). Assessing cardiorespiratory fitness without performing exercise testing. *American Journal of Preventive Medicine*, *29*(3), 185–193.

Kantomaa, M. T., Stamatakis, E., Kankaanpää, A., Kaakinen, M., Rodriguez, A., Taanila, A., Ahonen, T., Järvelin, M.-R., & Tammelin, T. (2013). Physical activity and obesity mediate the association between childhood motor function and adolescents' academic achievement. *Proceedings of the National Academy of Sciences*, *110*(5), 1917–1922.

Kariyawasam, A., Ariyasinghe, A., Rajaratnam, A., & Subasinghe, P. (2019). Comparative study on skill and health related physical fitness characteristics between national basketball and football players in Sri Lanka. *BMC Research Notes*, *12*(1), 1–5.

Kaur, H., Singh, T., Arya, Y. K., & Mittal, S. (2020). Physical Fitness and Exercise During the COVID-19 Pandemic: A Qualitative Enquiry. *Frontiers in Psychology*, *11*.

Knapik, A., Brzęk, A., Famuła-Wąż, A., Gallert-Kopyto, W., Szydłak, D., Marcisz, C., & Plinta, R. (2019). The relationship between physical fitness and health self-assessment in elderly. *Medicine*, *98*(25).

Köklü, Y., Alemdaroğlu, U., Özkan, A., Koz, M., & Ersöz, G. (2015). The relationship between sprint ability, agility and vertical jump performance in young soccer players. *Science & Sports*, *30*(1), e1–e5.

Kolimechkov, S. (2017). Physical fitness assessment in children and adolescents: A systematic review. *European Journal of Physical Education and Sport Science*.

Koundourakis, N. E., Androulakis, N. E., Malliaraki, N., Tsatsanis, C., Venihaki, M., & Margioris, A. N. (2014). Discrepancy between exercise performance, body composition, and sex steroid response after a six-week detraining period in professional soccer players. *PloS One*, *9*(2), e87803.

Kozieł, S. M., & Malina, R. M. (2018). Modified maturity offset prediction equations: validation in independent longitudinal samples of boys and girls. *Sports Medicine*, *48*(1), 221–236.

Kubo, K., Ikebukuro, T., Yata, H., Tsunoda, N., & Kanehisa, H. (2010). Time course of changes in muscle and tendon properties during strength training and detraining. *The Journal of Strength & Conditioning Research*, *24*(2), 322–331.

Laporte, R. E., Montoye, H. J., & Caspersen, C. J. (1985). Assessment of physical activity in epidemiologic research: problems and prospects. *Public Health Reports*, *100*(2), 131.

Lawman, H. G., Troiano, R. P., Perna, F. M., Wang, C.-Y., Fryar, C. D., & Ogden, C. L. (2016). Associations of relative handgrip strength and cardiovascular disease biomarkers in US adults, 2011–2012. *American Journal of Preventive Medicine*, *50*(6), 677–683.

Leitão, L., Pereira, A., Mazini, M., Venturini, G., Campos, Y., Vieira, J., Novaes, J., Vianna, J., da Silva, S., & Louro, H. (2019). Effects of three months of detraining on the health profile of older women after a multicomponent exercise program. *International Journal of Environmental Research and Public Health*, *16*(20), 3881.

Lesser, I. A., & Nienhuis, C. P. (2020). The impact of COVID-19 on physical activity behavior and well-being of Canadians. *International Journal of Environmental Research and Public Health*, *17*(11), 3899.

Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength & Conditioning Journal*, *34*(3), 61–72.

Lloyd, R. S., Oliver, J. L., Faigenbaum, A. D., Myer, G. D., & Croix, M. B. A. D. S. (2014). Chronological age vs. biological maturation: implications for exercise programming in youth. *The Journal of Strength & Conditioning Research*, *28*(5), 1454–1464.

Lloyd, R. S., Oliver, J. L., Hughes, M. G., & Williams, C. A. (2011). Specificity of test selection for the appropriate assessment of different measures of stretch-shortening cycle function in children. *The Journal of Sports Medicine and Physical Fitness*, *51*(4), 595–602.

Lloyd, R. S., Radnor, J. M., Croix, M. B. A. D. S., Cronin, J. B., & Oliver, J. L. (2016). Changes in sprint and jump performances after traditional, plyometric, and combined resistance training in male youth pre-and post-peak height velocity. *The Journal of Strength & Conditioning Research*, *30*(5), 1239–1247.

Lockie, R. G., Schultz, A. B., Callaghan, S. J., Jeffriess, M. D., & Berry, S. P. (2013). Reliability and validity of a new test of change-of-direction speed for field-based sports: the change-of-direction and acceleration test (CODAT). *Journal of Sports Science & Medicine*, *12*(1), 88.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. Human kinetics.

Manini, T. M., & Clark, B. C. (2012). Dynapenia and aging: an update. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *67*(1), 28–40.

Mannino, G., Giunta, S., Montefiori, V., Tamanza, G., Iacolino, C., Novara, C., Rita, P., La Fiura, G., & Bernardone, A. (2019). Healthy lifestyle, well-being, physical activity, sport, and scholastic/academic performance: interactions and connections. *World Futures*, *75*(7), 462–479.

Martinez-Santos, R., Castillo, D., & Los Arcos, A. (2016). Sprint and jump performances do not determine the promotion to professional elite soccer in Spain, 1994–2012. *Journal of Sports Sciences*, *34*(24), 2279–2285.

Maugeri, G., Castrogiovanni, P., Battaglia, G., Pippi, R., D'Agata, V., Palma, A., di Rosa, M., & Musumeci, G. (2020). The impact of physical activity on psychological health during Covid-19 pandemic in Italy. *Heliyon*, *6*(6), e04315.

Mayorga-Vega, D., Aguilar-Soto, P., & Viciana, J. (2015). Criterion-related validity of the 20-m shuttle run test for estimating cardiorespiratory fitness: a meta-analysis. *Journal of Sports Science & Medicine*, *14*(3), 536.

McArdle, W. D., Katch, F. I., & Katch, V. L. (2010). *Exercise physiology: nutrition, energy, and human performance* (seventh). Lippincott Williams & Wilkins.

Medicine, A. C. of S. (2013). *ACSM's health-related physical fitness assessment manual*. Lippincott Williams & Wilkins.

Melchiorri, G., Ronconi, M., Triossi, T., Viero, V., de Sanctis, D., Tancredi, V., Salvati, A., Padua, E., & Cruz JR, A. (2014). Detraining in young soccer players. *The Journal of Sports Medicine and Physical Fitness*, *54*(1), 27–33.

Meyers, R. (2016). *The influence of age, growth and maturation upon maximal sprint speed in male youth*. Cardiff Metropolitan University.

Meylan, C. M. P., Cronin, J. B., Oliver, J. L., Hopkins, W. G., & Contreras, B. (2014). The effect of maturation on adaptations to strength training and detraining in 11–15- year- olds. *Scandinavian Journal of Medicine & Science in Sports*, *24*(3), e156–e164.

Miles, L. (2007). Physical activity and health. *Nutrition Bulletin*, *32*(4), 314–363.

Miles, M. P., Heil, D. P., Larson, K. R., Conant, S. B., & Schneider, S. M. (2005). Prior resistance training and sex influence muscle responses to arm suspension. *Medicine & Science in Sports & Exercise*, *37*(11), 1983–1989.

Mirwald, R. L., Baxter-Jones, A. D. G., Bailey, D. A., & BEUNEN, G. P. (2002). An assessment of maturity from anthropometric measurements. *Medicine & Science in Sports & Exercise*, *34*(4), 689–694.

Moran, J., Parry, D. A., Lewis, I., Collison, J., Rumpf, M. C., & Sandercock, G. R. H. (2018). Maturation-related adaptations in running speed in response to sprint training in youth soccer players. *Journal of Science and Medicine in Sport*, *21*(5), 538–542.

Moran, J., Sandercock, G. R. H., Ramírez-Campillo, R., Meylan, C., Collison, J., & Parry, D. A. (2017). A meta-analysis of maturation-related variation in adolescent boy athletes' adaptations to short-term resistance training. *Journal of Sports Sciences*, *35*(11), 1041–1051.

Mota, J., Guerra, S., Leandro, C., Pinto, A., Ribeiro, J. C., & Duarte, J. A. (2002). Association of maturation, sex, and body fat in cardiorespiratory fitness. *American Journal of Human Biology*, *14*(6), 707–712.

Muehlbauer, T., Gollhofer, A., & Granacher, U. (2013). Association of balance, strength, and power measures in young adults. *The Journal of Strength & Conditioning Research*, *27*(3), 582–589.

Mujika, I., & Padilla, S. (2000). Detraining: loss of training-induced physiological and performance adaptations. Part I. *Sports Medicine*, *30*(2), 79–87.

Musselwhite, C., Avineri, E., & Susilo, Y. (2021). Restrictions on mobility due to the coronavirus Covid19: Threats and opportunities for transport and health. *Journal of Transport & Health*.

Neyzi, O., Bundak, R., Gökçay, G., Günöz, H., Furman, A., Darendeliler, F., & Baş, F. (2015). Reference values for weight, height, head circumference, and body mass index in Turkish children. *Journal of Clinical Research in Pediatric Endocrinology*, *7*(4), 280.

Ng, K., Cooper, J., McHale, F., Clifford, J., & Woods, C. (2020). Barriers and facilitators to changes in adolescent physical activity during COVID-19. *BMJ Open Sport & Exercise Medicine*, *6*(1), e000919.

Nugroho, M. S., & Or, M. (2005). *The detraining effects of complete inactivity*. Doctoral dissertation, Thesis.

Nuzzo, J. L. (2020). The case for retiring flexibility as a major component of physical fitness. *Sports Medicine*, *50*(5), 853–870.

Oh, J., Lee, H.-Y., Khuong, Q. L., Markuns, J. F., Bullen, C., Barrios, O. E. A., Hwang, S., Suh, Y. S., McCool, J., & Kachur, S. P. (2021). Mobility restrictions were associated with reductions in COVID-19 incidence early in the pandemic: evidence from a real-time evaluation in 34 countries. *Scientific Reports*, *11*(1), 1–17.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International Journal of Obesity*, *32*(1), 1–11.

Patel, R., Nevill, A., Cloak, R., Smith, T., & Wyon, M. (2019). *Relative Age, Maturation, Anthropometry and Physical Performance Characteristics of Players Within an Elite Youth Football Academy*.

Pereira, L. A., Freitas, T. T., Pivetti, B., Alcaraz, P. E., Jeffreys, I., & Loturco, I. (2020). Short-term detraining does not impair strength, speed, and power performance in elite young soccer players. *Sports*, *8*(11), 141.

Philippaerts, R. M., Vaeyens, R., Janssens, M., van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G., & Malina, R. M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. *Journal of Sports Sciences*, *24*(3), 221–230.

Pillsbury, L., Oria, M., & Pate, R. (2013). *Fitness measures and health outcomes in youth*.

Pinto, A. J., Dunstan, D. W., Owen, N., Bonfá, E., & Gualano, B. (2020). Combating physical inactivity during the COVID-19 pandemic. *Nature Reviews Rheumatology*, *16*(7), 347–348.

Plisky, P. J., Rauh, M. J., Kaminski, T. W., & Underwood, F. B. (2006). Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. *Journal of Orthopaedic & Sports Physical Therapy*, *36*(12), 911–919.

Power, K., Behm, D., Cahill, F., Carroll, M., & Young, W. (2004). An acute bout of static stretching: effects on force and jumping performance. *Medicine & Science in Sports & Exercise*, *36*(8), 1389–1396.

Prieske, O., Chaabene, H., Puta, C., Behm, D. G., Büsch, D., & Granacher, U. (2019). Effects of drop height on jump performance in male and female elite adolescent handball players. *International Journal of Sports Physiology and Performance*, *14*(5), 674–680.

Pritchard, H. J., Barnes, M. J., Stewart, R. J. C., Keogh, J. W. L., & McGuigan, M. R. (2018). Short-term training cessation as a method of tapering to improve maximal strength. *The Journal of Strength & Conditioning Research*, *32*(2), 458–465.

Read, P. J., Oliver, J. L., Croix, M. B. A. D. S., Myer, G. D., & Lloyd, R. S. (2019). A review of field-based assessments of neuromuscular control and their utility in male youth soccer players. *The Journal of Strength & Conditioning Research*, *33*(1), 283–299.

Romero, C., Ramirez-Campillo, R., Alvarez, C., Moran, J., Slimani, M., Gonzalez, J., & Banzer, W. E. (2021). Effects of maturation on physical fitness adaptations to plyometric jump training in youth females. *Journal of Strength and Conditioning Research*, *35*(10), 2870–2877.

Ruiz, J. R., Castro-Piñero, J., España-Romero, V., Artero, E. G., Ortega, F. B., Cuenca, M. M., Jimenez-Pavón, D., Chillón, P., Girela-Rejón, M. J., & Mora, J. (2011). Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *British Journal of Sports Medicine*, *45*(6), 518–524.

Ruíz-Roso, M. B., de Carvalho Padilha, P., Matilla-Escalante, D. C., Brun, P., Ulloa, N., Acevedo-Correa, D., Arantes Ferreira Peres, W., Martorell, M., Rangel Bousquet Carrilho, T., & de Oliveira Cardoso, L. (2020). Changes of physical activity and ultra-processed food consumption in adolescents from different countries during Covid-19 pandemic: An observational study. *Nutrients*, *12*(8), 2289.

Saglam, M., Arikan, H., Savci, S., Inal-Ince, D., Bosnak-Guclu, M., Karabulut, E., & Tokgozoglu, L. (2010). International physical activity questionnaire: reliability and validity of the Turkish version. *Perceptual and Motor Skills*, *111*(1), 278–284.

Salazar, H., Svilar, L., Garcia, L., González-Lago, L., & Castellano, J. (2020). Negative Impact Of COVID-19 HomeConfinement On Physical Performance Of EliteYouth Basketball Players. *Sport Performance & Science Reports*.

Sallis, J. F., Adlakha, D., Oyeyemi, A., & Salvo, D. (2020). An international physical activity and public health research agenda to inform COVID-19 policies and practices. *Journal of Sport and Health Science*.

Sallis, R., Young, D. R., Tartof, S. Y., Sallis, J. F., Sall, J., Li, Q., Smith, G. N., & Cohen, D. A. (2021). Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48 440 adult patients. *British Journal of Sports Medicine*.

Santos, E. J. A. M., & Janeira, M. A. A. S. (2009). Effects of reduced training and detraining on upper and lower body explosive strength in adolescent male basketball players. *The Journal of Strength & Conditioning Research*, *23*(6), 1737–1744.

Sarto, F., Impellizzeri, F. M., Spörri, J., Porcelli, S., Olmo, J., Requena, B., Suarez-Arrones, L., Arundale, A., Bilsborough, J., & Buchheit, M. (2020). Impact of potential physiological changes due to COVID-19 home confinement on athlete health protection in elite sports: a call for awareness in sports programming. *Sports Medicine*, *50*, 1417–1419.

Schmidt, S. C. E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A., & Woll, A. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports*, *10*(1), 1–12.

Schorer, J., Cobley, S., Büsch, D., Bräutigam, H., & Baker, J. (2009). Influences of competition level, gender, player nationality, career stage and playing position on relative age effects. *Scandinavian Journal of Medicine & Science in Sports*, *19*(5), 720–730.

Smith, D. J. (2003). A framework for understanding the training process leading to elite performance. *Sports Medicine, 33*(15), 1103–1126.

Smith, L., Yang, L., & Hamer, M. (2019). Handgrip strength, inflammatory markers, and mortality. *Scandinavian Journal of Medicine & Science in Sports*, *29*(8), 1190–1196.

Sporiš, G., Milanović, Z., Trajković, N., & Joksimović, A. (2011). Correlation between speed, agility and quickness (SAQ) in elite young soccer players. *Acta Kinesiologica, 5*(2), 36–41.

Spyrou, K., Alcaraz, P. E., Marín-Cascales, E., Herrero-Carrasco, R., Cohen, D. D., Calleja-Gonzalez, J., Pereira, L. A., Loturco, I., & Freitas, T. T. (2021). Effects of the COVID-19 Lockdown on Neuromuscular Performance and Body Composition in Elite Futsal Players. *The Journal of Strength & Conditioning Research*, *35*(8), 2309–2315.

Stockwell, S., Trott, M., Tully, M., Shin, J., Barnett, Y., Butler, L., McDermott, D., Schuch, F., & Smith, L. (2021). Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. *BMJ Open Sport & Exercise Medicine*, *7*(1), e000960.

Sunda, M., Gilic, B., Peric, I., Jurcev Savicevic, A., & Sekulic, D. (2021). Evidencing the Influence of the COVID-19 Pandemic and Imposed Lockdown Measures on Fitness Status in Adolescents: A Preliminary Report. *Healthcare, 9*(6), 681.

Tayech, A., Mejri, M. A., Makhlouf, I., Mathlouthi, A., Behm, D. G., & Chaouachi, A. (2020). Second wave of covid-19 global pandemic and athletes’ confinement: Recommendations to better manage and optimize the modified lifestyle. *International Journal of Environmental Research and Public Health*, *17*(22), 8385.

Thomassen, M., Christensen, P. M., Gunnarsson, T. P., Nybo, L., & Bangsbo, J. (2010). Effect of 2-wk intensified training and inactivity on muscle Na+-K+ pump expression, phospholemman (FXYD1) phosphorylation, and performance in soccer players. *Journal of Applied Physiology*, *108*(4), 898–905.

Tison, G. H., Avram, R., Kuhar, P., Abreau, S., Marcus, G. M., Pletcher, M. J., & Olgin, J. E. (2020). Worldwide effect of COVID-19 on physical activity: a descriptive study. *Annals of Internal Medicine*, *173*(9), 767–770.

Toraman, N. F. (2005). Short term and long term detraining: is there any difference between young-old and old people? *British Journal of Sports Medicine*, *39*(8), 561–564.

Tornaghi, M., Lovecchio, N., Vandoni, M., Chirico, A., & Codella, R. (2020). Physical activity levels across COVID-19 outbreak in youngsters of Northwestern Lombardy. *The Journal of Sports Medicine and Physical Fitness*.

Tsolakis, C. K., Vagenas, G. K., & Dessypris, A. G. (2004). Strength adaptations and hormonal responses to resistance training and detraining in preadolescent males. *The Journal of Strength & Conditioning Research*, *18*(3), 625–629.

Tsolakis, C., Messınıs, D., Stergioulas, A., & Dessypris, A. (2000). Hormonal responses after strength training and detraining in prepubertal and pubertal boys. *The Journal of Strength & Conditioning Research*, *14*(4), 399–404.

Tsoukos, A., & Bogdanis, G. C. (2022). The Effects of a Five-Month Lockdown Due to COVID-19 on Physical Fitness Parameters in Adolescent Students: A Comparison between Cohorts. *International Journal of Environmental Research and Public Health*, *19*(1), 326.

Villaseca-Vicuña, R., Pérez-Contreras, J., Merino-Muñoz, P., González-Jurado, J. A., & Aedo-Muñoz, E. (2021). Effects of COVID-19 confinement measures on training loads and the level of well-being in players from Chile women’s national soccer team. *Revista de La Facultad de Medicina*, *69*(1).

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: the evidence. *Cmaj*, *174*(6), 801–809.

WHO Coronavirus (COVID-19) Dashboard. https://covid19.who.int/ (n.d.).

Williams, H. G., Pfeiffer, K. A., O’neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008). Motor skill performance and physical activity in preschool children. *Obesity*, *16*(6), 1421–1426.

Yoshida, Y., Hatta, H., Kato, M., Enoki, T., & Bonen, A. (2005). Different sensitivities of muscle monocraboxylate transporters MCT1 and MCT4 to training intensity. *Proceedings of the Canadian Federation of Biological Sciences, Guelph, ON*, 124.

Zacca, R., Toubekis, A., Freitas, L., Silva, A. F., Azevedo, R., Vilas-Boas, J. P., Pyne, D. B., Castro, F. A. D. S., & Fernandes, R. J. (2019). Effects of detraining in age-group swimmers performance, energetics and kinematics. *Journal of Sports Sciences*, *37*(13), 1490–1498.

Zhou, Y., Xu, R., Hu, D., Yue, Y., Li, Q., & Xia, J. (2020). Effects of human mobility restrictions on the spread of COVID-19 in Shenzhen, China: a modelling study using mobile phone data. *The Lancet Digital Health*, *2*(8), e417–e424.

APPENDICES

A. ETHICAL COMMITTEE APPROVAL

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

Sayı: 28620816 /

29 Eylül 2020

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Settar KOÇAK

Danışmanlığını yaptığınız Gürcan ÜNLÜ'nün ***Çocuklarda antrenmansızlık ve fiziksel inaktivitenin atletik performanslara etkileri: Korona Virüs (COVID 19) pandemisinin getirdikleri"*** başlıklı araştırmanız İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve **258-ODTU-2020** protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof.Dr. Mine MISIRLISOY
İAEK Başkanı

B. CURRICULUM VITAE

Gürcan Ünlü

June 2019

EDUCATION

2014 - 2022 Middle East Technical University, Ph.D.
Major: Physical Education and Sports
Advisor: Mustafa Söğüt

2012 - 2014 Akdeniz University, M.A.
Major: Physical Education and Sports
Advisor: Tuba Melekoğlu

2006 - 2011 Akdeniz University, B.A.
Major: Coaching Education

PUBLICATIONS

Ünlü, G., Çevikol, C., &Melekoğlu, T. (2019). Comparison of the Effects of Eccentric, Concentric, and Eccentric-Concentric Isotonic Resistance Training at Two Velocities on Strength and Muscle Hypertrophy.Journal of strength and conditioning research.

Coskun, B., Unlu, G., Golshaei, B., Kocak, S., & Kirazcı, S. (2019). Comparison of the static and dynamic balance between normal-hearing and hearing-impaired wrestlers. Montenegrin Journal of Sports Science and Medicine, 8(1), 11-16.

Isık, A., Unlu, G., Gozubuyuk, O. B., Aslanyurek, T., & Bereceli, C. (2018). The relationship between previous lower extremity injury, body weight and bilateral eccentric hamstring strength imbalance in young soccer players. Montenegrin Journal of Sports Science and Medicine, 7(2).

Melekoğlu, T., Ünlü, G., &Işın, A. (2018). The Effects of Training on Respiratory System of Adolescents Aged 13-14. Ulusal SporBilimleri Dergisi, 2(1), 1-7.

Ünlü, G., Polat, B., Güler, A. H., &Işık, A. Futbolda Oyuncu Performans Takiplerinde Kullanilan Küresel Konum Belirleme (Gps) ve Çoklu Kamera Sistemlerinin Incelenmesi. Sportif Bakış: Spor ve Eğitim Bilimleri Dergisi, 38-45.

Ünlü, G., &Tatlıcı, A. (2018) Elit Güreşçilerde Proprioseptif Nöromuskuler Fasilitasyon (Pnf) Uygulamalarinin Dinamik Denge Performansina Akut Etkileri. Sportif Bakış: Spor ve Eğitim Bilimleri Dergisi, 57-63.

Ünlü G., &Koçak, S. (2018) An investigation of Eccentric Versus Concentric Resistance Training: The Role of Movement Velocity and Training Type. Turkish Journal of Sport and Exercise, 20(3), 297-300.

Ozalp, H., Ünlü, G., Cengiz, A., & Yaman, M. S. (2016). Insulin Resistance and Diets and Exercise. *The Online Journal of Recreation and Sport*, *5*(1), 20.

Ünlü, G., Cengiz, A., &Koçak, S. (2016). P-13 Effects of a short-term walking program on lung function of obese early adolescent boys.

Işık, A., & Ünlü, G. (2017). Spor Yaralanmalarından Korunmada Teknoloji. Turkiye Klinikleri Journal of Sports Medicine-Special Topics, 3(3), 214-218.

Deliceoğlu, G., Ünlü, G., Coşkun, B., Tortu, E., Kocahan, T., &Koçak, S. (2017). The Effect of Ground Contact Time and Drop Height on Work and Power Outputs for Drop Jump in Youth Turkish National Volleyball Players. Journal of Physical Education & Sports Science/Beden Egitimi ve Spor Bilimleri Dergisi, 11(3).

CONFERENCE PRESENTATION_________________________

Certel Z., Bahadir Z., Yildiz Ö., Unlu G., "Üniversitede Özel Yetenek Sınavı İle Öğrenci Alan Bölümlerde Öğrenim Gören Öğrencilerin Web'le İlgili Bilişsel Kapılmaları ve Kabulleri", IV. Beden Eğitimi ve Spor Öğretiminde Yeni ve Yaratıcı Yaklaşımlar Sempozyumu, ANKARA, TÜRKIYE, 25-26 Ocak 2013, ss.16-16

Gündüz B., Kalkavan A., Ekinci., E. N., Ünlü G. "Dumlupınar Üniversitesi, Akdeniz Üniversitesive Onsekiz Mart Üniversitesi Beden Eğitimi Öğretmenliği, Antrenörlük Eğitimi ve Yöneticilik Bölümü 1. ve 4. Sınıf Öğrencelerinin Sınav Öncesi Durumluluk Kaygı Düzeylerinin Belirlenmesi "30May-02 June 2013 International Balkan Symposium in Sport Sciences, Tetova-Macedonia.

Ünlü, G.,Melekoğlu T. (2014). Effect of Different Types of Resistance Training on Muscular Strength. Oral presented at the *International Conference of Physical Education and Sports*conference, Perak, MALAYSIA.

Melekoğlu T, Ünlü, G. (2014). The Effects of Training on Respiratory System of Children Aged 13-14. Poster presented at the *The 13th International Sports Sciences Congress*, Konya,TURKEY.

Melekoğlu T, **Ünlü, G.**,Gönen D.(2014).Investigating Differences on Physical and Physiological Parameters in Competitive Athletics between the Age of 14-16 Years. Poster presented at the *The 13th International Sports Sciences Congress*, Konya, TURKEY.

CoşkunB, Ünlü, G**.**, Golshaei B., Koçak S., Kirazcı S. (2016). Comparison of Static and Dynamic Balance Between Normal and Hearing-İmpaired Wrestlers. Oral presented at the *The 14th International Sports Sciences Congress*, Belek, Antalya, TURKEY.

Ünlü G, Cengiz, A**.**,Koçak S (2016). Comparison of The Effects of Fast Push-Up and Slow Push-Up Training on Upper Body Strength and Power Performance. Poster presented at the *The 14th International Sports Sciences Congress*, Belek, Antalya, TURKEY.

Ünlü G, **Yazıcı, T**., Cengiz A., Koçak S. (2016). The Comparison of Strength and Power Characteristics among Power Athletes, Endurance Athletes and Field Sport Athletes Aged Between 14-16 Years. Poster presented at the 3rd International Conference on Recent Trends on Fitness, Health & Sports Science, University of Mauritius, Mauritius.

Ünlü G, Cengiz, A**.**,Koçak S.(2016).Effects of a short-term walking program on lung function of obese early adolescent boys. Poster presented at the *34th FIMS World Sports Medicine Congress*, Ljubljana, SLOVENIA.

Ünlü G.,Melekoğlu T., Özdem S., "Acute Hematological Changes After Different Types of Resistance Training in Young Men", The International Balkan Conference in Sport Sciences, Talk presented at the BURSA, TURKEY, 21-23 May 2017, pp.96-96

Ünlü G., Melekoğlu T., Çevikol C., "A Comparative Study On The Effects Of Different Types Of High-Intensity Isotonic Leg-Extension Training At Different Velocities On Quadriceps Muscle Volume", 22nd Annual Congress of The European College of Sport Science, Talk presented at the Essen, Germany, 5- 8 july 2017, pp.573-573

Ünlü G., Cengiz A., Koçak S., " Elit Güreşçilerde Proprioseptif Nöromuskuler Fasilitasyon (Pnf) Uygulamalarinin Alt Ekstremite Fleksör-Ekstansör Kas Kuvvetleri Üzerine Akut Etkileri, Poster presented at the BURSA, Turkey, 21-23 May 2017, pp.566-577

Işık A., **Ünlü G**, Gözübüyük, B. Ö**.**, Aslanyürek T., Becereli C (2017). The Relationship between Previous Lower Extremity Injury, Body Weight and Bilateral Eccentric Hamstring Strength Imbalance in Young Soccer Players. Poster presented at the *The 15th International Sports Sciences Congress*, Antalya, TURKEY.

Deliceoğlu G., Ünlü G, **Coşkun, B**.,Tortu E., Kocahan T (2017). The Effect of Box Height And Ground Contact Time on Work Performed And Power Outputs For Drop Jump in Youth Turkish National Volleyball Players. Poster presented at the *The 15th International Sports Sciences Congress*, Antalya, TURKEY.

Ünlü G., Gözübüyük, B. Ö, Koçak, S.,(2017). Comparison of the Effects of Fast and Slow Velocity Push Up Workouts on Upper Extremity Strength and Power Enhancement and Detraining Effects on Strength and Power in Young Soccer

Players. Poster presented at the *The 15th International Sports Sciences Congress*, Antalya, TURKEY.

Işık A. and **Ünlü G**. (2018). Spor Yaralanmalarından korunmada Teknoloji. Oral presented at The International Congress of Sports for All and Wellness, Antalya, TURKEY 5-8 April 2018, pp.84.

Ünlü G.,Gözübüyük, B. Ö, Koçak, S (2018). Kuvvet Antrenmanlarinda Hareketin Yapiliş Hizinin Kuvvet ve Hipertrofi Üzerine Etkileri. Oral presented at The International Congress of Sports for All and Wellness, Antalya, TURKEY 5-8 April 2018, pp.80-81.

Tatlıcı A and **Ünlü G** (2018). Elit Güreşçilerde Proprioseptif Nöromuskuler Fasilitasyon (PNF) Uygulamalarının Dinamik Denge Performansına Akut Etkileri. Oral presented at the *The 16th International Sports Sciences Congress*, Belek, Antalya, TURKEY.

Ünlü G and Tatlıcı A (2018). Elit Güreşçilerde Proprioseptif Nöromuskuler Fasilitasyon (PNF) Uygulamalarının Kuvvet Üzerinde Akut Etkileri. Oral presented at the *The 16th International Sports Sciences Congress,* Belek, Antalya, TURKEY.

Polat B, Kartal A, **Ünlü G** (2018). Türkiye Spor Toto Süper Ligindeki Futbol Takımlarının Fiziksel Performans Değerlerinin Incelenmesi. Oral presented at the *The 16th International Sports Sciences Congress*, Belek, Antalya, TURKEY.

Tatlıcı A,**Ünlü G** and Çakmakçı E (2018).Elit Güreşçilerde Izokinetik Kuvvet Dengesizliği ve Esnekliğin Diz Yaralanmalarındaki Rolü. Oral presented at the *The 16th International Sports Sciences Congress*, Belek, Antalya, TURKEY.

Ünlü G. (2018). Sakatlık Geçirmemiş Genç futbolcuların Eksantrik diz fleksör kuvvetlerinde limb simetri indeksi değerleri (LSI). Oral presented at Cemil Meriç – 10. Sosyal Bilimler ve Spor Kongresi, Hatay, TURKEY 23-25Kasım 2018,

Ünlü G. (2018). Genç Futbolcularda Vücut Kitle İndeksi (VKİ) ve Eksantrik Diz Fleksör Kuvveti Arasındaki Korelasyon.Oral presented at CemilMeriç – 10. Sosyal Bilimler ve Spor Kongresi, Hatay, TURKEY 23-25Kasım 2018,

Ünlü G.,Tatlıcı A, Çakmakçı E (2018). The Acute Effects of PNF Stretching on Shoulder and Forearm Strength in Elite Wrestlers.Oral presented at CemilMeriç – 10. SosyalBilimlerveSporKongresi, Hatay, TURKEY 23-25Kasım 2018,

Ünlü G, Koç H., Gözübüyük Ö.B., Koçak S (2019). Correlates of Handgrip and Upper Extremity Strength in Young Soccer Players. Oral presented at 17th Turkish Sports Medicine Congress with International Participation, Antalya, TURKEY 22-24March, 2019, pp 164-165

Tatlıcı A, Çakmakçı E., **Ünlü G**. (2019). Elit güreşçilerde kuvvet ve postüral stabilite (Denge) arasındaki ilişkinin incelenmesi. Oral presented at 17th Turkish Sports Medicine Congress with International Participation, Antalya, TURKEY 22-24 March, 2019, pp 166

SCIENTIFIC PROJECTS

Melekoğlu T, Ünlü, G. (2013). The Effects of the Neurological and Muscular Adaptations During Resistance Training on Strength Capacity. The Scientific Research Projects Coordination Unit (2013.02.0122.009), Principal Investigator, 2014 - http://proje.akdeniz.edu.tr/sorgu/fon/baslik/baslik3tytl.asp

ASSOCIATIONS/COMMITTEES/OUTREACH:

European College of Sports Science Membership - 2017

Turkish Football Coaches Association (TÜFAD) 2018

AREAS OF EXPERTISE:

Strength & Conditioning, Exercise Physiology,

C. TURKISH SUMMARY / TÜRKÇE ÖZET

KOVİD-19 HAREKET KISITLAMALARININ FARKLI OLGUNLUK VE ANTRENMAN DÜZEYLERİNDEKİ GENÇ FUTBOLCULARIN FİZİKSEL UYGUNLUKLARINA ETKİSİ

Giriş ve Amaç

2020 yılının başından beri dünya genelinde büyük bir sağlık sorunu olarak varlığını sürdüren COVID-19 salgını, 2022 yılının ilk ayları itibariyle ciddiyetini korumakta; tüm dünyayo sosyal, beşeri ve ekonomik yönden etkilemeye devam etmektedir. Ülkeler COVID-19 pandemisi öncesinde var olan sorunlarını bir kenara koyup bütün çabalarını bu virüsten kurtulmaya harcasa da, tam bir koruma sağlayamayan aşılama çalışmaları dışında hastalığı tamamen ortadan kaldıracak bir müdahale 2022 yılının ilk ayları itibariyle henüz bulunmamıştır. Hastalığın etkilerini azaltan aşıların henüz geliştirilmediği salgının ilk dönemlerinde ise insanlar, uzun bir süre hijyen, maske ve sosyal mesafe gibi önlemlerle hayatlarını idame ettirmek zorunda bırakılmışlardır. Bu dönemlerdeki önlemlerin virüsün yayılmasını önleyici rolü tüm kesimlerce kabul görmekle birlikte; bazı başka sorunlara da kapı araladığı da sıklıkla dile getirilmiştir. Özellikle dünya genelinde hükümetlerin sosyal izolasyonu bir nevi zorunlu hale getiren "hareket kısıtlamaları" pandemi öncesi dönemde zaten büyüyen bir sağlık sorunu olan "fiziksel inaktivite" yi daha da tetikleyen bir duruma dönüşmüş, fiziksel aktivite yapma imkanlarının önüne ekstra bariyerler getirmiştir. Nitekim, bu konu üzerine yapılan çalışmalar COVID-19 kaynaklı hareket kısıtlamaları ile azalan fiziksel aktivite seviyelerini açıkça ortaya koymaktadır (Akbari et al., 2021; Giustino et al., 2020; Lesser & Nienhuis, 2020; Ruíz-Roso et al., 2020; Schmidt et al., 2020; Stockwell et al., 2021). Almanya, İtalya, İspanya, Avustralya, İran ve Latin Amerika gibi farklı ülkelerde yapılan bu çalışmalara ek olarak bu kısıtlamaların bir sağlık göstergesi olan "fiziksel uygunluk" profillerindeki negatif etkilerini gösteren çalışmalar da yapılmıştır (Guessogo et al., 2021; Salazar et al., 2020; Spyrou et al., 2021; Sunda et al., 2021; Tsoukos & Bogdanis, 2022). COVID-19 pandemisinin getirdiği hareket kısıtlamaları sağlıkla direk ilişkilisi olan fiziksel aktivite durumuna ek olarak, durdurulan sportif faaliyetlerle sporcular için performans kayıplarının söz konusu olduğu “antrenmansızlık” durumunu da beraberinde getirmiştir. Fiziksel inaktiviteyle ilgili sağlık endişeleri her kesimden insanlar için bir tehditken, kısıtlamalar ile meydana gelen “antrenmansızlık” durumu da sporcular için performans kayıplarını ortaya çıkartan başka bir sorunu da meydana getirmiştir. Hem bir sağlık göstergesi olması yönüyle fiziksel inaktivite kaynaklı sağlık sorunlarının incelenmesinde, hem de fiziksel performans testleri içermesi yönüyle “antrenmansızlık” kaynaklı performans kayıplarının incelenmesinde fiziksel uygunluk değerlendirmeleri yapılmaktadır.

Fiziksel uygunluk orta ila şiddetli fiziksel aktiviteler için gerekli olan yeteneklere sahip olma durumudur. Daha çok sağlıkla ilişkili olan fiziksel uygunluk temel olarak kardiyovasküler dayanıklılık, kas kuvveti, kas dayanıklılığı, esneklik ve vücut kompozisyonunu kapsayan 5 ana komponentle ele alınmaktadır (Medicine, 2013b). Yapılan çalışmalar, vücut kompozisyonunun obezite, kardiyovasküler hastalık, diyabet gibi birçok sağlık sorunuyla ilişkili olduğunu, ve yine diğer bileşenlerin de sağlıkla ilişkili olduğunu açıkça ortaya koymuştur (Kolimechkov, 2017). Bu bileşenlerin sağlık dışında sporda performansa etki eden ve beceri ile ilişkilendirilmiş olanları literatürde ayrıca ele alınmıştır. Spor branşına göre çeşitlendirilebilinen fiziksel uygunluk test bataryaları hem sağlıkla ilgili, hem de beceriyle ilişkili bileşenleri içerebilmektedir (DeMet & Wahl-Alexander, 2019; Kariyawasam et al., 2019; Williams et al., 2008). Çeviklik, sürat, çabukluk gibi yüksek şiddetli performansları içerebildiği gibi koordinasyon ve reaksiyon gibi bazı motor becerileri de içerebilmektedir.

Bu çalışmanın amacı COVID-19 nedenli bu hareket kısıtlamalarının hem atletik performans kayıplarını ortaya koyabilen hem de genel sağlığın bir göstergesi olan “fiziksel uygunluk” üzerine etkilerini araştırmaktır. Çalışmanın araştırma sorusunu oluştururken yararlanılan “Antrenmansızlık” ve “fiziksel inaktivite” alanlarındaki literatürlere bakıldığında fiziksel uygunluk adaptasyonlarının cinsiyet, yaş, olgunluk ve antrenelik düzeyi gibi birçok farklı faktöre göre değişebileceği görülmüştür (Bosquet et al., 2013). Özellikle yakın zamanda yapılan çalışmalar adölesan sporcularda "olgunluk" ve "antrenman düzeyinin" antrenmanlara bağlı farklı fizyolojik adaptasyonlara oluşturabileceğini göstermiş fakat antrenmansızlık sonrası bu adaptasyonlardaki farklılıklar henüz net bir şekilde ortaya konulamamıştır. Literatürdeki bu boşluk çalışmanın bir diğer araştırma sorusu olarak ele alınmış, adölesan futbolcularda "olgunluk" ve "antrenman düzeyinin" hareket kısıtlamalarının neden olduğu fiziksel uygunluk üzerine etkilerinin incelenmesi de amaçlanmıştır.

Çalışmanın Önemi

Fiziksel aktivite, egzersiz ve spor gibi kavramların sağlıklı bir yaşam için önemi daha önce birçok kez vurgulanmış (Mannino et al., 2019), buna karşın teknoloji çağının getirdiği rahat yaşam, bu hususların sıklıkla ihmal edilmesine sebebiyet vermiştir. Gelişmiş ülkelerde son yüzyılda giderek azalan fiziksel aktivite seviyeleri obezite başta olmak üzere ciddi sağlık sorunlarını meydana getirmektedir. COVID-19 pandemisi öncesi bu sorunla mücadele eden ülkeler, pandemiyle birlikte sağlıkla ilgili bu eforlarını virüsle mücadeleye yöneltmişlerdir. Bununla birlikte, hareket kısıtlamaları gibi virüsle mücadele kapsamında uygulanan önlemler fiziksel aktivite olanaklarını daha da zor hale getirmiştir. Özellikle tüm sosyal olanakların ve sportif faaliyetlerin kısıtlandığı, insanların ev hapsine alındığı pandeminin ilk dönemleri bu zorlukların en derinden yaşandığı zamanlar olmuştur. Bu çalışmadaki bulguların COVID-19 nedenli hareket kısıtlamalarının fiziksel aktivitesizliğe bağlı olarak bir sağlık göstergesi olan fiziksel uygunluk profillerine (Knapik et al., 2019; Ortega et al., 2008) etkilerini ortaya koyarak ilgili alandaki literatüre ciddi katkılar sağlayacağı düşünülmektedir. Ayrıca COVID-19 kısıtlamaların tüm spor olaylarını etkilemesi sporcuların antrenman ve müsabakalardan uzak kalmalarına sebebiyet vermiştir. Bu duruma bağlı olarak sporcularda performans kayıpları ile sonuçlanan "antrenmansızlık etkisi" oluşmuştur. Bu çalışmanın bağımsız değişkeni her ne kadar hareket kısıtlamaları olarak tanımlansa da, ortaya çıkan fiziksel uygunluk kayıpları antrenmansızlık etkisi ile de açıklanabilmektedir. Bu bağlamda çalışma bulgularının antrenmansızlık etkisini inceleyen çalışmalara da yol gösterici nitelikte olacağı düşünülmektedir. Çalışmanın bir başka önemi de gerek antrenman gerekse antrenmansızlık kaynaklı fizyolojik adaptasyonlarda belirleyici faktörler olan "antrenman düzeyi" ve "olgunluk" faktörlerinin fiziksel uygunluk değişimlerinin incelenmesinde ele alınmasıdır. Daha önce yapılan çalışmalar bu iki faktöre göre fizyolojik adaptasyonların farklı olabileceğini göstermesine karşın antrenmansızlık kaynaklı performans kayıplarını inceleyen çalışmalar bu faktörleri çoğunlukla göz ardı etmiştir. Ayrıca yazarların bilgisi dahilinde bu iki faktörü beraber ele alarak antrenmansızlık etkisini inceleyen bir çalışma yoktur.

Yöntem

Çalışma için Orta Doğu Teknik Üniversitesi, İnsan Araştırmaları Etik Kurulundan 258-ODTU-2020/28620816 protokol numarası ile etik onay alınmıştır. Tüm katılımcılar ve aileri çalışmanın içeriği hakkında bilgilendirilerek rızaları alınmıştır. Antrenman düzeylerinde belirgin farklılıkların olduğu bir profesyonel bir futbol kulübünün alt yapı futbolcuları, ve bir futbol okulundaki 10-14 yaş çocuklar çalışmaya çağrılmıştır. Üst düzey antrenman rutinlerine sahip U11, U12, U13 ve U14 takımlarında forma giyen futbolcular yüksek düzeyde antrenmanlı; futbol okulunda oynayan çocuklar ise rekreatif düzeyde antrenmanlı olarak sınıflandırılmıştır. Her iki antrenman düzeyindeki futbolcular için çalışmaya dahil edilme kriteri olarak; 10-14 yaş aralığında olmak, adölesan sonrası dönemde olmamak, 2 yıllık sportif özgeçmişi olmak, ve pandemi süresince fiziksel olarak inaktif olmak koşulları belirlenmiştir.

COVID-19 kısıtlamalarından hemen önce yapılan ölçümlerde bu kriterlere uygun olarak 63 üst düzey antrenmanlı genç futbolcu ile 79 rekreatif düzeyde antrenmanlı genç futbolcu çalışmaya dahil edilmiştir. Bu futbolcuların son iki yıldaki antrenman yoğunluklarını tespit ederek ait oldukları varsayılan popülasyonlarını (üst düzey antrenmanlı-rekreatif düzeyde antrenmanlı) doğrulamak için hem sporcuların kendileriyle hem de antrenörleriyle yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Bu görüşmelerdeki sorular; 1) kaç yıldan beri bu grup ile antrenmanlar yapıyorsun? 2) son altı aydır antrenmanların haftada kaç gün? 3) son altı aydır kaçırdığın antrenman sayısı kaçtır? 4) bir birim antrenmanın ortalama kaç dakika sürüyor? 5) yılda ortalama kaç müsabakaya katılıyorsun? Bu anket soruları ile sporcuların haftalık antrenman volumleri hesaplanmış ve yüksek düzeyde antrenmanlı sporcuların rekreatif düzeyde antrenmanlı sporcuların antrenman düzeyleri doğrulanmıştır. Pandemi nedenli hareket kısıtlamalarının çalışma öncesi ne kadar süreceği bilinmediğinden spesifik bir uygulama periyodu belirlenmemiştir. Çalışmanın bağımsız değişkenini oluşturan hareket kısıtlamalarının aslında bir "antrenmansızlık" durumunu açıklayıcı nitelikte olması nedeniyle çalışmaya dahil edilme kriteri olarak belirlenen "bu dönemdeki fiziksel inaktif olmak" koşulu Uluslararası Fiziksel Aktivite Değerlendirme Anketi Kısa Formu (IPAQ) ile değerlendirilmiştir. Seçili fiziksel uygunluk testleri COVID-19 nedenli hareket kısıtlamalarından hemen önce ve antrenmanların tekrar başlatıldığı ilk gün yapılmıştır.

Antropometrik ölçümlerde; vücut ağırlığı için Biyoelektrik impedans cihazından (Tanita® BC-418MA, Tanita Corp., Tokyo, Japan), boy ve oturma yüksekliği için taşınabilir stadyometreden (SECA 217, Hamburg, Germany) yararlanılmıştır. Oturma yüksekliği için denekler baş hizasında dik oturma pozisyonunda yerleştirilmiş ve başın üst kısmı ile oturma yüzeyi arasındaki mesafe ölçülmüştür. Bu değerin boy uzunluğundan çıkarılması bacak uzunluğunun hesaplanmasında kullanılmıştır. Vücut kitle indeksi (VKİ), kilogram cinsinden vücut kütlesinin metre cinsinden ayakta durma boyunun karesine bölünmesiyle de hesaplanmıştır. Seçili fiziksel uygunluk testleri: kavrama kuvveti el dinamometresi (Takei, Tokyo) ile, dinamik denge Y-denge testi ile, durarak uzun atlama zemin üzerine bant ile sabitlenmiş mezura ile, dikey sıçramalar (skuat sıçrama, drop sıçrama ve aktif sıçrama) Optojump (Microgate, Bolzano, Italy) fotoelektrik ölçüm sistemi ile, hızlanma (10m), hız (20m), ve toplu-topsuz zikzak çeviklik performansları(s) elektronik zamanlama sistemleri ile (Smart speed, Fusion Sport, Avustralya) ölçülmüştür.

El kavrama kuvveti için dinamometrenin kolları her katılımcının el ve parmak ölçülerine göre ayarlandıktan sonra sonra katılımcılar ayakta durma pozisyonunda altı saniye boyunca üç maksimum izometrik kuvvet uygulamışlardır. Bu uygulama ile elde edilen üç değerden en büyüğü kaydedilmiştir. Bu şekilde elde edilen mutlak kuvvet değerlerinin VKI değerlerine bölünmesiye göreceli değerler hesaplanmıştır. Dinamik dengeyi ölçmek için kullanılan Y-Denge testinde deneklere tek bacak ile dengede kalarak diğer bacaklarıyla anterior, posteromedial ve posterolateral bölgelere doğru maksimum erişme denemeleri yaptırılmıştır. Bacaklarıyla Y şeklinde bir desen çizdikleri hareketler zincirinde denekler; önce eller belde ve çıplak ayaklarla tam karşıya doğru (anterior) mümkün olan en uzak noktaya bir erişme denemesi yapar. Sonrasında bu çizgiden 135^0 oluşturacak şekilde çizilmiş sağ ve sol çapraza doğru yine mümkün olan en uzak mesafeye erişme denemesi yaparlar. Dominant bacakta topukların yerle teması kesilmeden non-dominant bacakla az 2 saniye dokunmanın sağlanabildiği mesafeler santimetre cinsinden kaydedilmiş, elde edilen değerler deneklerin bacak uzunluklarına yüzdelik hesaplama yapılarak standardize edilmiştir. Durarak uzun atlamada (yatay sıçrama) denekler, ayak parmakları başlangıç çizgisiyle aynı hizada olacak şekilde hareketsiz durduktan sonra serbest kol hareketleriyle sıçrayabildikleri kadar öne sıçradılar. Başlangıç çizgisi ile düşme noktası arasındaki mesafelerin dikkate alındığı 3 tekrar sonrası en iyi değerler kaydedilmiştir. 3 farklı dikey sıçrama testinde de katılımcıların "elleri bellerinde" konumlandırılmış ve 3 farklı denemenden en iyi değerleri kaydedilmiştir. Aktif sıçramada ayaktayken hızlı bir eksantrik kasılmayla çömelmeye geçerek güç alıp sonrasında sıçrayabildikleri kadar yükseğe sıçramaları istenilirken, squat sıçramada 90^0 diz açısıyla çömelmede beklenilirken sıçrayabildikleri kadar yükseğe sıçramaları istenilmiştir. Drop sıçrama için 30 cm yüksekliğindeki kutulardan ön bacakları uzatılarak bir düşüş sonrasında minimum yerle temas süresiyle maksimum sıçrama yapmaları istenilmiştir. Hızlanma ve maksimum hız ölçümlerinde katılımcılardan 20 metrelik mesafe boyunca maksimum hızlarında koşu yapmaları istenilmiştir. Başlangıç noktasının 20cm ilerisine, 10m ve 20m uzaklıklara yerden 0.8 m yükseklikte konumlandırılmış fotosellerle bu mesafelere ulaştıkları süreler kaydedilmiştir. Iki dakikalık dinlenme aralığı sonrası testi tekrar etmeleri istenilmiş iyi olan dereceleri kaydedilmiştir. Çeviklik testi toplu ve topsuz olarak 2 ayrı formda ölçülmüştür. Yön değiştirme, hızlanma, ve yavaşlama performanslarının olduğu zikzak testi 5m'lik lineer bir hızlanma ile başlar ve 100^0 açılarda yön değiştirmeler sonrası 3 lineer hızlanma ile sonlanır. Katılımcılar bu performansları kendi futbol ayakkabıları ile sentetik çimde gerçekleştirmişlerdir. Testler sırasında performanslarını etkileyecek herhangi bir teknik müdahale yapılmamıştır. Aralarda birer dakikalık dinlenmelerin olduğu toplu ve topsuz üçer deneme sonrası en iyi değerler kaydedilmiştir. İlk ölçümlerden bir hafta sonrasında katılımcıların büyük bir çoğunluğu ile (n=92) güvenilirlik analizi yapılmak için testler tekrarlanmıştır. Bu güvenilirlik analizi sonucunda iyi ile mükemmel arasında test-tekrar test güvenilirliği raporlanmıştır (ICC= 0,72-0,99). Son testler için farklı nedenlerle çalışmadan ayrılanlar ve çalışmaya dahil edilme kriterlerini sağlamayanların çalışmadan çıkartılması nedeniyle 27 yüksek düzeyde antrenmanlı, ve 25 rekreatif düzeyde antrenmanlı toplam 52 katılımcı ile örneklem oluşturulabilinmiştir. Zirve boy uzama hızı dönemi (PHV) tahminlerinde; Mirwald ve arkadaşları (2002) tarafından geliştirilen oturma yüksekliği, bacak uzunluğu gibi fiziksel özelliklerle formülize edilen denklemden yararlanılmıştır. Bu olgunlaşma değerlendirmesi sonucunda 31 futbolcunun pre-PHV döneminde (YA=16, RA=15) ve 21 sporcunun mid-PHV döneminde (YA=11, RA=10) olduğu görülmüştür. Verilerin analizi için SPSS 24.0 paket programdan yararlanılmıştır. Fiziksel aktivite seviyelerindeki değişimler "Wilcoxon Eşleştirilmiş İki Örnek Testi", güvenilirlik analizi ise "Sınıf İçi Korelasyon Katsayısılarına (ICC)" göre değerlendirilmiştir. Fiziksel uygunluk parametrelerindeki değişimlerin bağımsız değişkenlere göre karşılaştırılması için üç yönlü tekrarlanan ölçüm tasarımı (2 (zaman: öntest-sontest) x 2 (antrenman düzeyi: yüksek-rekreatif) x 2 (olgunluk durumu: pre-PHV-mid-PHV)) kurulmuş, anlamlı etkileşimlerdeki farkların kıyaslanması etki büyüklüklerine (ES) göre yapılmıştır.

Bulgular

Hareket kısıtlamaları boyunca fiziksel aktivite seviyeleri kısıtlamalar öncesi döneme göre yüksek düzeyde antrenmanlı futbolcularda %85, rekreatif düzeyde antrenmanlı futbolcularda ise %87 azalmıştır. Ön-testler için fiziksel özellikler bakımından antrenman düzeyine göre tek anlamlı farklılık pre-PHV kohortta, VKİ değerlerinde görülmüştür. Pre-PHV kohort için rekreatif düzeyde antrenmanlı futbolcuların 16.87±2.22 olan ön-test VKİ değerlerinin 15.25±1.63 olan yüksek düzeyde antrenmanlı futbolculara göre daha yüksek olduğu görülmüştür (p=0.03). Bunun dışındaki tüm demografik ve antropometrik parametrelerde (yaş, boy, vücut ağırlığı, oturma yüksekliği, bacak uzunluğu) rekreatif düzeyde antrenmanlı ve yüksek düzeyde antrenmanlı futbolcular arasında istatistiksel olarak anlamlı fark görülmemiştir (p>0.05). Mid-PHV kohort için de rekreatif düzeyde antrenmanlı ve yüksek düzeyde antrenmanlı futbolcular arasında bu parametreler bakımından istatistiksel olarak anlamlı bir farklılık bulunmamıştır.

27 haftalık hareket kısıtlamaları sonrasında kavrama mutlak kuvvet, drop sıçrama ve normalize olmayan Y-balance dışındaki tüm parametreler için performans kayıplarına yönelik anlamlı zaman etkisi bulunmuştur (p<0.05). Olgunluk ve antrenman düzeyine göre oluşturulan 4 farklı grubun her biri için anlamlı değişim görülen parametreler Tablo 1.'de delta değerleri ve etki büyüklükleri ile birlikte gösterilmiştir. Bu değişimlere göre; Pre-PHV kohort için yüksek düzeyde antrenmanlı futbolcularda anlamlı performans kayıpları rölatif kavrama kuvveti, reaktif kuvvet indeksi, hızlanma (10m), maksimum hız (20m), durarak uzun atlama, zikzak toplu çeviklik ve normalize Y denge parametrelerinde görülürken, rekreatif düzeyde antrenmanlı pre-PHV gruptaki anlamlı performans kayıpları; rölatif kavrama kuvveti, reaktif kuvvet indeksi, durarak uzun atlama, zikzak toplu çeviklik, zikzak topsuz çeviklik ve normalize Y denge parametrelerinde görülmüştür. Ayrıca Pre-PHV kohort için yüksek düzeyde antrenmanlı futbolcularda zikzak topsuz çeviklik performansındaki kayıp eğilimi görülmüştür (F= 4.60, p= 0.051). Yüksek düzeyde antrenmanlı pre-PHV futbolcularda ise anlamlı performans kayıplarının görüldüğü reaktif kuvvet indeksi ve toplu zikzak çeviklik parametreleri için etkiler büyük (d= 0.84, 0.82), normalize Y-denge için orta (d=0.61) ve diğer anlamlı parametreler olan rölatif kavrama kuvveti, hızlanma (10m), hız (20m) ve durarak uzun atlama için düşüktü (d=0.32, 0.48, 0.39, 0.26, 0.23). Rekreatif düzeyde antrenmanlı futbolcularda anlamlı performans kayıplarının görüldüğü zikzak toplu çeviklik için büyük etki, N-Y balance için orta etki (d=0.59) ve diğer anlamlı parametreler olan rölatif kavrama kuvveti, reaktif kuvvet indeksi, zikzak topsuz çeviklik için düşüktü. Mid-PHV kohort için yüksek düzeyde antrenmanlı futbolcularda mutlak kavrama kuvvet ve normalize olmayan Y-denge dışında tüm parametrelerde anlamlı performans kayıpları görülmüştür(p<0.05). Zikzak toplu çeviklik, hızlanma (10m) ve hız (20m) kayıplarında büyük etkiler (d=0.90, 0.81, 0.83), rölatif kavrama kuvveti, reaktif kuvvet indeksi, durarak uzun atlama, zikzak topsuz çeviklik ve Normalize Y-dengesi için orta düzeyde etkiler (d=0.50, 0.72,

0.66, 0.59, 0.77) ve 3 farklı dikey sıçrama parametresi için (Drop sıçrama, Skuat sıçrama, Aktif Sıçrama) küçük etkiler raporlanmıştır. Son olarak Mid-PHV kohort için rekreatif düzeyde antrenmanlı futbolcularda mutlak kavrama kuvveti için küçük fakat anlamlı performans gelişimi (p=0.02, d=0.46), rölatif kavrama kuvveti, reaktif kuvvet indeksi, zikzak topsuz çeviklik ve normalize -Y denge için orta düzeyde anlamlı performans kayıpları (d=0.66, 0.57, 0.54, 0.50), zikzak toplu çeviklik için büyük düzeyde performans kayıpları raporlanmıştır (d=0.88).

Tablo 1
Anlamlı değişim görülen parametreler

	Yüksek düzeyde antrenmanlı futbolcular		**Rekreatif düzeyde antrenmanlı futbolcular**	
	Pre-PHV	Mid- PHV	Pre-PHV	Mid- PHV
HG (kg)	-	-	-	Δ 2.52% (0.46)
RHG (kg/BMI)	Δ-7.69% (0.32)	Δ-11.19% (0.50)	Δ-7.69% (0.44)	Δ -6.45 (0.66)
RSI (mm/ms)	Δ-14.81% (0.84)	Δ-15.01% (0.72)	Δ-14.81% (0.28)	Δ -17.30 (0.57)
10m(s)	Δ3.68% (0.48)	Δ5.53% (0.81)	Δ3.68 % (0.20)	-
20m(s)	Δ2.13% (0.39)	Δ5.50% (0.83)	-	-
DJ (cm)	-	Δ-7.76% (0.35)	-	-
CMJ (cm)	-	Δ-6.33% (0.33)	-	-
SJ (cm)	-	Δ-7.62% (0.47)	-	-
SLJ (cm)	Δ-2.72% (0.26)	Δ-3.96% (0.66)	-	-
ZAWHB (s)	Δ1.13% (0.23)	Δ5.91% (0.59)	Δ1.13% (0.31)	Δ3.19 (0.54)
ZAWB (s)	Δ5.97 % (0.82)	Δ10.53% (0.90)	Δ5.97% (0.83)	Δ10.57 (0.88)
Y Balance	-	-	-	-
N-Y Balance	Δ-3.61% (0.61)	Δ-3.68% (0.77)	Δ-3.61% (0.59)	Δ-2.32 (0.50)

Legend: HG= Kavrama kuvveti, R-HG= Göreceli kavrama kuvveti, 10m= 10metre hızlanma 20m= 20metre koşu hızı, SLJ=durarak uzun atlama, DJ=Drop sıçrama, RSI= Reaktif kuvvet İndeksi, SJ= Skuat sıçrama, CMJ= Aktif sıçrama, ZAWB= Topla zikzak çeviklik süresi, ZAWHB= Topsuz zikzak çeviklik süresi, Y Balance= Ydenge, N-Y denge= normalize Y denge

Üç yönlü etkileşimler bakımından herhangi bir değişken için anlamlılık bulunamazken; anlamlı zaman*olgunluk etkileşimlerinin raporlandığı drop sıçrama(d=0.10), skuat sıçrama(d=0.18), toplu (d=0.21) ve topsuz(d=0.16) zikzak çeviklik performanslarında azalmaların mid-PHV grupta daha fazla olduğu görülmüştür. Küçük etki boyutunun olduğu toplu çeviklik dışındaki parametreler dışında farkların önemsiz düzeyde olduğu görülmüştür(d<0.20).

Anlamlı zaman x antrenman düzeyi etkileşimlerinin bulunduğu reaktif kuvvet indeksi (d=0.11), durarak uzun atlama (d=0.08), 20m koşu hızı (d=0.12) ve Normalize Y denge (d=0.09) performanslarında yüksek düzeyde antrenmanlı futbolculardaki performans kayıpları rekreatif düzeyde antrenmanlı futbolculara göre önemsiz düzeylerde olmakla birlikte daha fazlaydı.

Tartışma ve Sonuç

Çalışmanın sonuçları fiziksel uygunluğun tüm bileşenlerinin COVID-19 kısıtlamalarından etkilendiğini göstermiştir. Her ne kadar drop sıçramada anlamlı değişim görülmese de skuat sıçrama, aktif sıçrama ve yatay sıçramada değişimler negatif yönlü ve anlamlı olması fiziksel uygunluğun "sıçrama" bileşeninde COVID-19 kısıtlamalarına bağlı performans kayıplarının olduğunu göstermektedir. Ayrıca mutlak değerler bakımından anlamlı farklılık göstermeyen kavrama kuvveti, rölatif değerler bakımından anlamlıydı. Fiziksel uygunluğun kassal kuvvet bileşeninin değerlendirilmesinde fiziksel gelişimlerin kuvvet üzerindeki etkilerinin tamamen yok sayıldığı mutlak değerler yerine vücut kitle indeksine göre standardize edilmiş rölatif değerler dikkate alınmıştır. Benzer şekilde 27 hafta gibi uzun bir dönemde bacak uzunlukları artan çocukların bu artışlara bağlı Y-denge testi erişme mesafelerinin de artacağı ve bu durumun dinamik dengedeki değişimlerin göstergesi olmayacağı açıktır. Bu hassasiyetle yapılan çalışmalar Y-denge testindeki erişme mesafelerinde ortalama değerler yerine bacak uzunluğuna göre yüzdelik oranların hesaplandığı normalize edilmiş değerleri dikkate almaktadır(R. Hammami, Chaouachi, et al., 2016b; Muehlbauer et al., 2013). Bu husus göz önüne alınarak; anlamlı farklılık görülmeyen mutlak Y-denge değerleri yerine anlamlı performans kayıplarının görüldüğü normalize edilmiş Y-denge değerleri dikkate alınmış ve dinamik denge bileşeninde anlamlı farklılıkların olduğunu şeklinde değerlendirilmiştir. Bu hususlar dikkate alındığında çalışma sonuçların 27 haftalık KOVİD-19 kaynaklı hareket kısıtlamalarının çalışma popülasyonunu oluşturan genç futbolcularda tüm fiziksel uygunluk bileşenlerinde anlamlı performans kayıplarına sebebiyet verdiği görülmektedir. Anlamsız 3-yönlü etkileşimlerin bu performans kayıplarının gruplara göre değişmediğini gösterse de tüm fiziksel uygunluk bileşenlerinde anlamlı değişimlerin görüldüğü ve 2 parametre dışında (rölatif el kavrama kuvveti ve reaktif kuvvet indeksi) en yüksek etki büyüklüklerinin raporlandığı yüksek düzeyde antrenmanlı mid-PHV genel fiziksel uygunluk kayıpları bakımından ön plana çıkmıştır. Yine de zaman * olgunluk * antrenman düzeyi etkileşimlerinin tüm bu parametreler için anlamsız olması kesin çıkarımlarda bulunmayı mümkün kılmamaktadır. Bununla birlikte performans kayıpları “olgunluk” ve "antrenman düzeyleri” faktörlerine göre ayrı ayrı kıyaslandığında daha belirgin farklılıkların olduğu görülmektedir. Antrenman düzeyine göre değişimler kıyaslandığında; fiziksel uyguluğun bazı parametreleri için (reaktif kuvvet indeksi, durarak uzun atlama, 20m koşu hızı ve dinamik denge) COVID-19 hareket kısıtlamaları sonrası performans kayıplarının yüksek düzeyde antrenmanlı futbolcularda rekreatif düzeydeki antrenmanlı futbolculara göre daha fazla olduğu görülürken; rekreatif düzeyde antrenmanlı futbolcularda daha fazla performans kayıplarının görüldüğü herhangi bir parametre yoktur. Antrenman düzeyi * zaman etkileşimleri her ne kadar fiziksel uygunluklardaki COVID-19 hareket kısıtlamaları kaynaklı performans kayıpların yüksek düzeyde antrenmanlı futbolcularda daha fazla olabileceğini gösterse de; farklardaki etki büyüklüklerinin önemsiz seviyerde olduğu göz ardı edilmemelidir ($d<0.20$). Daha önceki çalışmalar antrenman düzeyine göre antrenmansızlığın etkilerinin elit sporcularda daha fazla olabielceğine yöneliktir. Yapılan çalışmalarda antrenmansız veya rekreatif düzeyde antrenmanlı sporculardaki performans kayıpları sınırlı olabiliyorken elit sporcularda bu kayıplar çok daha belirgindir (Izquierdo ve ark., 2007; Koundourakis ve ark., 2014; Mujika & Padilla, 2000). Antrenman düzeyine göre fiziksel uygunluk veya atletik performans değişimlerini inceleyen daha önceki çalışmalarda; antrenmanlara bağlı performans gelişimlerinin elit seviyeye yaklaşıldıkça daha az (McArdle et al., 2010), antrenmanlar sonrası performans kayıplarının ise daha fazla olacağı bildirilmiştir (Miles et al., 2005). 2). Bu çalışmalardaki bulgulara dayanarak mevcut çalışmanın hipotezlerini oluştururken performans içerikli fiziksel uygunluk kayıplarının yüksek düzeyde antrenmanlı futbolcularda daha fazla olabileceği öngörülmüştür. Bu çıkarım ilgili alandaki diğer literatürlerlr de desteklenebilir durumdadır. Atletik performans değerlendirmeleri dışında antrenmansızlığın antrenelik düzeyine göre farklı fizyolojik adaptasyonlar gösterdiği de görülmektedir. Örneğin, M. P. Miles ve ark., (2005) antrenmansız kalınan dönem sonrasında kassal kuvvetsizliğe neden olan kas atrofisinin elit sporcularda çok daha hızlı görüleceğini göstermiştir. Antrenmansızlık sonrası kardiyorespiratuar adaptasyonlar açısından da elit sporculardaki performans kayıplarının rekreatif düzeyde antrenmanlı sporculara göre daha fazla olacağı bildirilmiştir (Mujika & Padilla, 2000). Bu bilgiler ve çalışma bulguları yüksek düzeyde antrenmanlı sporculardaki antrenmansızlık kaynaklı performans kayıplarının rekreatif düzeyde sporculara göre daha fazla olabileceğini göstermektedir.

Anlamlı olgunluk * zaman etkileşimlerinin görüldüğü sıçrama (drop sıçrama, skuat sıçrama) ve çeviklik parametreleri (toplu çeviklik, topsuz çeviklik), adölesan dönemdeki futbolculardaki COVID-19 hareket kısıtlamaları sonrası performans kayıplarının adölesan öncesi dönemdeki futbolculara göre daha fazla olduğunu göstermektedir. Küçük etki boyutundaki anlamlı farklılığın olduğu "toplu çeviklik" dışındaki parametrelerde etkiler önemsiz düzeydeydi. Bu bulguların zaman * antrenman düzeyindeki bulgulardan farklı olarak literatür ile desteklenmediği görülmektedir. Meylan et al., (2014) çalışmalarında adölesan öncesi dönemdekilerde performans kayıplarının adölesan dönemdekilere göre daha fazla olabileceğini göstermiştir. Meylan et al., (2014) çalışmasında bu çalışmadan farklı olarak belirli bir antrenman periyodu sonrası antrenmansızlık etkilerine bakılması, popülasyon grubunun farklı olması ve destekleyen başka çalışmanın olmaması net çıkarımlarda bulunmayı mümkün kılmamaktadır. Ancak, fiziksel gelişimlerin en hızlı olduğu bu dönemde özellikle güç ve kuvvet gerektiren performanslarda da daha fazla "doğal gelişim" görülebileceği ve bu duruma bağlı antrenmansızlık kaynaklı performans kayıplarında daha fazla tölare edilebileceğini düşünmek mantıklıdır. Antrenmansızlık kaynaklı performans kayıplarını olgunluğa göre ele alan sınırlı sayıda çalışma olduğu için; bu çalışmadaki adölesan öncesi dönemde daha fazla olmayan fiziksel uygunluk kayıpları fizyolojik perspektiften ele alarak tartışmanın daha aydınlatıcı olabileceği düşünülmüştür. Bu kapsamda; antrenman ve antrenmansızlığın olgunluğa göre gösterdiği adaptasyonların farklı olabileceği gibi, adölesan ve adölesan öncesi dönemde fiziksel uygunluk değişimlerinde belirleyici olabilecek farklı fizyolojik mekanizmaların olduğu görülmüştür. Adölesan öncesi dönemde fiziksel performans gelişimleri daha çok nöral adaptasyonlar ile görülürken adölesan dönemde daha çok hormonal adaptasyonlar belirleyici olabilmektedir (Lloyd & Oliver, 2012). Dolayısıyla fizyolojik açıdan bu farklılıkların performans kayıplarına da etkisi olabileceği düşünülebilir. Çalışma popülasyonunu oluşturan adölesan öncesi ve adölesan dönemdeki sporcuların daha önce bu iki olgunluk durumuna göre sınıflandırma yapan çalışmalarda olduğu gibi farklı kronolojik yaşlarda olmaları da önemli bir farklılık yaratmış olabilir.

Sonuç olarak; fiziksel uygunluktaki bozulmaların yüksek düzeyde antrenmanlı sporcularda rekreatif düzeyde sporculara göre daha fazla olabileceği ve yine bu kayıpların adölesan dönemde olan futbolcularda adölesan dönem öncesi futbolculara göre daha fazla olabileceğini göstermektedir. Herhangi bir fiziksel uygunluk parametresi için anlamlı 3 yönlü etkileşim görülmese de; yüksek antrenmanlı mid-PHV futbolcularda reaktif kuvvet indeksi ve rölatif kavrama kuvveti dışındaki tüm parametrelerde en büyük etki büyüklüklerinin görülmesi ve yine bu grubun her bir fiziksel uygunluk bileşeni için anlamlı performans kayıplarının olduğu tek grup olduğu göz ardı edilmemelidir.

D. THESIS PERMISSION FORM / TEZ İZİN FORMU

ENSTİTÜ / INSTITUTE

Fen Bilimleri Enstitüsü / Graduate School of Natural and Applied Sciences	☐
Sosyal Bilimler Enstitüsü / Graduate School of Social Sciences	☒
Uygulamalı Matematik Enstitüsü / Graduate School of Applied Mathematics	☐
Enformatik Enstitüsü / Graduate School of Informatics	☐
Deniz Bilimleri Enstitüsü / Graduate School of Marine Sciences	☐

YAZARIN / AUTHOR

Soyadı / Surname : ÜNLÜ
Adı / Name : Gürcan
Bölümü / Department : Beden Eğitimi ve Spor Bölümü

TEZİN ADI / TITLE OF THE THESIS (**İngilizce** / English): THE EFFECTS OF COVID-19 INDUCED MOBILITY RESTRICTIONS ON PHYSICAL FITNESS IN YOUNG SOCCER PLAYERS AT DIFFERENT MATURITY AND TRAINING STATUS

TEZİN TÜRÜ / DEGREE**:** **Yüksek Lisans** / Master ☐ **Doktora** / PhD ☒

1. **Tezin tamamı dünya çapında erişime açılacaktır. /** Release the entire work immediately for access worldwide. ☒
2. **Tez iki yıl süreyle erişime kapalı olacaktır.** / Secure the entire work for patent and/or proprietary purposes for a period of **two years. *** ☐
3. **Tez altı ay süreyle erişime kapalı olacaktır.** / Secure the entire work for period of **six months**. ***** ☐

***** *Enstitü Yönetim Kurulu kararının basılı kopyası tezle birlikte kütüphaneye teslim edilecektir.* /
A copy of the decision of the Institute Administrative Committee will be delivered to the library together with the printed thesis.

Yazarın imzası / Signature .... **Tarih** / Date ....
(Kütüphaneye teslim ettiğiniz tarih. Elle doldurulacaktır.)
(Library submission date. Please fill out by hand.)

Tezin son sayfasıdır. / This is the last page of the thesis/dissertation.