

**VOL 2, ISSUE 2**  
**JULY 2021**

**ISSN 2767-5874 (PRINT)**  
**ISSN 2692-9864 (ONLINE)**

# JOHSK

**JOURNAL OF HEALTH, SPORTS, AND KINESIOLOGY**

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*The official Journal of  
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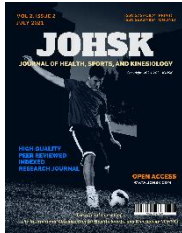
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## Literature Review

## Open Access

### Article History:

Received 20 September 2020

Accepted 23 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.4>

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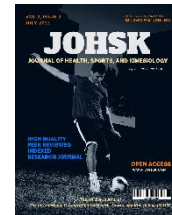
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# The Effect of Crank Arm Length on Cycling Economy and Performance in Triathlon

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**Keywords:** cycling kinematics, cycling kinetics, cycling time trials, crank arm length

## Introduction

Given the nature of a triathlon race, the cycling distance is typically much longer than swimming and running across race distances from sprint to Ironman. Besides, triathletes should try to not only maintain a certain level of cycling power but also consider cycling economy to make a better performance in both the cycling portion and the overall race (Bonacci et al., 2013; Sleivert & Rowland, 1996; Swinnen et al., 2018). The cycling economy is an important indicator to predict cycling performance in terms of time to complete a certain distance. Both cycling economy and performance are determined by the interaction between mechanical output and physiological input (Barratt et al., 2016; Korff et al., 2007; Sunde et al., 2010). Theoretically, improving cycling economy elicits a better cycling time trial performance and/or less physiological demands (e.g., rate of oxygen consumption:  $\dot{V}O_2$ , heart rate) to complete at a given distance. The crank arm length (CAL) is one of the important factors among many variables that affect the economy and performance in cycling (McDaniel et al., 2002). Therefore, the appropriate selection of CAL may play a key role in improving the cycling portion of the race and entire triathlon performance. The purpose of this review is to identify the effects of acute changing CAL on physiological and biomechanical responses during cycling.

## Overview

Previous researchers have reported changing of CAL affect cycling power production (MacDermid & Edwards, 2010; Martin & Spiraduso, 2001; Too & Landwer, 2000), lower limb joint angle, cadence (Barratt et al., 2011 & 2016; Candotti et al., 2007; Christiansen et al., 2013), pedal torque (Hull & Gonzalez, 1988), lower limb muscle activity (Watanabe, 2020), and  $\dot{V}O_2$  (Ferrer-Roca et al., 2017; Morris & Londeree, 1997).

The effect of different CALs on cycling power, lower extremity joint kinematics, and kinetics during such a short duration (~30 seconds) with supramaximal effort have been well documented (Barratt et al., 2011; Christiansen et al., 2013; MacDermid & Edwards, 2010; Martin & Spiraduso, 2001; Too & Landwer, 2000; Watanabe, 2020). There is also a strong body of research that provides insight into the physiological and biomechanical



responses according to acute changing of CALs at the constant work rate during submaximal cycling intensity (Barratt et al., 2016; Ferrer-Roca et al., 2017; Hull & Gonzalez, 1988; Korff et al., 2007; McDaniel et al., 2002).

Some researchers have recommended using shorter CAL than conventional lengths (165~175mm) for generating more cycling power (Barratt et al., 2016; Hull & Gonzalez, 1988; Inbar et al., 1983). Ferrer-Roca et al. (2017) revealed the tendency of increasing hip and knee range of motion and hip extensor moment with a longer CAL than preferred CAL. However, other studies have been reported that there were no significant differences in cycling power, joint angle, and  $\text{VO}_2$  depends on when using different CALs (Barratt et al., 2011; Inbar et al., 1983; MacDermid & Edwards, 2010; McDaniel et al., 2002; Morris & Londeree, 1997; Watanabe, 2020). Furthermore, previous studies were limited in the type of subject recruited either elite or well-trained cyclists (Barratt et al., 2011 & 2016; Christiansen et al., 2013; Korff et al., 2007; MacDermid & Edwards, 2010; Martin & Spirduso, 2001; McDaniel et al., 2002; Morris & Londeree, 1997) or young healthy students (Ferrer-Roca et al., 2017; Hull & Gonzalez, 1988; Inbar et al., 1983; Too & Landwer, 2000; Watanabe, 2020).

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## Considerations

In this review, we focused on the effect of the acute changing of CAL on cycling. Even though ample research has been conducted to investigate the relationship between cycling performance and CAL in both biomechanics and exercise physiology perspectives, the effects of changing CAL on cycling time trial performance still remains unclear.

Previous studies showed inconsistent results regarding the effect of changing CAL in cycling mechanic and physiological parameters. Increasing power output in a short duration may not a good indicator of cycling time trial performance. In terms of successful endurance cycling, the strategy to apply propulsion forces effectively over a long duration is more important than achieving a higher power output in a short amount of time. Furthermore, the maximum cycling power test mainly relies on anaerobic capacity (i.e., phosphagen & anaerobic glycolytic system); however, aerobic metabolism is a major energy source during endurance cycling from 80% up to 99% (Sunde et al., 2010). Therefore, the functional threshold power (FTP) test may be a better predictor of endurance cycling performance than the maximum power test in a short duration (Sørensen et al., 2019).

Besides, a large range of CALs (110 to 265mm) was used for several studies that were impractical to use for cycling training and real race event. Based on the review of literature, the well-trained triathletes/cyclists could maintain approximately the same amount of cycling power output and  $\text{VO}_2$  across different CALs (Barratt et al., 2011; Watanabe, 2020). However, the changing of CALs may have more influence on the cycling economy and performance to novice triathletes/cyclists.

Research by Martin and Spirduso (2001) demonstrated that the ratio between CAL and lower limb length for the maximal power production was 20% of leg length and 41% of tibia length, respectively. Also, this study showed an inverse relationship between cadence and speed depends on increasing CALs. Therefore, the aged group or novice triathletes should choose an appropriate CAL based on their lower limb length, cycling technique, and race strategies for better race performance.

From these points of view, more research is needed about the effect of CAL in a standard range (165 ~ 175mm) on endurance cycling performance as an aspect of both biomechanical and physiological parameters. Also, future research will be testing the reliability of the effect of CAL on cycling mechanics and power output between the laboratory setting and overground.

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**Journal of Health, Sports, and Kinesiology, 2021, 2(2), 8-10**  
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## Original Research

## Open Access

### Article History:

Received 20 September 2020

Accepted 23 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.8>

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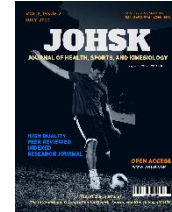
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# Eating Behavior Psychoregulation As a Resource for Increasing the Achievements of Athletes

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**Keywords:** eating behavior, psychological factors, athletes

## Introduction

The realities of today's sport indicate that the achievement of high sports results is not only due to high-quality technical-tactical preparation for the competitions but is also associated with a number of medical-biological character factors (Dmitriev & Gunina, 2020). For instance, one of the most important constituents of the training process in all sports events is a properly selected balanced diet, which takes into account the competitive activity specifics, the peculiarities of physical loads, the athlete individual physiological and psychological characteristics (Gunina et al., 2018; Malkina-Pykh, 2007).

Therefore, every year the attention of scientists in the field of sport is more and more focused on the issue of athlete eating behavior management as a factor of increasing the competitive activity efficiency, which determines the urgency of this research topic.

Besides, in the scientific literature, the psychological components of nutritional support in sport have received almost no attention. Available publications have mainly addressed the peculiarities of athlete nutrition in certain sports events (Polievsky, 2015) almost neglecting external and internal factors that influence the athlete eating behavior, which makes the presented topic especially interesting for study.

## Purpose

The purpose of this study was to identify the psychological factors that determine the peculiarities of nutrition and diet in sports, and to determine the degree of their influence and methods of psychoregulation. Previous researchers have reported changing of CAL affect cycling power production (MacDermid & Edwards, 2010; Martin & Spirduso, 2001; Too & Landwer, 2000), lower limb joint angle, cadence (Barratt et al., 2011 & 2016; Candotti et al., 2007; Christiansen et al., 2013), pedal torque (Hull & Gonzalez, 1988), lower limb muscle activity (Watanabe, 2020), and VO<sub>2</sub> (Ferrer-Roca et al., 2017; Morris & Londeree, 1997).



## Methods

To reveal the key psychological factors determining the success of following a meal plan by the athletes, an expert survey of 32 skilled athletes of different sports events has been conducted. Athletes were offered a list of factors that influence eating behavior. From this list, we have selected the main influencing factors and combined them into three groups. Methods of mathematical statistics were used to determine the consistency of expert opinions: the Kendall's coefficient of concordance (W).

## Results

According to the results of this survey, it was revealed that the main psychological factors influencing the athlete eating behavior are **severe restrictions** (55%, weight cutting before the competitions, refusal of favorite foods, permanent ban on exceeding the calorie limit, etc.); **unwanted habits** (26%, dependence on alcohol, cigarettes, etc.), **stress** (19%, including (a) *under the influence of internal irritants*, associated with unsuccessful performances at competitions, personal problems such as disappointment, deception, betrayal), feelings of uncertainty or inconsistency between results and needs, sense of guilt; and (b) *under the influence of external irritants*, caused by communication issues, such as unsatisfactory relationships with colleagues or coach, conflicts in the family.

The Kendall's coefficient of concordance (W) was 0,72, which indicates a high degree of agreement among experts and the reliability of the data obtained.

## Discussion

It should be noted that such a distribution of expert opinions is associated with the peculiarities of their lifestyle, developed volitional qualities, discipline, the ability to control desires and needs, as well as a high level of responsibility. The listed qualities are developed in professional athletes under the influence of long-term regular volitional efforts applied while practicing sport (Vysochina, 2016; Vysochina et al., 2018).

In addition, an important aspect determining the peculiarities of an athlete eating behavior is the ability to distinguish between hunger and appetite. Hunger is the bodily and physiological need for food, while appetite represents a psychological need, caused by strong feelings and emotions. Appetite may be evoked by food memories, delicious smells, emotional expectations, or anticipation of food. An interesting feature is that hunger leads to the appearance of negative emotions in a person, whereas appetite – positive ones.

Appetite often occurs as compensation for unsatisfied emotions, such as loneliness, melancholy, boredom, anxiety, guilt, shame, anger, irritation, fatigue. The main causes of appetite disorder are (a) unlive emotions (suppressed or forbidden feelings), (b) unmet needs, "I want", "do not do", and "I postpone", (c) "tension-relaxation" cycle disruption (constant tension, stress).

All listed causes result in a decrease of vital power and activity. Therefore, it is extremely important for an athlete to work through destructive emotions in due time and identify the sources of their appearance. Such work is carried out by the athlete's rational understanding of his thoughts, actions, and their consequences.

Athlete eating behavioral psychoregulation also includes analysis of problems caused by anxiety, low self-esteem, guilt, conflict situations, and difficulties in interpersonal relationships. Regardless of the eating behavioral psychoregulation method, the athlete should consistently perform the work including tasks to analyze and work through a specific issue and correct irrational affirmations that prevent to tackle it at the given stage. In addition, the athlete should evaluate the existing and form the ideal body image.

## Conclusion

This study suggests that the major psychological factors, influencing the athlete eating behavior include severe food restrictions, unwanted habits, and stress. At the same time, the ability to distinguish hunger from appetite may serve as an important aspect determining the peculiarities of nutrition and diet in sport, which is formed under the impact of certain emotions. The development of the skills of self-regulation and control over the eating behavior is one of the key factors for an athlete to improve achievements and maintain good physical condition.

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## Original Research

## Open Access

### Article History:

Received 20 September 2020

Accepted 11 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.11>

### Corresponding Author:

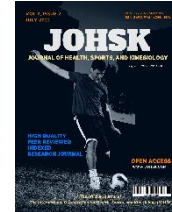
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# Understanding Korean Immigrants and Major League Baseball Fandom

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**Keywords:** Korean immigrant, acculturation, team identification

## Introduction

Currently, there are more than 40 million immigrants in the United States, and immigrant sports consumers have been considered a significant niche market in the sport industry. In particular, Major League Baseball (MLB) teams have realized that Korean immigrants, along with Japanese immigrants, are among the most attractive Asian immigrant MLB markets in the U.S., because of their large populations in the U.S. and the popularity of baseball in their native countries (Kim & Jeon, 2008). However, there has been limited research regarding Asian immigrants' team identification with MLB teams.

The theoretical framework of this study is drawn from acculturation theory (Berry, 1997) and social identity theory (Tajfel, 1982). Berry defines acculturation as "the general processes and outcomes (both cultural and psychological) of intercultural contact" (Berry, p. 8). Acculturation theory has been widely used to explain the adaptation patterns of immigrants to a new society. This theory further explains not only how immigrants evolve in new cultural contexts resulting from migration, but also how they retain their original cultural contexts and beliefs while in their new society (Berry, 1997). According to Berry (1980), there are four types of acculturation strategies: integration, assimilation, separation, and marginalization. These four acculturation strategies differ according to immigrants' efforts to adapt to new cultural contexts as well as the extent of their relationships with their new as well as with their old societies.

Social identity theory (Tajfel, 1982) is a useful theoretical framework for team identification. Social identity is defined as "the part of the individual's self-concept which derives from their knowledge of their membership in a social group together with the value and emotional significance attached to that membership (p.2)". Team identification research has been developed based on social identity theory and identity theory (Kwon, Trail, & James, 2007). Team identification is an extension of self-identity that results from a sports fan's psychological connection to a team (Fink, Trail, & Anderson, 2002).

## Purpose

The purpose of this study is to understand the Major League Baseball fandom of Korean immigrants by exploring factors associated with recent Korean immigrants' team identification with MLB teams in the U.S.

## Methods

A qualitative design, using in-depth, semi-structured interviews, was employed to explore factors associated with first-generation Korean immigrants' team identification with MLB teams. The interview questions address significant aspects of the immigrants' sport experiences and the meaning of team identification with MLB teams that have Korean players. The snowballing sampling method was implemented to recruit the research participants. Korean immigrants who lived in the U.S. more than five years and three years in Atlanta and came to the U.S. as first-generation Korean immigrants were considered potential research participants at the beginning stage of the data collection.

The authors conducted thirteen in-depth interviews with both male and female Korean immigrants in Atlanta, Georgia. After the interviews were completed, the process of data analysis was initiated. Although the conceptual framework was a guideline for identifying areas of interest in the interview data, the patterns, themes, and categories of analysis emerged from the data; they were not imposed on the data prior to data collection and analysis (Patton, 1990). Open coding was utilized to categorize the participants' responses into several themes. Through the open coding process, initial codes were assigned and "the first attempt to condense the mass of data into categories" was made (Neuman, 2000, p. 421). Each participant's interview responses were analyzed and placed into a category.

## Results

The findings of this qualitative study revealed the following five factors, which elaborate and explain essential perspectives in understanding team identification of Korean immigrants with MLB teams in the U.S.; (a) adaptation patterns; (b) baseball involvement levels before migration to the U.S. (c) the presence of a Korean player (d) team standing, and (e) satisfaction with immigrant life.

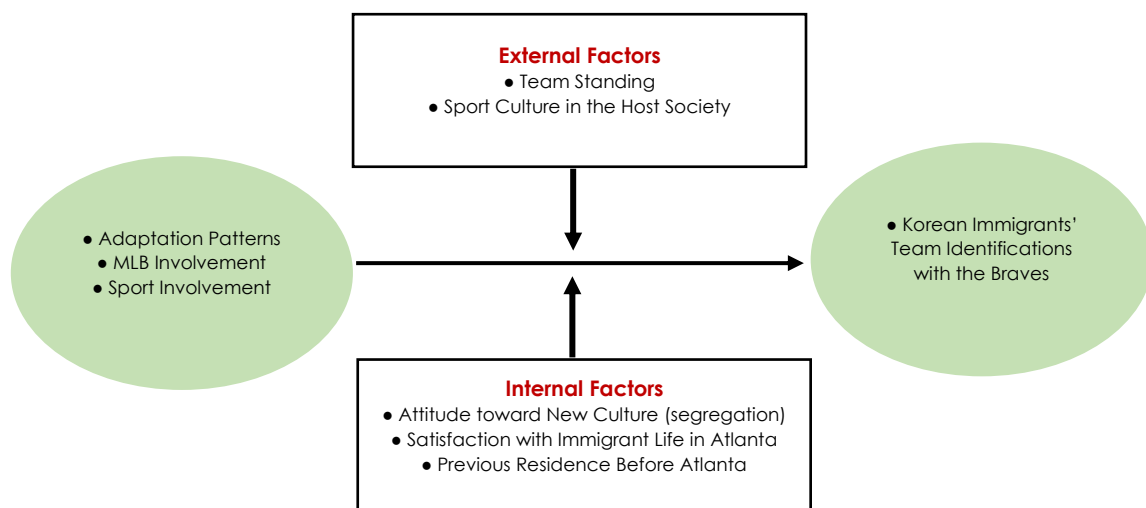


Figure 1. Conceptual Framework of Korean Immigrants' MLB Fandom

## Conclusion

The findings of this qualitative research revealed crucial factors researchers need to consider gaining a better understanding of immigrant' sport experiences. These factors are the immigrants' previous residence, satisfaction with current residence, the status of sport culture in the host society, the team's standing, and satisfaction with immigrant life. In other words, understanding the context surrounding immigrants' lives in the host society is essential to accurate interpretation of their sport experiences as an ethnic minority. The attitude of Korean immigrants toward accepting their new culture, their satisfaction with immigrant life in the Atlanta area, and their previous residence should be considered when understanding their team identification. In short, the holistic understanding of Korean immigrants' lives is necessary for a better comprehension of the MLB fandom of Korean immigrants.

## Discussion

This research shows that, regardless of adaptation patterns, the presence of Korean players in MLB games was the factor that appealed most to Korean immigrants and encouraged them to watch MLB games. Previous studies have shown that vicarious achievement was the most significant motive for team identification (Fink et al., 2002). Vicarious achievement, defined as the feeling Korean immigrants have when watching MLB games in which Korean players participate, was shown to be the main reason they watch MLB games. Vicarious achievement can be interpreted to mean that the presence of Korean players in the U.S. was a means to retain their ethnic identity through supporting Korean players. Also, the presence of Korean players seems to be a means of providing important glue for the Korean immigrant community, fandom to MLB teams, as well as the host society. The limitations in this study should be considered a guideline for future studies. For a deeper understanding of Korean immigrant sport consumer behaviors, future studies should explore the following three aspects: (a) second-generation Korean immigrants, (b) existence of Koreatown in the city vs. non-Koreatown, and (c) other American professional sports.

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## Original Research

## Open Access

### Article History:

Received 22 September 2020

Accepted 10 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.14>

### Corresponding Author:

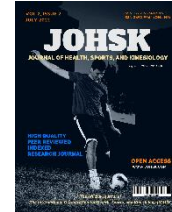
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# Eating Habits and Lifestyle Changes of College Students During COVID-19 Outbreak

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**Keywords:** COVID-19, eating habits, lifestyle habits

## Introduction

The epidemic that was a result of the Coronavirus (Cupples, 2019) began in China towards the end of 2019 and has quickly spread throughout the world. To minimize the spread of the virus and keep it as contained as possible, many countries have required residents to quarantine. This epidemic has been a major concern for students of all ages, especially college students. Students that attend universities have been affected more profoundly due to the close quarters of dorms, fraternities, sororities, and close classroom contact. Due to the contagiousness of the virus and the fact that many who are positive can be asymptomatic hundreds can be affected quickly. The pandemic has forced many students to quarantine themselves. This requires that they not leave their homes, rooms, and apartment for a period of up to 14 days.

## Purpose

The purpose of this research was to assess how COVID has affected college students and how it has affected their eating habits and lifestyle habits.

## Methods

The COVID19 questionnaire was specifically built by using Google Form by the department of Exercise Science of the Georgia College. The questionnaire included 35 questions divided into three different sections: (1) anthropometrics data, (2) lifestyle, eating habits changes, psychological and emotional aspects during the pandemic period, (3) physical activity habits information. All participants were fully informed about the study requirements and were required to accept the data sharing and privacy policy before taking part in the study. The participants completed the questionnaire directly connected to the Google Form. The participants' answers were anonymous and confidential. Descriptive statistics were employed to explore demographic, personal characteristics, and anthropometric parameters of the study sample. Data are represented as numbers and

percentages in parentheses (%) for categorical variables or mean and standard deviation (SD), as well as median and interquartile range in square brackets [IQR] for continuous variables. The Shapiro–Wilk test was carried out to evaluate variables distribution. All the variables had non-normal distribution. The estimated population size is total number of undergraduate students at Georgia College ( $n = 5,844$ ). Confidence level is 95%. When margin of error is 13%, estimated sample size is 57.

## Results

We conducted a survey of Georgia College students and asked them a series of questions related to their health, sex, diet, and how COVID has affected them. We asked them a series of questions that related to their health, age, sex, previous diseases, exercise, diet, and weight gain. We surveyed 58 students both male and female (Table 1). The majority of people surveyed were college students.

In regard to lifestyle changes during the COVID-19 lockdown most of the population sampled stated that their habits did not change, and COVID-19 did not negatively affect their diet and eating habits. Many students did not change their eating habits, or felt that their eating habits improved, to make healthier choices during the COVID-19 pandemic. Prior to the pandemic, 59% of those sampled ate out 1 to 2 times a week. During the pandemic, that percentage decreased to 46% and the number of subjects who ate out no times a week increased from 10.3% of the sample population to 26.3% of the sample population. This is likely as a result of the measures taken by local governments to help curb the spread of COVID. The survey also indicated that 48% of the population are ordering less from restaurants, take-out and delivery and 52% of the sample population's meals were prepared themselves at homes more often. Furthermore, 69% of those sampled either ate the same or less than they did before the pandemic began. Because exercise habits did not change considerably this decrease in consumption of non-homemade food likely contributed to the sample population's perception of their weight, as 63% said that they thought their weight stayed stable, or they had lost weight.

The COVID-19 pandemic lockdown had the biggest impact on the sample population's psychological health as 62.8% of those sampled felt more stressed and 57.6% of those sampled felt lonelier compared to before the pandemic (Table 2). While only 25% of the students found themselves eating more because of stress, 49.3% of the students found themselves eating more than normal due to being bored. Alcohol consumption did not increase significantly during the pandemic.

**Table 1. Physical Characteristics and Anthropometrics**

| Variables                      | Participants ( $n=58$ ) |
|--------------------------------|-------------------------|
| Age (years)                    | $20.7 \pm 0.8$          |
| Height (cm)                    | $169.0 \pm 16.6$        |
| Bodyweight (kg)                | $69.4 \pm 13.8$         |
| BMI ( $\text{kg}/\text{m}^2$ ) | $23.6 \pm 3.5$          |

**Table 2. Emotional State During the COVID-19**

| Variables         | A lot less | Somewhat less | The same   | Somewhat more | A lot more |
|-------------------|------------|---------------|------------|---------------|------------|
| <b>Stress</b>     | 2 (3.4%)   | 2 (3.4%)      | 18 (31.6%) | 26 (45.6%)    | 10 (17.2%) |
| <b>Loneliness</b> | 2 (3.4%)   | 2 (3.4%)      | 21 (36.2%) | 30 (51.8%)    | 3 (5.2%)   |

Note: Values are expressed as number and percentage ( $n$  (%)) for categorical variables

## Discussion

The survey asked specific questions about diet, health, and exercise. The results were similar to Gallè's study (2020). "There was a study done on Italian undergraduate students and this study indicated that most student's dietary

habits were not affected by the quarantine" (Gallè et al, 2020). In fact, some students felt that it had helped their diet by making healthier choices when possible. For those students that are being provided meals in quarantine and in dining halls, a majority of the food offered is pre-packaged and securely contained options. This helps to reduce the potential spread of the family style options that used to be available. All utensils are typically plastic and in pre-sealed packages. Enforcing these new procedures, is to help ensure the spread slows down or to reduce it as much as possible. Students that are forced to quarantine if following the rules correctly, will have to rely on outside help for meals. If they are on a meal plan, then most universities have implemented a food delivery plan that enables them to get meals from the dining hall. But, for those that live in apartments or off campus it can be more problematic. If students are quarantined, they would not technically be allowed to go to the grocery store and most students cannot afford to have the store delivery option. This has forced many to order fast food or take out and those typically tend to be less healthy and higher in sodium. The main limitation of this study was that the data collected was self-reported. This could lead to misreporting of data. Also, the sample size was small.

## Conclusion

When diet and food habits of a population of 58 college students were assessed, few major changes were seen, although psychological health did suffer to an extent. As the COVID-19 pandemic is still ongoing, our data need to be investigated in the future with a larger college population.


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## Literature Review

## Open Access

### Article History:

Received 16 September 2020

Accepted 23 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.17>

### Corresponding Author:

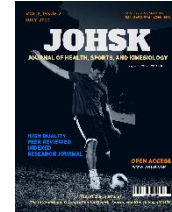
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# Elementary School Classroom Teachers' Perceptions of Teaching Physical Education: A Literature Review

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**Keywords:** generalists, ecological perspectives, professional development

## Introduction

Elementary school physical education (PE) can play a unique role in providing educational experiences to students and may support physical, cognitive, and social-emotional development (Institute of Medicine, 2013). Studies illustrate that PE programs can improve the possibility of achieving student learning outcomes only when appropriately designed and delivered (Rink & Hall, 2008).

Research suggests that students' early experiences with PE are mainly led by elementary school teachers (Kirk, 2005). Globally, in several countries, either classroom teachers (i.e., a teacher who teaches every subject; a generalist), or PE specialists (i.e., a teacher who mainly teaches PE), have the responsibility to teach elementary PE (Dyson et al., 2018; Faulkner et al., 2008). For instance, in South Korea's elementary education system, PE is a required subject, and most PE classes are taught by classroom teachers rather than specialists (Jo & Lee, 2012).

Classroom teachers are best suited to teach the child-centered, integrated curriculum in elementary schools, and hence often teach PE as one element of that curriculum (Coulter et al., 2009). However, some teachers believe that elementary level PE engagement experiences inadequately prepared children for accomplishing PE learning outcomes and physically active lifestyle (Hardman, 2008; Jess, Keay, & Carse, 2016). In other words, in order for classroom teachers to successfully teach PE, they need to consider a dynamic combination of adaptation in school contexts, teaching various subjects, and understanding different students' developmental characteristics (Tinning & Rossi, 2013). Additionally, classroom teachers' beliefs that they are not qualified to teach PE adversely affects their PE teaching confidence (Harris, Cale, & Musson, 2012; Morgan & Bourke, 2008).

Examination of classroom teachers' different perspectives on teaching PE is particularly vital as an avenue for developing effective teacher education programs (Hunter, 2006). However, this aspect of elementary PE taught by classroom teachers is still unknown due to a relative scarcity of research studies in this area (Kirk, 2005, p. 247). Therefore, this paper provides an overview and discussion of illustrative findings of research conducted on

classroom teachers' perceptions of teaching PE.

## Overview

The author conducted an exhaustive search of published research articles via three major databases: Google Scholar, Education Resources Information Center (ERIC), and Web of Science. The search terms included elementary school classroom teacher, primary school classroom teacher, generalist, non-specialist, physical education, perception, experience, practice, barrier, belief, and value (see Figure 1). Using the resulting articles, the review is organized into the following themes (Thomas & Harden, 2008): (a) apprehension of teaching PE, (b) different perceptions of value for PE classes, and (c) ecological perspectives in teaching PE.

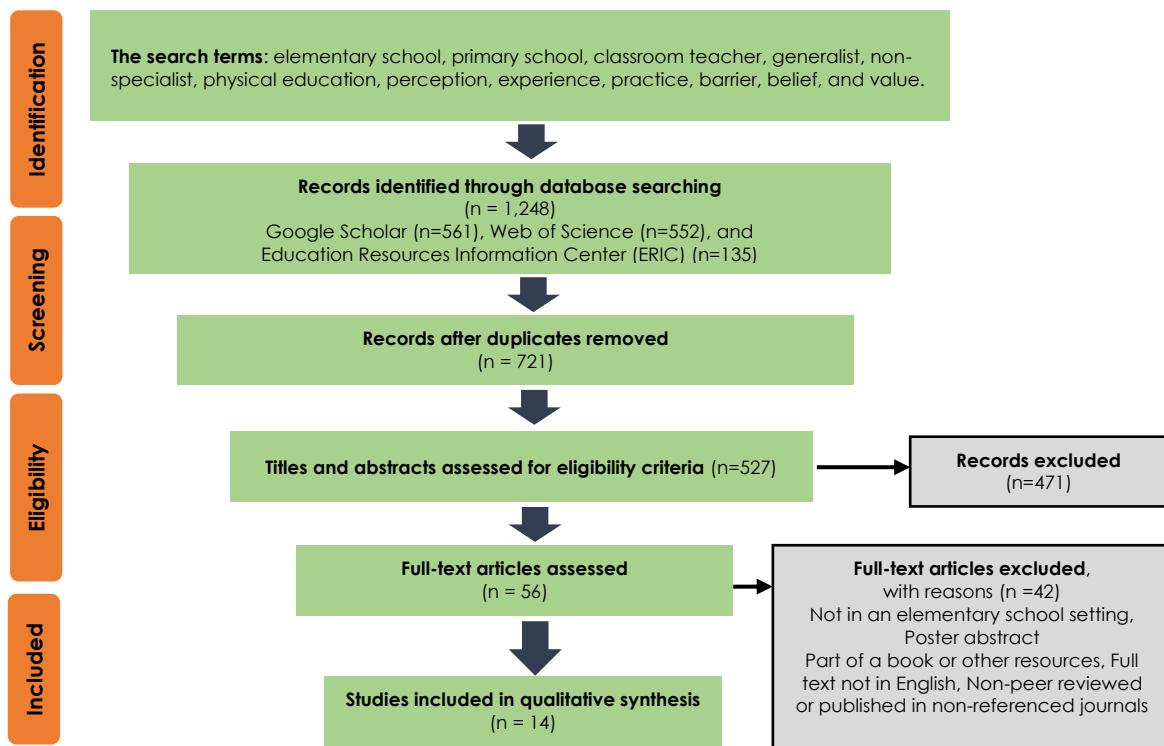


Figure 1. Flow Chart for Search Results and Selection of Article

### Apprehension of Teaching PE

Various studies have highlighted the low levels of teacher expertise and confidence about teaching PE (Dyson et al., 2018; Gordon et al., 2016; Harris et al., 2012; Miller et al., 2016). Truelove et al. (2019) found that many classroom teachers expressed that they did not possess the subject knowledge or skills to deliver adequate PE lessons. In addition, studies reported that classroom teachers recognized the benefits of PE but would generally prefer to teach other subjects due to a perceived lack of knowledge and ability in this key learning area (Harris et al., 2012; Morgan & Hansen, 2008). Moreover, once teachers are in-service, there is a lack of professional learning opportunities to support them (Dyson, Gordon, & Cowan, 2011; Petrie & Lisahunter, 2011). Limited training opportunities exacerbate classroom teachers' lack of confidence in their ability to teach PE (Dyson et al., 2018).



### **Different Perceptions of Value for PE Classes**

Studies have illustrated that some classroom teachers have negative attitudes and perceptions toward PE (Dyson et al., 2011; Sherman, Tran, & Alves, 2010) and do not believe that PE is an important subject (Barney & Deutsch, 2012). These negative perspectives significantly impact the quality of delivery and effectiveness of PE programs as well as the attitudes of their students (Morgan & Bourke, 2008; Morgan & Hansen, 2007). On the other hand, researchers have found that some classroom teachers do perceive PE to be an important part of the elementary school curriculum (Jess et al., 2016) but prefer to teach classroom-based subjects such as science and mathematics (Morgan & Bourke, 2008). Additionally, Morgan and Hansen (2008) mentioned that many classroom teachers were unwilling to teach PE but value it as an important curricula component. However, this perception of increased importance did not guarantee the delivery of quality PE or that students would develop desired knowledge and skills (DeCorby et al., 2005).

### **Ecological Perspectives in Teaching PE**

Researchers have also found that a theoretical approach related with this research topic concerns the ecological perspective, which posits that the individuals studied are unique and holistic beings in a continuous process of becoming and seeking full personal integration in a changing environment (Bronfenbrenner, 1992). This perspective can be used to describe the classroom teachers' dynamic relationships among individuals, groups, and their environments of teaching PE (Bronfenbrenner, 1992). Many research studies conducted work based on this perspective (Jess et al., 2016).

Studies address the issues with classroom teachers' environments, the lack of clearly defined roles for classroom teachers, and the lack of peer-teacher support (Hendricks et al., 2016; Morgan & Bourke, 2008; Sherman et al., 2010). Despite a number of studies indicating that the most substantial factors for teaching PE are related to a classroom teacher's attitudinal disposition, others have claimed institutional factors (i.e., school environment), or factors outside a teacher's control (e.g., policy), are more pertinent impediments (Morgan, 2008). Hardman and Marshall (2001) presented that reduced time, poor financial and material support, and increasing marginalization hinder classroom teachers' efforts to teach elementary school PE. Similarly, Mandigo et al. (2004) described how classroom teachers believed that lack of funding, lack of equipment, and constrained time for PE in an already crowded curriculum were the barriers to PE lessons.

## **Considerations**

This review can help provide educators with useful resources for classroom teachers' professional development that focuses on delivering quality PE lessons. In order to diminish the gap between instruction-theory and the practice of teaching in actual school contexts, more research is needed regarding the meaning of varied educational phenomena and lived experiences in school contexts (Pope, 2000). Additionally, there is very little empirical research conducted on the process by which novice classroom teachers develop into experienced teachers. For instance, there are insufficient studies to deeply understand the lived experiences of teaching PE that are based in the contexts of teachers who are required to teach every subject including PE, such as novice teachers in South Korea. Therefore, for future research, it is necessary to investigate the experiences of classroom teachers who teach PE in regard to their perceptions, barriers, and professional identity (e.g., teachers' perceptions of themselves, how their perceptions affect their teaching practices within school environments, etc.). This research will help to unveil the multiple realities of classroom teachers' experiences teaching PE, with the ultimate goal of improving pre- and in-service teacher education programs for quality teaching of PE.

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Journal of Health, Sports, and Kinesiology, 2021, 2(2), 22-27  
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## Research Critique

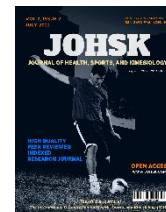
## Open Access

### Article History:

Received 10 April 2021  
Accepted 26 April 2021  
Published 1 August 2021  
Available online 30 July 2021  
<https://doi.org/10.47544/johsk.2021.2.2.22>

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# Cardarine (GW501516) Effects on Improving Metabolic Syndrome

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**Keywords:** Cardarine, GW501516, metabolic syndrome

## Abstract

The present study hypothesized that treatment with GW501516 (a selective PPAR- $\delta$  agonist) lowers lipids by increasing fatty acid oxidation without adverse effects on oxidative stress. Caucasian men (age 18–50 years,  $n=18$ ) were randomly assigned to treatment with GW501516, GW590735, or placebo for two weeks while residing in a clinical research facility. A meal tolerance test, skeletal muscle biopsy, and blood/breath sampling were conducted. The study reported that treatment with GW501516 ameliorated multiple metabolic abnormalities associated with metabolic syndrome including oxidative stress, obesity, dyslipidemia, and insulin resistance, all while increasing fatty acid oxidation. Notably, no adverse effects were reported. However, the restricted living conditions and/or diets that the participants were subjected to likely do not resemble their normal lifestyle. Therefore, the beneficial effects of GW501516 on metabolic health observed in the study should further be investigated in a real-life setting. During participant recruitment, the use of dietary supplements were minimally considered, thereby increasing the risk for confounding effects on the metabolic parameters assessed in the study. Also, recruiting a larger and more diverse population would allow for a more detailed analysis that may benefit a broader range of people (i.e., examining the effects of GW501516 in certain ethnic groups or with/without exercise programs). Additional research on GW501516 and other PPAR- $\delta$  agonists is encouraged since it appears that this class of drugs can ameliorate multiple metabolic syndrome features. Future studies should consider additional metrics relevant to metabolic syndrome such as C-reactive protein, cortisol, and homocysteine.

## Introduction

Peroxisome proliferator-activated receptors (PPARs) are a family of ligand-activated nuclear hormone receptors that are involved in the regulation of cellular metabolism. Fibrates (PPAR- $\alpha$  agonists) and thiazolidinediones (PPAR- $\gamma$  agonists) have been widely used to treat hypertriglyceridemia and type 2 diabetes (T2D), respectively (Tyagi et al., 2011). In comparison to PPAR- $\alpha$  and PPAR- $\gamma$ , rather little is known about the potential of PPAR- $\delta$  in the treatment of any metabolic disorders.

However, studies on mice suggest PPAR- $\delta$  agonism as a promising treatment approach for those with metabolic syndrome. Metabolic syndrome is characterized by obesity (particularly abdominal/visceral obesity), insulin resistance, hyperglycemia, dyslipidemia, and/or hypertension (Huang, 2009; Losko et al., 2016). Individuals with metabolic syndrome appear to be at higher risk for nonalcoholic fatty liver disease (NAFLD), cardiovascular disease (CVD), T2D, premature aging, and various inflammatory conditions (Al Rifai et al., 2015; Dominguez & Barbagallo, 2016). Thus, treatment of metabolic syndrome has emerged as an essential field of clinical research. In the present study, "Activation of Peroxisome Proliferator-Activated Receptor (PPAR) Promotes Reversal of Multiple Metabolic Abnormalities, Reduces Oxidative Stress, and Increases Fatty Acid Oxidation in Moderately Obese Men", Risérus et al. examined the effects of the PPAR- $\delta$  agonist, GW501516 (also known as Cardarine), on human participants with metabolic syndrome features.

## Purpose

The purpose of this study was to test the hypothesis that treatment with GW501516 lowers lipids by increasing fatty acid oxidation without adverse effects on oxidative stress (Risérus et al., 2008).

## Methods

Risérus et al. conducted a two-week long, double-blind, randomized, three-parallel group study. Healthy (no sign of any clinical health disorders), but obese Caucasian men with moderate dyslipidemia were recruited. Recruits were excluded if they were smokers, regularly engaging in intense exercise, taking antihypertensive/hypolipidemic/antidiabetic medications, or if they had a history of diabetes, CVD, thyroid dysfunction, appreciably elevated liver enzymes, abnormal electrocardiogram results, and/or hyperglycemia.

Inclusion criteria was a body mass index (BMI)  $> 27 \text{ kg/m}^2$ , waist girth  $> 95 \text{ cm}$ , age 18-50 years, fasting plasma triglycerides (TAGs) 100-350 mg/dl, and HDL  $< 50 \text{ mg/dl}$ . The PPAR- $\alpha$  agonist, GW590735, was included to better understand the mechanisms of GW501516. Selected participants ( $n=18$ ) were randomly assigned to treatment with either placebo, 10 mg/day of GW501516, or 20 micrograms/day of GW590735 ( $n=6$  for each group). Eight of the 18 selected participants fit the criteria for metabolic syndrome defined by The National Cholesterol Education Program Adult Treatment Panel III (James, 2001). Participants resided in a clinical research facility throughout the two-week study duration and were provided standardized diets. Physical exercise and alcohol consumption were inhibited. Metabolic parameters were evaluated during two visits on two consecutive days pre-treatment and after 12-14 days of treatment.

Upon the first day of investigation, liver fat (% fraction) measured by MRI and a skeletal muscle biopsy of the vastus lateralis was performed to assess mRNA expression of carnitine palmitoyl transferase 1B (CPT1b), carnitine acyltransferase (CRAT), acyl-CoA carboxylase 2 (ACBA2), hydroxyl coenzyme dehydrogenase (HADHA), and PPAR- $\delta$ . Slow and fast twitch muscle fibers were separated via laser capture microdissection (LCM). Pre- and post-treatment, a 6-hour meal tolerance test was conducted with corresponding sampling of the blood and exhaled breath. The standardized meal contained 100 mg of [U13C]palmitate (M+16) which served as a tracer for palmitate (M+0). Gas chromatography and mass spectrometry (GC/MS) was used to determine fatty acid composition and isotopic enrichment (tracer/tracee ratio: TTR) of plasma nonesterified fatty acids (NEFAs) and TAGs. TTR of [13C] $\text{CO}_2$  in the breath sample was used to compare postprandial fat oxidation between groups. Anthropometrics included BMI and weight. Plasma insulin and glucose concentrations were used to determine insulin sensitivity using the Homeostatic Model Assessment for Insulin Resistance (HOMA-IR).

In addition to TAGs and NEFAs, lipid profile was characterized by total cholesterol, LDL, HDL, and apoB. Whole-body oxidative stress was assessed via urinary F2 isoprostanes and liver enzymes measured included  $\gamma$ -glutamyl transferase ( $\gamma$ -GT), aspartate aminotransferase (AST), and alanine aminotransferase (ALT).  $\beta$ -OH-butyrate was used to monitor hepatic fatty acid oxidation.

## Results

Risérus et al. conducted a two-week long, double-blind, randomized, three-parallel group study. Healthy (no sign of any clinical health disorders), but obese Caucasian men with moderate dyslipidemia were recruited. Recruits were excluded if they were smokers, regularly engaging in intense exercise, taking antihypertensive/hypolipidemic/antidiabetic medications, or if they had a history of diabetes, CVD, thyroid



dysfunction, appreciably elevated liver enzymes, abnormal electrocardiogram results, and/or hyperglycemia. Inclusion criteria was a body mass index (BMI) > 27 kg/m<sup>2</sup>, waist girth > 95 cm, age 18-50 years, fasting plasma triglycerides (TAGs) 100-350 mg/dl, and HDL < 50 mg/dl. The PPAR- $\alpha$  agonist, GW590735, was included to better understand the mechanisms of GW501516. Selected participants (n=18) were randomly assigned to treatment with either placebo, 10 mg/day of GW501516, or 20 micrograms/day of GW590735 (n=6 for each group). Eight of the 18 selected participants fit the criteria for metabolic syndrome defined by The National Cholesterol Education Program Adult Treatment Panel III (James, 2001).

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## Conclusion

Two weeks of PPAR- $\delta$  activation led to beneficial effects on plasma lipid profiles, insulin sensitivity, whole-body oxidative stress, and liver fat content. mRNA analysis of the vastus lateralis suggests upregulation of fat oxidation pathways in both fast and slow muscle fibers. A strikingly large reduction in plasma NEFA was seen with GW501516 treatment and this may originate from a greater rate of fat oxidation and/or regulation of Niemann-pick C1 like-1 (NPC1L1) by PPAR- $\delta$ . Overall, it appears that GW501516 treatment would be beneficial in various ways for those with metabolic syndrome (Table 2). Limitations of the present study include a short treatment period and restricted living conditions. In summary, GW501516 appears to ameliorate numerous metabolic syndrome characteristics with minimal/absent adverse reactions.

## Critique

The purpose of the study was to test the hypothesis that treatment with GW501516 lowers lipids by increasing fatty acid oxidation without adverse effects on oxidative stress. Although Riséus et al. comprehensively measured the effects of PPAR- $\delta$  on metabolic improvements in humans by using various state-of-the-art techniques such as muscle biopsy and MRI scan, several limitations should be considered to conclude the potential effects of PPAR- $\delta$  on metabolic syndrome.

As opposed to restricting the participants to a standardized diet/lifestyle, allowing participants to carry out their normal diet/lifestyle patterns would provide a more practical demonstration of the effects of GW501516. Although not statistically significant, liver fat % tended to differ between pre- and post-treatment in the placebo group. One participant in this group exhibited a ~4% increase in liver fat % within the 2-week period. This suggests that the restricted living conditions were significantly different from participant's regular lifestyle/diet. If attempting to examine the effects of GW501516 in a practical context, future studies should consider allowing participants to maintain their normal lifestyle/diet as much as possible. Furthermore, it should be sophisticatedly required to consider the use of dietary supplements and/or prior special dieting patterns, both which may have altered the parameters evaluated in this study, while recruiting participants.

**Table 1. Change from Baseline to 14 days in Fasting Plasma Biochemistry, Liver Enzymes, and Urinary Isoprostanes**

[Adapted from Table 2 of original research study, Risérus, Ulf, et al. *Diabetes*, 57(2), 332-339].

|   | Placebo<br>(n=6) | GW590735<br>(n=6) | GW501516<br>(n=6) | P-value<br>(ANOVA) |
|---|------------------|-------------------|-------------------|--------------------|
| Glucose (mmol/l)  | -1 ± 0.1*        | -0.3 ± 0.2*       | -0.3 ± 0.2*       | 0.25               |
| Insulin (mU/l)  | 1.2 ± 1.1*       | 1.0 ± 1.9         | -1.7 ± 2.2*♦♥     | 0.01               |
| HOMA-IR   | 0.17 ± 0.18      | -0.02 ± 0.40      | -0.58 ± 0.53*♦♥   | 0.006              |
| NEFA (µmol/l)   | 22 ± 212         | -62 ± 90          | -247 ± 101♦♣♣     | 0.01               |
| Triglycerides (mmol/l)  | 1.1 ± 0.7        | -0.4 ± 0.6        | -0.5 ± 0.4*       | 0.16               |
| Total cholesterol (mmol/l)  | -0.3 ± 0.5       | -0.6 ± 0.4*       | -1.0 ± 0.7*       | 0.13               |
| LDL cholesterol (mmol/l)  | -0.3 ± 0.4       | -0.6 ± 0.4*       | -0.9 ± 0.6*       | 0.13               |
| HDL cholesterol (mmol/l)  | -0.05 ± 0.08     | 0.07 ± 0.07*      | 0.003 ± 0.07      | 0.049              |
| ApoB (g/l)  | -0.06 ± 0.09     | -0.12 ± 0.06♣     | -0.20 ± 0.15*     | 0.06               |
| β-OH butyrate (µmol/l)  | 8 ± 27           | -10 ± 37          | -19 ± 23*         | 0.14               |
| Urinary F2-isoprostanes<br>(nmol <sup>-1</sup> * mmol <sup>-1</sup> creatinine) | -0.02 ± 0.08     | 0.05 ± 0.10       | -0.10 ± 0.05♣♣    | 0.01               |
| γ-GT (U/l)  | -3 ± 6           | -5 ± 3*           | -8 ± 6♣           | 0.11               |
| AST (U/l)   | -1 ± 6           | 1 ± 2             | 0 ± 4             | 0.50               |
| ALT (U/l)   | -3 ± 14          | -4 ± 14           | -13 ± 13          | 0.44               |

Notes: Data are means ± SD.

P (ANOVA) describes the overall P value between groups.

\*P &lt; 0.05, within-group change from baseline (paired t test);

♦P &lt; 0.01, different from placebo (unpaired t test);

♥P &lt; 0.01, different from PPAR-α (unpaired t test);

♣P &lt; 0.05, different from PPAR-α (unpaired t test);

♣♣P &lt; 0.01, within-group change from baseline (paired t test);

| | P &lt; 0.05, different from placebo (unpaired t test).

**Table 2. GW501516 Ameliorates Multiple Metabolic Syndrome-Related Abnormalities**

| GW501516 Effect                      | Change   | Corresponding Metabolic Syndrome Features Ameliorated |
|--------------------------------------|----------|---|
| Improved Lipid Profile               |          |   |
| Total/LDL Cholesterol                | Decrease | Dyslipidemia/CVD Risk                                 |
| TAGs/NEFAs                           | Decrease |   |
| ApoB                                 | Decrease |   |
| Increased Fatty Acid Oxidation       |          |   |
| CPT1b mRNA Expressio                 | Increase | Obesity/NAFLD   |
| Meal-Derived Postprandial Exhalation | Increase |   |
| Liver Fat                            | Decrease |   |
| Improved Insulin Sensitivity         |          |   |
| Fasting Glucose                      | Decrease | Type 2 Diabetes                                       |
| Fasting Insulin                      | Decrease |   |
| Reduced Oxidative Stress             |          |   |
| Urinary F2-Isoprostanes              | Decrease | Inflammatory Diseases/Aging                           |

In addition, a larger cohort with various ethnic backgrounds, age, and weight status is required to draw clear conclusive statement regarding the beneficial effects of Cardarine on metabolic syndrome. Moreover, future studies on potential metabolic syndrome treatments should include inflammatory markers (i.e., C-reactive protein and homocysteine) and stress indicators (i.e., cortisol) since these variables are highly implicated with metabolic syndrome (Al Rifai et al., 2015; Dominguez & Barbagallo, 2016). The inclusion of additional metabolic syndrome-related metrics such as blood pressure may prove useful in evaluating the multifaceted benefits of PPAR- $\delta$  agonists. Later research has revealed potential oncogenic effects of GW501516 in mice which has deterred further research in humans (Mitchell & Bishop-Bailey, 2019).

However, many of the conditions associated with metabolic syndrome, such as inflammation, appear to increase the risk of cancers (Cowey & Hardy, 2006; Deng et al., 2016). Yet, in the present study, Cardarine was shown to reduce oxidative stress and attenuate obesity, which otherwise may activate inflammatory pathways and promote tumorigenesis (Reuter et al., 2010). Compound 1 examined by Lagu et al. is a more selective PPAR- $\delta$  agonist than GW501516 that appears to exhibit an improved safety profile (Lagu et al., 2018). Thus, further research on GW501516 and similar PPAR- $\delta$  agonists are required as some benefits may outweigh impeding risks, especially in the context of metabolic syndrome-like conditions.

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## Literature Review

## Open Access

### Article History:

Received 20 September 2020

Accepted 11 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.28>

### Corresponding Author:

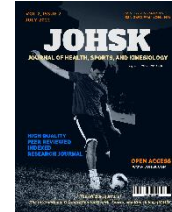
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# Collegiate Athletes' Challenge, Stress, and Motivation on Dual Role

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**Keywords:** collegiate athlete, motivation, dual role

## Introduction

In the United States higher education, collegiate athletes mostly have a four-year eligibility within a five-year time frame to compete for and represent their institutions. During this period, collegiate athletes are expected to perform successfully in both academic and athletic roles so that they can maintain benefits, such as scholarships and eligibility. In other words, being a collegiate athlete brings about a multitude of pressures and stressors from handling this dual role, which include but are not limited to, scheduling classes, fatigue, financial pressure, and inflexibility of coaches (Cosh & Tully, 2015). According to the National Collegiate Athletic Association (NCAA) (2020), collegiate athletes are only allowed to participate in athletic-related activities for 20 hours per week, four hours a day in season, and eight hours per week during off season (NCAA, 2020). However, previous empirical research has indicated that Division I level collegiate athletes spend about 40 hours per week participating in sport-related activities (Smith & Hardin, 2018). Even though collegiate athletes invest tremendous time and effort in athletics, less than two percent of collegiate athletes become professional athletes after college (NCAA, 2018).

For collegiate athletes, both athletic and academic performances require tremendous amounts of efforts due to their intense schedule. That is, it is convoluted for collegiate athletes to have identical motivation or reasons for attending college and participating in their sport. While collegiate athletes strive to balance in both academic and athletic responsibilities, they exhibit various types of motivation factors. According to Doupona Topic (2005), female collegiate athletes seem to be more academically motivated and less athletically motivated compared to male collegiate athletes. Also, Beamon and Bell (2006) found that African American collegiate athletes place less emphasis on academics than athletics, and they place less emphasis on education than Caucasian collegiate athletes. For African American collegiate athletes' academic underperformance and negative psychosocial experiences can happen due to unwelcoming campus climate, inadequate academic support, and an overemphasis on their athletic roles (Beamon, 2008).

As mentioned above, only a few collegiate athletes have a chance to move on to professional sport after their collegiate career. That is, majority of collegiate athletes go through a transitioning process moving out



from sport. Numerous studies within the literature support that collegiate athletes often have a difficult time transitioning out of sport (Lally, 2007; Smith & Hardin, 2018). Motivation may be one of the solutions to overcome this abstruse moment. To foster effective and successful higher education environments in collegiate athletics, it is essential to understand what motivates collegiate athletes in their dual roles and how collegiate athletes set up create and implement their goals.

## Overview

Motivation is the study of why people act and behave (McClelland, 1985; Weiner, 1992). Among major motivational theories, Self Determination Theory (SDT) focuses on the degree to which an individuals' behavior is self-motivated and self-determined based on the psychological needs for autonomy, relatedness and competence (Ryan & Deci, 2000). If an activity fulfills the three psychological needs, autonomy, competence, and relatedness, the activity will be considered freely chosen and self-determined. Also in SDT, there are three dimensions to explain people's motivation: intrinsic motivation, extrinsic motivation, and amotivation (Ryan & Deci, 2000). In other words, people's behavior can be intrinsically motivated, extrinsically motivated, or amotivated. Intrinsic motivation is defined as an engaging activity for its inherent satisfaction, such as interest and challenge while extrinsic motivation is a construct that posits an activity is done in order to attain some external rewards. Amotivation can be simply defined as a lack of motivation (Ryan & Deci, 2000).

Many researchers have concerns on how to balance the use of extrinsic rewards to foster students' intrinsic motivation (Ryan & Deci, 2000; Stipek, 1996). Specifically, Stipek (1996) argued that students need extrinsic rewards to be realistic and desirable motivation. Balancing intrinsic and extrinsic motivation is an important aspect to successfully meet academic and major requirements, athletic pressures and performances and navigate the social aspects of college life for collegiate athletes. In general, collegiate athletes are perceived to be less academically motivated (Wolverton, 2015; Yopyk & Prentice, 2005) because many collegiate athletes prioritize their sport over academics, especially, revenue generating sport athletes. In regard to revenue generating collegiate sports such as men's football and men's basketball athletes often utilize financial support (e.g., full-ride scholarship) which stimulates collegiate athletes' focus on extrinsic motivation (Gaston, 2002). Thus, in order to further understand collegiate athletes' motivations using an assessment like SDT is imperative. Additionally, to fully understand the dual roles of collegiate athletes exploring their goal setting in regards to academic and athletic is also essential.

To be motivated, setting goals can be one of the most significant factors. Previous research revealed that goals are incredibly effective for performance enhancement techniques (Locke & Lathan, 1990). Locke and Latham (1990) defined goals as "something that a person wants to achieve" (p. 2). Goal-Setting Theory (GST) explains human action is directed by conscious goals and intentions (Locke & Latham, 1990). Previous research findings have shown that specific, difficult or challenging goals have better results than vague and easy goals (Locke, 1968). More importantly, goals must be attainable and reachable in order to be effective (Erez & Zidon, 1984). Goal-setting research in sport has demonstrated significant effect on performance enhancement (Burton, 1993; Weinberg, 1992). Researchers have found that collegiate athletes who had effective goal-setting skills used all types of goals and implementation strategies for their performance more frequently and effectively than other athletes (Burton, Weinberg, Yukelson, & Weigand, 1998). Many collegiate athletes must set goals differently in comparison with their non-athlete student peers due to their dual roles and pressures (Curtis, 2006). As stated above, understanding collegiate athletes' types of motivation and goal setting are critical in developing a successful career during and after college.

## Considerations

Motivation is usually considered as one of the most important factors for understanding people's behavior, specifically in student success. Collegiate athletes have a significant amount of pressure put on them from conducting their dual roles. To successfully navigate their college life, collegiate athletes are required to be motivated in their academic and athletic commitments. In addition, since only a few collegiate athletes will continue their athletic career after college due to the very limited availability and competitiveness, they need to balance their dual roles to be prepared for their both wanted and unwanted retirement.

In general, coaches and academic advisors can have crucial roles in the motivation of collegiate athletes as they are responsible for guiding them in the right direction, especially their academic and career motivation as it is tied to a positive transition out of sport.

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## Original Research

## Open Access

### Article History:

Received 5 September 2020

Accepted 23 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.31>

### Corresponding Author:

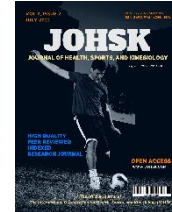
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# The Legal Implications of Korean Sports Violence

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**Keywords:** Korean sports law, Korean criminal effect, Korean sports illegality

## Introduction

Korean national laws may have limited application in the sports sector. Sports rules that restrain government intervention have allowed organizations to exercise power as autonomous and private sectors at the global level (Kim, 2011). Despite these constraints, certain issues, including criminal problems, economic interests, and bodily integrity in sports, sometimes call for intervention from judicial powers (Park, 2016).

## Purpose

As it is impossible to completely avoid physical contact in team sports games, acts of violence that have high chances of harming others naturally take place during games and competitive events. Thus, this paper seeks to define whether violence in sports is subject to criminal prosecution.

## Methods

After a descriptive exploration of pre-existing studies through a systematic literature review, qualitative research was conducted to examine the precedents in accordance with legal transition and flow. Legal concepts in Korea were first established, and key points of previous works and studies were examined thoroughly (Sohn, 2011).

## Results

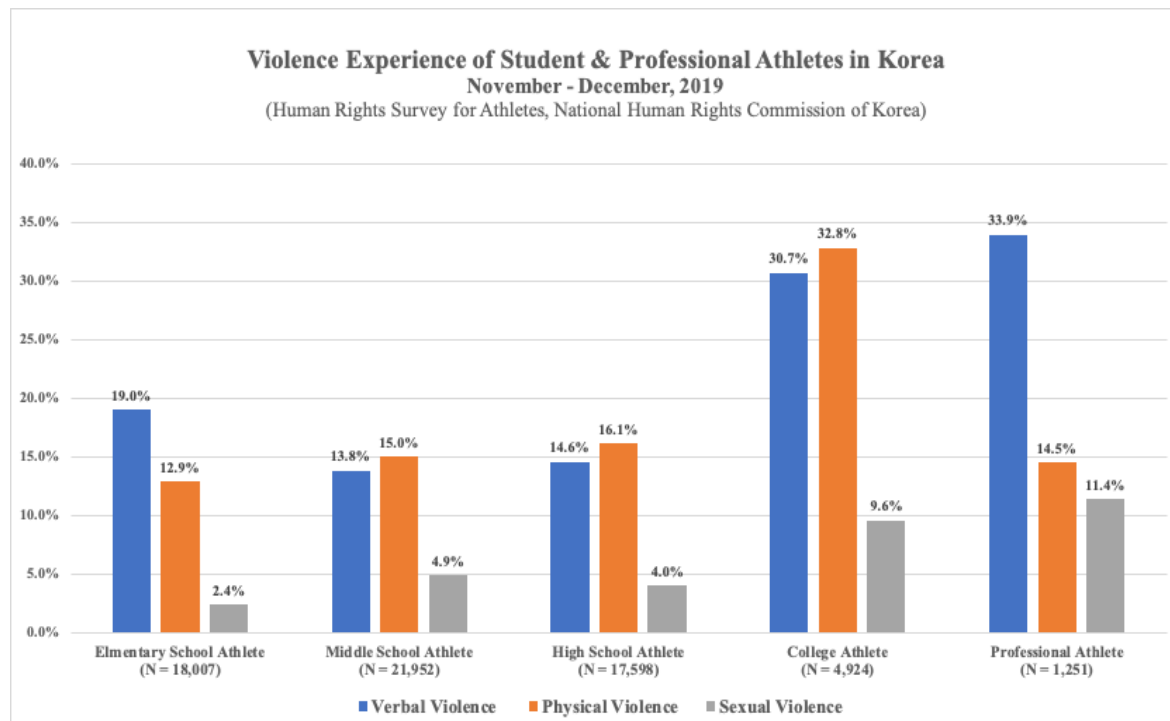
It is critical to judge the intentionality of such actions for a legal interpretation to see whether they can be deemed offensive (Sohn, 2011). As the concept of violence is defined as a physical assault on bodies, illegally exercised physical coercion, and invasion of other people's bodies, thus validating such action as a crime, the benefit and protection of law to be honored in such incidents are bodily integrity and its physiological functions (Oh, 2019). In order to decide criminality under penal law, each case consists of the "component validity-illegality-obligation" (Yeon et al., 2018).

Illegality is defined as a negative value judgment delivered objectively from the perspective of law and order as an act that corresponds to the component. In other words, an action is illegal and thus unacceptable when assessed from the overall perspective of society, law, and order. For an act corresponding to a component to be recognized as justifiable, the devaluation of the act or the devaluation of the results, which are the substance of illegality, must be justified.

A component is a prerequisite for the legal effect of a legal judgment as required to produce a certain effect. Compositional validity means that an act satisfies both the objective and subjective elements of the component case as provided by law.

Currently in sports, the general theory is that if a victim has consented to the assault and there is no violation of social norms, the victim will be subject to a justification and will not be subject to criminal punishment. Within this background, the range of the victim's acceptance and social norms is wide, and differences can exist depending on the scope of interpretation (Lee & Jeong, 2007).

In basketball, for example, an injury occurred when a Basketball's ball was deliberately used to hit the opponent's body. The problem of legal interpretation is that the victim's consent to participate in the basketball game and the injury caused by being hit by the ball are in accordance with the social norms of such a sport, and thus the perpetrator's intention is not taken into consideration (Oh, 2019).



**Figure 1. Violence Experience of Student and Professional Athletes in Korea**  
(National Human Rights Commission of Korea, 2019)

## Discussion

The following is a criminal interpretation of the 1999 Major League Baseball game case. At that time, a problem occurred when the opponent player Bell had been tagging Park's chest for a long time with a ball. In response to this action, Bell beat Park. This is acceptable behavior within the context of baseball games and not against social norms because it was not violent enough to cause a blow or wound. Later, when Park expressed irritation at Bell's

action, Bell made racist remarks and cursed, and Park, who was angry, hit Bell in the face with his left hand (Kim, 2016). This act ended in disciplinary action in the category of sports. However, it is necessary to think from a criminal legal point of view.

There was an incident in which Korea high school boxing students, who had failed to meet expectations at an athletic competition, were taken to a cemetery in the hills to dig a pit and buried a captain. The reason for the boxing coach's incident was that he failed to make it to the quarterfinals at the Korean National Sports Festival (Kil, 1998). In the Korean elite sports sector, it has been pervasive violence made by the hierarchical structure and the power of physical education (Ahn & Kim, 2019).

Referring to the above cases, the application of corporal punishment at any educational site is not allowed in principle as a violation of human rights. However, Article 31 (7) of the Enforcement Decree of the Korean Elementary and Secondary Education Act stipulates that "the head of a school should guide students by means of discipline, admonition, etc. that does not inflict physical pain or personal insults on students, except in cases where it is educationally inevitable when teaching students."

The opposite interpretation of this regulation can be interpreted as the possibility for educational corporal punishment if it is inevitable for education. In other words, if it is inevitable, physical punishment may be imposed for educational purposes when coaching athletes. In these cases, a coach's conduct requires a legal judgment whether it is an act of violence or corporal punishment (Park, 2016).

## Conclusion

In fact, if violence that occurs in the context of sports is directly related to a sport, it is often punished by a cooperative or organization in recognition of the special nature of sports. Although many student and professional athletes have had experiences of violence in Korea (see Figure 1; National Human Rights Commission of Korea, 2019), there is no law for the field of sports, which is currently interpreted and applied by criminal law, civil law, and commercial law. In view of the particular circumstances in the field of sports, it is necessary for the Korean government to experimentally demonstrate enacting sports law and sports ordinances in accordance with its special circumstance of sportspeople and the field.

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## Research Critique

## Open Access

### Article History:

Received 10 April 2021

Accepted 26 April 2021

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.35>

### Corresponding Author:

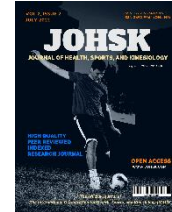
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# Relationship Between Nonalcoholic Fatty Liver Disease and Low Skeletal Muscle Mass in Obese Youth

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**Keywords:** NAFLD, NASH, childhood obesity, skeletal muscle mass

## Abstract

Previous studies in adults have found a correlation between nonalcoholic fatty liver disease (NAFLD) and sarcopenia. The present study evaluated the relationship between NAFLD and skeletal muscle mass in overweight/obese youth. A total of 234 children and adolescents (age 8–16) was stratified into tertiles based on relative muscle mass (RMM). Total, regional lean body mass, and total fat mass were obtained by dual-energy X-ray absorptiometry. RMM was defined as the percent of muscle mass (kg) relative to the sum of muscle and fat mass (kg). NAFLD was diagnosed via ultrasonography and a subset of participants with NAFLD ( $n=40$ ) underwent a liver biopsy. The lowest tertile had a significantly higher risk for obesity, dyslipidemia, insulin resistance, metabolic syndrome, NAFLD, and nonalcoholic steatohepatitis (NASH). The present study demonstrated an association between low muscle mass, NAFLD, and NASH in overweight/obese youth. Despite the strong scientific merits of the present study, a lack of race/ethnic description could be a major critique as different ethnic background (specifically in the minorities) may be disproportionately impacted by fat distribution and relative muscle mass. Even though there is a clear relationship between sarcopenia and NAFLD in the elderly, this association may not stem from the same origin in the pediatric population. Lastly, but not least, future studies should evaluate NAFLD in obese youth with varying degrees of metabolic disorders (i.e., metabolic syndrome).

## Introduction

NAFLD is currently one of the most prominent chronic diseases in the world, affecting 30% of adults in the U.S. and 60–70% of adults who are obese and diabetic (Farzanegi et al., 2019). NAFLD encompasses a multitude of liver complications including simple steatosis, NASH, and/or cirrhosis. NAFLD is diagnosed if accumulated triglycerides (TG) within hepatocytes exceeds 5% of the liver weight (Kneeman et al., 2012). Common risk factors for developing NAFLD include obesity, type 2 diabetes, hyperlipidemia, and hypertension (Pacífico et al., 2020).

Due to its nature of pathophysiology, NAFLD is often implicated with metabolic syndrome. Similar risk factors between the two disorder conditions are abdominal obesity, increased blood pressure, high levels of TG, insulin resistance, and glucose abnormalities (Pacifico et al., 2020). A significant overlap between these two suggests that patients diagnosed with NAFLD should be particularly weary of cardiovascular disease. The combination of a healthy diet and exercise routine has shown to be effective at preventing/ameliorating the unwanted effects of NAFLD on cardiometabolic health (Farzanegi et al., 2019). Previous studies have demonstrated a relationship between NAFLD and low skeletal muscle mass in the adult/geriatric population. However, there is a lack of research on the potential relationship between NAFLD characteristics and skeletal muscle mass profile in the pediatric population.

It is essential to study metabolic disorders such as NAFLD in children and adolescents (especially with obesity) in order to reduce the prevalence of disease and implement healthy lifestyle habits that will last through adulthood. To the best of our knowledge, the present study entitled "Nonalcoholic Fatty Liver Disease Is Associated with Low Skeletal Muscle Mass in Overweight/Obese Youths" is the first study to assess the relationship between skeletal muscle mass and NAFLD in a pediatric population (Pacifico et al., 2020).

## Purpose

The purpose of the present study was to determine if there was a correlation between low skeletal muscle mass and NAFLD in overweight/obese children and adolescents.

## Methods

A total of 234 children and adolescents (age 6-18 years) was recruited from the Clinics of the Department of Pediatrics (Sapienza University of Rome) for this study. Inclusion criteria was overweight/obese classification (body mass index [BMI] >85<sup>th</sup> percentile for age and sex), nondiabetic, free of chronic diseases and conditions that influence body composition. The pubertal status was measured by Tanner stage. Following an overnight fast, blood samples were collected to determine plasma glucose, insulin, total cholesterol, high-density lipoprotein cholesterol (HDL-C), TG, alanine aminotransferase (ALT), and aspartate aminotransferase (AST). Insulin resistance was assessed by the Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) using fasting insulin and fasting glucose concentrations.

An ultrasonography of the liver was used to diagnose NAFLD. Diagnosis of NAFLD was based upon liver echogenicity exceeding that of the renal cortex and spleen, attenuation of ultrasound wave, loss of definition of the diaphragm, and poor delineation of the intrahepatic architecture. RMM was defined as the percent of muscle mass relative to the sum of muscle and fat mass. Appendicular skeletal muscle mass (ASM) was defined as the sum of the muscle mass in the four limbs (kg) and expressed as percent of body weight [ASM/weight (kg) x 100]. Following evaluation, a subset of obese participants (n=40) diagnosed with NAFLD underwent a percutaneous needle liver biopsy in order to screen for NASH.

Researchers examined the liver sample for liver steatosis, lobular/portal inflammation, hepatocyte ballooning, and fibrosis. Patients were diagnosed with NASH upon the presence of steatosis with necroinflammation and hepatocyte ballooning. The subjects were split into three tertiles based on RMM.

## Results

The tertile with the lowest RMM had the greatest BMI, BMI standard deviation (BMI-SDS), waist circumference (WC), total body fat mass as well as the highest TG/HDL-C ratio, fasting insulin, and HOMA-IR (Table 1), leading the highest prevalence of metabolic syndrome and NAFLD. Under standardized age, sex, and Tanner stage, children in the lowest tertile of RMM had the highest risk for NAFLD (OR=2.80, 95% CI=1.57-5.02) compared with those in the other two tertiles. This association mostly persisted even after adjusting for potential confounders including central obesity, elevated blood pressure, elevated TG, low HDL-C, and insulin resistance. In the subset of participants that underwent a liver biopsy, 24 children tested positive for NASH, while 16 tested negative. Children with NASH showed significantly lower RMM [mean, 55.7 (SD, 6.0) vs. 63.4 (6.0) %; P<0.0001] and lower ASM/weight index [mean, 25.6 (SD, 2.8) vs. 28.6 (2.9) %; P=0.006].

NASH was most common in the lowest tertile of RMM [70.8 (95% CI, 61.8-79.8) % vs. 29.2 (20.2-38.2) %; P<0.001] as well as in the lowest tertile of ASM/weight index compared to those in the other two tertiles [62.5 (95% CI, 47.5-77.5) % vs. 37.5 (22.5-52.5) %; P<0.003, respectively]. After controlling for age, sex and Tanner

stage; the risk of NAFLD (OR=2.99, 95% CI =1.41-6.31) in the lowest tertile of ASM/weight index was significantly higher compared to that in the other two tertiles. Overall, RMM appeared to be negatively correlated with WC, diastolic BP, ALT, TG, TG/HDL-C ratio, insulin, and HOMA-IR.

**Table 1. Characteristics of Study Population According to Tertiles of RMM<sup>a</sup> .**  
(Adapted from Table 1 of original research study [Pacífico et al. *Frontiers in Pediatrics*, 8: 1–8]).

|                          | Relative Muscle Mass (RMM) |               |               | P       |
|--------------------------|----------------------------|---------------|---------------|---------|
|                          | Tertile I                  | Tertile II    | Tertile III   |         |
| Number of subjects       | 78                         | 75            | 81            |         |
| Age, years               | 11.3 (2.3)                 | 11.5 (2.8)    | 12.5 (3.0)    | 0.06    |
| Male sex, n (%)          | 38 (48.7)                  | 33 (44.0)     | 61 (75.3)     | 0.001   |
| Prepubertal Status       | 15 (19.2)                  | 16 (21.3)     | 14 (17.2)     | 0.26    |
| Weight, kg               | 65.0 (21.0)                | 59.3 (22.1)   | 64.1 (21.1)   | 0.21    |
| Height, cm               | 149.7 (14.4)               | 151.7 (17.4)  | 158.9 (18.0)  | 0.01    |
| BMI (kg/m <sup>2</sup> ) | 28.3 (4.5)                 | 24.7 (3.7)    | 24.6 (3.3)    | <0.0001 |
| BMI-SD score             | 2.13 (0.40)                | 1.70 (0.39)   | 1.60 (0.39)   | <0.0001 |
| Waist circumference, cm  | 91.2 (13.2)                | 84.8 (14.0)   | 84.6 (12.0)   | 0.002   |
| Systolic BP, mmHg        | 111 (11)                   | 111 (9)       | 112 (13)      | 0.81    |
| Diastolic BP, mmHg       | 69 (9)                     | 68 (8)        | 69 (9)        | 0.82    |
| Total cholesterol, mg/dL | 170 (39)                   | 177 (50)      | 163 (41)      | 0.19    |
| HDL-C, mg/dL             | 46 (13)                    | 47 (12)       | 49 (10)       | 0.17    |
| Triglycerides, mg/dL     | 97(72-141)                 | 91 (65-128)   | 76 (52-123)   | 0.031   |
| TG/HDL-C ratio           | 2.1 (1.3-3.6)              | 1.9 (1.2-3.3) | 1.6 (0.9-2.8) | 0.029   |
| AST, U/L                 | 25 (20-34)                 | 25 (20-30)    | 23 (19-29)    | 0.22    |
| ALT, U/L                 | 25 (17-47)                 | 22 (15-35)    | 20 (15-32)    | 0.15    |
| Glucose, mg/dL           | 4.8 (0.8)                  | 4.8 (0.45)    | 4.8 (0.39)    | 0.84    |
| Insulin, $\mu$ U/mL      | 18 (12-24)                 | 14 (9-19)     | 13 (9-18)     | 0.004   |
| HOMA-IR                  | 3.7 (2.5-4.8)              | 2.8 (1.9-3.9) | 2.8 (2.0-4.0) | 0.015   |
| Total body fat mass, kg  | 28.0 (10.0)                | 22.8 (9.0)    | 19.0 (5.9)    | <0.0001 |
| Total lean body mass, kg | 31.4 (9.6)                 | 32.5 (12.7)   | 39.6 (14.6)   | <0.0001 |
| RMM, %                   | 53.0 (3.3)                 | 58.9 (1.5)    | 66.9 (4.8)    | <0.0001 |
| ASM, kg                  | 15.1 (4.36)                | 15.5 (7.0)    | 20.7 (7.94)   | <0.0001 |
| ASM/weight index, %      | 24.5 (1.73)                | 26.2 (2.86)   | 30.8 (7.42)   | <0.0001 |
| ASM/ht <sup>2</sup>      | 6.7 (1.0)                  | 6.4 (1.6)     | 7.6 (2.0)     | 0.001   |
| NAFLD, n (%)             | 43 (55.2)                  | 25 (33.3)     | 27 (33.3)     | 0.006   |

RMM, relative muscle mass; BMI, body mass index; BMI-SDS, BMI-SD score; BP, blood pressure; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; AST, aspartate aminotransferase; ALT, alanine aminotransferase; HOMA-IR, homeostasis model assessment of insulin resistance; ASM, appendicular skeletal muscle mass.

<sup>a</sup>Tertile I, RMM: < 56.72; tertile II, RMM: 56.72–61.99; tertile III, RMM: > 61.99.

Results are expressed as n (%), mean (SD) or median (interquartile range)

## Conclusion

This study concluded that overweight/obese youth with lower muscle mass have a greater risk of NAFLD compared to those with higher muscle mass, and this inverse relationship between NAFLD and muscle mass in children and adolescents is independent from anthropometric/metabolic variables. In addition, overweight/obese youth with lower muscle mass demonstrate a greater prevalence of cardiometabolic risk factors (e.g., central obesity, dyslipidemia, and insulin resistance) and are at a higher risk for metabolic syndrome.

## Critique

The present study found that overweight/obese youth with lower muscle mass have a greater risk of NAFLD/NASH and other metabolic diseases compared to those with higher muscle mass. The researchers assessed the muscle mass of participants by using both RMM and ASM, as opposed to only using a single metric of assessing muscle mass. Using multiple metrics of muscle mass is ideal because it reduces the likelihood of lurking variables that may arise from disproportionate skeletal muscle distribution between participants.

Although the researchers standardized the data based on age, sex, and tanner stage, potential ethnic variations of participants were not considered. Ethnicity likely plays a very influential role as it can impact both fat distribution (stemming from unique genetics, socioeconomic status, diet, etc.) (Robinson et al., 2012) and RMM (Silva et al., 2009).

Moreover, considering that NAFLD and sarcopenia is often associated with metabolic syndrome, it may be useful to study metabolic syndrome-related variables aside from obesity and insulin resistance such as inflammation (i.e., C-reactive protein) as well as markers of muscle breakdown (i.e., creatine kinase). The present study alludes to previous studies that linked sarcopenia and NAFLD in the adult/geriatric populations (Kim et al., 2017). Indeed, the mechanism by which NAFLD and sarcopenia are linked may differ between children and adults. In adults/elderly, sarcopenia is largely attributed to the progressive loss of motor neurons over time, resulting in a preferential loss of type II muscle fibers (Larsson et al., 2019). Type II muscle fiber loss in aging adults has been linked to hormonal changes (i.e., testosterone) and a reduction of available satellite cells (Walston, 2012).

In addition, environmental factors (i.e., poor diet and/or poor exercise), chronic inflammatory diseases (i.e., rheumatoid arthritis), and mitochondrial abnormalities (i.e., mutations in mitochondrial DNA) can further degrade muscle mass in adults (Kvorning et al., 2015; Walston, 2012). At any rate, the relationship between sarcopenia and NAFLD in pediatrics may arise from overlapping factors as adults. In both children and adults, malnutrition and a sedentary lifestyle contribute to the development of sarcopenia (Gilligan et al., 2020). However, sarcopenia in children may be more influenced by these factors in particular because children appear to be less prone to declining anabolic hormones/mitochondrial dysfunctions that parallel aging and have usually been exposed to environmental stresses for a much shorter period of time compared to adults.

Therefore, studying the effects of an intervention of a healthy diet and/or exercise program in a sample of pediatric patients with prior substandard diets/physical activity levels may provide more insight on the role of diet/exercise in the relationship between childhood sarcopenia and NAFLD. Phenotyping of both type I and type II muscle fibers may lead to novel findings on the potentially unique mechanisms of pediatric sarcopenia (compared to adults). Finally, future studies should try to obtain a larger and more diverse sample and evaluate a wider range of variables.

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## Original Research

## Open Access

### Article History:

Received 20 September 2020

Accepted 23 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.40>

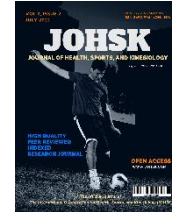
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# Structural Violence in Korean Sports Community

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**Keywords:** Korean sports law, Korean structural violence, Korean sports criminal Law

## Introduction

Competitions in sport games can cause athletes to become overly immersed, and it can lead to violent incidents. In Korea, structural violence and animosity between senior and junior athletes and between coaches and athletes have been rampant in the field of sports (Sohn, 2011). Although criminal acts under the code of criminal procedure have been applied in many different cases of violence and the perpetrators have been punished, structural violence in sports community is still a chronic problem in Korea.

## Purpose

The purpose of this study was to find and analyze specific examples of structural violence and actual cases of sports crimes occurring in sports to present countermeasures and mitigation measures against structural violence in the Korean sports community.

## Methods

First, an extensive literature review was undertaken to investigate the various cases of violent incidents in the sports community in Korea. Cases of structural violence were found and then legal interpretations were applied to those cases.

## Results

In Korea, violence by coaches, athletes, and other sports stakeholders has often been easily dismissed with assorted excuses, such as a practice, culture, or discipline. The result has led to the abuse of athletes and is becoming a social evil in the field of sports in Korea (Sohn, 2011). Violence between athletes means "a violent event occurring between athletes." Violent acts performed by athletes mean "violent acts, including physical and verbal violence against athletes, injury, fear, personality violation, harassment, demanding goods through psychological violence, bullying, dereliction of duty, abuse, etc." (Oh, 2020). In the Korean elite sports sector, one of the most problematic topics is undoubtedly structural violence. Structural violence refers to the customary violence that is taken for



granted by senior and junior ranks or by the wrong discipline and corporal punishment of the coach (Ahn & Kim, 2019).

There was a sensational death in Korea on June 26, 2020 due to structural violence. Her name is Sookhyun Choi, and she was a professional triathlete. She was the victim of structural violence by her coach, sports curer, and her team's senior members for a long time, and it led to her deciding to commit suicide. This is still a big issue in Korea, and this incident served as a reminder to people to recognize how prevalent structural violence is in the Korean sports community (Kim, 2020a). After the triathlete's death, the Joint Committee on the Death of Athletes in the Ironman Triathlon was officially formed; it is now trying to establish an independent and responsible fact-finding team from the sports community (Bae & Ramsay, 2020).

There was another recent shocking event in the sports community in Korea. A senior athlete in the men's college handball team poured ramen soup and threw a knife and bowl to junior athletes during camp training (Kim, 2020b). Later on, it was found that the senior athlete habitually assaulted his juniors. The senior athlete frequently slapped junior athletes' heads and made them do handstands. The hierarchical structure and the power of physical education are combined due to the characteristics of body-mediated activities.

The perpetrators are mostly senior athletes and coaches, and violence takes place in all spaces of their teams, including practice rooms and dormitories. According to data from the Korean Sport and Olympic Committee (2019), there were 124 confirmed cases of structural violence, including verbal, physical, and sexual in the past 5 years. Among the 124 cases, 16 were of sexual nature and included 2 victims who were underage. This issue shocked many people in Korea. Structural violence is not limited to any specific type of sports, but it is prevalent in many sports (Table 1).

**Table 1. Disciplinary Status of Violence (Verbal, Physical, & Sexual) in Korean Sports Organizations in 2013-2018**

| Football Association | Ice Skating Federation | Boxing Association | Baseball Softball Association | Rugby Association | Other Organizations   | Total         |
|----------------------|------------------------|--------------------|-------------------------------|-------------------|---|---------------|
| 53<br>(42.7%)        | 8<br>(6.5%)            | 7<br>(5.6%)        | 5<br>(4.0%)                   | 4<br>(3.2%)       | 7 Associations: 3 cases<br>8 Associations: 2 cases<br>10 Associations: 1 case | 124<br>(100%) |

## Discussion

In Korean athletic society, people tend to think that hardships inflicted on lower ranks by the seniors contributes to better performance. This thinking may have been influenced by Asia's Confucian ideas and the Korean military's top-down culture. Although the Confucian ideas state "respect" to older people or educators who have more experience of the world (Fengyan, 2004), Korean people in sports community might misunderstand the actual meaning of the ideas and abuse it as a violent tool. Moreover, in the Korean military, the reason for using the top-down culture within a strict atmosphere of discipline is to prevent various accidents (e.g., gun accidents, mutiny, etc.) and to work systematically and effectively for preparedness in case of a real war.

Over the past several decades, structural violence from coaches or senior athletes have been rationalized in the Korean sports community because the performance of Korean athletes in various international competitions (e.g., Asian Games, Olympic Games, etc.) has been steadily improving. However, in Korea, Article 1 of the National Sports Promotion Act and Article 1 of the Sports Industry Promotion Act are the only currently existing rules to deal with general crimes related to sports. Thus, it is necessary to nationally enact special laws to deal with the increased instances of violence in the Korean sports community. These special laws should include the standards of sports ethics and sports rights to investigate and judge the various types of structural violence that is difficult to be judged by the general nature of the current acts. These special laws would also protect athletes and provide them with a better environment to train. At the same time, various private organizations should be established to systematically investigate the laws and standards.

## Conclusion

Recently, many cases of sports-related structural violence have come to light and disseminated widely in the Korean society through the social media, especially after triathlete Choi's suicide. Although it is a very shameful and sensitive issue, this could be a huge turning point for the Korean sports community to eradicate the chorionic problem and to create a healthier sports community because regardless of reasons, violence can never be rationalized.

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## Original Research

## Open Access

### Article History:

Received 18 September 2020

Accepted 11 October 2020

Published 1 August 2021

Available online 30 July 2021

<https://doi.org/10.47544/johsk.2021.2.2.43>

### Corresponding Author:

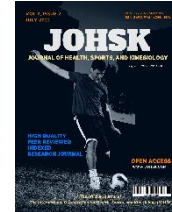
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# The Effects of App-Based Feedback on Students' Sport Knowledge in Sport Education Badminton Season

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**Keywords:** video technology, sport education, content knowledge

## Introduction

Sport education is a curriculum model that helps students to be a competent, literate, and enthusiastic sportsperson (Siedentop et al., 2020). The effectiveness of the model on badminton skill development has been demonstrated by previous literature (Hastie et al., 2011). Along with the skill development, cognitive outcomes (e.g., sport-specific knowledge) are considered to be important parts of one's performance in sports. Cognition of 'how to play' in a sport is associated with improved performances (Thomas & Thomas, 1994). Therefore, teaching sport knowledge is important to enhance the effectiveness of practice and gameplay.

Thomas and Thomas (1994) described the three concepts of sport knowledge in performance: (a) declarative (factual information, such as rules), (b) procedural (techniques and tactics), and (c) strategic knowledge (knowing how to learn). Given that the nature of sport knowledge has great potential to be developed for all levels of players (Dexter, 1999), it is important to dive into diverse ways to boost students' cognitive learning while playing sports in physical education.

Using advanced video technology, such as motion analysis mobile applications (Apps) with a feature of live capture for instant feedback, may enhance cognitive learning outcomes in physical education. Video technology has grown rapidly to support learning in physical education over the past decades (Palao et al., 2015; Rikli & Smith, 1980; van Wieringen et al., 1989). However, little is known about the effectiveness of a motion analysis App on students' sport knowledge enhancement in sport education. Therefore, the App-based feedback was examined to identify its effectiveness on students' sport knowledge enhancement during sport education badminton season.

## Methods

8<sup>th</sup> grade students from two physical education classes participated in the 20-lesson badminton sport education season (Cohort A;  $N=20$ , Cohort B;  $N=16$ ). An alternative control treatment group design (Borg, 1984) was applied to provide all participants with the benefit from the intervention. In Cohort A, only the teacher used the App named 'Hudl Technique' to teach and provide feedback; whereas the students used the App during the 20-minute team practice in Cohort B. The teacher in Cohort A and the students in Cohort B were asked to create video clips to provide individual and visual feedback by using features of slow-motion, rewind, drawing tools, and voice recording through the motion analysis App.

Badminton knowledge tests were administered at the pre (Lesson 1) and post (Lesson 20). The knowledge test had 30 items selected from the badminton test battery (12 items for rules and scoring, 13 for technique, and 5 for strategy) (McGee & Farrow, 1987). The number of items correctly answered by each student was recorded and analyzed.

Descriptive and Two-way repeated measures analysis of variance (ANOVA) were used for data analysis. Each area of test score for the knowledge test at pre- and post-test was computed and analyzed by the total score percentage, ranging from 0 to 100, to better understand the effects of App-based visual feedback on the specific learning domain of knowledge in badminton. In addition, overall knowledge score was calculated by adding all three areas, ranging from 0 to 30. A critical incident (CI) instrument by Flanagan (1954) was also used to examine the effects of App-based visual feedback. The CI sheets were completed by each student at lessons 8, 11, 14, and 17, reflecting on their experiences and perceptions on the App. Constant comparative analysis was used to incorporate the frequency of the data categories with students' comments (Goetz & LeCompte, 1984). The CI data trustworthiness were validated by triangulation by researchers of the study.

## Results

A total of 490 videos were created throughout the season (293 videos in Cohort A and 197 videos in Cohort B). Compared to the pre-test ( $M=9.92$ ,  $SD=3.53$ ), students' overall post knowledge test scores ( $M=15.03$ ,  $SD=4.72$ ) significantly increased by the use of motion analysis App [ $F(1,34) = 57.253$ ,  $p < .001$ ]. Specifically, there were also statistically significant increases in percentages of correct answers for all three knowledge categories (See Figure 1). No statistically significant differences were found in both pre and posttest scores between the two classes. 178 CI sheets were completed by both classes and 93 performance-related comments by the constant comparative analysis were categorized as: (a) reflecting myself/team ( $n=30$ ), (b) correcting motion skills ( $n=14$ ), (c) developing tactics ( $n=21$ ), and (d) getting better and overall improvement ( $n=28$ ) (See Table 1).

**Table 1. Frequency of Students' Comment in Critical Incidents**

|                                      | Lesson    |    |           |    |           |    |           |    |       |    |
|--------------------------------------|-----------|----|-----------|----|-----------|----|-----------|----|-------|----|
|                                      | Lesson 8  |    | Lesson 11 |    | Lesson 14 |    | Lesson 17 |    | Total |    |
|                                      | A         | B  | A         | B  | A         | B  | A         | B  | A     | B  |
| Cohort                               |           |    |           |    |           |    |           |    |       |    |
| Themes                               | Frequency |    |           |    |           |    |           |    |       |    |
| Reflecting myself/team               | 7         | 3  | 5         | 4  | 2         | 2  | 5         | 2  | 19    | 11 |
| Correcting motion skills             | 5         | 2  | 0         | 1  | 1         | 0  | 2         | 3  | 8     | 6  |
| Developing Tactics                   | 0         | 0  | 4         | 2  | 2         | 5  | 4         | 4  | 10    | 11 |
| Getting better & Overall improvement | 3         | 6  | 2         | 3  | 3         | 2  | 3         | 6  | 11    | 17 |
| Total                                | 15        | 11 | 11        | 10 | 8         | 19 | 14        | 15 | 48    | 45 |

## Discussion

This study investigated the effects of App-based feedback on middle school students' badminton knowledge in the sport education season. The main features of the sport education model such as longer season, team affiliations, and formal competitions created the active environment to implement the motion analysis App. Supported by Thomas and Thomas (1994), the knowledge test was divided into three categories to determine the changes in each category. For the 'Rules' category, 33 students were able to answer the questions of basic rules (e.g., point system or basic terminology) in the post-test, showing overall dramatic changes throughout the season. Figure 1 shows the noticeable increases in percentages of test scores in 'Rules' and 'Strategies', compared to 'Techniques'. Even though there were statistically significant differences in scores of the 'Techniques' category ( $p < .05$ ), the scores have shown relatively few changes in both cohorts. However, based on the CI comments, it was understood that students' actual basic skills would have improved by watching and fixing their motions. However, the low percentage of knowledge improvement in technique was due primarily to the insufficient skill-related lessons for skill practices. It should be noticed that the improvement of knowledge in technique requires repetition that develops intuitive understanding of the movements and more efficient performance.

The results showed significant improvement in student cognitive domains at pre and post-test. However, due to the nature of the class that was the introductory level and no prior experiences, the percentages of correct answers in test scores showed relatively low. However, as shown in Figure 1, it is important to note that the use of the App had positive impacts on the students' post-test scores in the 'Strategies' category. Students' CI comments supported this positive effect on the students' improvement in tactical movements. In Figure 1, the students had little knowledge of strategies before the intervention but showed great enhancement in the post-test. This finding indicates that video technology using motion analysis App has the potential to enhance students' tactical movements and strategies. As suggested by Dexter (1999), further research will be warranted to identify the relationships between students' sport knowledge and their skill development and game performance.

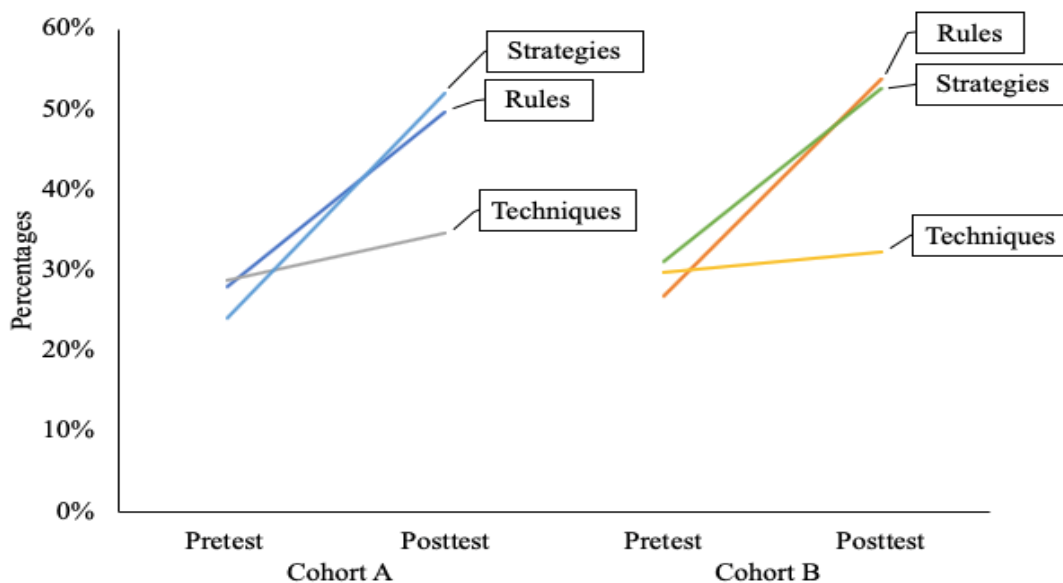


Figure 1. Badminton Knowledge Test Results in Cohort A and B

## Conclusion

The study showed the improvement in student learning outcomes measured by the cognitive tests on rules, techniques, and strategies of badminton in sport education classes. The use of motion analysis App in sport education and the App-based feedback were positively associated with students' badminton-specific knowledge, supporting the national physical education standards.

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**VOL 2, ISSUE 3(S)**  
**OCTOBER 2021**

**ISSN 2767-5874 (PRINT)**  
**ISSN 2692-9864 (ONLINE)**

# JOHSK

**JOURNAL OF HEALTH, SPORTS, AND KINESIOLOGY**

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*The official Journal of  
The International Organization for Health, Sports, and Kinesiology (IOHSK)*



*JOHSK ISSN*  
*Volume URL*  
*Volume DOI*  
*Issue DOI*

2692-9864 (Online) & 2767-5874 (Print)  
<https://www.johsk.com/2021-vol2-issue2>  
<https://doi.org/10.47544/johsk.2021.2.2.0149>  
<https://doi.org/10.47544/jhsk.2021.8.1>



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