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RESEARCH ARTICLE

The Impact of Food Security Status on Body Composition Changes in Collegiate Football Players

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Abstract

Background: Food insecurity negatively affects nutrition intake and diet quality, and college students specifically experience food insecurity in greater proportions than the general adult population. However, the prevalence and effects of food security among Division 1 college football athletes is unknown.

Aim: This study investigates the relationship between food security and body composition changes in Division 1 football players during off-season training.

Methods: This study was conducted as a secondary analysis of routine data collected from football players in a southeastern collegiate athletic department. Body composition was measured before and after a typical off-season training program on campus. Athletes completed the USDA adult food security 10-item survey following the second body composition measurement. Differences in the rate of change in body composition by food security status over the training period were calculated using ANCOVA. Additionally, we assessed the prevalence of food security across racial groups.

Results: Sixty-three percent of surveyed athletes (n = 85) reported some degree of food insecurity. Food insecurity was more prevalent among Black athletes. Food insecurity was not associated with changes in body weight, body fat percent, muscle mass, or BMI among athletes during an off-season training period.

Conclusion: Our findings indicate that levels of food insecurity were not associated with body composition changes during off-season training in collegiate football players. Supplemental food assistance and athletes' interaction with the on-staff Registered Dietitian Nutritionist (RDN) may have reduced the prevalence of food insecurity, as athletes who communicate with a RDN regularly may make healthier dietary choices. However, survey results suggest that food insecurity is prevalent in collegiate athletics, with higher prevalence among Black athletes than other races, but more research is needed to evaluate the effect of food security on body composition changes.

Keywords

Body Composition, Football, Food Insecurity

Abbreviations

BIA: Bioelectrical Impedance Analysis; BMI: Body Mass Index; IRB: Institutional Review Board; NCAA: National Collegiate Athletic Association; RDN: Registered Dietitian Nutritionist; U.S: United States; USDA: United States Department of Agriculture

Introduction

Collegiate athletes have immense physical and academic demands placed upon them by their sports and studies. With the growing number of students from low-income backgrounds pursuing postsecondary education [1], the ability of student- athletes to meet their basic needs (e.g., access to food, housing, etc.) while financing the expense of college is a growing concern. While many college students seek paid employment to supplement their finances, collegiate athletes rarely maintain steady employment throughout the year given their obligation to sport and academics. Collegiate athletes may thus be particularly vulnerable to financial stress, including food insecurity.

Individuals who lack the resources needed to

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access enough food to support a healthy lifestyle are considered food insecure [2]. College campuses have recently seen a higher prevalence of food insecurity among students. An estimated 32.9 percent of college students experience food insecurity [3], three times the national average for adult food insecurity (10.5%) [4]. Like the overall U.S. adult population, food insecurity is more prevalent among minority groups, including Hispanic and non-Hispanic Black college students, and those from low-income households [5,6]. While research related to food insecurity among college students has increased over the last decade, there is a need to explore the impact of food insecurity among collegiate athletes specifically.

Food insecurity among traditional college students is associated with multiple health concerns, including inadequate nutrient intake [7,8] and an increased risk of weight gain or obesity [8]. These health concerns are particularly acute for collegiate athletes as they may adversely affect athletic performance.

Unique to collegiate athletes experiencing food insecurity is their additional nutritional requirements for performance. College football players need between 5,200 and 6,500 calories a day, much greater than the 3,000 calories/day required by the average active male college student [9,10]. The need for up to twice the additional calories to adequately fuel may place a significant financial strain on collegiate football players, especially given the barriers to steady paid employment faced by student-athletes. The nutritional quality of an athlete's diet may thus suffer as they strive to meet higher calorie intake needs. Athletes may substitute lower calorie, higher nutrient density foods with energy-dense foods lower in nutritional value to meet caloric needs, negatively affecting body composition and performance [11]. Whereas the consumption of healthy fats, complex carbohydrates, and proteins positively influences body composition, a diet rich in these foods may be challenging to achieve on a limited budget and with low levels of nutrition knowledge [12,13].

While many collegiate athletic departments provide nutritional support to college football players to help meet their fueling needs around training and competition, most only provide supplemental nutrition, leaving athletes responsible for major meals (e.g., breakfast, etc.). This lack of consistent nutritional support for athletes is problematic, particularly for athletes with limited resources to maintain a healthy diet, as body composition and performance in collegiate football players is influenced by consistent and adequate nutrient intake [14]. From a performance perspective, increases in lean mass and decreases in total body fat in collegiate football players increase power, strength, and speed across all position groups [15]. Body fat percentage is also of importance given the inverse relationship between body fat and speed and endurance [16]. The development of a nutrition plan with a goal of improved body composition requires the consideration of macronutrient needs and timing of food ingestion. These plans can be highly variable, as training programs and needs to achieve optimal body composition vary between position group [17].

Football is considered a moderate-to high-intensity activity for which carbohydrate is the primary fuel [18]. However, a combination of carbohydrate and protein should be ingested post workout to increase net muscle protein balance, promote muscle tissue repair, and enhance muscle adaptation [4,18]. If food insecurity forces players to substitute nutrient dense foods for high calorie foods with low nutritional value, it is unlikely they can adhere to their nutrition training program, potentially impeding progress towards body composition and performance goals.

This study aims to evaluate the relationship between food security and body composition changes during off-season training in collegiate Division 1 football players. Strength and conditioning are emphasized during off-season training to prepare players physically and mentally for the upcoming football season. To excel in their preparation, athletes must be consistent with their diet to adequately fuel and recover from training. Insofar as food insecurity leads to inconsistent fueling and impedes recovery times, athletes may struggle to achieve nutrition and performance goals. Our primary hypothesis is that food insecurity is associated with a decreased rate of muscle mass accretion and increased rate of body fat accretion in collegiate football players during off-season training. Additionally, we hypothesize that changes in body composition and the prevalence of food insecurity varies by race.

Methods

Study design and participants

We used data collected from eighty-five collegiate football players in a southeastern athletic department as part of routine care. This study was approved by the university Institutional Review Board (IRB Protocol Number 300007733). Those eligible for inclusion were medically cleared for athletic participation by the Athletics Sports Medicine Department. Those who had not completed both body composition assessments or had an injury or long illness during the off-season training cycle were excluded. All athletes were National Collegiate Athletic Association (NCAA) Division 1 football players between 18-24 years.

Study protocol

Body composition was assessed per the Athletics Sports Medicine Department's standard of care protocol. Athletes reported to the athletic training facility for an initial body composition assessment (Visit 1) at the beginning of off-season football training. All athletes

completed a standard 8-week off-season strength and conditioning program directed by the director of football athletic performance on campus at the athletic facility. Athletes had full access to the athletic facility nutrition station where they could meet daily with the team Registered Dietitian Nutritionist (RDN) and obtain food selected by the RDN to support performance and recovery.

The second body composition measurement (Visit 2) was conducted at the conclusion of the training program. Body composition and weight were measured using a multi-current, segmental bioelectrical impedance analysis (BIA) device. Athletes completed a food security screening survey upon completing their second body composition measurement. All athletes completed the survey individually on a private computer using a Qualtrics survey instrument (Qualtrics, Provo, UT). Food insecurity was assessed using the United States (U.S.) Adult Food Security Survey Module, a validated measure of food security over the last 12 months created by the United States Department of Agriculture (USDA). Cumulative scores can be used to classify adults into one of four levels of food security, including high food security, marginal food security, low food security, and very low food security. Both high food security and marginal food security indicate that an individual is "food secure," while low food security and very low food security indicate "food insecure." Lastly, age, race, and football position group data were collected to include in the statistical analysis.

Body composition and weight analysis

All weight and body composition measurements were taken using a Tanita MC-780U (Tanita Corp of America, Inc. Arlington Heights, Illinois, USA), an eight-mode segmental BIA system that has three assessment frequencies (5 kHz/50 kHz/250 kHz) and one measurement current (up to 90 μA). All athletes were reminded to follow the standard of care daily hydration protocol prior to measurement, and all assessments were taken in the morning before training. Athletes were required to wear light clothing and remove shoes and socks for each measurement. Each participant stepped on the scale with toes and heels placed on the electrodes of the Tanita weighing platform. Body weight, whole-body fat mass, fat-free mass (lean mass), percent body fat, total body water, and Body Mass Index (BMI) were recorded.

Statistical analysis

Changes in total body weight, fat-free mass (lean mass), percent body fat, and BMI were calculated as the difference between Visit 1 and Visit 2. A total of six participants from the original ninety-one participants were removed from the study for clinical reasons (i.e. injury or illness) that may have affected results as determined by RDN, resulting in 85 participants. Food security scores were summed from athletes' survey answers post body composition testing.

Athletes were categorized as food secure/food insecure following the USDA Food Secure Scale guidelines, with cumulative scores equal to or less than two indicative of food security, and scores greater than two indicating food insecurity. The USDA guidelines also allow for more precise classification based on varying levels of food security, with raw scores of 3-5 indicating "low food security" and raw scores between 6-10 indicating "very low food security". Ten is the maximum score participants can receive, and indicative of the most severe degree of food insecurity.

Dependent variables (total body weight change scores, muscle mass change scores (MMchange), percent body fat change scores, and BMI change scores), were normally distributed. Data was determined to have equal variances via Levene's test. For each dependent variable, one-way ANCOVA was used to test for mean differences by food security classification. All models included age, race, position, and initial body weight as covariates.

Position group was included as a covariate to account for varying training methods between groups. Additional adjustments were added for models assessing muscle mass or body fat percent change. Models assessing body fat percent change were additionally adjusted by muscle mass change and models assessing muscle mass change were adjusted by body fat percent change. Additional ANCOVA models tested the hypothesis that food insecurity and body composition change were associated with race. Analyses were conducted using SAS Version 9.4(SAS Institute, Cary, NC) and an alpha level of $p < 0.05$ for statistical significance.

Results

The mean age and height of each group, along with other characteristics, such as race and position group, are described in Table 1. Sixty-three percent of respondents were food insecure, with twenty percent indicating "low food security" and forty-three percent experiencing the most severe form of food insecurity, "very low food security." Table 2 summarizes affirmative responses to the ten food security questions on the survey. Tables 3, Table 4 report the results from one- way ANCOVA models. Food insecurity was not associated with mean change in any of the four measures of body composition (Table 3).

To test the hypothesis that changes in body composition and the prevalence of food insecurity at visit 2 differed by race, we estimated exploratory ANCOVA models with race as the independent variable and each body composition outcome as the dependent variable. In these models, the summed score of each players food security assessment results (FS Score-visit 2) were included as a covariate. Finally, we investigated

whether FS Score differed by race. As shown in Table 4, there was a significant difference in food security scores between races, such that Black athletes reported more food insecurity than White athletes.

Discussion

The objective of this study was to evaluate the relationship between food security and body composition changes in football players during off-season training. We hypothesized that food insecurity would be associated with changes in muscle mass and body fat in collegiate football players completing an 8-week off-season training program; however, food insecurity was not associated with changes in any measure of body composition. Position group was associated with body composition changes, perhaps due to varying body types and training regimens for each position.

Table 1: Group Participant Characteristics (N = 85).

Characteristic	Mean ± SD
Age (yr)	20.55 ± 1.45
Race	
White	29.41%
Black	70.59%
Height (in)	73.15 ± 2.39
Baseline Weight (kg)	103.87 ± 22.49
Baseline BMI (kg/m2)	29.78
Baseline Fat Mass (kg)	21.9 ± 14.13
Baseline Muscle Mass (kg)	77.95 ± 9.07
Position group (%)	
Offensive line	18.82%
Wide Receivers	11.76%
Tight Ends	4.71%
Running Backs	7.06%
Quarterbacks	4.71%
Inside Linebackers	9.41%
Defensive Backs	21.18%
Special Teams	4.71%
Defensive Line	11.76%
Outside Linebackers	5.88%

Overall, 63% of the football players in this study were food insecure. We observed a significant difference in food security score between racial groups, such that Black athletes reported more food insecurity than White athletes. This finding is consistent with national data which demonstrates that food insecurity is higher among minority households, including that 21.7 percent of Black U.S. adults experience food insecurity compared to 7.1 percent of White U.S. adults (less than the 10.5 percent U.S. adult average) [4]. While not specific to collegiate athletes, prior research examining food insecurity among college students has observed similar findings [5,6]. However, these results demonstrate the prevalence of food insecurity among college students from different racial or ethnic backgrounds varies [3].

While there was no significant relationship observed between food security status and body composition change in this sample, the high prevalence of food insecurity in this population (63%) is concerning, as collegiate football players' have higher caloric needs than the general population. Specifically, this population requires, on average, double the estimated energy requirements of other male college students [9], making them uniquely disadvantaged in their experiences of

Table 2: Affirmative Responses (%) to USDA Food Security Scale Questions.

USDA Food Security Questions on Survey	Affirmative Responses % (n = 85)
"I worried whether my food would run out before I had the money to buy more."	64.71%
"The food that I bought just didn't last, and I didn't have money to get more."	62.35%
"I couldn't afford to eat balanced meals."	61.18%
"In the last 12 months, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?"	50.59%
"In the previous question, you indicated cutting the size of your meals or skipping meals because there wasn't enough money for food. How often did this happen? (Almost every month or some months but not every month)"	86.05%
"In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?"	45.88%
"In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food."	41.18%
"In the last 12 months, did you lose weight because there wasn't enough money for food?"	37.65%
"In the last 12 months, did you ever not eat for a whole day because there wasn't enough money for food?"	18.82%
"If yes, how often did this happen?" *(Affirmative responses include: "Almost every month" or "some months but not every month")*	81.25%

Table 3: Analysis of Variance for Body Composition Changes Between Food Secure vs. Food Insecure Categorical Groups.

Model	Dependent Variable	Independent Variable	Covariate	F-Value	P-Value
1	Body Weight Change	Food Security	Age	0.82	0.3696
			Race	0.00	0.9809
			Initial Wt	38.94	**< 0.0001**
			Position	5.05	**< 0.0001**
			Food Security	0.49	0.4884
2	Body Fat Percent (BFP) Change	Food Security	Age	0.03	0.8731
			Race	0.34	0.5621
			Initial Wt	14.16	**0.0003**
			MM Change	29.37	**< 0.0001**
			Position	2.22	**0.0303**
			Food Security	1.65	0.2036
3	MM Change	Food Security	Age	0.07	0.7974
			Race	3.46	0.0668
			Initial Wt	14.63	**0.0003**
			BFP Change	17.33	**< 0.0001**
			Position	1.52	0.2206
			Food Security	0.25	0.6187
4	BMI Change	Food Security	Age	0.36	0.5522
			Race	0.14	0.7047
			Initial Wt	16.67	**0.0001**
			Position	3.87	**0.0005**
			Food Security	2.26	0.1370

Table 4: Analysis of Variance for Dependent Variables between Races.

Model	Dependent Variable	Independent Variable	Covariate	F-Value	P-Value
1	Food Security Score	Race			
		Age		8.03	**0.0059**
		Position		1.57	0.1419
		Race		5.03	**0.0280**
2	Body Weight Change	Race			
		Age		0.42	0.5180
		Initial Wt		36.03	**< 0.0001**
		Position		4.97	**0.0001**
		FS Score		0.00	0.9973
		Race		0.04	0.8452
3	Body Fat Percent (BFP) Change	Race			
		Age		0.04	0.8358
		Initial Wt		12.64	**0.0007**
		Position		2.23	**0.0299**
		MMChange		30.14	**< 0.0001**
		FS Score		0.07	0.7962
		Race		0.10	0.7496
4	MM Change	Race			
		Age		0.26	0.6139
		Initial Wt		23.53	**< 0.0001**
		Position		2.95	**0.0050**

		BFP Change	30.14	**< 0.0001**
		FS Score	0.16	0.6865
		Race	0.69	0.4098
5	BMI Change	Race		
		Age	0.17	0.6827
		Initial Wt	15.78	**0.0002**
		Position	3.93	**0.0004**
		FS Score	1.12	0.2943
		Race	0.11	0.7413

food insecurity. The need for college football players to consume significantly more food than the average college student may explain the high prevalence of food insecurity in our study sample. Interestingly, our findings also indicate a higher prevalence of food insecurity than prior research on food insecurity and collegiate athletes [19,20]. However, this present study is unique in looking at Division 1 collegiate football athletes, specifically.

Table 2, which summarizes participant responses to individual items screening for food insecurity, illustrates the severity of food insecurity in many athletes. For instance, when asked, *"did you ever eat less than you felt you should because there wasn't enough money for food?*", 46 percent of the athletes surveyed in this study responded "Yes". When asked, *"did you ever not eat for a whole day because there wasn't enough money for food?"*, about 19% of athletes responded "Yes". Eighty-one percent of those who responded "Yes" to not eating for an entire day stated this happened "almost every month" or "some months but not every month". Until recently, there were NCAA restrictions on feeding athletes, but on April 14, 2014 the NCAA voted to lift these restrictions to allow Division 1 schools to provide meals and snacks to student-athletes [21]. While this change may have helped to bridge some of the gap between resource availability and energy demands in this population, it is important to note that this food is purely supplemental and intended to provide athletes fuel for practice or competition and to recover well after these events. While this undoubtedly gives athletes some relief from the financial burden of fueling their high calorie needs, in most cases college athletes are still responsible for their own major meals. And, as demonstrated in this study, they are not always able to meet these basic needs.

The athletes in this study work with a RDN regularly during this training cycle to make dietary changes to improve body composition. The RDN can aid the athletes in meal planning to optimize nutrition on a tight budget and connect athletes to outside food resources which could also have increased intake in nutritionally adequate foods. For instance, athletes may have been recommended to use of the on-campus food pantry available to all campus students.

Previous research by Hull, et al. concluded collegiate athletes with regular access to a dietitian eat foods higher in nutrient quality, adequately fuel prior to workouts, and also consume healthier options post workout to promote recovery [22]. Athlete's utilization of this RDN consultation service was also not collected in this specific study as it was not included in the Athletics Sports Medicine Department's standard of care protocol.

This study had both strengths and limitations. One strength of this study is that the food security survey used is a validated survey utilized by the USDA to assess food security status across the nation, making the data comparable to the national, regional, and state-level statistics. This USDA food security survey is also widely used and recognized as the standard food security measure in the literature. There have been few recent publications questioning the effectiveness of this survey when used with college students specifically [23-25]. However, it remains the best option for assessing food security in any adult population at the time of this publication. Another strength of this study is that the data was collected in-person by the team dietitian who has strong interpersonal relationships with the athletes. Athletes were able to ask questions during survey completion to increase likelihood of accurate responses. The survey was conducted privately, and responses were kept confidential to help the athletes feel comfortable in asking for clarification and answering questions honestly. A limitation of this study was not having data on use of the athletic facility nutrition station to examine possible differences in body composition related to utilization of provided pre- and post- training fuel. Since the food provided is geared towards optimal performance, including foods like nutrient rich, high protein snacks, athletes' proper utilization of provided training fuel may have reduced any possible effect of food insecurity on body composition changes.

Another limitation of this study is that body composition was measured using BIA which is highly sensitive to hydration and electrolyte changes [26,27]. While all athletes were reminded to follow the standard of care daily hydration protocol prior to measurement, results could have been affected by variation in athlete's hydration status. Finally, our sample contains only

college football males at one school in the southeast. While this limits generalizations to other athletes and regions, it does suggest a high level of food insecurity among college football players specifically. Though food security was not found to significantly impact body composition changes in this sample, more research in this area, including a study which collects information on use of fueling stations and overall dietary intake, would be beneficial in further evaluating the relationship between food security and body composition in athletes.

Conclusion

While our main hypothesis was not supported, the high prevalence of food insecurity observed in this sample of Division 1 football players is noteworthy. There are significant health concerns for athletes experiencing food insecurity while committed to a high-energy demanding sport.

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References

1. Fry R, Cilluffo A (2019) A rising share of undergraduates are from poor families, especially at less selective colleges. Pew Research Center: 1-16.
2. Gundersen C, Ziliak JP (2015) Food Insecurity and Health Outcomes. Health Aff (Millwood) 34: 1830-1839.
3. Bruening M, Argo K, Payne-Sturges D, Laska MN (2017) The Struggle Is Real: A Systematic Review of Food Insecurity on Postsecondary Education Campuses. J Acad Nutr Diet 117: 1767-1791.
4. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A (2021) Household Food Security in the United States in 2020. ERR-298, U.S. Department of Agriculture, Economic Research Service.
5. Morris LM, Smith S, Davis J, Null DB (2016) The prevalence of food security and insecurityamong Illinois University students. J Nutr Educ Behav 48: 376-382.e1.
6. Maroto ME, Snelling A, Linck H (2015) Food insecurity among community college students: Prevalence and association with grade point average. Community Coll J 39: 515- 526.
7. El Zein A, Shelnutt KP, Colby S, Vilaro MJ, Zhou W, et al. (2019) Prevalence and correlates of food insecurity among U.S. college students: a multi-institutional study. BMC Public Health 19: 660-660.
8. Freudenberg N, Goldrick-Rab S, Poppendieck J (2019) College Students and SNAP: The New Face of Food Insecurity in the United States. American Journal of Public Health 109: 1652-1658.
9. Berning JR (2021) Fueling a football team. Gatorade Sports Science Institute.
10. Ellis CE (2021) How many calories does my teen need? EatRight.
11. Seligman HK, Schillinger D (2010) Hunger and socioeconomic disparities in chronic disease.New Engl J Med 363: 6-9.
12. ODPHP (2014) Health Communication and Health Information Technology.
13. Kerksick CM, Wilborn CD, Roberts MD, Smith-Ryan A, Kleiner SM, et al. (2018) ISSN exercise & sports nutrition review update: research & recommendations. Journal of the International Society of Sports Nutrition 15: 38.
14. Anding R, Oliver JM (2015, April) Football player body composition: Importance of monitoring for performance and health. Gatorade Sports Science Institute.
15. Churchill TW, Krishnan S, Weisskopf M, Yates BA, Speizer FE, et al. (2018) Weight Gain and Health Affliction Among Former National Football League Players. Am J Med 131: 1491-1498. PMC6279549.
16. Trexler ET, Smith-Ryan AE, Mann JB, Ivey PA, Hirsch KR, et al. (2017) Longitudinal Body Composition Changes in NCAA Division I College Football Players. J Strength Cond Res 31: 1-8.
17. Bosch T, Carbuhn A, Stanforth P, Oliver J, Keller K, et al. (2019) BodyComposition and Bone Mineral Density of Division 1 Collegiate Football Players: A Consortium of College Athlete Research Study. J Strength Conditioning Res 33: 1339-1346.
18. Rosenbloom CA, Coleman EJ (2012) Sports nutrition: A practice manual for professionals. Academy of Nutrition and Dietetics.
19. Brown ML, Karpinski C, Bragdon M, Mackenzie M, Abbey E (2021) Prevalence of food insecurity in NCAA Division III collegiate athletes. J Am Coll Health. 1:1-7.
20. Goldrick-Rab S, Richardson B, Baker-Smith C (2020) Hungry to Win: A First Look at Food and Housing Insecurity Among Student-Athletes.
21. NCAA deregulation of feeding (2021) NCAA Deregulation of Feeding - CPSDA | SportsRd.org| Collegiate & Professional Sports Dietitians Association. (n.d.).
22. Hull MV, Neddo J, Jagim AR, Oliver JM, Greenwood M, et al. (2017) Availability of a sports dietitian may lead to improved performance and recovery of NCAA division I baseball athletes. Journal of the International Society of Sports Nutrition 14: 29.
23. Ames AJ, Barnett TM (2019) Psychometric Validation of the 10-Item USDA Food Security Scale for Use with College Students. J Appl Meas 20: 228-242.
24. Ellison Bruening M, Hruschka DJ, Nikolaus CJ, van Woerden I, Rabbitt MP, et al. (2021) Viewpoint: Food insecurity among college students: A case for consistent and comparable measurement. Food Policy 101: 102031.
25. Nikolaus CJ, Ellison B, Nickols-Richardson SM (2019) College students' interpretations of food security questions: results from cognitive interviews. BMC Public Health 19: 1282-1282.

26. Castizo-Olier J, Irurtia A, Jemni M, Carrasco-Marginet M, Fernandez-Garcia R, et al. (2018) Bioelectrical impedance vector analysis (BIVA) in sport and exercise: Systematic review and future perspectives. PLoS One 13: e0197957.

27. Moonen HPFX, van Zanten FJL, Driessen L, de Smet V, Slingerland-Boot R, et al. (2020) Association of bioelectric impedance analysis body composition and disease severity in COVID-19 hospital ward and ICU patients: The BIAC-19 study, Clinical Nutrition.