Orthorexia nervosa and its association with narcissism in professional athletes

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DIPLOMA THESIS

Academic year:
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Assoc. Prof. Josko Bozic, MD, PhD

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I would like to thank my family back in Norway for supporting me. And to my fantastic friends here in Split, you guys are amazing and as we would say in Denmark: "Kameláså to you all".

Additionally, I would like to thank my mentor Assoc. Prof. Josko Bozic, MD, Ph.D., for always supporting me.

LIST OF ABBREVIATIONS

kJ – Kilojoule

kcal – Kilocalories

Kg – Kilo

G – Grams

NCD – Noncommunicable Diseases

BMI – Body Mass Index

WHO – World Health Organization

NCD – Non-communicable disease

AD – Anno Domini

NPD – Narcissistic personality disorder

DSM – The Diagnostic and Statistical Manual of Mental Disorders

ICD – International Classification of Diseases

ON – Orthorexia Nervosa

DEXA - Dual Energy X-ray Absorptiometry

AI – Adequate intake

EAR – Estimated average requirement

MVMS – Multivitamin/mineral supplements

DASH - The Dietary Approaches to Stop Hypertension

1. INTRODUCTION

1.1. Nutrition

The fact that what we eat and the nutritional value of what we eat affect our health has been an indisputable fact for centuries. There is constantly an increasing amount of evidence pointing to environment and diet now being the main attributes affecting the health and disease of a person. It has thus been important to research what nutrition is in regards to the components and the positive or negative aspects they have on health. This all leads to the findings of macro- (protein, fat, carbohydrate) and micro- (vitamins, minerals, etc.) nutrients. The human diet is approximated to contain around 20 000 compounds, of which approximately 50 are needed to sustain life (1). Studies of these nutrients have led up to a number in regards to daily requirements to form recommendations for the general public. However, since it is impractical for the individual to keep track of every single nutrient, dietary recommendation tools such as Choose My Plate (USDA) or Healthy Eating Plate (Harvard University) and various diets have been created to achieve the recommended dietary goals(2, 3).

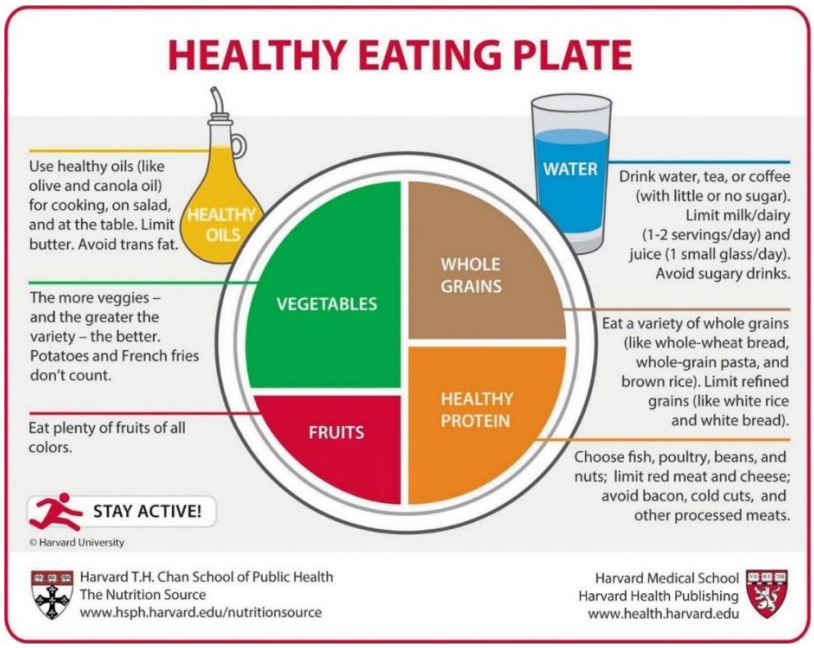

Figure 1. Healthy Eating Plate. Source: Locke A, Schneiderhan J, Zick SM. Diets for Health: Goals and Guidelines. Am Fam Physician. 2018;97:721–8.

1.1.1. Nutrients

There are seven main classes of nutrients which include carbohydrates, fats, proteins, minerals, fiber, vitamins, and water. They can further be subdivided into macronutrients and micronutrients, which differ in the quantity of which they are needed. Carbohydrates, fats, and proteins provide energy and belong to the macronutrient class. Fiber and water are also

macronutrients but they do not provide energy. Minerals and vitamins also do not provide energy, but are needed for other reasons, and belong to the micronutrient class (4–6).

Carbohydrates and proteins both yield approximately 17 kJ (4 kcal) of energy per gram, and fats yield approximately 37 kJ (9 kcal) per gram, although the net energy gained depends on various factors varying from person to person such as absorption and digestive effort. The energy derived from these macronutrients is required in the human body to sustain growth, metabolism, and various other functions (7).

1.2.1.1 Proteins

Proteins are long molecules that primarily consist of chains with hundreds of amino acids. 20 of the amino acids are vital for life. Some of these the body can convert itself, but 9 of the amino acids we need to get through the diet, these are what we call essential amino acids. These are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Amino acids are produced in plants, which means we need to get the essential amino acids through herbivorous animals, a variation of different plants and crops, or a combination of both. When one type of food contains all the essential amino acids, we call it a “complete protein”. Examples of these are meat, bird, fish, eggs, dairy products, cheese, and soya beans. Examples of vegetarian sources you can combine to get the essential amino acids are corn, rice, beans, peas, lenses, and nuts. Animal protein has mostly better quality than vegetarian protein sources, but if you combine different vegetarian sources in your meal you will get quality comparable to protein from animal sources (8). It is recommended that 12-15% of the total energy is needed from protein. Per kilo of body weight, it is recommended 1 gram of protein per day, those who exercise a lot can have the advantage of up to 2 grams per kilo of body weight per day (9). If you don’t cover your daily caloric needs the body will use protein as an energy source in addition to carbohydrates and fat. This means your muscles will weaken, which in turn can lead to reduced metabolism. It is therefore important if you are trying to lose weight to get a sufficient protein intake so that it is the fat and not the muscles that will primarily disappear. Protein plays a crucial role in basically all the biological processes in the body. For example, protein is crucial for building and maintaining cells, and tissue and the production of hormones and enzymes (10).

1.2.1.2 Fats

When it comes to fat it is important to reduce intake, but it is absolutely required for the body to get some fat. Fat is divided into 4 main categories: saturated, monounsaturated,

polyunsaturated, and trans fats. Saturated and trans fats are linked to increased risk for cardiovascular disease. It is recommended with a total fat intake of around 20-35% of the daily energy need. Out of this, not more than 10% should come from saturated fat and a maximum of 1% from trans fats. Fat is necessary for many important functions in the body. Fat is responsible for transporting the fat-soluble vitamins A, D, E and K. Fat protects the internal organs. Fat is a concentrated source of energy. Fat contains essential fatty acids that are believed to have a positive effect on the cardiovascular and immune systems (11, 12).

1.2.1.3 Carbohydrates

Carbohydrates are an important part of a healthy diet. For several organs, such as the brain, the central nervous system, and the kidneys carbohydrates are the only energy source. When we eat carbohydrate-rich food the digestive system breaks carbohydrates down to simple sugars which include glucose, fructose, or galactose. In addition, the pancreas produces the hormone insulin which is necessary to get the glucose from the blood and into the cells. This sugar is then used as energy for the cells, tissue, and organs of the human body. If you have a surplus of carbohydrates it will be stored in the liver, muscles, and fat cells in the form of glycogen and fat which can be utilized at a later point. There are 3 types of carbohydrates but not all carbohydrates are equally healthy. Monosaccharides, which mostly consist of glucose, are single molecules and are found in most carbohydrates. In fruit, vegetables, and honey you can find fructose which will be transformed into glucose in the liver. Galactose is a part of lactose which is the sugar found in milk and milk products. Disaccharides consist of 2 monosaccharides connected and are being split in the intestines into monosaccharides. Disaccharides can be found as sucrose in pure sugar, but they can also exist naturally in fruit and vegetables. Lactose is found in milk and milk products, while maltose is found in budding seeds and is formed when starch is broken down to maltose and then further on to glucose. As a general recommendation, you should eat mostly natural fiber-rich foods such as whole grains, potatoes, vegetables, fruit, berries, and nuts. The consumption of free sugars should be below 10% of total energy intake for both children and adults, also consumption of no more than 5% would yield more health advantages (13, 14).

1.2.2 Effect on human health

Nutrition is an essential component of health and development. A good diet is linked to healthier infants, children, and maternal health, an improved immune system, a more secure

pregnancy, and childbirth, reduced risk of non-communicable diseases (i.e., cardiovascular disease and diabetes), and generally increased longevity. If the child is healthy it also learns better, in general, an individual with a good nutritional status is more productive and is more likely to get out of poverty and hunger (15–18).

A big threat to the general population's health is malnutrition which manifests as a double burden with both undernutrition and overweight. Malnutrition ranges in the spectrum from undernutrition with wasting, stunting, and underweight to overweight and obesity. 1.9 billion adults are overweight or obese while 462 million are underweight (19).

The most commonly used measure for overweight and obesity is BMI. It is calculated using the individual's weight in kilograms and then divide by the square of the individual's height in meters. Adults with a BMI over 25 are classified as overweight and with a BMI over 30 are classified as obese. Other indirect measures include a weight-for-height index, waist circumference, waist-hip ratio, and body fat percentage estimated by skinfold thickness. Unfortunately, indirect measures, such as the BMI, are not able to differentiate between adipose tissue, muscle tissue, or bone mass and are thus often miscalculated, especially amongst individuals with a large amount of muscle tissue (20). Body fat measured by bipolar bioelectrical impedance analysis and body fat measured by DEXA scan has been shown to be much more reliable, especially amongst muscular subjects (21).

Individuals with overweight or obesity are prone to many dangerous conditions compared to an individual with a healthy weight. Some of these include cardiovascular disease, hypertension, type 2 diabetes, stroke, gallbladder disease, osteoarthritis, sleep apnea, mental illnesses such as clinical depression, anxiety, and many others (22–26).

Underweight individuals have been shown to be more prone to depression, suicide risk, and increased mortality rate from external factors like accidents (27). Underweight individuals are also at an increased risk for developing infections (28). Adequate wound healing also requires sufficient nutrient intake, putting underweight individuals at an increased risk of developing pressure ulcers and delayed wound healing which can result in chronic nonhealing wounds (29). Underweight individuals have also been shown to have a greater risk of cardiovascular disease compared to individuals with normal weight, but not as high as those who are overweight (30).

Both individuals who are overweight and underweight are also associated with lower fertility (31).

There can also be an inadequate intake of minerals and vitamins. Figure 2 shows the percentages of deficiencies for some nutrients and minerals for the US population.

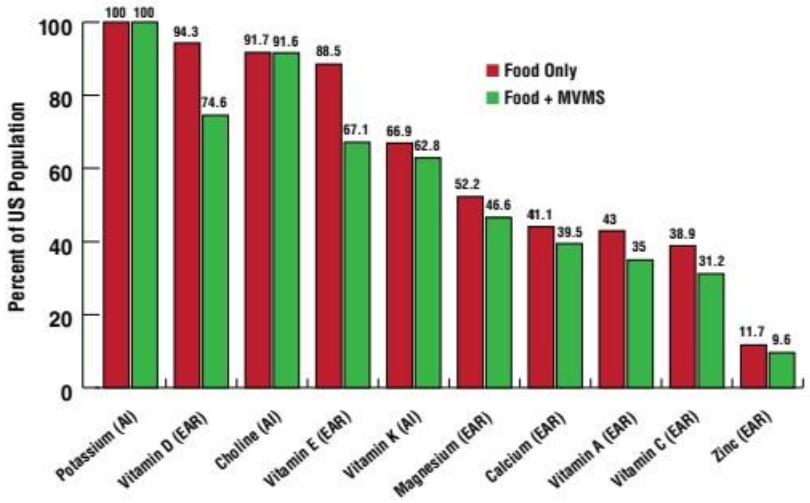

Figure 2. Percent of the US Population Obtaining Less Than the EARs or Ais for Selected Nutrients From Food Alone or Food Plus Multivitamin/Mineral Supplements. Source: Wallace TC et al. Multivitamin/mineral supplement contribution to micronutrient intakes in the United States, 2007-2010. J Am Coll Nutr. 2014;33:94-102.

Vitamin A deficiency can result in night vision reduction and other vision defects as well as reduced immune function. Vitamin C deficiency can lead to scurvy, impaired wound healing, weakness, and fatigue. Vitamin D deficiency can lead to rickets in children as well as osteomalacia in adults, general muscle weakness, reduced immune function, and pain in the bones. Vitamin E deficiency can lead to ocular and neurological damage, frail red blood cells, and muscle weakness. Vitamin K deficiency can lead to impairment of the blood clotting cascade resulting in increased bleeding. Calcium deficiency can lead to rickets in children, osteoporosis, and subsequent higher fracture risk in adults. Magnesium deficiency can lead to lower calcium levels and subsequent hypocalcemia with muscle cramps, neuronal hyperexcitability, and an increased chance of seizures. Zinc deficiency can lead to growth retardation, hair loss, ocular and cutaneous lesions, diarrhea, and reduced appetite. Potassium deficiency can lead to muscle weakness, fatigue, cramps, glucose intolerance, and cardiac abnormalities (32, 33).

When it comes to the prevention of NCD's WHO has some dietary recommendations. They recommend at least 400 g of fruits and vegetables daily, which several countries have used to make an easier recommendation of "5 per day". Excluded from this list are potatoes and sweet potatoes, cassava, and other starch roots (34). This also helps to make sure the individual gets an adequate daily intake of fiber. They also recommend reducing your daily intake of fat to less than 30% of your daily total intake of energy to help in preventing overweight and

obesity as well as reducing the risk of NCDs (11, 35).

Free sugar consumption can lead to several health concerns such as dental caries, and weight gain, and it is also shown that free sugars influence blood pressure and serum lipids. It is also suggested by evidence that a reduction in free sugars lowers the chance of developing cardiovascular disease (36).

1.2.3 Recommended healthy diets

The US Dietary Guidelines recommend 3 healthy diets which include the Mediterranean diet, the DASH diet, and a vegetarian diet (37, 38).

1.2.3.1 The Mediterranean diet

The Mediterranean diet is derived from ancient civilizations encircling the Mediterranean Basin, including Italy, Greece, Spain, and France, and has later adapted dietary habits from other countries such as the Balkans and others (39). The essence of the diet is the intake of olive oil as the primary form of added fat, minimally processed plant foods such as tree nuts, seeds, vegetables, intake of fish, seafood, and dairy, and a small consumption of alcohol, mainly red wine. Research shows that this diet has a beneficial effect on cardiovascular disease and as well showed benefits in the interventional approach to obesity, type 2 diabetes, metabolic syndrome, cancer, and neurodegenerative illness (40–44). It is not known exactly how the Mediterranean diet provides the aforementioned benefits, but data suggests that there are 5 main factors deriving from this diet. It has a lipid-reducing effect, oxidative stress, inflammation, platelet aggregation protection, hormone and growth factor modification in regards to cancer pathology, nutrient-sensing pathway inhibition by restriction of particular amino acids, and production of metabolites from the gut affecting metabolic health (43).

1.2.3.2 The DASH diet

The DASH diet was as the name implies an effort to lower blood pressure in the population, but was later found to be beneficial also for weight loss and general health. Fruits, vegetables, whole grains, and low-fat dairy products are abundant in the DASH diet (45). It contains meat, fish, poultry, nuts, and beans but is low in red meat, added fats, and sugar-sweetened meals and beverages. Based on daily caloric intake ranging from 1,600 to 3,100 dietary calories, the DASH dietary pattern is modified (46). Even though this diet is linked to

lower blood pressure and improved gout, it is unclear whether or not it is useful to promote low-fat dairy products (47). Obese or diabetic people are also advised to follow the diet (38).

1.2.3.3 Vegetarian Diet

For all phases of the human life cycle, including during pregnancy, nursing, infancy, youth, and adolescence, appropriately planned vegetarian diets are nutritious and beneficial. A vegetarian diet is one that excludes meat (including poultry) and seafood, as well as any items made from those foods (48). The development and health of children may be jeopardized by vegetarian diets that are low in calories or vitamin B12 (49). Vegetarian diets should adhere to the general guidelines for healthy diets, such as limiting the intake of fat, salt, and sugar and eating five fruits or vegetables each day. According to evidence, vegetarians tend to have reduced rates of osteoporosis, type 2 diabetes, obesity, hypertension, and coronary heart disease (50). Carbohydrates, omega-6 fatty acids, dietary fiber, carotenoids, folic acid, vitamin C, vitamin E, potassium, and magnesium are typically abundant in vegetarian diets. They may be low in animal protein, cholesterol, and saturated fat (48).

1.2.4 Dietary requirements of professional athletes

For the professional athlete, there are additional factors other than general health recommendations that need to be taken into account. For one, they might require more of some nutrients than others. Professional athletes are in need of a bigger amount of carbohydrates to retain a glycogen depot (51). The recommendation for carbohydrates is suggested to be more than 5 g/kg/day and fat intake should be 20-35% of the energy (52). They are also in need of a bigger number of proteins to maintain improvements in lean body mass, protein consumption of 1,2-2,1 g/kg/day has been recommended (53, 54). Also, some endurance athletes need added amounts of iron to retain their iron storage to compensate for increased blood loss (55). There are also those athletes who need to limit their dietary consumption to reduce body weight, maintain specific body weight, or reach a certain weight requirement.

Even with all the scientific data suggesting nutritional guidelines for athletes, studies are showing many athletes are not getting the recommended amounts of energy and macro-and micro-nutrients. This is especially true when it comes to a deficient carbohydrate intake and an excess protein intake. A deficiency in total caloric intake has been reported especially for females in sports requiring leanness or a prepubescent body shape. In regards to micronutrients a deficient intake of vitamin E, calcium, folate, and magnesium has been shown amongst many athletes, in particular female athletes (56, 57).

1.3 Narcissism

Narcissism is an exaggerated, self-absorbed interest in oneself, especially when it comes to one's physical appearance, often at the sacrifice of others (58). The notion of narcissism goes all the way back to the year 8 AD from the Roman poet Ovid. There it narrates the story of Narcissus who was a very good-looking young man who rejects many potential lovers. But when Narcissus denies the advances of the nymph Echo, he was punished by the gods, made to love the reflection of himself seen in the water. Discovering the reflection can't love him back he eventually fades away and dies (59).

Narcissism does not have to be either good or bad and it hinges on the circumstances and results being measured. In some settings such as making new friends, impressing clients at work, initiating romantic relationships, and looking at results such as a positive self-image healthy narcissism can be good. In other settings such as preserving long-term relationships and looking at results such as correct self-knowledge, healthy narcissism can be damaging (60).

Narcissism can be considered an ordinary personality trait, but with higher levels of narcissistic behavior, it can be disadvantageous and nonsensical. Destructive narcissism can be defined as a persistent display of some extreme traits associated with pathological Narcissistic Personality Disorder like a "pervasive pattern of grandiosity", this being shown as feelings of privilege and supremacy, arrogant or vain behaviors, and a generalized shortfall of empathy and concerns for others. Destructive narcissism is on a range more severe than healthy narcissism but less severe than pathological narcissism (61).

Pathological levels of narcissism are extreme levels of narcissistic behavior. Clinical theorists Kernberg, Kohut, and Theodore Millon viewed pathological narcissism as a potential result of unemphatic and inconsistent interactions in early childhood. Their suggestion was then that narcissists try to recoup in adult relationships (62). Narcissistic Personality Disorder (NPD) was first defined in 1980 in DSM-III and persons with NPD show lower levels of empathy and exploit relationships for their own gain. They are also more prone to infidelity and both verbal and physical hostility (63). Persons with NPD have also been shown to be more prone to psychological distress and have a hard time dealing with aging (64). These factors contribute to the fact that suicidal risk is increased in persons with NPD and narcissistic traits (65–67). It has also been shown that persons suffering from NPD often avoid treatment and cause significant distress to others (68, 69).

1.4 Orthorexia Nervosa

The term orthorexia was originally termed in 1997 and the diagnosis orthorexia nervosa means an enslaving thought when it comes to proper or "healthful" eating in terms of correct nutritional values in food. People become so fixated that it often leads to a decrement in their well-being (70). Orthorexia nervosa is a suggested eating disorder that has the individual preoccupied with consuming healthy food. It often starts with an innocent desire to treat or prevent illnesses such as asthma, arthritis, cancer, heart disease, or diabetes or to reduce your weight. American physician Steven Bratman introduced the term in 1997. He theorized that for some individuals who had severe restrictions in terms of eating habits that it could paradoxically result in unwanted sequelae such as anxiety, diminished inter in other people, and their health interests which in turn can lead to social isolation and in rare cases severe malnutrition and possibly death (71, 72). People with ON might also display behaviors such as ferociously inspecting ingredient lists and nutrition labels, intensively criticizing other people's nutritional intake, and bringing their own premade meals to events to ensure they will meet their own standards of healthy. This often leads to these individuals trying to remove food items containing preservatives, pesticides, color additives, GMO's, and food containing large amounts of sugar, fat, and salt. These individuals also often tend to attain food from ecological farming (73–75).

There is an increasing amount of research and interest towards ON as shown in figure 3, but it is not yet recognized by the industry standards DSM or ICD as an eating disorder (76, 77).

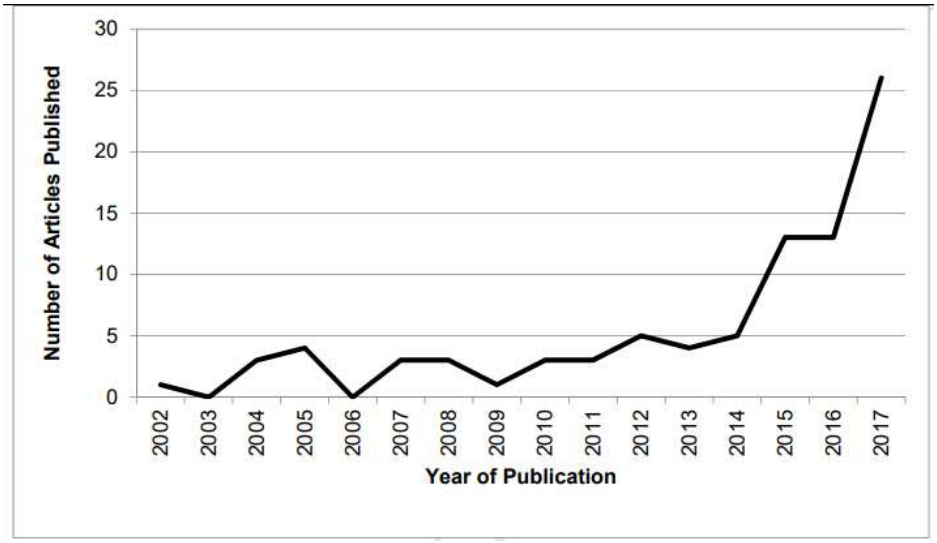

Figure 3. Number of articles posted each year with key words "orthorexia" or "orthorexia nervosa". Source: McComb SE, Mills JS. Orthorexia nervosa: A review of psychosocial risk factors. Appetite. 2019;140:50-75.

ON differs from other eating disorders such as anorexia nervosa and bulimia and nervosa in regards that people with ON are concerned with the quality of the food and not the quantity of the food eaten. It also differs in respect to AN in the fact that AN has a 9 to 1 ratio in women to men while ON is suggested to have minimal differences in the gender. However, partially due to the fact that ON is not recognized as an eating disorder research is still lacking. In regards to BMI, studies are suggesting that increased ON symptoms correlate to increased BMI. This might be partially due to the fact that ON starts in many people with an increased BMI with a wish to lose weight. But since no studies have shown a negative correlation between BMI and ON this suggests that ON is different from AN which is characterized by a very low BMI (78–80).

It is suggested that the problem with ON has been rising in the last few years, especially due to an increasing focus on nutrition and achieving the "perfect body figure" which has been increasingly promoted through media, the internet, and social media (81–83).

In 2016 Steve Bratman and Thom Dunn suggested formal criteria for ON which can be seen in the table below. The previous most popular used diagnostic method was the ORTO-15, but this has been criticized for lacking suitable internal and external validation (84, 85).

Table 1: Dunn and Bratman's proposed diagnostic criteria for ON. Source: Dunn TM, Bratman S. On orthorexia nervosa: A review of the literature and proposed diagnostic criteria. Eat Behav. 2016;21:11–7.

Criterion A: Obsessive focus on "healthy" eating as defined by a dietary theory or set of beliefs whose specific details may vary; marked by exaggerated emotional distress in relationship to food choices perceived as unhealthy; where weight loss may ensue but is conceptualized as an aspect of ideal health rather than the primary goal; as evidenced by the following
1. Compulsive behavior and/or mental preoccupation regarding affirmative and restrictive dietary practices believed by the individual to promote optimum health
2. Violation of self-imposed dietary rules causes exaggerated fear of disease, sense of personal impurity and/or negative physical sensations, accompanied by anxiety and shame
3. Dietary restrictions escalate over time and may come to include elimination of entire food groups and involve progressively more frequent and/or severe "cleanses" (partial fasts) regarded as purifying or detoxyfing; this escalation commonly leads to weight loss but the desire to lose weight is absent, hidden or subordinated to ideation about health
Criterion B: The compulsive behavior and mental preoccupation becomes clinically impairing by any of the following
1. Malnutrition, severe weight loss, or other medical complications from restricted diet
2. Intrapersonal distress or impairment of social, academic, or vocational functioning secondary to beliefs or behaviors about healthy diet
3. Positive body image, self-worth, identity, and/or satisfaction excessively dependent on compliance with self-defined "healthy" eating behavior

Abbreviations: ON – Orthorexia Nervosa

There is still not enough evidence in regards to the negative effects of ON on your body, but it is suggested that it can lead to a shortfall of essential nutrients, digestion problems, electrolyte and hormonal disturbances, metabolic acidosis, and general weakness and weakened immune system (74, 86).

2. OBJECTIVES

The main aim of this study was to compare tendency towards orthorexia nervosa and narcissistic behavior between professional and recreational athletes who visit fitness centers.

Hypotheses:

1. ORTO-15 score will show a higher affinity to ON in the professional athletes' group than in the recreational athletes' group.
2. Higher percentage of professional athletes will have ON tendency in comparison to recreational athletes.
3. Professional athletes will have higher scores than recreational athletes in all domains of NPI-13 scale.
4. ORTO-15 score will correlate with NPI-13 score and level of physical activity.

3. SUBJECTS AND METHODS

3.1. Study design and participants

This study is designed as cross-sectional, and conducted at chosen fitness centres in Croatia. Time period of data collection was between September and November 2021. Investigation is performed according to the ethical guidelines from Helsinki Declaration, while University of Split School of Medicine Ethics Committee approved the study protocol. As this study is structured as survey-based, online investigation through Google Forms® application, final submission of answers was considered as obtained informed consent.

Study included 100 professional athletes that were enrolled at selected fitness centres. All of them were 18-40 years old, and involved in professional sports (registered, competing athletes, training minimally for 5 times per week). Participants were excluded from the study if their sport of interest was non-physical or if they have had a pause of training for more than 3 months. Furthermore, control group consisted of 100 recreational athletes of the same age range, that were involved in recreational sports minimally 2 times a week.

3.2. Survey

A link for anonymous Google Forms® survey was distributed via fitness groups and e-mails of population of interest. It consisted of three main parts, with first one investigating baseline subjects' information. A total of 10 questions were assessed, including information regarding age, gender, sport of interest, anthropometric measurements, and duration of training. Second part of survey investigated levels of subclinical narcissism through Narcissistic Personality Inventory (NPI), and pathological obsession with eating "clean" and "pure" food with ORTO-15 questionnaire. Finally, third part investigated levels of physical activity.

Used NPI questionnaire was in the form of short form NPI-13, validated version that assessed grandiose exhibitionism (GE), leadership/authority (LA) and entitlement/exploitativeness (EE) domains of narcissism (87, 88). All of the 14 items had dichotomous answers (low and high narcissism choice), while certain answers were combined to provide final score for each of the scales, and overall combination was presented as total score of this questionnaire.

Finally, orthorexia nervosa levels were assessed with ORTO-15 questionnaire, validated and commonly used tool for this purpose (84). It is a 15-item, self-reported tool that provided possible answers through 4-point Likert scale (from "always" to "never"). Total score was calculated between 15 and 60 points, while higher scores were indicating lower pathological

obsession with healthy food. Original authors of ORTO-15 questionnaire determined that a cut-off value of <40 points is suggesting presence of ON (89). However, for the purposes of this study, a cut-off value of <35 points was chosen for suggestion of ON, as several different studies pointed that higher cut-off leads to high percentage of false positive cases (90–92).

Last, third part of the survey investigated levels of physical activity through International Physical Activity Questionnaire Short Form (IPAQ-SF). It is a self-reported questionnaire, validated on Croatia language as well (93, 94). It consists of questions that evaluate personal physical activity of different intensity levels by recalling the last seven days. Accordingly, from the obtained results, metabolic equivalent of task (MET) minutes per week were calculated according to standard formulas (95).

3.3. Statistical analysis

The statistical analyses of the data were conducted using MedCalc for Windows (MedCalc Software, Ostend, Belgium, version 17.4.1). The normality of data distribution was estimated using Kolmogorov-Sminrnov test. Quantitative data was presented as mean ± standard deviation or median and interquartile range, and qualitative as number and percentage. Mann–Whitney U test was used for statistical comparison of quantitative variables, while Chi-squared test was used for comparison between qualitative variables. Spearman's rank correlation coefficient was used to test association between non-parametric variables. Finally, multiple linear regression analysis was used to determine significant independent predictors for the ORTO-15 score. From these analyses, we reported the p values with unstandardized β-coefficients, standard error and t values. The level of statistical significance was set at p value < 0.05.

4. RESULTS

This investigation included a total of 200 athletes, of which 100 was recreational and 100 professionals. In comparison of the baseline characteristics between the two groups, the subjects significantly differed in regards to height, weight and BMI. Based on these parameters, BMI was then higher for professional athletes (25.38 ± 6.1 vs. 23.5 ± 3.0 kg/m^2, P<0.001). Professional athletes also had a higher total MET score than recreational athletes (2565 (1528-3961) vs. 2088 (1449-2632) min/wk, P<0.001). The rest of the baseline characteristics can be seen in Table 2.

Table 2. Baseline characteristics of the study sample.

	Study sample N=200	**Professional athletes N=100**	**Recreational athletes N=100**	***P***
Male gender (N, %)	105 (52.5%)	61 (61.0)	44 (44.0)	0.023
Age (years)	24.4 ± 5.0	24.1 ± 5.9	24.8 ± 4.0	0.351
Height (m)	1.80 ± 0.10	1.83 ± 0.11	1.77 ± 0.9	<0.001
Weight (kg)	79.6 ± 15.4	84.6 ± 16.3	74.6 ± 12.7	<0.001
BMI (kg/m^2)	24.4 ± 4.9	25.38 ± 6.1	23.5 ± 3.0	<0.001
Walking MET (min/wk)	580 (300-1386)	594 (315-1386)	560 (255-1386)	0.362
Moderate MET (min/wk)	480 (180-960)	660 (180-1200)	480 (180-720)	0.016
Rigorous MET (min/wk)	480 (360-1440)	680 (360-1440)	420 (360-980)	0.017
Total MET (min/wk)	2268 (1534-3156)	2565 (1582-3961)	2088 (1449-2632)	<0.001
Education level				
Elementary school	2 (1.0%)	2 (2.0)	0 (0)	<0.001
High school	70 (35.0%)	37 (37.0)	33 (33.0)	
Bachelor's degree	51 (25.5%)	38 (38.0)	13 (13.0)	
Master's degree	77 (38.5%)	23 (23.0)	54 (54.0)	

Data is presented as mean ± standard deviation or whole numbers (percentage).
Abbreviations: BMI - body mass index; **MET**- metabolic equivalent of task.

As shown in Figure 4**,** recreational athletes have a significantly higher ORTO-15 score compared to professional athletes (33 (31-39) vs. 37 (33-39), P= 0.002). Moreover, as shown

in Figure 5, professional athletes had significantly higher percentage of those participants which had higher tendency to ON, when compared with recreational athletes (57 vs 35 %, P= 0.002).

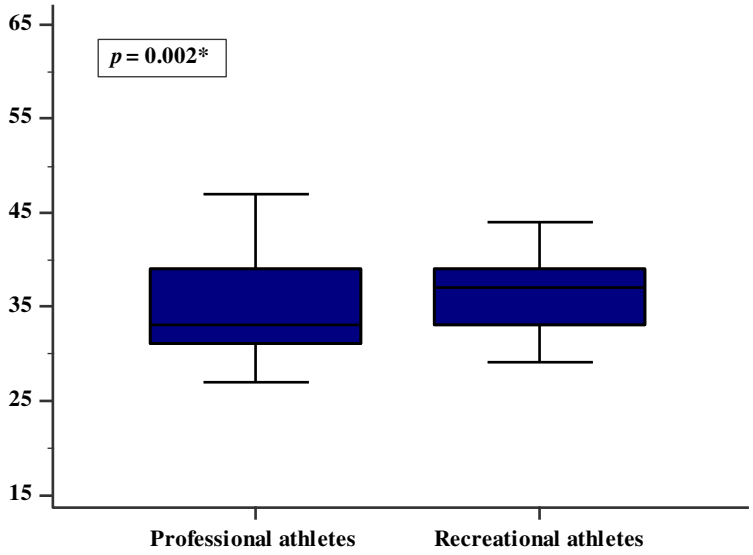

Figure 4. Comparison of the ORTO-15 score between the professional athletes group (N=100) and the recreational athletes group (N=100).
*Mann-Whitney U test

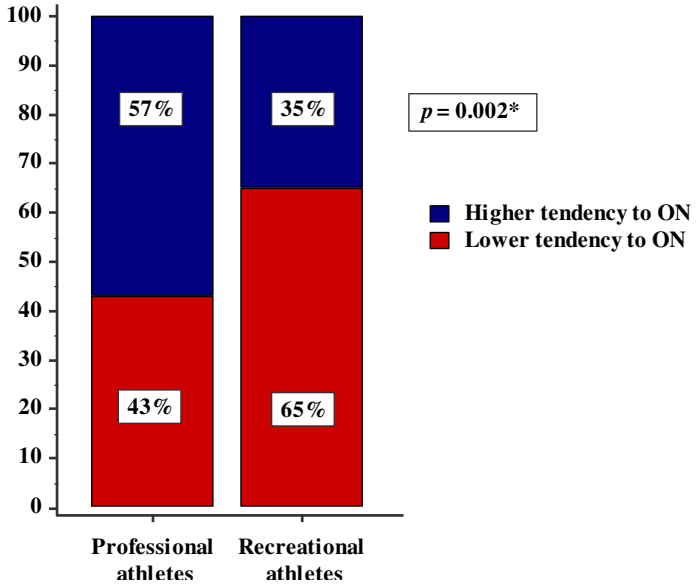

Figure 5. Frequency graph of the ON tendency comparison between the professional athletes (N=100) and recreational athletes (N=100).
* chi-square test

Furthermore, narcissism levels were analyzed with NPI-13 scale. The results have shown that professional athletes had significantly higher score in leadership/authority domain (1.0 (1.0-2.0) vs. 0.0 (0.0-2.0), P= 0.015) and in grandiose exhibitionism domain (2.0 (1.0-3.0) vs. 1.0 (1.0-2.0), P=0.049) of the questionnaire, when compared with recreational athletes. However, total NPI-13 score did not significantly differ between the investigated groups of athletes (Table 3).

Table 3. Comparison of the NPI-13 results between the professional and recreational athletes.

Parameter	**Professional athletes N=100**	**Recreational athletes N=100**	***P****
NPI-13 total score	5.0 (3.0-8.0)	4.0 (2.0-7.0)	0.220
Leadership/authority	1.0 (1.0-2.0)	0.0 (0.0-2.0)	0.015
Grandiose exhibitionism	2.0 (1.0-3.0)	1.0 (1.0-2.0)	0.049
Entitlement/ exploitativeness	1.0 (0.0-1.0)	1.0 (0.0-1.0)	0.970

Data is presented as median(IQR)
* Mann-Whitney U test
Abbreviations: NPI-13 - Narcissistic personality inventory-13.

There was a significant negative correlation between total NPI-13 score (r= -0.402, P<0.001) and total MET min/wk (r= -0.441, P<0.001) with ORTO-15 score. Detailed correlation coefficients between ORTO-15 score and selected variables are shown in Table 4.

Table 4. Correlation of ORTO-15 score with baseline parameters in the whole study sample.

Parameter	r*	*P*
Age (years)	-0.045	0.529
Height (m)	-0.001	0.986
Weight (kg)	0.004	0.960
BMI (kg/m^2)	-0.026	0.711
NPI-13 score	-0.402	<0.001
Total MET min/wk	-0.441	<0.001

Data is presented as mean ± standard deviation or whole numbers (percentage).
Abbreviations: BMI - body mass index; **NPI-13** - Narcissistic personality inventory-13; **MET**- metabolic equivalent of task.
* Spearman's correlation coefficient

Finally, a multiple linear regression model was made that investigated independent predictors of ORTO-15 score set as an independent variable. Analyses have shown that NPI-13 score (β= -0.213, P=0.023) and total MET min/wk (β= -0.014, P<0.001) retained significant association with ORTO-15 score, when computed in the model with age and BMI (Table 5).

Table 5. Multiple linear regression model of independent predictors for the ORTO-15 score.

Parameter	β*	SE†	t	*P*
Age	-0.0409	0.054	-0.753	0.452
BMI	-0.0279	0.056	-0.492	0.623
NPI-13	-0.213	0.093	-2.287	0.023
Total MET (min/wk)	-0.014	0.001	-7.248	<0.001

* unstandardized coefficient β
† standard error
Abbreviations: BMI - body mass index; **NPI-13 -** Narcissistic personality inventory-13.

5. DISCUSSION

The NPI-13 score and the ORTO-R score were found to have a strong negative association, according to the study's findings. Scoring lower on the ORTO-R score indicates higher pathology, thus this shows that in the study sample there is a correlation between the propensity for ON conduct and the propensity for narcissistic behavior. There is also shown a negative correlation between total MET/wk and the ORTO-R score, indicating that ON could be associated with a longer duration or higher frequency of exercising.

This study showed with a high statistical significance that professional athletes had a higher tendency toward ON than recreational athletes (57% vs 35%). It has previously been shown that ON occurs more often in athletes than in non-athletes, and other studies show similar results showing that individuals who exercise are more prone to ON (96–98). As mentioned, this study showed increasing ON tendency in professional athletes, so based on available research there is an association between the rising amount of exercise and rising ON tendency all the way from the people not doing any exercise, to the professional athletes. However, the ORTO-15 has been criticized for overestimating the prevalence of ON (99, 100). This is particularly detrimental to ON research because, when it is diagnosed, the prevalence is estimated to be less than 1% taking into consideration behavioral signs and internal states (101). All of these data imply that ORTO-15 should not be used alone as a diagnostic tool since it cannot distinguish between pathologically healthy eating and healthy eating.

In regards to narcissism and ON, this study showed with high statistical significance that there is a higher tendency in the trait of leadership/authority and a moderate statistical significance for grandiose exhibitionism in professional athletes compared to recreational athletes. The third subscale in the NPI-13, Entitlement/Exploitativeness was shown to be similar for both groups. After model correction for age and BMI, multiple linear regression analyses revealed that NPI-13 score was a significant predictor of ORTO-15 score.

Paulhus and Williams speak of the so called “Dark Triad”, which includes Narcissism, Machiavellianism, and psychopathy. Studies have shown that these characteristics are higher in professional athletes than in recreational athletes, and also showing higher traits in recreational athletes in comparison to non-athletes. One study of elite Spanish athletes demonstrated a high correlation between competitiveness and the characteristics of the dark personality triad. Both the urge to win and the fear of losing are associated to narcissism, whereas Machiavellian tendencies are more prevalent when athletes feel like losers. Finally, inferiority complexes and failure fears are linked to psychopathic inclinations. The findings

imply that dark personality qualities are associated with athletes disctiniveness as well as their perceptions of their psychological reactions and the level of competition in their athletic environments (102–104).

Furthermore, according to a focus group study, athletes would be concerned if others found out they were getting therapy for a mental health issue (105). Stigma might be viewed as a tactic to ensure one's survival inside the group as well as to remove people who posed a threat to the group's success. Because they are accustomed to being in the spotlight and may exhibit "situational narcissism," athletes may find it challenging to ask for or accept help. It is further thought that because sportsmen have been trained to deal with discomfort, they can find it difficult to talk about their feelings (106, 107).

In summary, this study found a substantial positive link between the inclination to ON behavior and the tendency to narcissism in both professional and recreational athletes, but with a higher tendency in professional athletes. Narcissism was shown to be a major predictor of ON tendencies, according to multiple linear regression model with a high statistical significance and total MET min/wk showed the highest statistical significance as a predictor for ON tendencies. Like other well-known eating disorders, ON is still not regarded as a psychiatric diagnosis, and unlike them, it continues to have unknown symptoms and risk factors. Further studies are recommended on the prevalence, risk factors and clinical significance of ON and also on the positive and negative effects of narcissism in professional athletes.

It's important to address the present study's limitations. As this is a cross-sectional study a chronological sequence cannot be established and thus causality between the obtained results cannot be established. Participants were included only from one city in Croatia, meaning this is not the ideal participants group to represent athletes in general as various factors could impact the results. The professional athlete’s group were a diverse group made up of various different sports, which could further affect the outcomes. Lastly, self-administered questionnaires were used implying that individuals could have submitted false information in their responses.

6. CONCLUSIONS

Based on this cross-sectional study obtained from chosen fitness centers in Croatia we can conclude the following:

1. ORTO-15 score shows a significantly higher affinity to ON in the professional athletes' group than in the recreational athletes' group.
2. Higher percentage of professional athletes have higher tendency to ON compared to recreational athletes.
3. Professional athletes score higher in leadership/authority and grandiose exhibitionism than recreational athletes while the scores are more balanced in regards to entitlement/exploitativeness.
4. ORTO-15 score correlates with significant negative association with NPI-13 score and level of physical activity calculated in total MET min/wk.

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8. SUMMARY

Objectives: The main aim of this study was to compare tendency towards orthorexia nervosa and narcissistic behavior between professional and recreational athletes who visit fitness centers.

Subjects and methods: In this cross-sectional survey-based study we recruited a total of 200 athletes, 100 of them professional athletes, and 100 of them recreational athletes, from chosen fitness centers in Croatia. The athletes filled out baseline information, the Narcissistic Personality Inventory (NPI-13) form to look for levels of subclinical narcissism and the ORTO-15 questionnaire to investigate for tendencies towards orthorexia nervosa. Finally, the participants filled out the survey investigating levels of physical activity through International Physical Activity Questionnaire Short Form (IPAQ-SF).

Results: Professional athletes had a higher BMI (25.38 ± 6.1 vs. 23.5 ± 3.0 kg/m^2, P<0.001) and total MET (2565 (1528-3961) vs. 2088 (1449-2632) min/wk, P<0.001) than recreational athletes. Recreational athletes have a significantly higher ORTO-15 score compared to professional athletes (33 (31-39) vs. 37 (33-39), P=0.002). Professional athletes had significantly higher percentage of those participants which had higher tendency to ON, when compared with recreational athletes (57 vs 35 %, P= 0.002). Moreover, results from NPI-13 questionnaire revealed that professional athletes had significantly higher score in leadership/authority domain (1.0 (1.0-2.0) vs. 0.0 (0.0-2.0), P= 0.015) and in grandiose exhibitionism domain of narcissism (2.0 (1.0-3.0) vs. 1.0 (1.0-2.0), P=0.049), when compared with recreational athletes. There was a significant negative correlation between total NPI-13 score (r= -0.402, P<0.001) and total MET min/wk (r= -0.441, P<0.001) compared to their ORTO-15 score. Finally, analyses have shown that NPI-13 score (β= -0.213, P=0.023) and total MET min/wk (β= -0.014, P<0.001) retained significant association with ORTO-15 score, when computed in a multiple linear regression model with age and BMI.

Conclusions: Professional athletes have a higher tendency to ON compared to recreational athletes, and score higher in leadership/authority and grandiose exhibitionism domains of narcissism. In addition, ORTO-15 score shows significant negative correlation with NPI-13 score and level of physical activity.

9. CROATIAN SUMMARY

Naslov: Ortoreksija nervosa i njezina povezanost s narcisoidnosti u profesionalnih sportaša

Cilj: Glavni cilj ovog istraživanja bio je usporediti sklonost ortoreksiji nervozi i narcisoidnom ponašanju između profesionalnih i rekreativnih sportaša koji posjećuju fitness centre.

Materijali i metode: U ovo presječno anketno istraživanju uključeno je ukupno 200 sportaša, od kojih 100 profesionalnih sportaša i 100 rekreativaca, iz odabranih fitness centara u Hrvatskoj. Sportaši su ispunili osnovne podatke, obrazac Narcisoidnog popisa osobnosti (NPI-13) za traženje razina subkliničkog narcizma i ORTO-15 upitnik za istraživanje sklonosti prema ortoreksiji nervozi. Na kraju, sudionici su ispunili anketu o razinama tjelesne aktivnosti putem kratkog obrasca Međunarodnog upitnika o tjelesnoj aktivnosti (IPAQ-SF).

Rezultati: Profesionalni sportaši imali su veći BMI (25,38 ± 6,1 naspram 23,5 ± 3,0 kg/m2, P<0,001) i ukupni MET (2565 (1528-3961) naspram 2088 (1449-2632) min/tjedno, P<0,001) od rekreativaca. Rekreativci imaju značajno viši ORTO-15 rezultat u usporedbi s profesionalnim sportašima (33 (31-39) prema 37 (33-39), P= 0,002). Profesionalni sportaši imali su značajno veći postotak onih sudionika koji su imali veću sklonost ON-u, u usporedbi s rekreativcima (57 prema 35 %, P= 0,002). da su profesionalni sportaši imali značajno viši rezultat u domeni vodstva/autoriteta (1,0 (1,0-2,0) u odnosu na 0,0 (0,0-2,0), P= 0,015) i u domeni grandioznog egzibicionizma (2,0 (1,0-3,0) u odnosu na 1,0 (1,0- 2,0), P=0,049) upitnika, u usporedbi s rekreativcima. Postojala je značajna negativna korelacija između ukupnog rezultata NPI-13 (r= -0,402, P<0,001) i ukupnog MET min/tjedno (r= -0,441, P<0,001) u usporedbi s njihovim rezultatom ORTO-15. Analize su pokazale da su rezultat NPI 13 (β= -0,213, P=0,023) i ukupni MET min/tjedno (β= -0,014, P<0,001) zadržali značajnu povezanost s rezultatom ORTO-15, kada su izračunati u modelu višestruke linearne regresije s godinama i BMI.

Zaključci: Zaključujemo da profesionalni sportaši imaju veću sklonost ON-u u usporedbi s rekreativcima, da profesionalni sportaši postižu više rezultate u vodstvu/autoritetu i grandioznom egzibicionizmu od rekreativaca, dok su rezultati uravnoteženiji u pogledu prava/izrabljivanja. Osim toga, rezultat ORTO-15 značajno negativno korelira s rezultatom NPI-13 i razinom tjelesne aktivnosti izračunatom u ukupnom MET min/tjedno.

10. CURRICULUM VITAE

Personal information

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Education

2016-2022	University of Split, School of Medicine, MD
2012-2016	Saxion University of Applied Sciences, Bachelor of Physiotherapy

Work experience

01/2022- 03/2022	Internal medicine and surgery rotations, Arendal Hospital
06/2018- 01/2022	Medical student with nurse responsibilities, Plankemyra Nursing Home
06/2020- 09/2021	Medical student with nurse responsibilities, Infectology & Surgical ward, Arendal Hospital
06/2017- 09/2017	Social educator, Intoxication & Addiction unit, Arendal Hospital

Additional activities and qualifications

Language Norwegian	Mother tongue
Language English	Excellent
Driver license	Category B, Category A
10/2016-03/2021	Vice-President & President, ANSA Croatia