




## RESEARCH ARTICLE

# Consumption of food supplements: is there a risk of muscle dysmorphia? [version 1; peer review: awaiting peer review]

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## Abstract

**Background.** Bigorexia is an eating disorder and obsessive-compulsive disorder where the subject has an incorrect perception of their body image with exercise addiction. This study aims to determine whether there is a relationship between body mass index (BMI), food supplement consumption, dietary adherence, gender and risk of muscle dysmorphia in the individual and to provide information to build recommendation systems to monitor the health and mental state of the population.

**Methods.** A cross-sectional descriptive observational study was conducted in Barranquilla (Colombia) between February – May 2020. A face-to-face survey of 200 individuals of both sexes was used in which users evaluated different variables that helped to identify their risk of muscle dysmorphia.

**Results.** Of the 200 participants, 105 men: N=48, 45.7% vs. women: N=57, 54.3%) consume nutritional supplements. There is no relationship in the total population with the risk of muscle dysmorphia with the consumption of nutritional supplements nor with the feeling of guilt for non-adherence to the diet, nor with age, gender, or BMI ( $p < 0.05$ ). In contrast, gender, age and BMI are related to nutritional supplement consumption, and gender is related to feelings of guilt for non-adherence to the diet. In the population that consumes nutritional supplements the risk of muscle dysmorphia is increased and the frequency varies by risk group: low risk: N=16, 15.2%; medium risk: N=46, 43.8%; high risk: N=28, 26.7%; and very high risk: N=15, 14.3%. The consumption of food supplements is higher in the female gender (57, 54.3% vs. 48, 45.7%), and moderate the feeling of guilt for not completing the diet, BMI and the risk of muscle dysmorphia.

**Conclusions.** Women consume more food supplements, but gender does not determine the risk of muscle dysmorphia. Food supplement consumption influences the feeling of guilt for not completing the diet, BMI and the risk of muscle dysmorphia.

## Open Peer Review

**Approval Status** AWAITING PEER REVIEW

Any reports and responses or comments on the article can be found at the end of the article.

**Keywords**

Physical Exercise, Muscle Dysmorphia, Body Mass Index, Bigorexia, Food Supplements, Diet

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## Introduction

### Background

Disorders are defined as changes or alterations that occur in the normal functioning of the body. According to the World Health Organization (WHO), mental health and mental disorders are currently not given the necessary importance in comparison to physical health; strictly speaking, they have been rather ignored or neglected.<sup>1</sup> Mental health problems affect society as a whole, and not just a limited or isolated segment of it, and therefore constitute a major challenge for the integral development of human beings.<sup>1</sup>

About 450 million people are affected by a mental or behavioural disorder.<sup>1,2</sup> Among the mental disorders that affect people is bigorexia, which develops when people become obsessed with their physical state, directly affecting their eating behaviour.<sup>2</sup> From childhood onwards, food preferences are influenced by the habits of choosing different dishes; eating should be a conscious and voluntary act that allows one to decide what and how to eat.<sup>3</sup>

Feeding is linked to culture and begins to change once weaning takes place; the child is almost always given what is considered to be the best possible food: daily bread.<sup>4</sup> In most cases, the child is conceived as a small adult and is fed accordingly; ingesting what his culture has taught him.<sup>4</sup>

In Bigorexia, eating is sometimes extreme in quantity but reduced in variety.<sup>5</sup> The first references to this term are found in the research group of psychiatrist Harrison Pope in the United States, who first described the “disease” in 1993 while investigating steroid use and abuse; when the first cases were diagnosed it was called “reverse anorexia nervosa”, due to the common characteristics that in certain respects make up these disorders, although in the opposite direction.<sup>6</sup>

Bigorexia is an eating disorder (ED) and obsessive compulsive disorder (OCD) where the subject has an incorrect perception of their own body image (muscle dysmorphia) with exercise addiction: constant thoughts about the need to exercise and whose compulsion is the physical activity itself.<sup>7</sup> Bigorexics tend to restrict their food intake, use drugs and excessive physical exercise; and as in anorexia nervosa, they share an excessive concern for their physical appearance, distortion of the body schema, obsession with weighing food, interest in food, calories and composition of what is eaten, self-observation, weighing themselves several times a day, fat suppression.<sup>8</sup>

In bigorexia, subjects show recurrent thoughts about their image, their lack of muscle and how to improve it; and they decide to “compulsively” do physical exercise to compensate for this “defect” in their body.<sup>8,9</sup> Bigorexia in the past was characterised by a fear of being too small, and perceiving oneself as small and weak, even when one is really big and muscular.<sup>10</sup> It is a multifactorial pathology involving genetic, biological, psychological and socio-cultural variables that can affect all people with a tendency towards low self-esteem, i.e. they are more perfectionist and have some difficulty in interpersonal relationships.<sup>11</sup> Young people who are overweight or obese during childhood are more likely to suffer from this disorder, and it can also be seen in common with those who have been exposed to bullying because of their physical appearance or mannerisms during childhood.<sup>12</sup>

The use of ergogenic substances (ESU) is not restricted to consumption for the achievement of athletic performance in the case of athletes, it is nowadays also a behaviour used for body change and muscle development, but little is known about the relationship between ESU and the development of muscular dysmorphia (MD).<sup>13</sup> There are factors that influence whether there is an EUS-MD relationship such as socio-cultural influences; men tend to read more magazines and are associated with the use of supplements to increase muscle mass, body image has been identified as the most significant concern, comparisons, and the use of supplements to increase muscle mass.<sup>13</sup>

In this situation, it is necessary to take into account some guidelines such as psychological help for adolescents, especially those who have been violated in this way, and additional physical examinations to determine the state of health, needs and capabilities of the individual to adapt the exercises they can perform in their daily lives.<sup>12</sup>

Symptoms identified in people suffering from bigorexia include an obsession with their physical well-being, which may involve changes in eating habits, frequent preoccupation with reaching their daily protein intake target, comparing their fitness with others, and anxiety when skipping a training session or a meal.<sup>14</sup> The diagnosis of this condition is made by health professionals supported by instruments for the identification of bigorexia.<sup>15</sup>

MD could be framed within the framework of obsessive compulsive disorders, due to the verification behaviours experienced by the people who suffer from it, specifically associated with subjects who have a low self-concept, identity problems, depression and substance abuse.<sup>16</sup>

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5<sup>17</sup>) defines 4 essential features for the diagnosis of body dysmorphic disorder:

- A. Concern about one or more perceived defects or flaws in physical appearance that are not observable or appear minor to others.
- B. At some point during the course of the disorder, the individual has engaged in repetitive exercise behaviours (e.g., mirror gazing, excessive grooming, skin pinching, seeking reassurance) or mental acts (e.g., comparing her appearance to others) in response to appearance concerns.
- C. The preoccupation causes clinically significant distress or impairment in social, occupational or other important areas of functioning.
- D. Concern with appearance is not best explained by concerns with body fat or weight in an individual whose symptoms meet diagnostic criteria for an eating disorder.

At present there is no specific protocol for treating muscle dysmorphia; some authors emphasise the motivation of those suspected of having MD to seek help through techniques that are used for eating disorders.<sup>9</sup> It is proposed that to help patients with cognitive and behavioural techniques, patients will be able to identify cognitive distortions and irrational beliefs, i.e. the patient is confronted with the beliefs without creating maladaptive behaviours.<sup>9</sup> This research seeks to determine which variables are related to bigorexia disorder in a population of Barranquilla, Colombia.

## Objectives

To determine if there is a relationship between body mass index (BMI), consumption of food supplements, adherence to a diet, gender and risk of muscular dysmorphia in the individual and to provide information that will allow the construction of recommendation systems that monitor the health and mental state of the population.

## Methods

### Ethics and consent

The study is consistent with the ethical principles of the Declaration of Helsinki and was approved by the Simón Bolívar University of Barranquilla and BiomedKcal – Advanced Medical Nutrition & Lifestyle Center on 14 January 2020 under identification number BK01-20. Written informed consent was received from all participants and data have been treated anonymously and in a strictly protected way.

The study design is a cross-sectional descriptive observational study conducted in the city of Barranquilla-Colombia (GPS coordinates: 10°58'6.74"N -74°46'52.75"W) during 12 weeks between February and May 2020. Participants were recruited from five gyms in areas with different socioeconomic levels (medium and high) spread out over different parts of the city of Barranquilla. Data collection was done directly through a face-to-face survey in which users had assessed their physical activity, dietary habits and some aspects that helped to identify their risk of muscle dysmorphia. Based on height and weight, participants chose the BMI group to which they belonged; we provided the formula for those who did not know it:  $BMI = kg/m^2$  where kg is a person's weight in kilograms and  $m^2$  is their height in metres squared. Because we used a scientifically validated questionnaire published in a previous study by Palazón-Bru A *et al.* with 180 participants, the sample size of the study was estimated according to the formula:

$$\text{Necessary sample size} = \frac{(Zscore)^2 \times StdDev \times (1 - StdDev)}{(\text{margin of error})^2}$$

Confidence level: 95%

Population size: 180

Margin of error: 5%

Ideal sample size: 123

For our study, the calculated sample size was approximately 123, but we decided to increase the number of participants to improve the quality and efficiency of the survey. This study includes 200 individuals of both sexes, aged between 20 and

49 years. Inclusion criteria were people who are physically active, people who take food supplements, and older people. Exclusion criteria were people who are not physically active, BMI<20, and people who refused to participate. The dataset analysed in this study was previously published as a data article.<sup>18</sup>

A scientifically validated questionnaire<sup>15</sup> was used and the variables gender, age, weight, risk of muscle dysmorphia, consumption of food supplements, feelings of guilt for not adhering to the diet were statistically analysed. The risk of muscle dysmorphia was calculated using a scientifically validated computer application by entering the necessary data (age group, BMI, food supplements, feelings of guilt).<sup>15</sup>

**Statistical methods**

Raw data were transferred to IBM SPSS statistics version 26 for further analysis, testing for normality and comparative non-parametric statistics. A robust two-tailed equivalence analysis is performed by strengthening the t-test for comparative analysis. The Mann-Whitney U test was used to compare whether there is a difference in the dependent variable for independent groups. Kruskal-Wallis test was used to determine whether or not there is a statistically significant difference between the medians of independent groups. The significance level is 0.05.

**Results**

**Participants**

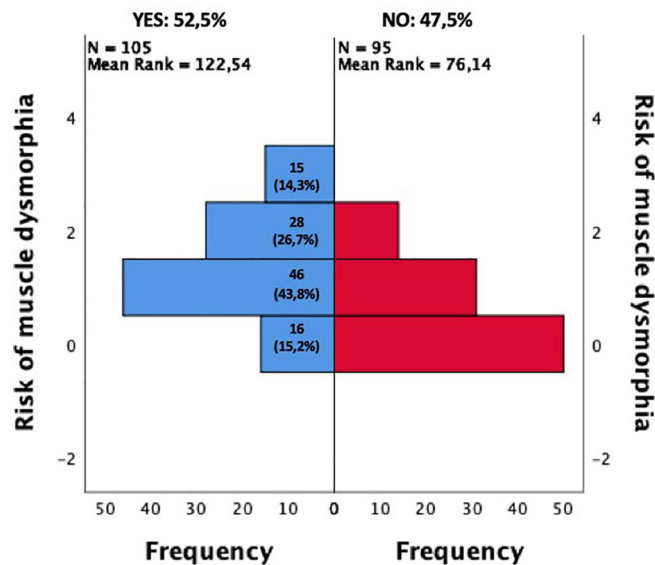
There is a total population of 200 participants where the majority were women (N=107, 53.5%) as opposed to men (N=93, 46.5%).<sup>31</sup> A second selection was carried out, choosing only those who consume food supplements, leaving a total population of 105, (men: N=48, 45.7% vs. women: N=57, 54.3%). See **Table 1** and **Figure 1**. None of the participants withdrew or incompletely filled in the questionnaires; all surveys were recorded for data analysis.

**Outcome data**

There is no relationship in the total population (N=200) with the risk of muscle dysmorphia with the consumption of nutritional supplements nor with the feeling of guilt for non-adherence to the diet, nor with age, gender, or BMI (p<0.05).

**Table 1. Total number of participants.**

Gender	N	Percentage	Consumption of food supplements
Male	93	46.5	48 (45.7%)
Female	107	53.5	57 (54.3%)
Total	200	100	105



**Figure 1. Independent-samples Mann-Whitney U test.**

**Table 2. Total study population.**

	Not related to	p
Risk of muscle dysmorphia	Consumption of food supplements	0.00
	Feelings of guilt about non-adherence to diet	0.00
	Gender	0.00
	Age	0.00
	BMI	0.00
Consumption of food supplements	Feelings of guilt about non-adherence to diet	0.02
	Gender	0.82
	Age	0.34
	BMI	0.54
Feelings of guilt	Gender	0.68
	Age	0.00
	BMI	0.00

Asymptotic significances are displayed. The significance level is 0.05.

**Table 3. Independent-samples Kruskal-Wallis Test.**

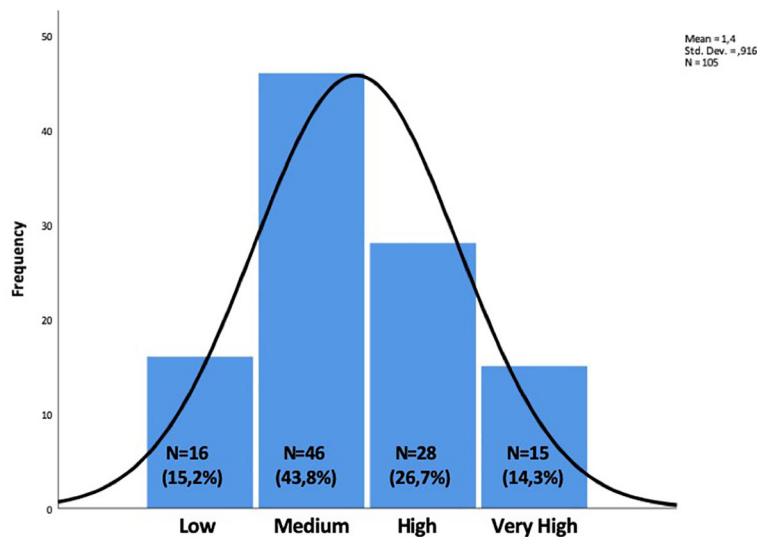
	p
Taking food supplements is not related to the risk of muscle dysmorphia	>0.05

The significance level is 0.05.

In contrast, gender, age and BMI are related to nutritional supplement consumption, and gender is related to feelings of guilt for non-adherence to the diet (see Table 2). To analyse the ages of the participants, they were grouped and stratified with a number: 1. < 20; 2. 20-29; 3. 30-34; 4. 35-44 and 5. > 45 (see the questionnaire<sup>18</sup>).

When analysing only the population that consumes nutritional supplements (N=105; Female 57, 54.3% vs Male 48, 45.7%) we find that the risk of muscle dysmorphia is increased (Table 3).

Figure 2 shows that the frequency varies by risk group: low risk: N=16, 15.2%; medium risk: N=46, 43.8%; high risk: N=28, 26.7% and very high risk: N=15, 14.3%.



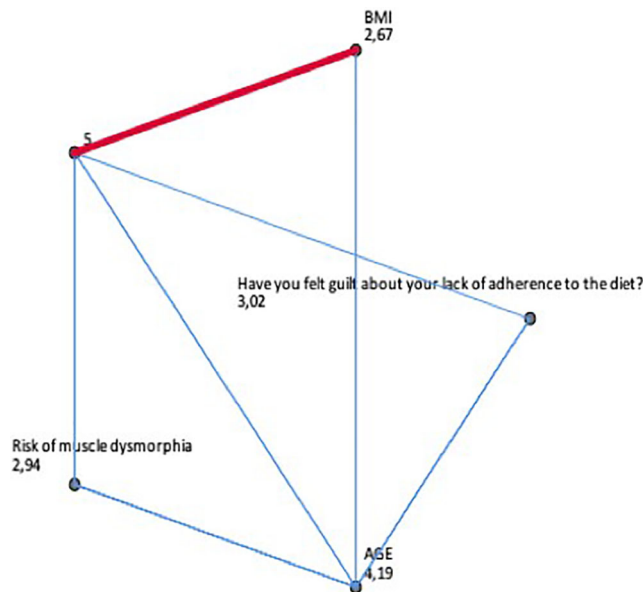
**Figure 2. Risk of muscle dysmorphia with the consumption of food supplements.**

**Table 4. Pairwise comparisons related to the consumption of food supplements.**

Not related to	<i>p</i>	Adj. Sig. <sup>1</sup>
Gender-BMI	0.03	0.26
Gender-Risk of muscle dysmorphia	0.00	0.00
Gender-Have you felt guilt about your lack of adherence to the diet?	0.00	0.00
Gender-AGE	0.00	0.00
BMI-Risk of muscle dysmorphia	0.21	1.00
BMI-Have you felt guilt about your lack of adherence to the diet?	0.11	1.00
BMI-AGE	0.00	0.00
Risk of muscle dysmorphia-Have you felt guilt about your lack of adherence to the diet?	0.73	1.00
Risk of muscle dysmorphia-AGE	0.00	0.00
Have you felt guilt about your lack of adherence to the diet?-AGE	0.00	0.00

The significance level is 0.05.

<sup>1</sup>Significance values have been adjusted by the Bonferroni correction for multiple tests.



Each node shows the sample number of successes.

**Figure 3. Pairwise comparisons.**

The consumption of food supplements is higher in women (57, 54.3% vs. 48, 45.7%), and influences the feeling of guilt for not completing the diet, BMI and the risk of muscle dysmorphia (Table 4 and Figure 3); however, it does not influence the rest of the variables analysed ( $p < 0.05$ ).

**Discussion**

**Key results**

This analysis was conducted to determine if there is a relationship between BMI, consumption of food supplements, adherence to a diet, gender and risk of muscular dysmorphia in the individual and to provide information that will allow the construction of recommendation systems that monitor the health and mental state of the population. Bigorexia is generally associated with male gym-goers<sup>19</sup> but also occurs in women<sup>20</sup>; and although in the present study there are more women than men (53% vs 46.5%), the results show that gender does not condition the risk of muscle dysmorphia ( $p < 0.05$ ) consistent with findings from studies suggesting that women prefer a toned, slim female figure to an exclusively slim one,

in line with figures commonly seen in fitness-inspiring media.<sup>21,22</sup> Therefore, the inclusion of women in epidemiological studies of MD is critical for accurate estimation of the population burden of this disorder. Contesini *et al.*<sup>23</sup> conclude that active individuals with muscle dysmorphia ingest dietary and ergogenic supplements to reduce weight; our study shows that in those individuals who go to the gym and consume nutritional supplements, these play a mediating role between guilt for not completing the diet, BMI and risk of muscle dysmorphia (Tables 3, 4, and Figure 3) and when analysed by the sex of the participants, women consume more (Table 1). 52.5% of the Colombian population who go to the gym consume nutritional supplements, similar to the results of other studies in other countries.<sup>24,25</sup>

Our study shows that 86% of gym-going, overweight or obese individuals who consume food supplements have a medium, high or very high risk of muscle dysmorphia and guilt for dietary withdrawal ( $p < 0.05$ ). This result is similar to the results published by Martínez-Segura, A. *et al.*<sup>26</sup> This data is really high if compared to other studies<sup>27–29</sup> carried out in South America, in which the percentage varies between 25–60%; but they concede that they have been carried out before 2010, which means that at the present time this percentage is high. Pope *et al.* concluded that the use of dietary supplements and abuse of anabolic steroids were linked to a higher frequency of disorders like bulimia and anorexia nervosa and lack of adequate nutrition was associated with worsening psychopathology and engagement.<sup>30</sup>

### Strengths and limitations

This study has collected data using a scientifically valid questionnaire and from an adequate sample size. While the data collected is useful, it may lack depth and detail. More detailed variables could have provided more useful and in-depth data. Although 200 surveys can be done in two to three days; it took a little longer as movement restriction measures in the city were beginning to be enforced due to the recent pandemic. The study is well positioned to be generalisable to the Colombian population. While it may not be generalisable beyond that, neighbouring countries with the same economic and socio-cultural contexts can learn from the results of this study. Another limitation is that no other recent studies have been found that directly relate muscle dysmorphia to dietary supplement consumption in Colombia to make comparisons with our results. Our results have a theoretical-methodological implication of great contribution to dietary health research. We invite researchers in our region to replicate our study and compare their results.

### Conclusion

Women consume more food supplements, but gender does not determine the risk of muscle dysmorphia. Food supplement consumption influences the feeling of guilt for not completing the diet, BMI and the risk of muscle dysmorphia.

### Data availability

#### Underlying data

figshare: Dataset for estimation of muscle dysmorphia in individuals from Colombia, <https://doi.org/10.6084/m9.figshare.12482516.v3>.<sup>31</sup>

This project contains the following underlying data:

- Muscle Dysmorphia Data.sav (raw data file)

#### Extended data

figshare: Dataset for estimation of muscle dysmorphia in individuals from Colombia, <https://doi.org/10.6084/m9.figshare.12482516.v3>.<sup>31</sup>

This project contains the following extended data:

- Questionary and Informed consent.pdf
- Datakey.pdf

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/) (CC-BY 4.0).



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