

## Research Article

### Comparison between Body Mass Index and Phase Angle in Predicting Nutritional Status in Patients with Anorexia Nervosa

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#### Abstract

**Background:** Phase angle (PA) is an important parameter for the diagnosis of malnutrition in many diseases, but there are only a few studies that demonstrate its importance and efficacy in patients affected by Anorexia Nervosa (AN). Moreover, BMI is only a partial predictor of nutritional status of patients with AN, as there is a great variety of other factors that can affect its utility and that can be detected through bioimpedance.

**Methods:** Phase angle values stratified by BMI were measured in a population of patients with AN at admission in a residential care setting.

**Results:** Our population has a mean BMI of  $14,7 \pm 1.7$  kg/m<sup>2</sup> and a mean PA of  $4.91 \pm 1.16$ , both indicating a status of severe malnutrition. The comparison between PA and BMI showed that, in this population, a higher PA is not associated to a higher BMI, but to a BMI between 15 and 17 kg/m<sup>2</sup>.

**Conclusions:** The results suggest the utility of PA as a better parameter for the diagnosis of malnutrition in patients with AN and that, in clinical practice, we could aim to a BMI between 15 and 17 kg/m<sup>2</sup> than to a BMI corresponding to normal weight, less sustainable for this kind of patients and easily leading to a major risk of relapse.

**Keywords:** Phase angle; Anorexia Nervosa; Malnutrition; Biop impedance; Body Mass Index

#### Introduction

Anorexia Nervosa (AN) is the psychiatric illness with the highest mortality rate [1], attributable to the medical complications that involve every body system, as gastrointestinal, cardiac, pulmonary, hematology, musculoskeletal, endocrine and neurologic systems [2]. Therefore, it is important to motivate patients affected by AN to improve their nutritional status in order to avoid the risk of serious complications, even though the admission process in a treatment setting is perceived as a coercion.

Many studies have demonstrated in anorexic patients the

existence of a relation between Body Mass Index (BMI) at admission in a treatment setting and BMI at discharge and follow-up [3]. It is well demonstrated that the tracking, or the tendency of an individual to maintain his/her BMI is maintained also in AN. A low admission BMI is related to significantly higher likelihoods of re-admission within 1 year. However, there are no studies which define which BMI is associated with a particular medical complication. Relapse appears also more likely among patients who leave treatment with a greater drive to exercise, residual concerns about weight and shape, and a lower readiness to maintain treatment gains [4]. A better outcome is, therefore, correlated to a less severe condition at admission and a minor duration of

illness. Another important factor is the subtype of Eating Disorder (ED), in fact, compared to patients with Bulimia Nervosa (BN) and Eating Disorders Not Otherwise Specified (EDNOS), patients with AN, and especially those with AN Binge Purge subtype, have the slowest improvements in eating disorder symptoms and psychosocial functioning during treatment [5]. Body dissatisfaction is often identified as a negative predictor of a clinically significant change, especially in those patients who had a pre-treatment based on weight restoration before admission in a residential treatment setting [6]. Other important predictors of long-term outcomes are motivation to recover, depression, self-esteem, interpersonal functioning and family problems [7].

Up to date, there are only a few studies that have utilized the instrument of bioimpedance (BIA) in the analysis of body composition in patients with AN [8,9]. Moreover, actual reference values of phase angle (PA) still do not include BMI < 18.5 [10]. As in many other disease, PA could be useful in patients with AN as a better descriptor of nutritional status, but there is much to learn about it.

It is therefore important to identify prognostic variables available at admission to define target weight, to plan weight management and to foresee the possibility of relapse after discharge.

## Materials and Methods

### Patients:

The population analyzed in the present study was selected among the patients hospitalized in a residential treatment setting at "Villa Miralago" (Cuasso al Monte, Italy). In particular, we decided to select the patients respecting the following criteria:

- Diagnosis of Anorexia Nervosa according to DSM V criteria

- Hospitalization between February 2010 and September 2014 - Body composition analyzed using BIA at the moment of admission.

### Body composition assessment

BIA is a methodic for body composition evaluation based on the different electric conduction of body tissues in accordance with their content of water and electrolytes (Fat Free Mass shows a better conduction than Fat Mass). BIA utilizes a weak alternated electric current (not felt by the subject) and measures the reactance and the resistance that the body presents toward the current.

Reactance and resistance were measured through the use of BIA 101 Akern and its software, which can calculate the quantity of Fat Mass (FM), of Fat Free Mass (FFM), of Body Cellular

Mass (BCM), of Total Body Water (TBW), of Extracellular Water (ECW), of Intracellular Water (ICW), the Body Cellular Mass Index (BCMI) and the Phase Angle (PA).

PA is the ratio between reactance and resistance; it is, therefore, a parameter always reliable because directly measured on every single patient.

Before assessing the body composition, all the patients were instructed in the factors which can invalidate the result of the test. Patients were recommended not to drink or eat during the 8 hours before the test, not to do physical activity during the 12 hours before, not to wear metal accessories and to empty their bladder.

The exam was made during the first hours of the day, before breakfast. At the same time, weight and height were measured, too.

In some cases the result of the exam was not reliable because of the alterations due to the advanced degree of the illness, in particular on the levels of ECW and ICW, from which are derived the percentages of FFM and FM.

In addition to the data given from BIA, we decided to consider BMI.

## Statistical Analysis

Results are expressed as means  $\pm$  SDs. Continuous variables were analyzed with the use of an independent sample t test (Kruskal-Wallis test) and a multiple linear regression was used to adjust for confounding variables or test for interaction between variables. In some cases, it was used the analysis of variance (ANOVA). All statistical analysis was performed with SPSS Software (IBM Corporation).

## Results and Discussion

We enrolled 132 patients, with mean age of  $25 \pm 10$  years.

Table 1 shows the demographic data of the patients enrolled in the study.

**Table 1.** Demographic data of the subjects.

Variable	
Sex (% male)	6.1
Age (mean $\pm$ SDS)	$25 \pm 10$ years
Age (% adults)	73

Table 2 shows mean BMI in the whole group of patients, among male, female, adults and underage patients. Mean BMI of whole group of patients is  $14.7 \pm 1.7$ . There were no significant differences in BMI at admission between males and females and between adults and minors.

**Table 2.** Mean BMI  $\pm$  Standard Deviation Score of the subjects divided per sex and age.

	N	Mean	$\pm$	Std. Dev.
All patients	132	14.7	$\pm$	1.7
Males	8	15.1	$\pm$	1.7
Females	124	14.6	$\pm$	1.7
Adults	97	14.6	$\pm$	1.8
Minors	35	14.8	$\pm$	1.6

Table 3 shows the mean PA of the subjects in the whole group and divided per sex and age. Mean PA of whole group was  $4.91 \pm 1.16$ . There were no significant differences in PA between males and females and between adults and Minors.

**Table 3.** Mean PA  $\pm$  Standard Deviation Score of the subjects divided per sex and age.

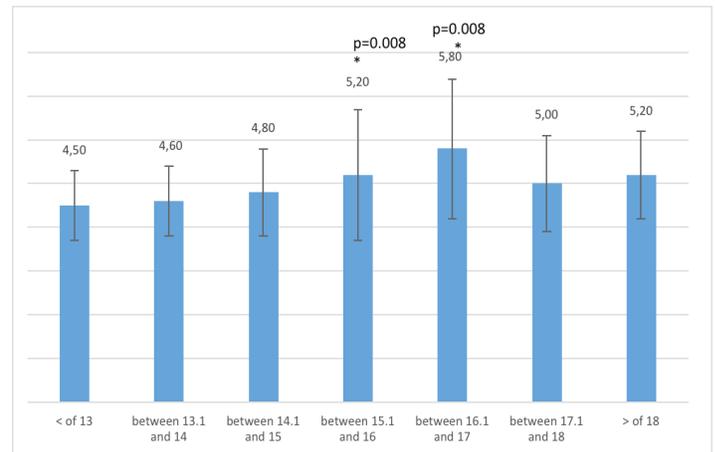
	N	Mean	$\pm$	Std. Dev.
All patients	132	4.91	$\pm$	1.16
Males	8	4.95	$\pm$	0.95
Females	124	4.91	$\pm$	1.17
Adults	97	4.91	$\pm$	1.27
Minors	35	4.96	$\pm$	0.79

It was decided to stratify the patients depending on BMI. We individuated seven categories of patients:

BMI kg/m <sup>2</sup>	N	Percentage %
> 13	27	20.5
Between 13.1 and 14	22	16.7
Between 14.1 and 15	32	24.2
Between 15.1 and 16	24	18.2
Between 16.1 and 17	15	11.4

Between 17.1 and 18	8	6.1
< 18	4	3.0

Then we compared the PA among the different categories of BMI; the results are presented in graphic I. As the graphic shows, there is a statistically significant difference in PA among the categories of BMI: patients having a BMI between 15.1 and 17 have a better PA than those with major and minor BMI. The analysis of variance confirmed the result ( $p < 0.02$ ).



Graph. I – PA of the subjects stratified per BMI.

As already explained, some exams did not give reliable results because of the serious conditions of the patients. Therefore, in this population, 31.8% of the exams (N=42) were not considered in the further analysis we made.

Table 5 shows the results obtained from the analysis of the water distribution in all patients. As expected, most patients showed a level of TBW and ECW exceeding normal levels, due to their status of severe malnutrition.

**Table 5.** Number of patients and percentage among patients with reliable results:

	N	Percentage %
TBW at normal levels	7	7.8
TBW exceeding normal levels	79	87.8
TBW under normal levels	4	4.4
ECW at normal levels	20	22.2
ECW exceeding normal levels	57	63.3
ECW under normal levels	13	14.4

We analyzed the correlations between BMI, ICW, ECW, TBW, BCM and BCMI and between PA, ICW, ECW, TBW, BCM and BCMI.

PA and BMI were correlated with ICW (positive correlation), with ECW (negative correlation), with BCM and BCMI (positive correlation) with significance  $< 0.01$ , but the analysis of variance (ANOVA) confirmed the correlation only for PA.

The purpose of this study was to analyze the importance of PA as a predictor of nutritional status in patients with AN and its use in clinical practice.

We assessed the nutritional status in a population of patients with AN at admission in a residential treatment setting and compared the efficacy of PA and BMI in predicting the nutritional status. A large number of clinical studies confirms the importance of phase angle (PA) as a parameter for the diagnosis of malnutrition in many pathologies (liver cirrhosis, dialysis, several types of cancer, HIV infection and AIDS, bacteremia and sepsis and pulmonary disease).

However, there are only few studies that analyzed the efficacy of the use of PA in anorexia nervosa (AN). These studies have demonstrated that an improvement of nutritional status connected to a better nutrition is correlated to an increase of PA in patients with AN. We were able to confirm this statement (our patients with lower BMI had also a lower PA), but we can add that a higher BMI do not always correlate to a higher PA.

Our analyses indicate that BMI is only a partial indicator of the nutritional status of patients. Some studies have also shown that patients do not always reach a BMI  $>17.5$  kg/m<sup>2</sup>, but this fact does not always correspond to a major risk of relapse.

## Conclusions

As many studies have demonstrated, it is important to identify predictors of outcome, in order to improve outcomes in eating disorders treatment [11], but we still have to define which are the best parameters to describe nutritional status in AN. A recent review has analyzed many predictors of long-term outcome and BMI was one of them.

At present, we don't have any data available on the importance of PA as a predictor of risk of relapse, but from our analyses, it's clear how PA is a better predictor of the nutritional status of patients with AN, as it correlates with a higher number of other parameters than BMI.

As in many cases, patients do not perceived need for cure in a residential setting, another important function of PA could be as a motivational instrument. A recent study has demonstrated that physical symptoms of the eating disorder, as BMI, and cognitive symptoms are inversely correlated and that a higher weight is associated with a lower perceived need for hospital-

ization. Maybe, it could be possible to explain to these patients that BMI is not the best descriptor of nutritional status and to use PA to better motivate them to begin a nutritional treatment, even though their BMI is not so low.

The limitations of the present study are represented by the absence of a follow-up period that can confirm the importance of PA at discharge.

Further analysis will be done to investigate the changes of PA during the treatment and at discharge and its correlation to risk of relapse and to other parameters.

## References

1. Nielsen S. Epidemiology and mortality of eating disorders. *Psychiatr Clin North Am.* 2001, 24: 201-214.
2. Patricia Westmoreland, Mori J Krantz, Philip S Mehler. *Medical Complications of Anorexia Nervosa and Bulimia.* The American Journal of Medicine. 2015.
3. Manuel Föcker, Bühren K, Timmesfeld N, Dempfle A, Knoll S et al. The relationship between premorbid body weight and weight at referral, at discharge and at 1-year followup in anorexia nervosa. *Eur Child Adolesc Psychiatry.* 2015, 24(5): 537-544.
4. J. C. Carter, Blackmore E, Sutandar-Pinnock K, Woodside DB. Relapse in anorexia nervosa: a survival analysis. *Psychological Medicine.* 2004, 34(4): 671-679.
5. Allison C Kelly, Jacqueline C Carter. Eating disorder subtypes differ in their rates of psychosocial improvement over treatment. *Journal of Eating Disorders.* 2014, 2: 2.
6. Redgrave GW, Coughlin JW, Schreyer CC, Martin LM, Leonpacher AK et al. Refeeding and Weight Restoration Outcomes in Anorexia Nervosa: Challenging Current Guidelines. *Int J Eat Disord.* 2015.
7. Vall E, Wade TD. Predictors of Treatment Outcome in Individuals with Eating Disorders: A Systematic Review and Meta-Analysis. *Int J Eat Disord.* 2015.
8. Mika C, Herpertz-Dahlmann B, Heer M, Holtkamp K. Improvement of Nutritional Status as Assessed by Multifrequency BIA During 15 Weeks of Refeeding in Adolescent Girls with Anorexia Nervosa. *J Nutr.* 2004, 134(11): 3026-3030.
9. Marra M, Caldara A, Montagnese C, De Filippo E, Pasanisi F et al. Bioelectrical impedance phase angle in constitutionally lean females, ballet dancers and patients with anorexia nervosa. *Eur J Clin Nutr.* 2009, 63(7):905-908.

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10. Anja Bosy-Westphal, Danielzik S, Dörhöfer RP, Later W, Wiese S et al. Phase Angle From Bioelectrical Impedance Analysis: Population Reference Values by Age, Sex, and Body Mass Index. JPEN J Parenter Enteral Nutr. 2006, 30(4): 309-316.
  11. Keel PK, Brown TA. Update on course and outcome in eating disorders. Int J Eat Disord. 2010, 43(3):195-204.