How Does Orthorexia Nervosa Assessment Tools Can Differ – Comparison of Two Questionnaires: BOT and ORTO-15

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Abstract. The paper presents a comparison of the two most commonly used diagnostic tests for orthorexia – ORTO-15 Questionnaire and BOT (Bratman Orthorexia Test) – that use data-mining methods. Orthorexia nervosa is perceived as a new, unclassified eating disorder, which is characterized with pathological fixation on the consumption of healthy foods. In order to assess the coherence of the aforementioned tests, a method from the data-mining group, i.e. correspondence analysis, was used in addition to traditional statistical methods. On the basis of the obtained results, only average correlation between ORTO-15 Questionnaire and BOT test was found. More cases of orthorexia were diagnosed with the use of ORTO-15 Questionnaire, which may result from its higher sensitivity. It was also noted that the coherence of tests increases with increasing BMI values, despite no relationship between BMI and the presence of orthorexia having been proved. Diagnosis of an orthorexia case with the use of BOT test implies that there is a high probability that it will also be diagnosed with the use of ORTO-15 test, but not necessarily the other way around. The performed correspondence analysis confirmed a not very strong coherence of the results of both tests.

Introduction

Orthorexia nervosa is a term used to describe a pathological obsession with eating healthy foods. It was first described by American doctor Steven Bratman in 1997 (Każmierczak et al., 2017). A wider prevalence of orthorexia can be observed among vegans, fruitarians, and rawists, but also among communities engaged in animal rights or environmen-

tal organizations as well as those non-genetically modified foods. According to recent publications, the factors that increase the risk of orthorexia are: obsessive-compulsive disorder and pathological attitudes to nutrition (Olejniczak et al., 2017). Persons suffering from orthorexia are usually characterized with normal body weight, mild overweight, or underweight with their body mass index is closely connected with the body metabolism (Kałedkiewicz & Doboszyńska, 2013). In addition, those who suffer from orthorexia more often are persons with a history of episodes of eating disorders as well as those with lower education levels (Olejniczak et al., 2017).

Compared to other eating disorders, the basis of orthorexia nervosa is also psychological. Contrary to anorexia and bulimia, both women and men suffer from orthorexia. These are usually persons aged 20 to 40, employed in the medical sector or involved in dietary activity (Kałedkiewicz & Doboszyńska, 2013).

Obsessive focus on consuming healthy products and eliminating unhealthy foods is observed in persons suffering from orthorexia. Such persons adhere strictly to their rigorous regimens, which leads to malnutrition. Due to the self-imposed dietary restrictions, such persons often withdraw from social life. A typical behaviour of an orthorexic person is to limit their conversations only to topics connected with healthy eating and resign from pursuing their previous interests (Gubiec et al., 2015).

The motivation behind introducing nutritional changes among those suffering from orthorexia nervosa is the will to prolong life, improve the body condition and exclude products they are allergic to from the diet. These are positive diet modifications, which makes it difficult to differentiate between healthy eating from the orthorexic attitude (Rzońca et al., 2016). Moreover, the diagnosis is compounded by the fact that the similarity between features describing orthorexia and anorexia, Anorexia Readiness Syndrome, and obsessive-compulsive disorder is close enough to make diagnosis very difficult (Koven & Abry, 2015).

Orthorexia nervosa has not yet been described in any current DSM classification, but it is routinely categorized as an eating disorder (Janas-Kozik et al., 2012). The first diagnostic for orthorexia was Bratman Test created by Steven Bratman and David Knight. It is based on 10 “yes”/“no” questions, with at least 4 “yes” answers diagnosing orthorexia. These questions are as follows: “1) Do you spend more than 3 hours a day thinking about your diet? 2) Do you plan your meals several days ahead? 3) Is the nutritional value of your meal more important than the pleasure of eating it? 4) Has the quality of your life decreased as the quality of your diet has increased? 5) Have you become stricter with yourself lately? 6) Does your

self-esteem get a boost from eating healthily? 7) Have you given up foods you used to enjoy in order to eat the ‘right’ foods? 8) Does your diet make it difficult for you to eat out, distancing you from family and friends? 9) Do you feel guilty when you stray from your diet? 10) Do you feel at peace with yourself and in total control when you eat healthily?” (Janas-Kozik et al., 2012).

Diagnostic criteria were formulated empirically for the second time by Lorenzo Mario Donini et al. in 2004 (Łucka et al., 2019). The research team created 4 conditions on which orthorexia diagnosis is based: “1) The presence of obsessive-compulsive personality traits, 2) Excessive preoccupation with healthy eating, 3) Permanent, non-transitory character of the disorder, 4) Demonstrating that behaviour connected with eating has a negative effect on the individual’s quality of life.”.

Using these criteria, Donini et al. formulated a newer diagnostic method, i.e. ORTO-15 Questionnaire, which takes into account the original Bratman and Knight classification. (Kaźmierczak et al., 2017). This is currently the most common method used for orthorexia diagnosis. The questionnaire consists of 15 items with a 4-point Likert scale with 4 possible responses, i.e. “always”, “often”, “sometimes”, “never” (Figure 1).

<ol style="list-style-type: none"> 1. When eating, do you pay attention to the calories of the food? 2. When you go in a food shop do you feel confused? 3. In the last 3 months, did the thought of food worry you? 4. Are your eating choices conditioned by your worry about your health status? 5. Is taste of food more important than the quality when you evaluate food? 6. Are you willing to spend more money to have healthier food? 7. Does the thought about food worry you for more than three hours a day? 8. Do you allow yourself any eating transgressions? 9. Do you think your mood affects your eating behaviour? 10. Do you think that the conviction to eat only healthy food increases self-esteem? 11. Do you think that eating healthy food changes your life-style (frequency of eating out, friends)? 12. Do you think that consuming healthy food may improve your appearance? 13. Do you feel guilty when transgressing? 14. Do you think that on the market there is also unhealthy food? 15. At present, are you alone when having meals? <p>Points: 1 response on 4-point scale: always/often/sometimes/never Interpretation: score below 40 points shows orthorexic tendencies</p>				
Question no.	Points for responses			
	always	often	sometimes	never
2 5 8 9	4	3	2	1
3 4 6 7 10 11 12 14 15	1	2	3	4
1 13	2	4	3	1

Figure 1. ORTO-15 Questionnaire design (Stochel et al., 2015)

Responses scoring 1 point represent a tendency to display orthorexic behaviour while responses scoring 4 points describe a healthy relationship with eating, with responses in each of the questions can be scored in a different order (not necessarily in a linear manner). Gaining less than 40 points indicates the occurrence of orthorexic tendencies (Brytek-Matera et al., 2015). The questionnaire assesses obsessive attitudes of the examined persons to dietary choices, shopping, and preparation and storage of the foods perceived by orthorexic individuals as healthy (Brytek-Matera et al., 2015). Cognitive-rational, clinical, and emotional elements were also examined (Brytek-Matera et al., 2014).

A question may be asked whether both questionnaires predict orthorexia in a similar manner. Certainly, results of both these methods depend on many other variables; moreover, it is possible that correlation between their results depends on these variables. The aim of this paper is to compare the two aforementioned most popular diagnostic tests for orthorexia and assess their relevance and reliability, taking into account confounding variables and using data-mining methods.

Materials and Methods

The studies covered 87 students of dietetics (1st, 2nd, 3rd and 4th year of study). The test location was Medical University of Białystok. The group consisted of 76 women and 11 men. The average age was 21. The average BMI in the group was 21.6 kg/m². There were 25 underweight persons, 52 persons had normal body weight, while 10 persons were overweight. The group included 42 persons avoiding specific products and 15 persons suffering from chronic conditions. The study was performed with the use of the authors' own survey questionnaire concerning the health condition of those surveyed and tests of risk assessment or degree of orthorexia: ORTO-15 Bratman tests.

In the statistical analysis, McNemar's test was used to examine the relationship between dependent quality characteristics. Normality of distribution was verified using the Kolmogorov-Smirnov tests with the Lilliefors correction and the Shapiro-Wilk test. Normality of distribution of the analysed quantitative variables was not found. When comparing quantitative variables without normal distribution, the nonparametric U Mann-Whitney test was used for two groups and the nonparametric Kruskal-Wallis ANOVA rank test with post-hoc test of multiple comparisons of mean ranks for all samples, in the case of multiple groups. Spearman's rank correlation coef-

ficient was also calculated. In addition, correspondence analysis was performed for the results of the analysed tests divided into groups according to medians and quartiles. Statistically significant results were determined at $p < 0.05$. The calculations were performed with the use of Statistica 13.1 by Dell Inc.

Results

A statistically significant ($p = 0.0002$) average ($R = -0.39$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires was found. The scatter plot is presented in Figure 2.

Figure 2. Scatter plot of the correlation between the sums of points obtained in BOT and ORTO-15 questionnaires

A statistically significant ($p = 0.0003$) average ($R = -0.41$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires was found in the group of women. In the group of men, the correlation was not statistically significant ($p = 0.43$, $R = -0.27$). The scatter plot, broken down by sex, is presented in Figure 3.

A statistically significant ($p = 0.04$) average ($R = -0.31$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires was found in the group of persons avoiding specific food products.

Figure 3. Scatter plot of the correlation between the sums of points obtained in BOT and ORTO-15 questionnaires broken down by sex

Figure 4. Scatter plot of the correlation between the sums of points obtained in BOT and ORTO-15 questionnaires, taking into account the avoidance of selected food products

In the group of persons who did not avoid any food products, the correlation was also significant and slightly stronger ($p = 0.002$, $R = -0.46$). The scatter plot, taking into account the avoidance of selected food products, is presented in Figure 4.

A statistically significant ($p = 0.001$) very strong ($R = -0.75$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires in the group of persons suffering from chronic conditions was found, as well as statistically significant ($p = 0.003$) average ($R = -0.35$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires in the group of persons not suffering from chronic conditions. The scatter plot, broken down by the existence of chronic conditions, is presented in Figure 5.

Figure 5. Scatter plot of the correlation between the sums of points obtained in BOT and ORTO-15 questionnaires, taking into account the existence of chronic conditions

Considering the division into groups according to BMI, no statistically significant correlation between the sums of points obtained in BOT and ORTO-15 questionnaires was found among underweight persons ($p = 0.27$, $R = -0.23$). Among persons with normal BMI, a statistically significant ($p = 0.003$) average ($R = -0.41$) negative correlation between the sums of points obtained in BOT and ORTO-15 questionnaires, whereas among overweight persons the correlation minimally exceeded the threshold of

statistical significance ($p = 0.07$), while the correlation coefficient was $R = -0.59$. The scatter plot, divided into BMI categories, is presented in Figure 6.

Figure 6. Scatter plot of the correlation between the sums of points obtained in BOT and ORTO-15 questionnaires divided into BMI categories

At a level of $p < 0.0001$, statistically significant differences were found for orthorexia diagnosis with the use of BOT and ORTO-15 tests (Table 1). For 47 persons (54.65%), both tests gave an identical diagnosis (33 cases – 38.37% orthorexia and 14 cases – 16.28% without the condition). Only in 3 cases (3.49%) was orthorexia diagnosed by BOT test but not by ORTO-15 test, whereas in as many as 36 cases (41.86%) a reverse situation occurred where orthorexia was diagnosed by ORTO-15 test but not by BOT test.

Table 1. Relationship between orthorexia diagnosis with the use of BOT and ORTO-15 tests

	BOT diagnosis NO	BOT diagnosis YES	SUM
ORTO-15 diagnosis NO	14 (16.28%)	3 (3.49%)	17
ORTO-15 diagnosis YES	36 (41.86%)	33 (38.37%)	69
SUM	50	36	86

At a level of $p = 0.02$, statistically significant differences were found for the numbers of points obtained in ORTO-15 test among persons with diagnosed orthorexia and persons without orthorexia according to BOT test. In the group of orthorexia diagnosis according to BOT test, the median of the number of points obtained according to ORTO-15 test was $Me = 36$ ($Q_1 = 33$, $Q_3 = 37$), whereas in the group without orthorexia, it was much higher at $Me = 38$ ($Q_1 = 34$, $Q_3 = 40$). The differences are illustrated in Figure 7.

Figure 7. Comparison between the numbers of points obtained in ORTO-15 test between the groups with and without orthorexia according to BOT test

At a level of $p = 0.0005$, statistically significant differences were found for the numbers of points obtained in BOT test among persons with diagnosed orthorexia and persons without orthorexia according to ORTO-15 test. In the group of orthorexia diagnosis according to ORTO-15 test, the median of the number of points obtained according to BOT test was $Me = 3$ ($Q_1 = 2$, $Q_3 = 5$), whereas in the group without orthorexia, it was much lower at $Me = 1$ ($Q_1 = 1$, $Q_3 = 3$). The differences are illustrated in Figure 8.

At a level of $p = 0.002$, statistically significant differences were found between the numbers of points obtained in BOT test between groups of persons indicated based on ORTO-15 test divided into 3 categories (no or-

Figure 8. Comparison between the numbers of points obtained in BOT test between the groups with and without orthorexia according to ORTO-15 test

Figure 9. Comparison between the numbers of points obtained in BOT test between the groups with and without orthorexia according to ORTO-15 test divided into 3 categories

thorexia, tendency, orthorexia). In the group without orthorexia according to ORTO-15 test, the median of the number of points obtained according to BOT test was $Me = 1$ ($Q_1 = 1$, $Q_3 = 3$), in the group with orthorexic tendencies it was much higher at $Me = 3$ ($Q_1 = 2$, $Q_3 = 5$), whereas in the group with diagnosed orthorexia $Me = 3$ ($Q_1 = 3$, $Q_3 = 5$). The performed post-hoc analysis showed statistically significant differences only between the no orthorexia and tendency ($p = 0.008$) and the no orthorexia and orthorexia ($p = 0.002$) groups. No statistically significant differences between the orthorexia and orthorexic tendencies groups were found. The differences are illustrated in Figure 9.

For the scores obtained in both tests, a division into four parts was performed (into 4 groups according to medians and quartiles) and correspondence analysis was performed for thus created groups (Milewska et al., 2012; Stachurska et al., 2017). The obtained results showed that the corresponding groups from both tests (group 1 from BOT and 4 from ORTO-15, group 2 from BOT and 3 from ORTO-15, etc.) lie quite close together, there are, however, closer neighbours, such as e.g. group 1 from ORTO-15 and group 2 from BOT. The results of the analysis are presented in Figure 10.

Figure 10. Correspondence analysis performed for groups in quartiles for BOT and ORTO-15 test results

Discussion

The latest studies suggest that the currently used methods of orthorexia assessment are insufficient and new, standardized scales or tests need to be found (Missbach et al., 2017; Valente et al., 2019). Initial studies lead to conclusions that ORTO-15 questionnaire has good predictability in terms of orthorexia diagnosis, but at the same time they did not exclude the need for it to be monitored and improved (Donini et al., 2005). The main reason for criticism of the current diagnostic tests was the fact that each of the tests is based on a different characteristics and research ideas as far as orthorexia is concerned. In the case of the tests used for this study, they were the target of various criticisms. Several research studies (Bundros et al., 2016; Grammatikopoulou et al., 2018) suggest that as far as Bratman test is concerned, the greatest problem is lack of its validation – there is no international position that would establish BOT as a diagnostic tool. ORTO-15, on the other hand, was assessed as a too low specificity test, indicating too many cases of orthorexia in comparison with other tests (Cliford & Blyth, 2019; Dunn et al., 2017; Gramaglia et al., 2017; Missbach et al., 2017). It was also criticized for too weak psychometric properties, which do not allow to verify patients thoroughly (Almeida et al., 2018; Clifford & cBlyth, 2019; Dunn et al., 2017). Moreover, in comparison with other tests that displayed a similar reliability and had matched structural models of questions (BOT, DOS, Dusseldorf Orthorexia Scale, EHQ, Eating Habits Questionnaire), ORTO-15 was clearly distinct and its correlations with other tests were negligible (Meuele et al., 2019).

In this paper, a significant negative average correlation between ORTO-15 and BOT tests was found (Figure 2). The negative correlation results from the fact that the tests make use of contrary systems of assignment of points – in ORTO-15 fewer than 40 points are needed to obtain a positive result, while 4 points or more are needed in BOT 4. Despite the aforementioned correlation, it can be noticed that more persons were diagnosed as orthorexic in ORTO-15 test in comparison with Bratman test (Table 1). This is probably due to the higher sensitivity of ORTO-15, which was shown by Gubiec et al. (Gubiec et al., 2015). An additional problem is that analyses of results of both tests differ depending on the study (different cut-off points for orthorexia diagnosis). Some studies interpret the results of tests as ill/healthy, while others as ill/orthorexic tendencies/healthy (Ditfeld et al., 2016; Varga et al., 2014). According to the first division, the tests show considerable differences in the numbers of diagnosed persons. Diagnosing orthorexia with ORTO-15 test may not be accurate as it defines

the very fact of being on a diet as pathological, not taking into account the circumstances for using the diet. It is difficult, however, to choose which of the tests is more accurate and which should be recognized as the golden standard as they are both based on different definitions of orthorexia (Valente et al., 2019). It is a fact that when orthorexia is diagnosed in BOT test, it should also be diagnosed in ORTO-15, but not necessarily the other way around.

An interesting relationship was noticed in the comparison of compatibility of tests taking into account confounding variables. Among the women who filled in both tests, a stronger correlation was found between the results than among men, which means that the tests are less coherent in the case of males (Figure 3). This may result from the fact that women are more prone to orthorexia, which is corroborated in a study by Strahler (2019). Perhaps if the group of men had been bigger, the difference in coherence would have turned out even greater. A more coherent result of both tests was also obtained by persons who responded affirmatively to the authors' own question "do you avoid any food products (not connected with allergies)?" in comparison with persons who did not avoid any products (Figure 4). This result may be caused by the fact that the topics of questions that are repeated in both tests concern the influence of diet on social behaviour. Persons avoiding certain products or types of meals may feel more strongly that this has an impact on their lifestyle and social behaviour in comparison with persons who do not avoid any products. Among those who responded in the survey that they suffer from chronic diseases, the coherence of the studied tests was strong, whereas it was average in the case of healthy persons (Figure 5). Again, this may indicate a stronger influence of diet on the lifestyle of ill persons as there exist products whose consumption should be limited in the case of certain chronic conditions (e.g. diabetes, non-specific inflammatory bowel diseases). The most interesting result seem to be the differences in coherence of both tests in sub-groups according to BMI values: underweight, norm, overweight/obesity. The coherence of tests in these groups was weak, average, and strong, respectively (Figure 6). This means that as BMI increases, the coherence of tests also increases. The result suggests that questions in both tests were interpreted in a similar manner among the groups with greater problems maintaining normal body weight. What is interesting, no direct relationship between BMI values and the presence of orthorexia was found.

Statistically significant differences were found in the study between the numbers of points scored in ORTO-15 test between persons with diagnosed orthorexia and those without orthorexia according to BOT test (Figure 7).

Significant differences were also found in a reverse comparison (Figure 8) as well as difference in the case of a division of ORTO-15 diagnosis results into 3 groups (Figure 9). The size of these differences, however, once again confirms that the assumption that the tests are not significantly coherent.

The correspondence analysis performed for the groups divided into four parts (according to medians and quartiles) for both tests also shows a low level of coherence. In the case of strong coherence, group 1 from ORTO-15 test and group 4 from BOT test would lie very close to each other (and similarly group 2 from ORTO-15 test and group 3 from BOT test, etc.). The result of the analysis shows, however, that the distances between these groups are not sufficiently small; in addition, apart from those mentioned, there exist pairs that lie closer to each other such as, for instance, group 1 from ORTO-15 test and group 2 from BOT test (Figure 10).

Conclusions

BOT and ORTO-15 tests differ significantly. ORTO-15 test has greater sensitivity, indicating that more of those studied suffer from orthorexia in comparison with BOT test, which results from their different approaches to orthorexia, the number and accuracy of questions. The tests showed greater coherence among those persons who avoid certain food products, those suffering from chronic conditions, and those with higher BMI. The coherence of tests differentiated according to sex, due to the insufficient number of men participating in the study, requires further research. An orthorexia diagnosis in BOT test is usually also confirmed in ORTO-15, yet not necessarily the other way around. Correspondence analysis is a useful tool for the comparison of coherence of tests that diagnose the same chosen phenomenon.

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