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Assessing effects of diet alteration on selected parameters of chronically mentally ill residents of a 24-hour Nursing Home. Part 2: Effects of nutritional changes on anthropometric parameters and composition of the body

Mariola Friedrich[1], Joanna Fugiel[2], Zuzanna Goluch[3], Izabela Dziaduch[4]

[1] Faculty of Food Sciences and Fisheries, West Pomeranian University of Technology in Szczecin
[2] Doktor Edmund Wojtyła's Nursing Home, Szczecin
[3] Department of Food Technology and Nutrition, Wroclaw University of Economics and Business
[4] Department of Applied Microbiology and Human Nutrition Physiology, Faculty of Food Sciences and Fisheries, West Pomeranian University of Technology in Szczecin

Summary

Aim. The study was aimed at finding out whether, and how, changes in dietary habits would be reflected in anthropometric parameters and body composition.

Method. Anthropometric measurements (Martin's technique) were taken on 52 chronically mentally ill patients, twice: before and a year after diet correction. The patients' body composition was examined, directly after the measurements, by bioelectric impedance analysis (BIA) in tetragonal arrangement, using a Bodystat ®1500MDD device.

Results. Changes in dietary habits were reflected in a significant reduction of body weight, BMI, and waist circumference in schizophrenic women; WHR in men with other diseases increased significantly. BMI analysis showed an increase in the percentage of normal-weight schizophrenic women and men, a decrease in the proportion of underweight women and men, and an increase in the proportion of individuals with normal weight suffering from other diseases. Both groups showed beneficial changes in body composition (increased content and percentage of fatless body weight and water, reduced content and percentage of fat tissue). These changes were statistically significant only in men suffering from other diseases and concerned the increased content of fatless body weight.

Conclusions. Changes in dietary habits enhanced body weight reduction in overweight and obese individuals and resulted in desired changes in BMI, WHR, and body composition. The body fat content was distinctly reduced, with no concurrent changes in the fatless body weight and/or water content. Changes in dietary habits were beneficial for the nutritional status of undernourished patients or those with low body weight.

Key words: the mentally ill, nourishment, body composition

Introduction

Numerous studies have demonstrated that individuals suffering from mental disorders (schizophrenia, affective diseases) run a particularly high risk of development of overweight, obesity, diabetes, coronary artery disease and the associated premature death [1, 2]. Additional effects of excessive body weight include inflammatory processes, neuroendocrine dysregulation and the associated various metabolic disturbances, including insulin resistance and dyslipidaemia [3], intensified by the prescribed medications [4]. It is thought that excessive body weight gain occurs in 15-72% of patients with chronic mental disorders, including both those treated pharmacologically and those not receiving any medication [5].

The authors' long-term involvement in health-promoting nutrition education associated with diet modification revealed that principles of correct nutrition, learned and applied by the education recipients, led to beneficial changes in biochemical blood parameters, body weight and composition, and adipose tissue loss (with a particular reference to the loss of visceral fat). Those changes proved particularly meaningful for post-mastectomy [6], menopausal [7, 8], and elderly women [9, 10]. Analysis of changes in dietary habits and changes in the selected blood parameters of chronic psychiatric patients receiving round-the-clock care in a nursing home, described in Part 1 of the study [11], has motivated addressing the question posed in this study, namely if, and to what extent, the changes in nutritional habits and behaviours would be reflected in changes of anthropometric parameters and body composition. This question is particularly pertinent to patients suffering from schizophrenia and bipolar disorder, as the antipsychotics those patients are treated with adversely affect glucose and insulin metabolism [12-15], appetite [15] and body weight [16, 17].

Material and methods

The study involved 52 subjects – 18 women aged 45-80 (64 ± 10.2), and 34 men aged 27-80 (59.2 ± 12.5), residents of a round-the-clock nursing home for chronically mentally ill patients. Details of the study, data collection, nutrition education, diet modification and nutritional supervision were described in Part 1 of the study [11]. The limitation of the study was the size of the groups, which resulted from the number of residents at the nursing home at the time of the study.

Anthropometry

Anthropometric measurements were taken twice: before the diet correction and a year after, using the classic Martin technique [18]. The measurements were taken in the morning. Body height was measured, to 0.1 cm, with a SECA 215 stadiometer. The waist and hip circumferences were measured, to 1 mm, with the Gulick anthropometric tape. The body weight was determined (to 0.1 kg) with a RADWAG WPT–200.0 physician's scale. The measurements were performed following standard procedures and were taken in triplicate. The body mass index (BMI) was calculated from the formula: BMI = body weight (kg) / height squared (m^2) and compared with the reference values and classifications of the World Health Organisation (WHO) [19] for patients aged 18-64 and Lipschitz [20] for patients over 65. Waist circumference (WC) and hip circumference (HC) were measured, and the following indices were calculated: waist-to-hip ratio (WHR) from the formula WHR = waist circumference (cm) / hip circumference (cm), and the waist-to-height ratio (WHtR) from the formula WHtR = waist circumference (cm) / height (cm) [8, 21]. A waist circumference in the range of 80-87.9 cm in women and 94-101.9 cm in men is indicative of overweight status, and WC ≥ 88.0 cm and ≥ 102.0 cm, respectively, is indicative of obesity [21].

Body composition was determined directly after the anthropometric measurements were taken, using the tetrapolar (arm-leg) non-invasive bioelectrical impedance analysis (BIA) technique with the Bodystat1500MDD (Bodystat Ltd.) apparatus. The Body Manager software, utilising regression equations for body composition of individuals from birth up to the age of 99, was used.

During the procedure, the patients were in horizontal position, and the preparation process followed the manufacturer's instructions. The apparatus made it possible to determine the fat mass (FM) content, fat-free mass (FFM), and total body water (TBW) content.

During the study, the patients were leading their normal, unchanged (particularly in terms of physical activity) lifestyle, taking into account their habits and little rituals. Neither the medications nor their doses were altered.

Statistical analysis

Data were checked for normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test), and were tested for significance of differences ($p \leq 0.05$ and $p \leq 0.01$) using Student's *t*-test for paired samples. The tests were run with the statistical software Statistica® 9.0.

Results

Analysis of the results showed the change in nutrition habit to be reflected in the patients' anthropometric parameters (Tables 1 and 2). Body weight loss was observed in both groups of women, and resulted in a change in the proportion of individuals assigned to specific BMI ranges (Tables 3 and 4). In the group of patients with schizophrenia (group I), weight loss was observed in 11 women (73.3%), the body weight remained unchanged in 1 woman (6.7%) and increased in 3 (20.0%), including an undernourished woman. Similarly, in the group of women with other psychiatric conditions (group II), weight loss was found in 2 individuals (66.6%), and weight gain in 1 underweight woman (33.3%). The changes in body weight in the female schizophrenia patients were statistically significant.

Table 1. **The impact of dietary correction on selected anthropometric indicators of nursing home residents with schizophrenia (group I) (min-max, ± SD)**

Indicator	Women (n = 15)		Significance of differences	Men (n = 18)		Significance of differences
	"before"	"after"		"before"	"after"	
Weight (kg)	47.0–118.0 75.8 ± 19.8	47.3–112.0 73.4 ± 18.5	*	50.5–102.0 76.0 ± 12.9	50.5–106.0 75.9 ± 14.9	-
BMI (kg/m^2)	19.6–51.1 29.4 ± 8.0	19.3–48.0 28.5 ± 7.4	*	16.5–36.6 26.0 ± 5.0	16.5–38.0 26.0 ± 5.5	-
Waist circumference (cm)	78.0–135.0 99.7 ± 14.2	71.0–130.5 97.9 ± 14.5	-	69.0–114.0 98.0 ± 11.0	68.0–120.0 98.9 ± 12.1	-
Hip circumference (cm)	90.0–140.0 107.1 ± 13.7	90.0–140.0 103.6 ± 13.3	*	88.0–118.0 102.7 ± 7.3	87.0–117.0 100.4 ± 8.0	-
WHR (cm)	0.79–1.00 0.93 ± 0.06	0.77–1.07 0.95 ± 0.08	-	0.78–1.07 0.95 ± 0.07	0.78–1.11 0.98 ± 0.07	-
WHtR (cm/cm)	0.45–0.89 0.62 ± 0.10	0.41–0.86 0.61 ± 0.10	-	0.40–0.72 0.57 ± 0.08	0.39–0.72 0.58 ± 0.08	-

* – statistically significant difference at $p \leq 0.05$

Table 2. **The impact of dietary correction on selected anthropometric indicators of nursing home residents with other psychiatric conditions (group II) (min-max, ± SD)**

Indicator	Women (n = 3)***		Men (n = 16)		Significance of differences
	"before"	"after"	"before"	"after"	
Weight (kg)	38.0–76.0 57.4 ± 15.7	38.2–60.0 49.4 ± 8.9	58.0–114.0 79.0 ± 15.7	58.0–110.1 79.3 ± 15.0	-
BMI (kg/m ^{2})	15.4–30.8 22.6 ± 6.3	15.5–24.3 20.2 ± 3.6	18.9–40.4 27.6 ± 5.8	19.6–39.0 27.7 ± 5.5	-
Waist circumference (cm)	68.0–106.0 84.3 ± 16.0	67.0–104.0 82.7 ± 15.6	82.0–130.0 102.9 ± 13.7	80.5–125.4 102.6 ± 12.2	-
Hip circumference (cm)	72.0–124.0 97.3 ± 21.2	72.0–118.0 95.3 ± 18.8	90.0–125.0 106.1 ± 10.3	90.0–119.0 102.8 ± 9.1	-

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WHR (cm)	0.82–0.94 0.87 ± 0.05	0.80–0.93 0.87 ± 0.05	0.86–1.07 0.97 ± 0.06	0.89–1.09 1.00 ± 0.06	*
WHtR (cm/cm)	0.43–0.68 0.54 ± 0.10	0.43–0.66 0.53 ± 0.10	0.49–0.77 0.61 ± 0.09	0.48–0.75 0.61 ± 0.08	-

* – statistically significant difference at $p \leq 0.05$; *** – due to the small size of the group, no statistical analysis was performed

In the group of male schizophrenia patients, 8 individuals (44.4%) showed weight loss after diet correction, while body weight gain was observed in 1 undernourished patient (5.5%) and in 2 patients (11%) with normal body weight. In the group of men with other psychiatric conditions, weight loss was observed in half of the patients (i.e. 8 individuals, including 1 normal-weight individual). Weight gain was recorded in 1 undernourished patient and in 1 individual with low body weight.

Analysis of the BMI values, indicative of the patients' nutritional status, showed a deviation from the reference level in about 72% of the patients (37 individuals), regardless of the psychiatric disorder and gender. Although the changes in body weight in most of the patients were not large enough to bring the BMI to normal range, a beneficial trend of changes was visible. Changes in BMI after diet modification, i.e. both the increase in an underweight woman (1 individual) and the reduction in overweight and obese female patients (8 individuals) and in the normal-weight women (2 individuals) occurred in both groups of women and were statistically significant in the schizophrenia patients. In the group of women with other psychiatric disorders, BMI was observed to increase in 2 underweight patients (66.6%), whereas a BMI reduction was recorded in 1 obese subject (33.3%). Among the schizophrenic men, 7 (about 45%) showed a BMI reduction, including 2 normal-weight and 5 overweight individuals. In the group with other psychiatric conditions, a BMI reduction was noted in half of the group (8 males, including 1 normal-weight and 7 overweight patients). As few as 3 men (1 schizophrenic and 2 from group II) showed no BMI changes.

The initial WC data showed the parameter to be normal (i.e. lower than 80 cm) in only 1 schizophrenic woman (5.5%) and in 2 women (66.7%) with other psychiatric disorders. Following diet modification, the above percentages did not change; however, WC decreased in about 67% of females with schizophrenia (10 individuals) and in all the female patients from group II. The differences in the schizophrenic group were statistically significant. When analysing WC changes in men, it was found that the effect of diet correction was marked by a reduction in WC in 33% of the schizophrenics (6 individuals) and in as many as 62.5% of the remaining men (10 individuals). However, the changes observed were not statistically significant.

The WHR values analysed prior to diet modification showed the fat tissue to be accumulated viscerally in all the schizophrenic women and in 67% of the other female patients (2 individuals). Following diet modification, more than 50% of the schizophrenic women showed a reduced WHR, with 7 women (46%) achieving reference values. In the second group, the WHR values decreased in all of the women. Increased WHR values in men were recorded in almost 78% and 87.5% of schizophrenic and group II patients, respectively. Following diet modification, non-reference values were still visible in similar proportions of the male patients, although a reduced WHR was observed in 33.3% (6 individuals) and 12.5% (2 individuals) of the schizophrenic and other patients, respectively. The increase in mean WHR values, including the statistically significant increase in the group of non-schizophrenic male patients, was related to the fact that a reduced waist circumference was accompanied by a reduced hip circumference, whereby the WHR value does not change or even increases.

Excessive values of the WHtR index, indicative of the risk of cardiometabolic disorders, were observed – prior to diet modification – in more than 73% of the schizophrenic female patients. Following diet correction, 60% of group I women (9 individuals) showed a reduced WHtR. In the other group of female patients, the WHtR values declined in 2 out of the 3 women, and only 1 patient was still at risk of diabetes and hypertension. Also in males with schizophrenia, prior to diet modification, WHtR values were indicative of the risk of developing diabetes in 83% of the subjects. Following dietary changes, the WHtR values declined in about 30% of the patients, and about 44% (8 individuals from group I) showed WHtR values close to normal. Similarly, in the other group of male patients, abnormal WHtR values were recorded in almost 82% of the subjects. Diet modification resulted in a WHtR reduction in 56% of the patients (9 individuals), but the reduction was not large enough to bring the WHtR values to reference range.

As neither the range of anthropometric parameters nor their mean values provide information on the direction of changes, Tables 3 and 4 summarise the percentage of patients falling within specific ranges.

Table 3. **Percentages of women and men with schizophrenia (group I) compared to the clinical values of BMI**

Nutritional status (%)	Women (n = 15)		Men (n = 18)	
	"before"	"after"	"before"	"after"
Underweight	6.7	6.7	11.1	11.1
Risk of underweight / low body weight	0.0	0.0	0.0	5.5
Normal	40.0	53.3	33.3	44.5
Overweight	26.65	20.0	44.5	27.8
Obesity	26.65	20.0	11.1	11.1

Table 4. **Percentages of women and men with other disorders (group II) compared to the clinical values of BMI**

Nutritional status (%)	Women (n = 3)		Men (n = 16)	
	“before”	“after”	“before”	“after”
Underweight	66.6	33.3	6.3	0.0
Risk of underweight / low body weight	0.0	33.3	18.7	18.7
Normal	0.0	33.3	18.7	25.0
Overweight	33.3	0.0	25.0	25.0
Obesity	0.0	0.0	31.3	31.3

Interpretation of changes in the BMI values allowed to regard 13% of the formerly overweight and obese schizophrenic female patients as those with normal body weight; in the other group of women, one underweight patient showed her body weight to increase to the low body weight level, and one overweight woman displayed a shift towards normal weight. About 17% of the overweight schizophrenic men returned to normal-weight status after the dietary intervention. Among the male patients with other disorders, the body weight of one underweight individual (6.3%) changed to low, and one individual (6.3%) from the low body weight category improved to normal-weight status. Unfortunately, despite very beneficial changes in body weight of the overweight and obese group II men, none of them could be qualified to the normal weight category.

Analysis of the results revealed that the changes in diet and nutrition translated to changes in body composition of the subjects (Tables 5 and 6).

Table 5. **Impact of diet correction on the body composition of the residents of the nursing home suffering from schizophrenia (group I) (min-max, ± SD)**

Parameters and indices	Women (n = 15)		Significance of differences	Men (n = 18)		Significance of differences
	“before”	“after”		“before”	“after”	
Total body fat [kg]	15.7-70.4 38.3 ± 16.4	15.7-67.7 37.5 ± 15.6	-	10.1-51.8 24.1 ± 11.4	10.8-53.6 22.7 ± 10.8	-
Total body fat [%]	27.9-63.5 49.4 ± 12.0	28.0-60.4 48.7 ± 10.1	-	15.3-50.8 31.2 ± 10.6	14.1-50.6 29.5 ± 10.1	-
Lean body mass [kg]	26.0-49.7 37.3 ± 7.4	27.7-51.9 36.6 ± 7.4	-	33.3-68.2 52.0 ± 9.6	35.1-64.6 52.0 ± 9.6	-
Lean body mass [%]	36.5-72.1 50.6 ± 12.0	39.6-72.0 51.3 ± 10.1	-	49.2-84.7 68.8 ± 10.6	49.4-85.9 70.5 ± 10.1	-
Total body water [L]	26.0-49.2 35.7 ± 6.5	28.5-53.6 35.4 ± 7.1	-	31.3-50.5 41.7 ± 4.5	32.3-51.6 41.6 ± 5.3	-
Total body water [%]	39.6-58.1 47.9 ± 6.0	42.8-63.2 48.9 ± 5.5	-	47.5-69.5 55.6±5.5	47.5-68.8 56.6 ± 6.5	-

Table 6. **Impact of diet correction on the body composition of the remaining residents of the nursing home (group II) (min-max, ± SD)**

Parameters and indices	Women (n = 3)***		Men (n = 16)		Significance of differences
	"before"	"after"	"before"	"after"	
Total body fat [kg]	15.7-45.4 27.7 ± 15.6	16.3-19.4 17.8 ± 1.6	11.5-60.5 30.4 ± 14.0	8.3-55.8 29.1 ± 13.9	-
Total body fat [%]	41.3-47.8 43.9 ± 3.5	29.7-41.9 36.8 ± 6.3	16.7-53.1 37.1 ± 12.6	12.6-53.9 35.1 ± 12.6	-
Lean body mass [kg]	22.3-49.6 33.9 ± 14.1	22.6-42.2 31.8 ± 9.9	28.8-66.1 49.9 ± 10.3	29.9-68.1 51.5 ± 10.2	*
Lean body mass [%]	52.2-58.7 56.1 ± 3.5	58.1-70.3 63.2 ± 6.3	46.9-83.3 62.9 ± 12.6	46.1-87.4 64.2 ± 12.1	-
Total body water [L]	24.7-49.0 35.0 ± 12.6	25.0-36.9 32.0 ± 7.3	29.5-52.2 41.9 ± 5.7	30.2-54.9 42.8 ± 5.4	-
Total body water [%]	51.6-65.0 58.9 ± 6.8	62.6-66.0 64.3 ± 1.7	45.8-62.2 52.9 ± 5.2	46.2-67.7 53.7 ± 6.7	-

* – statistically significant difference at $p \leq 0.05$; *** – due to the small size of the group, no statistical analysis was performed

A reduction of total body fat was observed in both groups of overweight and obese women. On the other hand, the body fat content in the underweight women slightly increased. The fat mass decline (expressed both in absolute and relative values) was recorded in about 60% of the schizophrenic women (9 individuals) and in 66% of women (2 individuals) suffering from other psychiatric disorders. These changes, in about half of the patients with schizophrenia, were accompanied by an increase in absolute lean body mass, with 80% of the schizophrenic females showing an increase in relative lean body mass. The respective percentages in the group affected by other psychiatric disorders were 66% and 66%. A similarly positive effect of diet modification was observed when analysing data on the total body water content. In about 60% of women with schizophrenia and 66% of women with other disorders, the body water content (both absolute and relative) increased. Analysis of the effects of changes in dietary habits of men on their body composition revealed a reduction in total body fat in both patients with schizophrenia and other disorders – in 56% and 67% of the patients, respectively. Increased contents of total body fat were recorded in 44% of schizophrenia patients, including underweight individuals (11%), and in 33% of men from group II, including underweight patients (18.7%). The percentage of fat tissue in the body composition was reduced in 61% of schizophrenic males (11 individuals) and in 67% of men with other psychiatric disorders (10 individuals). In 39% and 73% of men with schizophrenia and other disorders, respectively, the changes were accompanied by an increase in absolute lean body mass, with an increase in relative lean body mass being observed in 61% and 67% of the patients, respectively. A positive effect of diet modification on the body composition was also noted when analysing the total body water content. About 40% and 73% of the schizophrenia and other patients, respectively, showed increased absolute and relative body water contents.

Discussion

The presented results of the study concerning the effects of diet modification and nutritional supervision on the eating behaviours of chronically mentally ill patients in a 24-hour nursing home have shown a number of beneficial changes, which are described in detail in Part 1 of the study [11]. Generally, the modifications involved: a statistically significant reduction in the mean energy content of the diet; a reduction in protein, fat, cholesterol, and total carbohydrate contents; and an increased consumption of dietary fibre and liquids. The following also significantly changed: proportions and amount of energy of major nutrients and their contributions to the diet composition; vitamin and mineral contents; and the daily glycaemic load (despite the afternoon tea being added as an additional meal). Modifications of dietary habits were reflected in statistically significant changes of carbohydrate-lipid metabolism indicators, also found in schizophrenic patients treated with antipsychotics [11].

In addition to the aforementioned changes, diet modification and supervision as well as nutrition education were reflected in positive changes in the examined anthropometric parameters and patients' body composition. These were person-specific changes in body weight and, more importantly, in waist circumference and body composition, both in women and in men as well as both in patients with schizophrenia treated with second-generation antipsychotics and in those suffering from other psychiatric disorders.

Generally, excessive accumulation of fat tissue is perceived as an effect of positive energy balance. However, in psychiatric – particularly schizophrenic – patients treated with clozapine (12 individuals: 8 women and 4 men in this study) and olanzapine (15 individuals: 5 and 10, respectively), the process is more complex. The drugs block serotonin and dopamine receptors, which stimulates the hunger centre, disrupts glucose metabolism, and stimulates insulin release [15, 17, 22]. All this, taken together, promotes body weight gain. Olanzapine and clozapine turned out to be drugs of the highest risk of lipid complications [23], and their effects on body weight gain were confirmed by Leucht et al. [24]. Clozapine treatment has been demonstrated to result in body weight gain, by more than 10%, in about 60% of the patients treated for 12 months [15], and olanzapine shows this effect (body weight gain by an average of 2.2 ± 3.4 kg) to appear as soon as in 4 months [17]. Moreover, neuroleptics have been observed to disrupt the leptin-dependent mechanism controlling the body's energy budget [22]. In the conducted study, the significantly reduced energy content of the diet in all the women and in about 60% of the men was still higher than the gender – and age-specific reference levels. Therefore, it seems that the obtained effects were associated with qualitative changes in the diet rather than with its reduced energy content.

The increased uptakes of vitamin D_3, calcium, magnesium, and B complex vitamins, translating into improved carbohydrate-lipid metabolism already described in Part 1 of the study, promoted body weight loss. Important for the weight loss of the subjects must have also been the change in the source of basic diet components and the increased consumption of dietary fibre; adding of the afternoon tea as the fifth meal, which reduced the between-meal snacking; and the health-promoting nutrition education, which influenced the composition of the fifth meal. Those changes, while contributing to the significant reduction of the daily glycaemic load, must have summed up to produce a flattened glycaemic response and the associated reduction in the secretion of lipopoietic insulin [7]. This is also indicated by the BMI values, which changed beneficially along with the body weight changes, particularly in the schizophrenic female patients. Insulin secretion has been demonstrated to vary proportionally to changes in BMI. Insulin removal from the blood by the liver is reversely correlated with WC [25], and the magnitude of both of these indicators is positively correlated with the extent of glycaemia.

The noted changes in the examined nursing home patients are important also in view of the known association between BMI on the one hand and cognitive functions and depression on the other [26]. Jaracz et al. [26] found that obese individuals have been shown to perform worse in cognitive tests, and have been more frequently diagnosed with depression. Also, Morgan et al. [27], who examined 1,642 psychiatric patients, concluded that increased BMI together with diagnosed metabolic syndrome was associated with reduced cognitive abilities.

An additional risk of complications associated with excessive body weight is the location of the accumulated fat tissue: not only is it directly correlated with metabolic disorders, but also is strongly associated with cognitive disorders and, in consequence, leads to changes in brain plasticity [28]. As shown by Stefańska et al. [29] and Konarzewska et al. [30], women with schizophrenia and depression have a significantly higher WC and a significantly higher WHR compared to the control group; moreover, increased accumulation of visceral fat tissue in schizophrenia patients is observed in individuals with both excessive and normal body weight.

Analysis of the effect of diet modification on WC showed beneficial changes in about 2/3 of women and 1/3 of men with schizophrenia; in the remaining patients, beneficial changes of this parameter were revealed in a higher proportion of the subjects. However, although the WC values did not drop to the reference level, even the attained changes produced a health-promoting effect in the form of altered carbohydrate-lipid metabolism, described in Part 1 of the study [11]. Numerous studies have shown that WC reduction is in itself conducive of reduced insulin resistance, particularly its peripheral form, and improves the hormonal-metabolic status [7, 31, 32].

Unfortunately, despite beneficial changes in WC, the WHR values in some overweight and obese patients in both groups remained unchanged or even increased. This was associated with a simultaneous loss of fat tissue located around the waist and hips. It may be presumed that the effect was related to the medication applied which, despite dietary changes, did not allow for a full normalisation of insulin and cortisol, hormones responsible for fat tissue accumulation and location [33]. In a study involving menopausal women, it was shown that correct diet modification has been demonstrated to promote loss of visceral fat tissue, the loss being higher (frequently by a factor as high as 2.5) than that of the subcutaneous fat tissue [7]. Although the WHtR values decreased in 60% and 30% of the schizophrenic women and men, respectively, and in 56% of the men with other conditions, they reached the reference level in as few as 40% of all the subjects. However, considering the specificity of the examined patients, type of their disorders and the medication applied, it would be perhaps more appropriate to express the result as "in as many as 40%" rather than "in as few as 40%"?

Numerous studies have shown virtually every antipsychotic to produce a clinically important body weight gain [34]. On the other hand, there is evidence that some patients receiving antipsychotics maintain a normal body weight. The body composition of those patients is, however, abnormal and they show an increased amount of visceral fat tissue [30].

In the study described here, dietary changes were found to be beneficial for the body composition. Prior to diet modification, the fat mass was frequently higher than that suggested by the BMI value. Following diet modification, however, the loss of absolute fat was frequently much larger than that suggested by the loss of body weight. The effect was produced by the parallel increase in the fat-free mass and/or water content. The loss of the adipose tissue (including visceral fat) could be a result of normalised carbohydrate metabolism, observed in the patients, supported by a substantial reduction in the daily glycaemic load and increased uptake of dietary fibre, and their joint effect on the glycaemic and insulin curves [7]. In addition, increased uptake of vitamins and minerals participating in those processes as well as augmented consumption of antioxidants must have contributed to the fat tissue loss. Increased accumulation of fat tissue has been demonstrated to be frequently correlated with impaired oxidative metabolism; the oxidative phosphorylation rate has been shown to increase, and the amount of perivisceral fat tissue to distinctly decrease following the improvement of oxidative metabolism [35]. Calcium deficiency, stimulating the release of calcitriol affecting the specific receptors of adipocytes and B vitamins (particularly B6), was found to stimulate the rate of lipogenesis [36, 37]. Dietary supplementation of calcium and B vitamins could, too, have acted in favour of fat tissue loss.

The changes made to the diet also had a positive effect on the percentage of lean body mass, which is obvious given the reduction in body fat percentage. Therefore, it is more important to maintain the absolute lean body mass, and in some cases even increase it. One of the causes could be an improved sensitivity of insulin receptors, and hence improved amino acid and protein metabolism. Even at a reduced muscle mass, the amino acid and protein metabolism rate does not change in the liver of undernourished individuals [33, 38]. This is important considering that stimulation of energy substrate accumulation is one of the most common effects accompanying incorrect diet modification [39], and body weight loss is primarily associated with a loss of fat-free mass [40].

Interesting from the physiological point of view is the retention of, or an increase in, water content, particularly in patients with a total body water content below the recommended level (46%). Generally, the reduction of fat mass (with water contributing about 10%) should be accompanied by an adequate loss of water. This effect was observed in only one woman of the "other disorders" group; during the one-year duration of the study, she lost 6 kg of fat tissue and 1 l of water. In the remaining subjects, particularly in the men of both groups, the body water content remained at an unchanged level or even increased. This effect could have been related to the statistically significant increase in potassium uptake. Increased consumption of potassium and its absorption in renal tubules have been demonstrated to be accompanied by, on the one hand, a reduced sodium uptake (resulting in blood pressure normalisation, observed in the patients examined in this study), and by a reduced calcium removal on the other [41]. As an intracellular ion, potassium enhances water absorption by cells, particularly muscle cells, and thus contributes to the osmotic equilibrium of the body and blood pressure control. Changes in dietary habits also induced beneficial effects in the body composition of underweight patients. The changes involved a slight increase in fat mass and an increase in the absolute contents of fat-free mass and water, which is indicative of a general improvement of the patient's nutrition status.

To sum up, it has to be pointed out that the diet correction, nutritional supervision and health-promoting education resulted in improvement of the anthropometric parameters and body composition of the subjects. The magnitude of beneficial changes was person-specific and was dependent on the gender, age, disease, and medication applied. Nevertheless, the observed changes were positive and involved a reduction in both body weight and waist circumference as well as beneficial alterations in body composition.

The observed effects contributed not only to the improvement of health and physical capacity, but also to the improvement of the well-being of the respondents, which was reported by the staff and caretakers of the residents. These observations are confirmed by a study by Aucoin et al. [42] who, after analysing the results of 25 clinical trials and 2 meta-analyses, state that the nutritional intervention aimed at weight loss not only positively modifies metabolic parameters, but also, as shown in 19 clinical trials, had a positive effect on mental health. It concerned the improvement of, among others, symptoms of psychosis, cognition, and quality of life [42]. A similar position is represented by Adamowicz et al. [43]. In their experiment involving 87 people diagnosed with schizophrenia, they assessed the cognitive effects of a 7-day Mediterranean diet with reduced energy value and found a significant improvement in the test scores. Their main conclusion that „changing eating habits may be an important element of a holistic approach to the problems related to the treatment of schizophrenia" ... is in accordance with the beliefs of the authors of this work, with the note that not only „may" but „should" [43]. And while Fernández-Abascal et al. [44], who analysed the results of 59 studies, concluded that no beneficial effects were observed (including of diet correction) on the values of the tested blood parameters, the improvement in the values of anthropometric parameters translated into a reduction in the severity of psychotic symptoms, improvement in cognitive abilities and improvement in physical well-being and quality of life [44].

These opinions are in line with the reports that one of the factors contributing to lowering self-esteem and creating a negative self-image, especially in women, is excessive body weight. This is confirmed by the results of European studies, which indicate a significant, positive relationship between the BMI value and the occurrence of mood and anxiety disorders in the general (non-clinical) population [1] and in the case of women, neither age nor health condition changes this fact [7-10, 45].

Conclusions

1. Nutrition habits of chronic psychiatric patients can be improved with patients' full consent and cooperation.
2. Regardless of the patients' mental disorder and medication applied, changes in nutrition were conducive to a slow weight loss in overweight and obese individuals, the weight loss being accompanied by person-specific changes in BMI, WC, WHR and WHtR.
3. Body composition changed as well, the changes involving a reduction in fat mass and an increase in fat-free mass; in addition, the absolute fat content was reduced, with no changes in the fat-free mass and/or water content.
4. Nutrition changes in underweight or low body weight patients were beneficial for their nutritional status, manifested as an increase in absolute fat-free mass and water content and a slight increase in the fat mass.

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Address: Izabela Dziaduch
Faculty of Food Sciences and Fisheries
Department of Applied Microbiology and Human Nutrition Physiology
West Pomeranian University of Technology in Szczecin
71-459 Szczecin, Papieża Pawła VI Street 3
e-mail: izabela.dziaduch@zut.edu.pl