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# Overweight, obesity and cognitive functions disorders in group of people suffering from mental illness

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**Summary**

**Aim**. The aim of this study was to examine whether obesity affects cognitive functions in people suffering from mental illness.

**Method**. 91 persons suffering from mental illness, including 51 women and 40 men took part in the study. Mean age of patients was 46 years. These persons were under constant psychiatric care, they were the participants of the daily support centre. Overweight and obesity was measured by Body Mass Index (BMI). Abdominal obesity was measured according to IDF guidelines and waist-hip ratio (WHR). Cognitive functions were examined using STMS, Verbal Fluency Test and Rey Auditory Verbal Test.

**Results**. Abdominal obesity was diagnosed in 70% of patients according to IDF guidelines and in 61% according to WHR, in women these results were respectively: 83% and 94%, while in men 62% and 32%. BMI distribution in the study group was respectively: obesity class II – 5 persons (5%), obesity class I – 26 persons (28%), overweight – 32 persons (35%), correct BMI – 27 persons (30%), underweight – 1 person (2%). There was a negative correlation between WHR, waist circumference and abstract reasoning, direct memory and delayed memory. BMI and body mass correlated negatively only with delayed memory. Number of medications taken by the studied persons showed a positive correlation with body mass and waist circumference. Negative correlations between cognitive functions and body mass, overweight and abdominal obesity was observed in women. In men these correlations were not observed, there were only correlations between cognitive functions and age.

**Conclusions**. Obesity contributes to a decline in cognitive functions especially in direct memory and abstract reasoning.

**Key words**: cognitive functions, mental illness, obesity

The study was not sponsored

## Introduction

Relationship between metabolic disorders and mental disorders was noted already in 1919 [1], before antipsychotic medications appeared. Recent studies in the group of persons suffering from mental illness, just before starting a pharmacological treatment, indicate that tendency to increased body mass is to some extent an image of mental illness such as schizophrenia [2, 3]. This leads to the conclusion that there are some genetic predispositions for depositing of excessive adipose tissue in this group of people [4]. Additionally, treatment of mental illnesses using psychotropic medications also contributes to the formation of metabolic disorders, including overweight and obesity. This is particularly true for the antipsychotic medications (second generation) [5, 6].

Obesity, the civilization disease of contemporary times has several negative health consequences, both somatic and psychological. The somatic diseases caused by obesity include among others: cardiovascular diseases, type 2 diabetes and some cancers [7]. Psychological consequences of obesity are just as serious. Excess body mass contributes to a reduction in their own self-evaluation, the emergence of a negative image of the person, which contributes to occurrence of depression and mood disorders [8]. Eating large amounts of food affects the mental processes and behaviour, which is caused by, among others, the fact, that the individual nutrition components have an impact on brain biochemistry [9].

It has been shown that eating high calorie food, rich in saturated fatty acids and simple sugars, causes deterioration of nervous system by, among others, the increase of oxidative stress and reduction of synapse plasticity [10]. What is more, obese people consume large amounts of food often very poor in components for proper brain functioning, such as docosahexaenoic acid (DHA), group B vitamins and fiber [11].

Metabolic disorder due to deposition of adipose tissue, particularly abdominal, is strongly linked with cognitive impairment. Obesity leads to changes in brain plasticity and, as a consequence, cognitive functions are reduced [12].

Studies in population of persons without mental disorders indicate clearly that, along with the increase in waist circumference cognitive functions are lowered, and this correlation causes neurodegenerative changes in the brain, especially in the area of hippocampus, as proved by research using magnetic resonance imaging (MRI) [13].

Scientific reports draw attention to the fact that obesity by an inflammatory processes (the so-called metabolic inflammation) and dysregulation of the neuroendocrinological system causes a variety of metabolic disorders such as insulin resistance, leptin resistance, dyslipidaemia, hypercortisolemia [14, 15]. Later in life, obesity leads to dementia disorders [16] by changes in white matter in brain and hippocampus [17, 18].

In people suffering from mental illnesses, metabolic disorders and changes in cognitive functioning are closely connected, especially in the case of e.g. schizophrenia [19]. It was found that obesity leads to mood disorders of depression, but depression may also lead to an increase in body mass [20]. A correlation between BMI, cognitive functions and depression has been observed in studies conducted by Jaracz et al. It has been shown that people with obesity performed worse in cognitive tests; they were also more often diagnosed with depression [21].

Persons suffering from mental disorders are more at risk for overweight, obesity, and consequently the metabolic syndrome. Australian research by Morgan et al. in a group of 1,642 people have shown that in people suffering from mental illnesses an increase in BMI and diagnosis of metabolic syndrome were linked with a decline in cognitive abilities [22]. Similar dependencies were shown by the team Guo et al. in group of 896 people diagnosed with schizophrenia [23].

## Aim

This research is intended to analyse relationship between cognitive processes and medical parameters such as overweight and obesity in people with diagnosed mental illness. The existing scientific publications in this field concern pharmacological treatment, particularly with respect to the effects of atypical (second generation) and typical (first generation) medications on body mass. In the own study we decided to check, how overweight and obesity affect the cognitive function in a group of persons suffering from mental illness covered by the support program, taking into account not the type of medication, but number of types of medications, taking into account that people in this group take psychotropic medications from different groups.

## Material and method

The study included 91 patients (age range from 26 to 66 years), with a diagnosed mental illness, being in remission, who voluntarily signed consent to participate in the study. There were 51 women and 40 men. The mean age of patients was 46 years (standard deviation +/– 13.3 years). The average age of women was 49 years and of men 42 years and this difference has proved to be statistically significant (Mann-Whitney U test, $p < 0.01$). Studies have been approved by the Bioethics Committee of Medical University of Lublin (No. KE-0254/101/2013).

The tested persons were participants of Assisted Living Facility in Leczna and Lublin, Occupational Therapy Workshops in Lublin and the staff of District Vocational Rehabilitation Facility in Leczna.

Among these were 48 people with schizophrenia (F20), 3 with schizoaffective disorders (F25), 3 with persistent delusional disorder (F22), 7 with affective bipolar disorder (F31), 6 with depression (F32), 13 with neurotic, stress-related and somatoform disorders (F40–F48), 11 with disorders of adult personality and behaviour (F60–F69).

In the own study, it was noted that patients were prescribed psychotropic drugs from different groups. Therefore a variable "Number of taken medications" was introduced which meant the number of taken psychotropic medications. It happened, that one person took medicines from several groups such as typical, atypical, antidepressants, sleeping pills and sedatives, or mood stabilizers/antiepileptics, simultaneously.

The largest group constituted of persons taking atypical medications (34%), then persons taking both typical and atypical medications (30%), people taking typical medications (14%), and the rest 21% of the participants took psychotropic medicines other than neuroleptics, namely: antidepressants, sleeping pills or sedatives, antiepileptics.

Table 1 shows the exact distribution of taken medications in the group of women and men; in this respect these groups were close to one another.

Table 1. **The type of medications taken in the group of women and men**

| Sex | Type of medication | Number | Percentage | Sex | Type of medication | Number | Percentage |
|---|---|---|---|---|---|---|---|
| Women | Typical and atypical medications | 16 | 31.37 | Men | Typical and atypical medications | 15 | 37.50 |
| | Typical | 14 | 27.45 | | Typical | 13 | 32.50 |
| | Atypical | 9 | 17.64 | | Atypical | 5 | 12.50 |
| | Other medicines: antidepressants, sedatives, sleeping pills mood stabilizers/ antiepileptics | 12 | 23.52 | | Other medicines: antidepressants, sedatives, sleeping pills mood stabilizers/ antiepileptics | 7 | 17.50 |

Among all participants the most people, i.e. 29 (32%) had secondary education, 28 (31%) vocational education, 15 (16%) post-secondary education, 13 (14%) primary education, and 6 higher education (7%). Education distribution in the group of women and men is given in Table 2. 69 people lived in a city (75%) and 22 lived in a village (38%).

Table 2. **Educational stage in the group of women and men**

| Sex | Educational stage | Number | Percentage | Sex | Educational stage | Number | Percentage |
|---|---|---|---|---|---|---|---|
| Women | Secondary | 17 | 33.33 | Men | Secondary | 12 | 30.00 |
| | Vocational | 12 | 23.52 | | Vocational | 16 | 40.00 |
| | Post-secondary education | 12 | 23.52 | | Post-secondary education | 3 | 7.50 |
| | Higher | 5 | 9.80 | | Higher | 1 | 2.50 |
| | Primary | 5 | 9.80 | | Primary | 8 | 20.00 |

The participants were also treated for other disorders than mental illness. The most frequent coexisting diseases included hypertension, stable ischaemic heart disease, optimally treated hypercholesterolemia, a history of cancer (multiannual interview), and viral hepatitis that did not require pharmacological treatment. Impact of particular coexisting diseases on cognitive processes will be the subject of further research.

The study consisted of two stages. At the beginning there was a physical examination, in order to determine: height, body mass, waist circumference, hip circumference. Body mass index (BMI; body mass (kg)/height ($m^2$)) [24] was calculated and abdominal obesity, or its lack, was diagnosed according to guidelines of the International Diabetes Federation (IDF; waist circumference in men ≥ 94 cm, and in women ≥ 80 cm) [25].

WHR (Waist-hip Ratio; waist circumference/hip circumference) was also calculated. Abdominal obesity was diagnosed in women when this ratio was ≥ 0.8, and in men ≥ 1.0 [26].

Then the psychological evaluation was conducted. General cognitive functions were assessed using the Short Test of Mental Status (STMS) (subsequent analyses included the result obtained in abstract reasoning part to assess abstract reasoning function) [27], the Verbal Fluency Test (VFT) to evaluate the verbal semantic and category fluency [28], and the Auditory Verbal Learning Test (assessment of immediate and delayed memory) [29].

## Statistical analysis

The obtained results were statistically analysed using STATISTICA software, version 10. Because the distribution of several variables was not normal, correlations between variables were analysed using the Spearman's rank correlation coefficient. Due to the lack of normal distribution and non-equipotency of tested groups, testing of hypotheses was performed using Mann-Whitney U test (comparison of 2 groups). In case of comparison of more than 2 groups, the statistical analysis was conducted using Kruskal-Wallis test for independent trials, taking into account post hoc analyses (Dunn test). The results were found to be significant at the level of $p < 0.05$.

## Results

The participants were divided into groups. In the first division the participants were divided according to BMI. Due to the small number of people with obesity class II (5%) and underweight (2%) (Table 1), only three groups were included in this division: overweight persons (35%), persons with obesity class I (35 %) and those with normal BMI (30%). The exact distribution is given in Table 3.

Table 3. **The prevalence of overweight and obesity in the study group and according to sex**

| Groups | BMI | | Abdominal obesity according to the IDF guidelines | Abdominal obesity according to WHR |
|---|---|---|---|---|
| All the participants<br>N = 91 | Obesity class II – 5 persons (5%)<br>Obesity class I – 26 persons (28%) | Overweight – 32 persons (35%)<br>Normal BMI – 27 persons (30%)<br>Underweight – 1 person (2%) | 70 persons (70% of total number of participants) | 61 persons (67% of total number of participants) |
| Women<br>N = 51 | Obesity class II –2 persons (3.9%)<br>Obesity class I – 16 persons (31.4%) | Overweight – 18 persons (35.3%)<br>Normal BMI – 14 persons (27.4%)<br>Underweight – 1 person (1.9%) | 40 persons (83%) | 45 persons (94%) |

*table continued on the next page*

| | | | | |
|---|---|---|---|---|
| Men<br>N = 40 | Obesity class II – 3 persons (7.5%)<br>Obesity class I – 10 persons (25%) | Overweight – 14 persons (35%)<br>Normal BMI – 13 persons (32.5%)<br>Underweight – no one | 25 persons (68%) | 12 persons (32%) |

Analysis by means of Kruskal-Wallis test did not reveal any statistically significant differences between the BMI and cognitive functions in different groups ($p > 0.05$).

A further group division was carried out in relation to identify abdominal obesity, or lack thereof, taking into account IDF guidelines and the WHR ratio. In addition, it was shown that people with abdominal obesity (according to IDF guidelines) performed worse in the test measuring delayed memory (Mann-Witney U test, $p < 0.04$). Such dependencies are not found in the case of WHR (Mann-Whitney U test, $p < 0.87$).

In addition, it was examined whether the education in group of people suffering from mental illnesses affects the level of cognitive functions. Post hoc multiple comparison analysis showed that statistically significant differences occurred between people with higher and post-secondary education and the rest of the participants i.e. those with primary, vocational and secondary education ($p < 0.0009$). People with higher and post-secondary education performed better in test measuring general cognitive function than other persons, the median was respectively 29.5 and 28. People with vocational education obtained the worst results (median 24).

Another criterion of comparison in the groups was sex. For this purpose a correlation between particular medical and psychological parameters in relation to all participants and in the group of women and men was examined (Table 4, 5, 6).

Table 4. **Spearman' rank correlation between BMI, body mass, waist circumference and cognitive functions for all the respondents**

| | N – important | Spearman's r | p |
|---|---|---|---|
| Age & Abstract reasoning STMS* | 91 | -0.22 | 0.0347 |
| Age & Immediate recall * | 91 | -0.23 | 0.0256 |
| Age & Delayed recall * | 91 | -0.29 | 0.0057 |
| Body mass & The number of types of medications* | 91 | 0.22 | 0.0339 |
| Body mass & Delayed recall * | 91 | -0.27 | 0.0091 |
| BMI & Delayed recall * | 91 | -0.23 | 0.0311 |
| Waist circumference & The number of types of medications* | 91 | 0.24 | 0.0245 |
| Waist circumference & Abstract reasoning STMS* | 91 | -0.29 | 0.0055 |
| Waist circumference & Immediate recall * | 91 | -0.23 | 0.0320 |
| Waist circumference & Delayed recall * | 91 | -0.36 | 0.0004 |
| WHR & Abstract reasoning STMS* | 91 | -0.32 | 0.0017 |
| WHR & Immediate recall * | 91 | -0.34 | 0.0008 |
| WHR & Delayed recall * | 91 | -0.29 | 0.0056 |

*– marked coordinates of correlation are significant at $p < 0.05$

Table 5. **Spearman' rank correlation between BMI, body mass, waist circumference and cognitive functions in women**

| | N – Important | Spearman's r | p |
|---|---|---|---|
| Age & General cognitive functions –STMS | 51 | -0.01 | 0.9550 |
| Age & The number of types of medications | 51 | -0.01 | 0.9564 |
| Age & Abstract reasoning STMS | 51 | -0.19 | 0.1757 |
| Age & Literal fluency | 51 | -0.07 | 0.6490 |
| Age & Semantic fluency | 51 | -0.12 | 0.3944 |
| Age & Immediate recall * | 51 | -0.32 | 0.0215 |
| Age & Delayed recall * | 51 | -0.45 | 0.0008 |
| Body mass & General cognitive functions – STMS | 51 | 0.10 | 0.4928 |
| Body mass & The number of types of medications | 51 | 0.27 | 0.0575 |
| Body mass & Abstract reasoning STMS* | 51 | -0.31 | 0.0277 |
| Body weight & Literal fluency | 51 | 0.19 | 0.1713 |
| Body mass & Semantic fluency | 51 | 0.09 | 0.5367 |
| Body mass & Immediate recall | 51 | -0.16 | 0.2572 |
| Body mass & Delayed recall * | 51 | -0.38 | 0.0064 |
| BMI & General cognitive functions – STMS | 51 | 0.13 | 0.3763 |
| BMI & The number of types of medications | 51 | 0.18 | 0.2174 |
| BMI & Abstract reasoning STMS* | 51 | -0.37 | 0.0076 |
| BMI & Literal fluency | 51 | 0.20 | 0.1546 |
| BMI & Semantic fluency | 51 | 0.02 | 0.8892 |
| BMI & Immediate recall | 51 | -0.14 | 0.3112 |
| BMI & Delayed recall * | 51 | -0.33 | 0.0178 |
| Waist circumference & General cognitive functions – STMS | 51 | 0.08 | 0.5744 |
| Waist circumference & The number of types of medications | 51 | 0.26 | 0.0670 |
| Waist circumference & Abstract reasoning STMS* | 51 | -0.40 | 0.0039 |
| Waist circumference & Literal fluency | 51 | 0.10 | 0.4759 |
| Waist circumference & Semantic fluency | 51 | -0.01 | 0.9395 |
| Waist circumference & Immediate recall | 51 | -0.27 | 0.0566 |
| Waist circumference & Delayed recall * | 51 | -0.43 | 0.0018 |
| WHR & General cognitive functions – STMS | 51 | 0.11 | 0.4279 |
| WHR & The number of types of medications* | 51 | 0.36 | 0.0088 |
| WHR & Abstract reasoning STMS* | 51 | -0.34 | 0.0144 |
| WHR & Literal fluency | 51 | 0.11 | 0.4495 |

*table continued on the next page*

| | | | |
|---|---|---|---|
| WHR & Semantic fluency | 51 | -0.05 | 0.7470 |
| WHR & Immediate recall | 51 | -0.23 | 0.1016 |
| WHR & Delayed recall * | 51 | -0.28 | 0.0494 |

* – marked coordinates of correlation are significant at p <0.05.

Table 6. **Spearman' rank correlation between BMI, body mass, waist circumference and cognitive functions in men**

| | N – Important | Spearman's r | p |
|---|---|---|---|
| Age & General cognitive functions –STMS | 40 | -0.30 | 0.0617 |
| Age & The number of types of medications | 40 | -0.13 | 0.4394 |
| Age & Abstract reasoning STMS* | 40 | -0.41 | 0.0085 |
| Age & Literal fluency* | 40 | -0.44 | 0.0043 |
| Age & Semantic fluency* | 40 | -0.32 | 0.0436 |
| Age & Immediate recall * | 40 | -0.40 | 0.0107 |
| Age & Delayed recall * | 40 | -0.23 | 0.1609 |
| Body mass & General cognitive functions – STMS | 40 | 0.11 | 0.4899 |
| Body mass & The number of types of medications | 40 | 0.28 | 0.0845 |
| Body mass & Abstract reasoning STMS | 40 | 0.01 | 0.9769 |
| Body mass & Literal fluency | 40 | 0.22 | 0.2052 |
| Body mass & Semantic fluency | 40 | 0.08 | 0.6447 |
| Body mass & Immediate recall | 40 | 0.24 | 0.1330 |
| Body mass & Delayed recall | 40 | -0.02 | 0.8964 |
| BMI & General cognitive functions – STMS | 40 | 0.07 | 0.6690 |
| BMI & The number of types of medications | 40 | 0.24 | 0.1375 |
| BMI & Abstract reasoning STMS | 40 | -0.05 | 0.7495 |
| BMI & Literal fluency | 40 | 0.07 | 0.6596 |
| BMI & Semantic fluency | 40 | 0.15 | 0.3623 |
| BMI & Immediate recall | 40 | 0.15 | 0.3538 |
| BMI & Delayed recall | 40 | -0.07 | 0.6898 |
| Waist circumference & General cognitive functions – STMS | 40 | 0.01 | 0.9492 |
| Waist circumference & The number of types of medications | 40 | 0.26 | 0.1008 |
| Waist circumference & Abstract reasoning STMS | 40 | -0.11 | 0.4940 |
| Waist circumference & Literal fluency | 40 | 0.08 | 0.6296 |
| Waist circumference & Semantic fluency | 40 | 0.09 | 0.5611 |
| Waist circumference & Immediate recall | 40 | 0.09 | 0.5769 |

*table continued on the next page*

| | | | |
|---|---|---|---|
| Waist circumference & Delayed recall | 40 | -0.17 | 0.3077 |
| WHR & General cognitive functions – STMS | 40 | -0.18 | 0.2641 |
| WHR & The number of types of medications | 40 | 0.04 | 0.8282 |
| WHR & Abstract reasoning STMS | 40 | -0.23 | 0.1608 |
| WHR & Literal fluency | 40 | -0.11 | 0.4836 |
| WHR & Semantic fluency | 40 | -0.10 | 0.5545 |
| WHR & Immediate recall | 40 | -0.12 | 0.4608 |
| WHR & Delayed recall | 40 | -0.12 | 0.4442 |

* – marked coordinates of correlation are significant at p <0.05

Age of the patients showed negative correlations with immediate memory (Sperman's r – 0.23, p < 0.02) and delayed memory (Sperman's r – 0.28, p < 0.005) and abstract reasoning (Sperman's r – 0.23, p < 0.03). In the field of overweight and obesity, WHR showed the strongest correlations with respect to abstract reasoning (Sperman's r – 0.32, p < 0.001), immediate memory (Sperman's r – 0.34, p < 0.0008) and delayed memory (Sperman's r – 0.28, p < 0.005). Abdominal obesity diagnosed according to IDF guidelines also showed relation with abstract reasoning (Sperman's r – 0.28, p < 0.005), immediate memory (Sperman's r – 0.22, p < 0.03) and delayed memory (Sperman's r – 0.36, p < 0.004). BMI correlated negatively only with delayed memory (Sperman's r – 0.22, p < 0.03). Identical dependencies were observed in relation to body mass (Sperman's r – 0.27, p < 0.03). Number of medications taken by tested persons showed positive correlations with body mass (Sperman's r 0.22, p < 0.03) and waist circumference (Sperman's r 0.23, p < 0.02).

The distribution of particular dependencies in relation to the variable which groups sex is slightly different. Negative relationships between body mass, overweight and abdominal obesity were observed in women, whereas no such dependencies were observed in men.

In women age showed correlation with recent memory (Sperman's r – 0.32, p < 0.02) and delayed memory (Sperman's r – 0.45, p < 0.0008). Body mass, BMI, waist circumference and WHR correlated negatively with abstract reasoning (Sperman's r: – 0.30, p < 0.02; – 0.37, p < 0.007; – 0.40, p < 0.03; – 0.34, p < 0.01, respectively) and delayed memory (-0.37, p < 0.006; – 0.33; p < 0.01, – 0.34, p < 0.01; – 0.27, p < 0.04). In the group of women the WHR increased with the increase in quantity of taken medications (Sperman's r 0.36, p < 0.008).

With regard to men, significantly negative correlations were observed between age and abstract reasoning, literal and semantic fluency, as well as immediate memory (Sperman's r: – 0.41, p < 0.008; – 0.44, p < 0.004; – 0.32, p < 0.04; – 0.39, p < 0.01, respectively).

## Discussion

Obesity, especially abdominal obesity leads to a number of negative health consequences. Among other things it increases the risk of brain stroke [30], but above all it can lead to dementia-like disturbances. Reduced cognitive functions are one of the first symptoms of dementia [31].

The results show that obesity may contribute to a decline in cognitive performance of persons suffering from mental illness, which in many cases are burdened with basic illness [32]. Correlation analysis of individual indicators of overweight and obesity with the cognitive parameters indicate that the excess body fat contributes to a decrease in abstract reasoning as well as in immediate and delayed memory; however, there are differences between women and men in this respect.

Disturbances in abstract reasoning are part of the image of some mental disorders [33]. In the own study we have obtained a broader view of this phenomenon. Abstract reasoning function worsens with the increase in body mass and waist circumference, age of patients and the number of psychotropic medications. Short-term memory, particularly this of the delayed nature, has proved to be strongly linked with obesity parameters in terms of body mass, BMI, waist circumference as well as abdominal obesity. This is confirmed by research in the group of persons without cognitive impairment. It has been shown that obesity is closely linked with memory disorders. Obesity, through vascular changes, leads to secondary brain damage [17, 34].

By analysing the results, it is concluded that abdominal obesity is closely linked with deterioration of cognitive ability in terms of short-term memory, and thus learning. People with abdominal obesity performed worse in delayed memory test than persons without abdominal obesity. This result indicates that the excess abdominal body fat contributes to the reduction of learning ability. In the studies carried out by Gunstad et al. in the group of 1,703 persons without mental disorders, it was pointed out that there was a decrease in short-term memory functions with an increase in BMI, waist circumference and WHR [14]. Additionally, these parameters correlated negatively with verbal fluency and general memory functions, measured using the Mini-Mental State Examination (MMSE), however, such dependencies has not been observed in the own study. Perhaps this is related to antipsychotic medications taken by the participants. Medications such as olanzapine or clozapine positively affect general cognitive functioning. This issue requires further detailed studies of the correlation between psychotropic drugs, body mass and cognitive functions.

The results indicate that there are significant differences in the correlations between overweight and obesity parameters and cognitive functions in women and men. Body mass, BMI, waist circumference and WHR did not show any relation with cognitive functions in men. The only statistically significant correlation was observed between age and the above mentioned parameters. Abstract reasoning ability, short-term memory and verbal fluency deteriorated with the age of patients.

These relations are slightly different in women. There were no links between body mass, BMI, waist circumference and WHR and verbal fluency. However, short-term memory and abstract reasoning deteriorated with the increase in body mass indexes.

Age did not play any role in this case, it correlated only negatively with short-term memory.

It should be noted that men were statistically younger than women and they were less often diagnosed with abdominal obesity. Hence the relation between obesity and cognitive functions did not occur in such intensity as in women.

Similar studies are known from scientific reports carried out in the group without mental disorders. Elias et al. in group of 551 men and 872 women also observed negative associations of obesity with cognitive functions such as memory and learning ability. Researchers also found that memory and learning ability deteriorated with the increase in body mass, but only in men. The authors explain this fact that tested women more often than men were treated due to hypertension [35]. In our research there were no differences in the use of hypotensive therapy between women and men. Differences in results of cognitive tests between women and men may result from the fact that abdominal obesity was more often diagnosed in women, i.e. in 83% according to IDF guidelines and up to 94% with respect to the WHR. In men these results were respectively: 68% and 32%.

The analysis shows that education influenced cognitive functioning in a group of people suffering from mental illnesses. People with higher and post-secondary education scored better in a test measuring general cognitive functions. The team of McLaren et al. obtained similar results in the group of people suffering from depressive disorders. The level of education has proved to be a protective factor in the reduction of cognitive capacity in people with high severity of depression [36]. Currently there are studies showing that regular cognitive trainings improve the working of the brain in people suffering from mental illnesses, which positively affects cognitive processes, quality of life and opportunities for self development [37].

The studied group participated regularly in the cognitive training, organised by assistance centres. Maybe comparison of this group with people suffering from mental illnesses not attending occupational therapies would give a broader picture of the phenomenon.

The presented study is not free of limitations. We do not analyse the influence of medications or lifestyle on general cognitive functioning and body mass gain. Age of studied men and women in group slightly differs, which could affect the final results. However, it should be noted that the group of people suffering from mental illnesses is very heterogeneous, because individual medical conditions, medications, lifestyle, duration of the disease affect the overall functioning of the patient. An attempt to identify the phenomenon of overweight and obesity and their cognitive implications in the above mentioned group was made and further analysis on the impact of coexisting diseases, as well as physiological and metabolic disorders will be the subject of further detailed study.

## Conclusions

There is a negative correlation between obesity and cognitive functions, such as immediate and delayed memory and abstract reasoning in people suffering from mental illness. Abdominal obesity negatively affects the immediate memory functions and abstract reasoning. With the increase in the number of types of psychotropic medications, waist circumference and age abstract reasoning functions worsens.

There is a need for further research on the impact of obesity on cognitive functions in people suffering from mental illness concerning their lifestyle, coexisting diseases and treatment.

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