

ORIGINAL ARTICLE / PRACA ORYGINALNABlanka Dwojaczny¹, Tomasz Zegarski², Wojciech Sikorski¹, Piotr Złomańczuk³, Małgorzata Tafil- Klawe¹**THE INCREASED BODY MASS INDEX EFFECT ON DECLARATIVE MEMORY****WZROST WSKAŹNIKA MASY CIAŁA
MOŻE MIEĆ NEGATYWNY WPŁYW NA PAMIĘĆ DEKLARATYWNĄ**¹ Department of Human Physiology, Nicolaus Copernicus University, Collegium Medicum Bydgoszcz, Poland² Centre for Physical Education and Sport, Nicolaus Copernicus University, Collegium Medicum Bydgoszcz, Poland³ Department of Neuroimmunology, Nicolaus Copernicus University, Collegium Medicum Bydgoszcz, Poland**S u m m a r y**

Several lines of evidence suggest that being overweight or obese not only impacts the cardiovascular and respiratory systems but also exert a negative effect on the central nervous system. We examined the relationship between body mass index and cognitive performance in three groups of volunteers: obese (17 women; aged 59.88 ± 4.29; BMI 34.08 ± 2.31), overweight (35 women; aged 59.70 ± 4.68; BMI

27.87 ± 1.44), and normal body weight group (18 women; aged 64.5 ± 4.84; BMI 23.53 ± 1.21). To evaluate the cognitive performance in our subjects we used face/name association test. Our data demonstrate that the increased body mass weight may have a negative effect on some cognitive function such as declarative memory.

S t r e s z c z e n i e

Wyniki dotychczas przeprowadzonych badań wykazały, że rozwój nadwagi oraz otyłości oprócz negatywnego wpływu na funkcjonowanie układu sercowonaczyniowego czy też oddechowego może również prowadzić do powstawania niekorzystnych zmian w funkcjonowaniu ośrodkowego układu nerwowego. Zbadano zależność pomiędzy wartością wskaźnika masy ciała a zdolnościami poznawczymi w trzech grupach wolontariuszy: osób otyłych

(17 kobiet; wiek 59,88 ± 4,29; BMI 34,08 ± 2,31) osób z nadwagą (35 kobiet; wiek 59,70 ± 4,68; BMI 27,87 ± 1,44), osób z prawidłową masą ciała (18 kobiet; wiek 64,5 ± 4,84; BMI 23,53 ± 1,21). Do określenia funkcji poznawczych użyto testu kojarzenia twarz/imię. Otrzymane wyniki wskazują, że wzrost masy ciała może mieć negatywny wpływ na pamięć deklaratywną.

Key words: face/name association, memory, body weight, BMI**Słowa kluczowe:** kojarzenie twarz/imię, pamięć, masa ciała, BMI**INTRODUCTION**

It is well known that the excessive body weight have a negative effect on overall health. Several lines of evidence indicate that increases in body weight may be associated with hypertension, stroke, heart disease, skeletal muscular diseases, urinary incontinence, knee osteoarthritis, respiratory problem and mellitus

diabetes [1, 2, 3, 4, 5]. Obesity is also described as one of the factors predisposing to development of many types of cancer, for example breast, colon and pancreas [6]. Recent research reports suggest that increased body weight may also be associated with reduced cognitive performance such as learning, memory and executive function [7, 8, 9, 10, 11, 12]. Furthermore, obesity is described as a very important risk factor for

dementia and neurodegenerative diseases such as Alzheimer's disease [13, 14, 15].

The potential mechanism for the effect of increased body mass on the central nervous system is unclear but a growing body of research suggests that being overweight or obese is related to atrophy of certain areas of the brain. The MRI/CT analysis demonstrated that a higher body mass was associated with lower whole brain volume. Some studies have demonstrated that the structures of the brain that are particularly sensitive to increases in body weight include temporal and frontal lobes, parietal cortex, hippocampus, cerebellum and midbrain. In obese people, reduction in grey matter volume was observed in these areas [16, 17, 18, 19]. Moreover, experimental studies in animals demonstrated that mechanism of obesity-related cognitive dysfunction may be related to reduced synaptic plasticity in the hippocampus and cerebral cortex [20, 21] or increased neuronal apoptosis in the hippocampus and hypothalamus [22]. Currently, it is accepted that potential side-effects include impairment of cerebral metabolism [23], elevated leptin levels [24, 25, 26], and systemic and central inflammation [27].

MATERIAL AND METHODS

The study was conducted in accordance with the Declaration of Helsinki for Human Studies. The study protocol was approved by a local Ethics Committee.

Volunteers (70 women, age 60.95 ± 4.97) were recruited from the local The Third Age University in Bydgoszcz. The volunteers were divided on three groups, differentiated by body mass index (BMI): obese group (17 women; aged 59.88 ± 4.29 ; BMI 34.08 ± 2.31), overweight group (35 women; aged 59.70 ± 4.68 ; BMI 27.87 ± 1.44) and normal body weight group (18 women, aged 64.5 ± 4.84 ; BMI 23.53 ± 1.21). Based on medical examination and interviews, the selected women were healthy, and did not suffer from any serious chronic condition, were post-menopausal, and had not underwent hormone replacement therapy.

Body weight status was assessed based on BMI calculated according to the standard formula (weight in kilograms divided by height in square meters). BMI was categorized according to the National Institutes of Health obesity standard: BMI 18.5-24.9 normal weight, BMI 25-29.9 overweight, BMI 30-34.9 class I obesity [28].

Evaluation of cognitive abilities was measured using a face/name association test. The detailed experimental protocols for these tests were described previously [29]. Shortly, in the acquisition phase of the face/name association test, subjects were exposed to 100 faces associated with a single name on a computer screen. Each face/name pair was presented for 2 seconds. After 10 min from the end of acquisition phase the retrieval phase began. During this phase test subjects were presented with the same faces as in acquisition phase but each face was associated with two names, one of which was the same name as in acquisition phase. The task of the subject was to indicate the name associated with the face during acquisition phase. No time limitations for retrieval phase were imposed by the protocol. The percent of correctly answered names, and the duration of the retrieval phase were monitored for each subject.

Statistical significance of the differences between the two groups was assessed using two-tailed T-Test. The results are presented as means with standard deviation. $p < 0.05$ was considered statistically significant.

RESULTS

In the normal body mass group, the mean score of face/name association test was 71.94 ± 8.93 %. In the same test for the overweight and obese group, the scores were $60.44 \pm 8.3\%$ and 61.00 ± 11.72 , respectively (Fig. 1a). The scores between overweight and the normal weight group as well as between the obese and the normal weight group were different at statistically significant level, with $p < 0.005$. Statistically significant differences were observed also between the two groups for the duration of the retrieval phase of this test. The normal weight group mean retrieval duration equalled 196.21 ± 74.56 seconds and in the overweight group the retrieval duration was 303.29 ± 122.66 while the obese group was 307.64 ± 139.97 seconds (Fig. 1b). We observed a positive relationship between BMI and the results face/name association test ($p < 0.005$) (Fig. 2a, 2b).

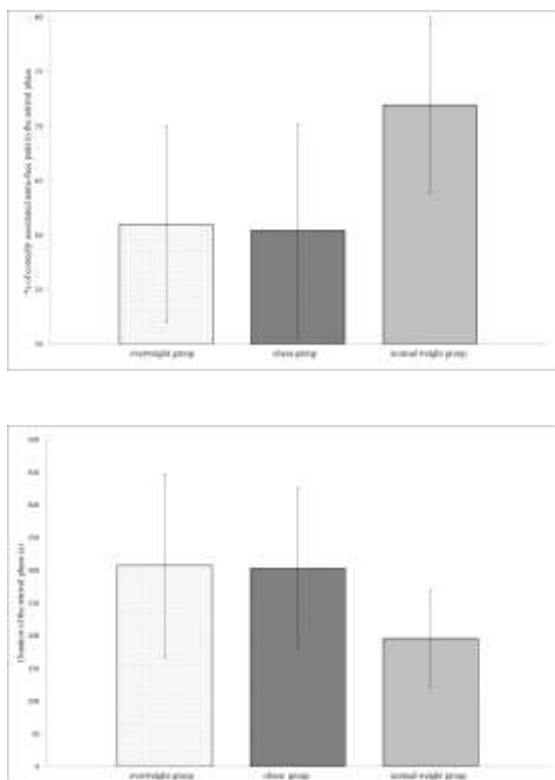


Fig. 1. Face/name association test results in normal, overweight and obese groups. A) The mean values for % of correctly associated name-face pairs (\pm SD), in the retrieval phase. B) The mean values duration of the retrieval phase (\pm SD)

Ryc. 1. Wyniki testu kojarzenia twarz/imię w grupie z prawidłową masą ciała, nadwagą oraz w grupie osób otyłych. % twarzy poprawnie skojarzonych z imieniem w fazie odtwarzania a) średnie wartości uzyskane w poszczególnych b) Czas trwania fazy odtwarzania

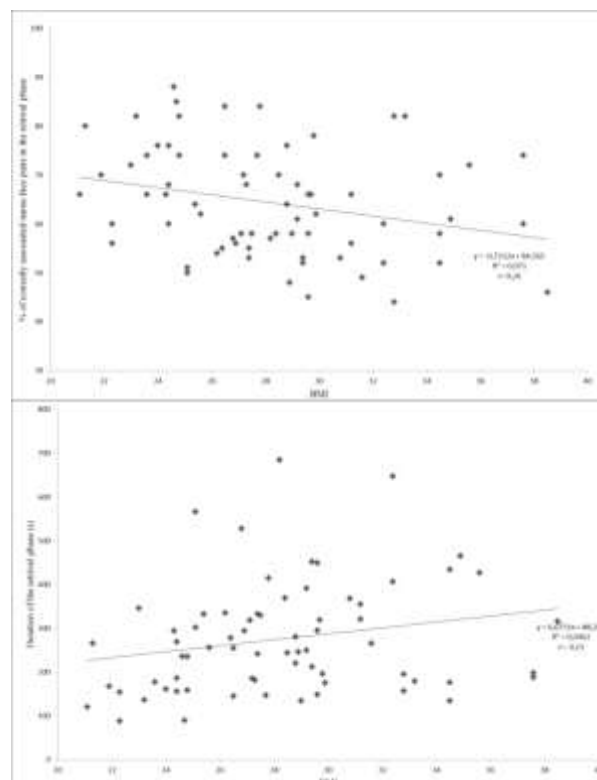


Fig. 2. Correlation between BMI and the face/name association test results in overweight and obese group. The % of correctly associated name-face pairs in the retrieval phase (a) or the duration of the retrieval phase (b) is plotted against individual BMI values

Ryc. 2. Zależność pomiędzy BMI i wyniki testu kojarzenia twarz/imię w grupie osób z nadwagą oraz w grupie osób otyłych. % twarzy poprawnie skojarzonych z imieniem w fazie odtwarzania a) średnie wartości uzyskane w poszczególnych; $p < 0,05$ b) Czas trwania fazy odtwarzania; $p < 0,05$

DISCUSSION

In this study we examined the relationship between body mass index and cognitive performance (declarative memory) in elderly, health women. The data presented in this report indicate that there is a dependence between body mass weight and declarative memory. Our studies revealed that persons with a normal body weight scored higher in the face/name test compared with the overweight ($p < 0.005$) and obese ($p < 0.005$) subject. Overweight and obese subjects demonstrated lower accuracy in name/face association task and longer times of completion for this test. We demonstrated correlation between Body Mass Index and the results of face/name association test. The increased body mass impacted negatively the percentage of names correctly associated with faces and also resulted in prolongation of the retrieval phase of the test ($p < 0.005$).

Interestingly, we did not observe any significant progression of cognitive impairment between overweight and obese groups of subjects. This observation suggests that the observed correlation between the body mass and performance in our cognitive test may be a threshold phenomenon. Even the low levels of excessive body weight may result in significant cognitive decline without significant additional decline associated with further increase in body weight.

The relationship between body weight and cognitive function is not yet completely understood. The observed differences in cognitive test performance between normal, overweight and obese group indicated the potential impact body mass has on cognitive function (declarative memory). The impact of body mass weight on the face/name association test result seems to be independent of age [8]. Moreover, the volunteers were healthy and therefore, we can exclude

impact co-existing illnesses such as hypertension or diabetes on cognitive function [9,30].

Our findings are concordant with the results from other studies which demonstrated lower levels of cognitive performance such as executive function [7,8,23] or attention and memory [10,31] in overweight and obese people. In animal models, it was also found that the cognitive parameters are influenced by obesity. In high-fat feeding models of obesity, impairments of working memory [32], learning [20], and memory performance [33,34] have been observed. However, other studies demonstrated that increased body-weight has no effect on cognitive performance [35,36]. For example, in one study overweight subject scored higher on reasoning task and visual-spatial tests than normal weight subjects [37]. Different effect of body weight on cognitive ability may be associated with other factors such as hypertension, gender, hormone levels and topological distribution of body fat, life-style and diet [30,38]

Our results are consistent with findings reported by other labs. The data strongly suggest a link between body mass and the level of cognitive performance [7,8,23]. Namely, excessive body mass appears to be an important factor in the development of cognitive dysfunction.

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Received: 26.04.2016

Accepted for publication: 28.06.2016