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Correlation of BMI and cognitive functioning tests in older people – a spurious relationship? Preliminary study

Korelacja BMI z wynikami testów poznawczych – zależność pozorna? Badania wstępne

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Abstract

Introduction. *In developed countries, public health institutions emphasize an increased health risks correlated with being overweight, including the cognitive functioning decline. In the case of older people the direction of this correlation is not well established.* ***Aim.*** *The aim of this study is to examine the correlation between body mass index (BMI) and scores of cognitive functioning assessment.* ***Material and methods.*** *In these preliminary studies 128 patients were examined. Cognitive functioning was assessed with Mini–Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA) and Trail Making Test Part B (TMT B). Body mass was evaluated based using Tanita body-fat analyzer score.* ***Results.*** *BMI correlated negatively with MoCA score (r = -0.14), Verbal Fluency (r = -0.17), and Delayed Recall (r = -0.13), and positively with MMSE score (r = 0.03) and TMT B (r = 0.1), however all the above mentioned results were not statistically significant (p > 0.05). Mean BMI in the hypertensive group was significantly greater than in normotensive (27.9 vs 25.6, p < 0.05).* ***Conclusions.*** *Linear, negative correlation between BMI and results of cognitive functioning tests was noted in some researches, however, ill-nourishment could be reflected in the low BMI value, what in turn can coexist with diminished cognitive performance. There is possibility that previous researches showed, in fact, a spurious relationship. Further*

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studies on relationship between BMI and cognitive functioning with adjustment of co-factors (fat-free mass, aerobic capacity, physical activity and blood pressure) are needed. (Gerontol Pol 2018; 26; 172-176)

Key words: *BMI, cognitive functioning, older people*

Streszczenie

Wstęp. *W krajach rozwiniętych, instytucje zdrowia publicznego podkreślają zwiększony stopień ryzyka zdrowotnego u osób z nadwagą, która skorelowana jest z gorszym funkcjonowaniem poznawczym. W przypadku osób starszych kierunek tej korelacji nie jest jednoznacznie określony.* ***Cel.*** *Celem tego badania jest sprawdzenie kierunku korelacji pomiędzy wartością BMI z wynikami oceny funkcjonowania poznawczego.* ***Materiał i metody.*** *W niniejszych, wstępnych badań przebadano 128 pacjentów. Funkcjonowanie poznawcze oceniono za pomocą skal Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA) i Test Łączenia Punktów część B (TMT B). BMI oceniano przy użyciu analizatora składu ciała Tanita.* ***Wyniki.*** *BMI korelowało ujemnie z wynikiem MoCA (r = -0,14) Fluencją Werbalną (r = -0,17) i odroczonym przypominaniem (r = - 0,13), a dodatnio z wynikiem MMSE (r = 0,03) oraz TMT B (r = 0,1), jednakże wszystkie wyżej wymienione wyniki nie były istotne statystycznie (p > 0,05). Wartość średnia BMI w grupie z nadciśnieniem jest znacznie większa niż w grupie normotensyjnej (27,9 vs. 25,6, p < 0,05).* ***Wnioski.*** *W niektórych badaniach zaobserwowano liniową, negatywną korelację pomiędzy BMI a rezultatami testów poznawczych, jednak niskie wartości BMI mogą odzwierciedlać niedożywienie, co z kolei może współistnieć z gorszymy zdolnościami poznawczymi. Istnieje możliwość, że wcześniejsze badania, które zaobserwowały zależność pomiędzy BMI a funkcjonowaniem poznawczym wykazały w istocie na pozorną korelację. Konieczne są dalsze badania, w których dodatkowo pod uwagę zostaną wzięte kofaktory, takie jak: beztłuszczowa masa ciała, wydolność tlenowa, aktywność fizyczna i poziom ciśnienia tętniczego krwi. (Gerontol Pol 2018; 26; 172-176)*

Słowa kluczowe: *BMI, funkcjonowanie poznawcze osób starszych*

Introduction

Body Mass Index (BMI) is a value defined as the body mass divided by the square of the body height, and is universally expressed in units of kg/m^2, (mass in kilograms and height in meters). According to the World Health Organization (WHO) proper BMI range is 18.5-24.99 kg/m^2, cut-off point for overweight is = 25 kg/m^2, while = 18.49 kg/m^2 for underweight [1,2], however, there is much dispute about the determination of proper BMI values in older people. Correlation between BMI and many values has been studied, however the relationship is poorly understood [3]. Previous researches gave contradictory results: some showed that low BMI, or decline of body mass is related to increased risk of Alzheimer Disease occurrence [4] and high BMI could coexist with worse cognitive performance in older people [5-7]. Some have noted an U-shape correlation, while other noted J shape relationship between BMI and cognitive functioning in the older populations [8]. Hypothetically, there could be several biological mechanisms underlying this relationship. Adipocytes produce several hormones, including estradiol and leptin, which levels, in turn, could be possibly related to cognitive functioning [9,10]. Moreover, discoveries from the last decades showed that muscle could be regarded as an endocrine organ producing myokines [11]. Based on BMI measurement solely, it is impossible to distinguish if higher score is caused by higher fat-free mass or fat mass. Therefore, at least in some cases, higher BMI in older people could indicate a positive health state, while lower scores can be caused by sarcopenia and/or osteoporosis development. Moreover, higher level of fat-free mass could be beneficial; in older people with insulin resistance and type 2 diabetes [12].

Considering all above mentioned issues, it would be interesting to estimate is there is negative or positive correlation between BMI and cognitive functioning.

Aim

The main aim of this study was to assess the correlation between BMI values with results of cognitive functioning tests among older people.

Material and methods

Patients were enrolled into studies based on advertisement in regional TV and radio, during health-promoting lectures, in Day Care Centers for the Elderly, and at various meeting-groups for older people. Initial examination was conducted in the Department and Clinic of Geriatrics, Collegium Medicum University Hospital in Bydgoszcz, Poland. In these preliminary studies 128 patients (21 men, mean age: 68.80, age range 58-88) were examined.

Cognitive functioning was assessed with Mini–Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA) and Trail Making Test Part B (TMT B).

Aerobic capacity was measured using 6-minute walk test (6MWT). Comprehensive description of examination using these tests is provided elsewhere [13].

Weight was measured using Tanita BC-545 body--fat analyzer. Measuring method used by the analyzer is bioelectric impedance analysis (BIA) made through ball-of-foot and hand electrodes. Weighing accuracy is 0.1% [14]. Patients were weighed in light clothing. Respondents themselves gave information about height and then BMI was calculated with accordance to WHO recommendations.

Blood pressure: Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were measured on one followed by another upper limb. All of the examinations were done in doctor's office, while physician was casually dressed most often, to minimize possible influence of 'white-coat' effect. Mean value for each patient's SBP and DBP from these two measurements were analyzed. Hypertension diagnosis was based on SBP > 140 and DBP > 90 mmHG.

To compare BMI value in hypertensive group *vs.* normotensive one Independent t-test was used. The strength of correlation was measured with r-Pearson test. All statistical analyses were performed using statistical package STATISTICA 12 (StatSoft, Inc.).

Results

Description of participants

Table I. Description of participants (n = 128)

Characteristics (n1, n2)	Percentage/Mean (SD)
Age	68.80 (6.08)
BMI	26.9 (4.1)
Education years > 14	41.40%
Worked/working as physical worker	18.75%
Still maintain a job position	17.96%
Hypertension diagnosis	42.6%
Current smoker	7.03%
SBP	140.57 (21.20)
DBP	83.78 (11.07)
6-minute walk test	517.31 (81.86)
TMT B	126.61 (57.74)
MoCA	23.89 (3.20)
MoCA Verbal Fluency	12.86 (4.22)
MoCA Delayed Recall	2.21 (1.61)
MMSE	27.46 (2.26)

Participants' age ranged from 58 to 88 years old were well educated, their mean years of education is 14.12 (ranged 7-23 years). Mean BMI was 26.9. Twenty-four participants were working in past, or still working as a physical employee, rest were white-collar workers or owner of a craft, service, entrepreneur or maintained/maintained other jobs. 23 participants still maintained a job position at the time of examination. Moreover, there were 9 current smokers.

Strength of correlation between values of BMI with cognitive functioning tests scores

BMI correlated negatively with MoCA score (r = -0.14), and two subtests: Verbal Fluency (r = -0.17), and Delayed Recall (r = -0.13). BMI correlated positively with MMSE score (r = 0.03) and TMT B (r = 0.1), however all above mentioned results were not statistically significant (p > 0.05).

Differences in BMI values due to the level of blood pressure and strength of correlation with 6MWT

Mean BMI value in hypertensive group was significantly greater than in normotensive one (27.9 *vs.* 25.6, t = 2.92, p < 0.01). Moreover, BMI values correlated negatively with results of 6MWT (r = -0.35, p < 0.05).

Discussion

In the above, preliminary study, correlation between BMI and cognitive functioning were assessed. According to WHO standards, BMI of patients was mildly elevated (26.9 kg/m2). Over 40% of study population had long education time (> 14 years). Usually, time of education is incorporated into assessment of socioeconomic status (SES). Nevertheless, in studies addressing the correlation between BMI and education level, no significant trend was observed among men, while obesity prevalence among women decreased along with increasing education level [15]. Results of studies in performed in developed countries show that low SES is linked with obesity [16]. In general, higher BMI values in old age can be correlated with better SES and in fact, SES, not BMI, could explain the level of cognitive functioning. For example, after including factors such as IQ at age of 11, SES and health behaviors, higher BMI was correlated with worse verbal ability [7].

A study conducted in Singapore evaluated the relationship between BMI and cognitive performance among 2.550 community-living elderly (age > 55, mean age 65.8). For the entire study group, mean BMI value was 27.9 kg/m^2. For further analysis, a subgroup of 137 individuals with low BMI (< 18 kg/m^2) was selected. In multivariable analysis, low BMI value (in the presence

of chronic comorbidity) was significantly and independently correlated with low MMSE result (≤ 23 points). However, time of education for most of these patients (60.6%) was < 6 years [16], while in the above study it was 14 years for more than 40% of group. The relationship between BMI and cognitive function was also assessed in Korean studies. 5.125 adults (age ≥ 45) with proper cognitive function measured with Korean version of the Mini-Mental State Examination (K-MMSE ≥24) were enrolled into a study. After 6 years of follow up, 358 patients developed a severe cognitive impairment (K-MMSE ≤ 17). Patients with BMI indicating overweight and obesity (≥ 25 kg/m^2) and also patients with MMSE of 24-26 at baseline were less likely to develop severe cognitive impairment. This study demonstrated a protective effect of a higher body weight and BMI value on the development of cognitive impairment among the elderly [18]. Studies conducted in Brazil have obtained similar results: increased BMI was associated with greater functionality and cognitive test scores [19].

The Health, Aging and Body Composition Study also confirmed the negative influence of high BMI value on mobility. In this study, limited mobility was defined on basis of two tests results: unable to walk 0.4 km or climb up 10 steps without resting. Elderly, who were overweight or obese had a greater risk of limited mobility. Moreover, early onset of overweight and obesity contributed to an increased risk of mobility limitations in old age [20]. Also, increase of body weight in old age can have a detrimental effect on health and mortality risk, especially among individuals who were not overweight previously. Such negative changes were not observed in patients who were initially overweight [21].

In the present study, normotensive patients had BMI of 25.6 kg/m^2, while hypertensive 27.9 kg/m^2. These results are in line with those obtained in studies conducted in Sweden. 578 elderly men took part in a reinvestigation at age of 70, after being previously identified (at age of 50) as subjects at risk for cardiovascular disease. Normotensive patients had BMI of 24.8 kg/m^2, while hypertensive 26.3 kg/m^2. Researchers demonstrated that isolated ambulatory hypertension and sustained hypertension predicted cardiovascular morbidity. Moreover, patients with high BMI and blood pressure levels had diabetes more frequently and a positive correlation for BMI value and cardiovascular disease was demonstrated. Observing an increase in blood pressure along with increasing BMI value is a common remark, regardless of ethnic group [22].

We have showed previously [13] a statistically significant correlation between results of 6-minute walk test and cognitive functioning. It is worth to re-consider results of previous studies showing a correlation between BMI and cognitive functioning [5-8]. In fact, correlation between BMI and cognitive functioning could be a spurious relationship. There are several other factors, which could explain the level of cognitive functioning and in the same time be related with higher BMI value, for example, diminished physical activity as well as decreased aerobic capacity. Moreover, overweight and obesity could coexist with hypertension and diabetes type 2, diminished physical activity and aerobic capacity. Level of these factors, rather than BMI per se, could explain cognitive function tests scores.

Conclusions

In the presented study we have showed that correlation between BMI and scores of cognitive functioning tests are statistically non-significant. However, we noted statistically significant coexistence of other factors, such as hypertension or diminished aerobic capacity with elevated BMI.

There is possibility, that results of previous researches, which showed direct correlation between BMI and cognitive functioning test scores, are, in fact, the spurious relationship. Above studies limitation is that it relies on BMI measurement only, no other anthropometric measurements, such as fat-free mass, were included into above analysis. Researches based on BMI as a variable is not free from limitations in drawing conclusions from results. Therefore, further studies which would adjust co-factors: fat-free mass, aerobic capacity, physical activity and blood pressure level, socioeconomic status and other factors are needed.

Conflict of interest
None

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