Obesity in Relation to Cognitive Functions and Subjective Wellbeing among a Group of Adult Egyptian Females

Salwa M. El Shebini, Yusr M.I Kazem, Maha I.A. Moaty, Nihad H.A. El-Arabi


Abstract: Recently controversy studies have been published relating BMI and waist circumference as indicators of obesity to cognitive functions and subjective wellbeing. The aim of this study is to explore the relation between obesity on one hand and cognitive function, and subjective wellbeing among a group of obese Egyptian females. Also to study the nutritional patterns related to our findings. Our study included a group of 53 obese Egyptian females (BMI $\geq 30$ kg/m$^2$) age range was from 40 to 70 years old. All were enrolled in a program for losing weight at the Nutrition Department, NRC. A group of 21 females matched for age, health status and social background and with BMI between 21 and 25 kg/m$^2$ were taken as controls. All included patients were subjected to the following: clinical examination, 24 hours dietary intake recall, anthropometric measurements including weight, height and waist circumference, Kendrick battery for evaluation of cognitive functions (short term memory and attention) and the Subjective well being questionnaire. SPSS (10.0) software was applied to analyze the data. Results: Significant differences were recorded ($p<0.001$) between obese cases and normal controls regarding short term memory, attention, subjective cognitive, emotional and physical status, total caloric intake and number of servings of fresh fruits and vegetables consumed daily. BMI was inversely correlated ($p<0.001$) to short term memory, attention, subjective wellbeing including cognitive, emotional and physical status, protein intake, and fresh fruits and vegetables intake. The percentage of protein intake per day was found to be correlated to short term memory and subjective cognitive status. Number of serving of fresh fruits and vegetables consumed daily were found to be correlated to subjective wellbeing. Conclusion: Obesity has negative effects on both cognitive functions and subjective wellbeing. The intake of proteins, fresh fruits and vegetables are correlated to memory and subjective wellbeing. The need for new creative methods to combat obesity pandemic and the importance of healthy diet is gaining more value every day.

Key words: Obesity, cognitive functions, subjective wellbeing, nutrition, emotional status

INTRODUCTION

Cognitive functions and subjective wellbeing seems to be somehow related to Obesity as a disease. The World Health Organization (WHO) reports that $\sim$1.6 billion adults were overweight and $\sim$400 million adults were obese in 2005. The epidemic of overweight and obesity is on the rise, and the respective values are projected to be 2.3 billion and $>$700 million, respectively, by 2015 (WHO,2009). Recently controversy results have been published relating BMI and waist circumference as indicators of obesity to cognitive functions and subjective wellbeing. A study reported that both underweight and obesity were associated with lower cognition. Long-term obesity and long-term underweight in adulthood are associated with lower cognitive scores in late midlife (Severine, 2009).

On the other hand a study reported that obesity was associated with better performance on tests of attention and visuospatial ability (Alka, 2009). The relationships between BMI and individual cognitive domains were non-linear. Overweight participants had better cognitive performance in terms of reasoning and visuospatial speed of processing than normal-weight participants (Ko Kuo, 2006). A study reported, overweight has been associated with cerebral atrophy and cerebral white matter lesions. Higher levels of all adiposity measures were associated with worsening cognitive function in men, however no association between adiposity and cognitive change in women was reported (Gunstad, 2010). But the growing evidence supports the idea that an increased body mass index (BMI) is a risk factor for dementia. Increased BMI is independently associated with increased risk of dementia (Emmanuel, 2007; Whitmer, 2005) Two other studies reported higher risk of dementia with...
increased BMI, but the association did not reach statistical significance (Gazdzinski, 2010; Cournot, 2006).

Body mass index may influence or be influenced by brain structures and functions involved in dementia processes, and have been shown to influence brain development in relationship to early and late measures of cognitive function, intelligence, and disorders of cognition. (Gustafson, 2008).

As for emotional and mood status, what we call collectively subjective well being, which is the way one perceive himself, there is a growing evidence that obesity is not only a weight problem, but it is linked to adverse neurocognitive outcomes. Besides obesity, frontal lobe based cognitive deficits in depressed patients are confirmed, and interactions between depression and obesity are known (Cserjési, 2009). In addition recent studies suggest a strong interaction between brain areas involved in cognitive, emotional, and metabolic-regulatory functions controlling body weight (Zheng, 2008). The obesity epidemic causes secondary health risks such as depression that significantly reduce the quality of life and burden the public health system. A study reported that for those trying to lose weight, normalized mood scores generally predicted a greater reduction in waist circumference stressing the relation between mood and obesity (Annesi, 2011).

Disordered eating and excess body weight may trigger each other's development. This triggers interpersonal discrepancies, low interpersonal esteem, depressive affect, and dietary problems (Urquhart, 2011). Western diet intake is associated with cognitive impairment, with a specific emphasis on learning and memory functions that are dependent on the integrity of the hippocampus (Kanoski, 2011). A high dietary fat intake may cause cognitive impairment by disrupting neurogenesis in the brain through an increase in serum corticosterone concentrations (Lindqvist, 2006).

It seems that obesity complications are spreading in all directions reaching the brain and the neurocognitive functions. The aim of this study is to explore the relation between obesity on one hand and cognitive function, and subjective wellbeing in a group of obese Egyptian females. Also to study the nutritional patterns related to our findings.

Subjects:
A group of 53 obese Egyptian females, age range was 40-70 years old. They were all working females and belong to middle social class. All were enrolled in a program for losing weight at the Nutrition Department at the National research center. Inclusion criteria for cases were BMI over 30 kg/m², and not suffering from any mental or neurological problems, no critical health problems and not receiving drugs or supplements that affects cognitive functions or mood and having blood pressure within normal range. A group of 21 females matched for age, health status and social background and with BMI between 21 and 25 kg/m² were taken as controls. Before starting this work the researcher explained the idea of the work and its aim. All participants were interested to share.

Methods:
All included females were subjected to the following: Full clinical examination, 24 hours dietary recall, anthropometric measurements including weight, height, and waist circumference (minimal waist). Kendrick Battery for evaluation of cognitive functions and Subjective well being questionnaire.

1-Food intake:
Data on dietary intake were performed using the 24 hours dietary intake recall. In order to estimate the individual food intake items, portion size as well as the amount of food left for each subjects were recorded. Any snacks taken between meals were also recorded. The total dietary intake was analyzed using the (Nutrisurvey, 2007) computer program to convert the food taken into nutrients. Total caloric intake in 24 hours was calculated. The percentage of protein, carbohydrates and fats in relation to total calories were calculated to determine the nutritional pattern of each individual. Number of fresh fruits and vegetables servings per day was recorded.

2- To evaluate cognitive functions and detection of dementia. Kendrick Battery for the Detection of Dementia was used for assessing memory status and attention (Gibson and Kindrick, 1977). The battery consists of two tests:
   a- The Object Learning Test (OLT) a test of recall of everyday objects after viewing for a brief period (assessment of memory and recalling). The OLT consists of four cards and has two forms, A and B for test-retest. It has a possible maximum score of 70. Dementia is diagnosed if the individual got a score less than 26 points, and in this case she is excluded from the study. A higher OLT score indicates better memory status.
b- The Digit Copying Test (DCT) a simple test of speed-performance (to assess attention and focus). It consists of a 10 by 10 matrix of the digits 0-9 each occurring randomly ten times within the matrix, the upper limit of the DCT is not defined. Dementia is detected if the volunteer needed 2 minutes or more to finish copying the digits. The given scores are the number of seconds needed to finish copying the matrix. The less time taken the better is the level of attention and vice-versa. Both tests are timed.

3- Subjective Well Being Questionnaire Consists of 15 Items Divided into 3 Subscales Evaluating:
   1- Cognitive functions 2-emotional status and mood 3-Physical condition. Items under evaluation are concentration, memory, depression, sense of oppression, sense of satisfaction, anger, nervousness, anxiety, recurrent headaches, sleep pattern, waking up fresh and active, fear of future, general activity, chronic diseases, sleeping during the day. A scale from 1-5 is put for each item and each individual ranks the item subjectively to evaluate herself, ranging from (1) not at all to (5) always. Maximum scoring is 75, the higher the scores the better the evaluation.

4- the Anthropometrical Examination:
   Measurements of height and body weight were taken to calculate body mass index (BMI) = weight in kg/square height in meters. Waist circumference (minimal waist) was taken as a guide to visceral adiposity. All measurements were taken by the same researcher to assure accuracy.

Study design and Statistics:
   This is a case-control study. The study was designed to compare results and data between obese cases and controls and to find the correlation between different included variables. Statistical analysis was performed using SPSS (10) software. Data are expressed as means ± SE. Paired-sample t tests compared the data between cases and controls. Pearson correlation coefficient (r) was calculated to find correlations between different variables. P value is considered significant at < 0.05.

Results:
   Table (1) presents the data as means ±SE for cases, and controls. Paired t-test was used to compare the two groups. Significant differences at P <0.01 were recorded between obese cases and normal controls regarding BMI, waist circumference, short term memory, attention, total subjective wellbeing, subjective cognitive, emotional and physical status, total caloric intake and number of servings of fresh fruits and vegetables consumed daily.

<table>
<thead>
<tr>
<th>Table 1:</th>
<th>Cases and Controls Data presented as Means ± SE. t-test for comparing means.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Cases Score Mean ± SE(n=53)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>48.7±1.7</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>34.4±1.2</td>
</tr>
<tr>
<td>Waist -cm</td>
<td>92.7±1.8</td>
</tr>
<tr>
<td>Memory OLT</td>
<td>42.3±1.07</td>
</tr>
<tr>
<td>AttentionDCT</td>
<td>70.0±3.1</td>
</tr>
<tr>
<td>T.Subjective Wellbeing</td>
<td>46.8±0.15</td>
</tr>
<tr>
<td>Subjective cognitive status</td>
<td>5.7±0.1</td>
</tr>
<tr>
<td>Subjective Emotional status</td>
<td>21.4±1.3</td>
</tr>
<tr>
<td>Subjective Physical condition</td>
<td>20.1±0.9</td>
</tr>
<tr>
<td>Total caloric intake/day(Kcal/day)</td>
<td>1742±61</td>
</tr>
<tr>
<td>#Carbohydrates</td>
<td>51±1.6</td>
</tr>
<tr>
<td>#Proteins</td>
<td>18.6±0.7</td>
</tr>
<tr>
<td>#Fats</td>
<td>29.4±2</td>
</tr>
<tr>
<td>Fresh fruits and vegetables servings/day</td>
<td>3.6±0.2</td>
</tr>
</tbody>
</table>

*P-value is significant at < 0.01  # %of total caloric intake

Table (2) presents the correlations between different variables. Correlation coefficient (r) is recorded in the table and the correlation is significant at the 0.05 level, and is highly significant at the 0.01 level. BMI is inversely correlated to short term memory, attention, subjective wellbeing including cognitive, emotional and physical status, protein intake and fresh fruits and vegetables intake. Waist circumference is inversely correlated to short term memory, attention, and subjective wellbeing including cognitive and emotional status and correlated to BMI. Memory is correlated to subjective cognitive status. Attention is correlated to total subjective wellbeing status. The percentage of protein intake was found to be correlated to short term memory and subjective cognitive status. Number of serving of fresh fruits and vegetables consumed daily were found to be correlated to subjective emotional status and mood.
Table 2: Pearson Correlations between different variables

<table>
<thead>
<tr>
<th></th>
<th>Memory</th>
<th>Attention</th>
<th>Subjective wellbeing</th>
<th>Subjective cognitive status</th>
<th>Subjective emotional status</th>
<th>Subjective physical condition</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.483*</td>
<td>0.649**</td>
<td>-0.596**</td>
<td>-0.440*</td>
<td>-0.458*</td>
<td>-0.460*</td>
<td>-</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>-0.455*</td>
<td>0.474*</td>
<td>-0.521**</td>
<td>0.424*</td>
<td>-0.448</td>
<td>NS</td>
<td>0.872**</td>
</tr>
<tr>
<td>Memory OLT</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>-</td>
</tr>
<tr>
<td>Attention DCT</td>
<td>NS</td>
<td>-0.429*</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>0.649**</td>
</tr>
<tr>
<td>Subjective wellbeing</td>
<td>NS</td>
<td>-0.429*</td>
<td>NS</td>
<td>NS</td>
<td>0.761**</td>
<td>0.663**</td>
<td>-0.596**</td>
</tr>
<tr>
<td>Protein%</td>
<td>0.438*</td>
<td>NS</td>
<td>NS</td>
<td>0.601**</td>
<td>NS</td>
<td>NS</td>
<td>-0.554**</td>
</tr>
<tr>
<td>Fresh fruits and vegetables servings/day</td>
<td>NS</td>
<td>NS</td>
<td>0.420*</td>
<td>NS</td>
<td>0.404*</td>
<td>NS</td>
<td>-0.430*</td>
</tr>
</tbody>
</table>

Numbers presented in this table are the value of $r$ =correlation coefficient

*Correlation is significant at the 0.05 level (2-tailed) **correlation is significant at the 0.01 level (2-tailed)

Discussion:

The first important finding in our study is that there is a significant difference between obese females and normal weight females regarding cognitive functions. Short term memory and attention are better in normal controls when compared with obese cases. Both BMI and waist circumference were inversely correlated to cognitive functions. Supporting our findings, previous studies mentioned that higher BMI was associated with lower cognitive scores (Cournot, 2006). Overweight and obesity, indicated by body mass index (BMI) has been found to be associated with a higher risk of dementia, dementia is the sever form of cognitive functions impairment (Gunstad, 2010). Prospective studies have shown that those with a higher BMI in midlife were at higher risk of cognitive impairment and dementia later in life and that individuals with mild cognitive impairment progress to clinically diagnosed dementia at an accelerated rate with age (Gustafon, 2008). A review by (Gorospe and Dave, 2007) supports the hypothesis that an increased body mass index is independently associated with an increased risk of dementia. Overweight and obesity may be associated with cognitive problems and both may share "neuroendocrinobiological roots" in common cerebral areas (Parisi, 2010). Cognitive decline seem more strongly related to body fat distribution, particularly visceral adipose tissue (VAT), indicated by waist circumference rather than to BMI (Emmanuel, 2007, Nancy, 2009). In our study both BMI and waist circumference are inversely correlated with cognitive functions.

While other studies showed different controversial results which reported that higher levels of all adiposity measures were associated with worsening cognitive function in men, but there was no association between adiposity and cognitive change in women (Alka, 2009). For women, a decreased obesity over time when obese in the baseline assessment and an increased obesity over time when they had a normal adiposity in the baseline assessment were both associated with cognitive decline (Han, 2009). Results suggest that the effect of obesity on cognition accumulates over the adult life course, examined over a mean duration of 36 y. This means that early detection of cognitive functions impairment is very important especially at a reversible stage (Séverine, 2009). Adiposity, may influence or be influenced by brain structures and functions involved in dementia processes. A study reported that a lower BMI is associated with prevalent dementia, potentially due to underlying brain pathologies. However, high BMI during mid-life or at least approximately 5-10 years preceding clinical dementia onset may increase risk (Gustafson D, 2008, 2004, Ko Kuo, 2006).

Trying to find explanation, a study reported that overweight has been associated with cerebral atrophy and cerebral white matter lesions (Gustafson, 2004). While prior studies have found that inflammatory factors are independently associated with cognitive decline. Some has proposed that adiposity in fetal development may influence cerebrovascular function and dementia risk (Gazdzinski, 2010). Second, adipose tissue hormones that cross the blood-brain barrier may influence brain function and health by affecting energy balance mechanisms and memory. Another possible mechanism is intrinsic differences in brain structure and function that can influence adiposity through energy homeostasis, reward, and other behavioral pathways (Zheng, 2008). Nowadays, adipose tissue should be considered as the largest endocrine organ, and it is well known that the intra-abdominal compartment is metabolically active as a source of cytokines, chemokines and hormone-like proteins, such as tumor necrosis factor-alpha (TNF-α). Thus, the role of both central obesity and the systemic action of VAT products has been proposed as factors affecting brain health and subsequent cognitive decline (Gorospe and Dave 2007).

Secondly, our study showed that there is significant difference between obese cases and normal controls regarding subjective wellbeing including subjective cognitive, emotional and physical status. Also, BMI and waist circumference are inversely correlated to subjective wellbeing including cognitive, emotional and physical status. This means that obese females have lower mood and lower self esteem than normal weight controls. This finding can be interactive, low subjective wellbeing status can lead to over eating ending with obesity, and also being obese makes the general subjective wellbeing status low.
Satisfaction with life correlates with other measures of subjective wellbeing and correlates predictably with individual characteristics and overall health. (Yiengprugsawas, 2009). The following studies supported our findings; a study reported that obese youth reported higher body dissatisfaction than overweight youth, who reported more body dissatisfaction than normal weight youth. These effects were independent of age and gender. Obese youth reported greater depressive symptoms, including negative self-esteem, and higher overall depression scores compared with overweight and normal-weight youth (Goldfield, 2010). Impairment in emotional well-being (self-esteem, depressive mood) associated with obesity is mediated by body dissatisfaction (Mond, 2011). There is a moderate association between obesity and mental disorders including mood and anxiety (Anderson, 2006). Depressive symptoms and obesity are positively related, depressive symptoms and emotional eating had positive correlation with BMI, WC, and percentage of body fat. (Konttinen, 2010). Normalized mood scores generally predicted a greater reduction in waist circumference (Annesi, 2011). Eating disorders were the most prevalent psychiatric condition followed by mood disturbance and anxiety disorders in obese subjects (Martinelli, 2011). A study reported that obese subjects had a 55% increased risk of being depressed and that depressed subjects had a 58% increased risk of being obese. The link between both is that obesity can be seen as an inflammatory state, and inflammation in turn has been associated with depression. In addition to biological mechanisms, psychological pathways should be mentioned. Association between depression and obesity are important for clinical practice, because weight gain appears to be a late consequence of depression (Luppino, 2010). Obese patients show reduced executive attention, more effortful control, than controls (Beutel, 2006). Western society emphasizes thinness for women, and the ideal female body size has become progressively smaller over the past half century. Meanwhile, the actual female body size has increased steadily. This triggers interpersonal discrepancies, low interpersonal esteem, depressive effect, and dietary problems. (Urquhart, 2011).

Recent studies explained this finding by the association between excess body weight with brain structural alterations, poorer cognitive function, and lower prefrontal glucose metabolism. Higher BMI was related to lower concentrations of N-acetyl-aspartate (NAA, a marker of neuronal integrity) in a healthy middle-aged cohort. Elevated BMI is associated with neuronal abnormalities mostly in frontal brain regions that subserve higher cognitive functions and impulse control (Gazdzinski, 2010). Serotonin-releasing brain neurons are unique in that the amount of neurotransmitter they release is normally controlled by food intake. Serotonin release is also involved in such functions as sleep onset, and control of mood. Hence many people learn to overeat carbohydrates to make themselves feel better. This tendency is a frequent cause of weight gain, and can also be seen in patients who become fat when exposed to stress (Wurtman, 1995). The addition of cognitive therapy while trying to lose weight might not only be effective in reducing weight and related concerns, depressed mood, and low self-esteem, but also has an enduring effect that lasts beyond the end of treatment (Werrij, 2009).

The third important finding, concerning the dietary pattern is the significant difference in number of servings of fresh fruits and vegetables consumed daily between obese females and normal controls, normal controls consume more fresh fruits and vegetables. An inverse correlation between BMI and consumption of fresh fruits and vegetables was recorded. Some previous studies supported this finding and reported that high fruit and vegetable intakes may be recommended to reduce the risk of weight gain (Brian, 2009). Fruit and vegetables have a low energy density because of their high content of water, low content of energy and high content of dietary fiber, which is considered to increase satiety and reduce feelings of hunger, they may also displace other high-energy-dense foods from the diet. Finally, they also contain flavonoids, a group of nonnutritive phytochemicals that may have anti obesity effects (Marjaana, 2002). Dietary patterns characterized by high amounts of fruit and vegetables relate to smaller weight gains and to a lower risk of overweight and obesity in prospective studies conducted in adult populations with different cultural backgrounds. Consuming a diet high in fruit, vegetables, reduced-fat dairy, and whole grains and low in red and processed meat, fast food and soda was associated with smaller gains in BMI and waist circumference (Jytte, 2006). Dietary patterns that include high intakes of energy and sweetened drinks and low consumption of fruits, vegetables and fiber are associated with obesity (Soltero, 2011). However, some prospective studies reported that fruit and vegetable intake was not associated with change in body weight or waist circumference (Brian, 2009).

Also the number of serving of fresh fruits and vegetables consumed daily were found to be correlated to subjective emotional status and mood. A study reported that a healthy Japanese dietary pattern characterized by high intakes of vegetables and fruit was associated with fewer depressive symptoms (Nanri, 2010). Healthy subjects of any age with a high daily intake of fruits and vegetables have higher antioxidant levels, lower levels of biomarkers of oxidative stress, and better cognitive performance than healthy subjects of any age consuming low amounts of fruits and vegetables. (Cristina, 2009).
In our study, the percentage of protein intake was found to be correlated to short term memory, and subjective cognitive status. In addition an inverse correlation between BMI and consumption of proteins was found. Supporting this finding a previous study reported that high protein (HP) intake improve reaction time significantly compared with the low protein intake. Branched chain amino acids and phenylalanine in plasma were significantly increased following the HP diet, which may explain the improved reaction time. Research has also shown that high protein diets such as Atkins is often more successful in helping people to lose weight, at least during the first few months of a weight loss plan (Gardner, 2007). Increased protein intakes prevent weight regain and preserve muscle function in obese subjects, and in addition, improve cognitive function measured by reaction time in healthy young males (Jakobsen, 2011). An increase in dietary protein from 15% to 30% of energy at a constant carbohydrate intake results in significant weight loss. The anorexic effect of protein may contribute to the weight loss produced. (David, 2005). Intervention studies show that a protein-rich diet during both a weight-loss and a weight-maintenance period or the addition of extra protein to a diet during a weight-maintenance period resulted in the better maintenance of previous total or abdominal weight loss (or both). A possible explanation of this effect may be that protein, compared with other macronutrients, induces a greater degree of satiety and possibly a greater energy expenditure and diet-induced thermogenesis (Denova-Gutiérrez, 2011).

In our study, no significant difference was found between obese group and normal weight group regarding the percentage of intake of fat and carbohydrates. Proteins intake is higher in normal controls than obese cases but not statistically significant. This can be explained by the fact that in our study both obese cases and normal controls have similar dietary patterns, both receive almost 50% of their total caloric intake from carbohydrates, and almost 30% from fats, while their intake of protein is 18.6% for cases and 20.3% for normal controls, with a little more intake of proteins in controls, and this part agree with previous studies which reported that total protein was inversely associated with BMI (David, 2005). In our study a significant increase in total caloric intake was seen among the obese group. Opposing our findings a study reported that neither total energy intake nor energy intake from each of the macronutrients was associated with waist circumference, as an indicator of obesity. Another study indicated that the sources of energy and not total energy may be important to prevent obesity. (Jytte 2006). Intake of saturated fats and simple carbohydrates, two of the primary components of a modern Western diet, is linked with the development of obesity in part, by interfering with a type of hippocampal-dependent memory inhibition (Kanoski, 2011).

In conclusion:
Our study suggests that obesity is correlated to cognitive function impairment and to lower subjective wellbeing in adult females, affecting the quality of life in a very big population. Obesity is a disease that can be treated. Knowing that obesity complication is spreading to affect the neurocognitive functions and if not stopped will increase the incidence of dementia and depression, should be a triggering power to prevent and stop obesity.

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