

## ORIGINAL ARTICLE

## RELATIONSHIP OF BODY MASS INDEX AND WAIST HIP RATIO WITH SCORES OF DEPRESSION, ANXIETY AND ACADEMIC PERFORMANCE IN FEMALES

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**Background:** Enhanced adipose tissue is likely to affect an individual's mental health. This study aimed to link its indices (BMI/WHR) with indices of depression/anxiety in female medical students. **Methods:** One hundred and six female medical students were equally divided into non-obese ( $BMI \leq 24.9 + WHR < 0.8$ ) and obese ( $BMI > 24.9 + WHR \geq 0.8$ ) groups. Depression/anxiety scores were calculated using Aga Khan University Anxiety Depression Scale (AKUADS), Beck's Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) while last exam percentage was considered as an indicator of academic performance. **Results:** AKUADS and BDI scores of obese subjects were higher than those of non-obese subjects ( $p=0.018$  and  $p=0.030$  respectively) while academic score of obese subjects was lesser than that of non-obese subjects ( $p < 0.0001$ ). Within non-obese and obese subjects, and within total study population AKUADS scores were positively correlated to BMI and WHR ( $\rho=0.39$ ,  $p=0.00$ ), ( $\rho=0.38$ ,  $p=0.00$ ), ( $\rho=0.36$ ,  $p=0.00$ ), ( $\rho=0.38$ ,  $p=0.00$ ) and ( $\rho=0.35$ ,  $p=0.00$ ), ( $\rho=0.35$ ,  $p=0.00$ ) respectively. BDI scores within non-obese group, obese group, and in total population were positively correlated to BMI and WHR too ( $\rho=0.40$ ,  $p=0.00$ ), ( $\rho=0.40$ ,  $p=0.00$ ), ( $\rho=0.32$ ,  $p=0.01$ ), ( $\rho=0.34$ ,  $p=0.01$ ), and ( $\rho=0.30$ ,  $p=0.00$ ), ( $\rho=0.31$ ,  $p=0.00$ ) respectively. AKUADS and BDI scores had a negative correlation with academic score in both non-obese and obese subjects ( $\rho=-0.29$ ,  $p=0.03$ ), ( $\rho=-0.30$ ,  $p=0.02$ ), and ( $\rho=-0.44$ ,  $p=0.00$ ), ( $\rho=-0.35$ ,  $p=0.00$ ) respectively. **Conclusion:** Within obese female medical students enhanced degree of depression/anxiety affects academic performance considerably; this calls for shrewder monitoring of their mental wellbeing.

**Keywords:** Depression, anxiety, obesity, female medical students, medical education, academic score

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## INTRODUCTION

Depression is a common mental disorder characterized by 'a feeling of persistent sadness and a lack of interest or pleasure in activities which used to be rewarding or enjoyable previously'<sup>1</sup> while anxiety is described as 'a feeling of uneasiness and undue concern to a situation that is only subjectively seen as menacing'.<sup>2</sup> Of the most reliably used inventories to deduce the degree of depression and/or anxiety, within a population, are the Aga Khan University Anxiety and Depression Scale (AKUADS), Beck's Depression Inventory (BDI) and Beck Anxiety Inventory (BAI).

Out of many psychological, social and biological factors governing depression and anxiety, obesity has become a cause of concern in recent times since it has been found that obese individuals are not only at a greater risk of development of aforementioned psychiatric disorders<sup>3</sup> but they perform poorly at various fronts of everyday life<sup>4</sup> (e.g., academic<sup>5</sup>) too.

The World Health Organization (WHO) describes obesity as a medical condition in which excessively accumulated fat in the body may have started to adversely affect health of an individual.<sup>6</sup> The extent of obesity can be evaluated through a myriad of indices, of

which the two most frequently adopted ones are Body Mass Index (BMI) and Waist Hip Ratio (WHR).<sup>7</sup>

Since, obese women are more likely to harbour stress disorders, contemporary researchers have been trying to correlate anthropometric parameters of obesity (like BMI, Waist Circumference, Hip Circumference and WHR) with scores of depression and anxiety<sup>8</sup> in their quest to settle the myriad of pathophysiologicals responsible for emergence of stress disorders in them.

Studies have deduced that several endocrine abnormalities tend to exist in obese women with reported changes of BMI and WHR which lead to development of depression and anxiety through several intricate pathways. One of the most probable endocrine parameter likely to be deranged in obese women with shifts in BMI and WHR is their serum oestrogen level.<sup>9</sup> Researchers suggest that effect of oestrogen on mood is due to its ability to increase the levels of serotonin and beta-endorphins which are the major neurotransmitters associated with the development of mental states that harbour the feeling of generalized wellbeing and content.<sup>10</sup>

Certain recent studies have shown that expression of oestrogen receptor  $\alpha$  gene is reduced in obese females (as compared to normal weight females)<sup>11</sup>

which is likely to reduce the positive effect of oestrogen on serotonin levels and hence is likely to result in the development of psycho-psychiatric disorders in obese women<sup>12</sup>. Moreover, conditions like Polycystic Ovarian Syndrome (PCOS –low oestrogen state) are also associated with low levels of serotonin and women harbouring them report more symptoms of depression and anxiety.<sup>13</sup> All these facts put together, do suggest that obese females are likely to be at an increased risk of development of mood disturbances.<sup>14</sup>

In this study, we tried to explore if obese female medical students are likely to have low serotonin levels and hence are likely to depict more obvious symptoms of depression and anxiety which in turn is likely to affect their academic performance in a negative fashion.

### SUBJECTS AND METHODS

It was a cross-sectional comparative study conducted at various medical institutes of Multan between the months of January and June 2020. The sample size was calculated with a power of 90% and an alpha level of 5% by using the formula:

$$n = \frac{\sigma^2 (Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_0 - \mu_1)^2}$$

from the WHO software ‘Sample size determination in health studies–A practical manual<sup>15</sup> version 2.0.21.

One hundred and six (106) age and ethnicity matched female subjects (aged 18–23 years) were selected through convenience sampling. Subjects were equally divided into two groups. Group A consisted of 53 non-obese female subjects (controls, BMI≤24.9 and WHR<0.8)<sup>16</sup>, while Group B had 53 obese female subjects (BMI>24.9 and WHR≥0.81)<sup>16</sup>. Students with a BMI>30 and/or WHR>0.94 (morbidly obese females<sup>16</sup>) with family history of depression, with previous history of psychiatric illness and/or drug abuse were excluded.

Data was collected after taking written informed consent, from the subjects on a specifically developed proforma. Portable weighing machine was used to measure weight (in Kg), and portable height/length measuring board was used to measure height (m). Waist Circumference (WC) and Hip Circumference (HC) were recorded on WHO procedures of 2008 guidelines. BMI and WHR were derived through standard formulas using these indices. To deduce the degree of depression and/or anxiety AKUDAS (a 25-item, 13 psychological, 12 somatic) questionnaire, available in both English and Urdu was used. The questions were answered numerically (0–4, based on the mood pattern of past 2 weeks)<sup>17</sup>. It has a Cronbach’s alpha value of 0.83.<sup>18</sup> BDI-II [a self-reporting questionnaire used worldwide is actually a modified form of its original version (1961) which consists of 21-items, each of which is ranked by subject between 0 and 3 as per severity of features experienced over last 2

weeks. The scores of each question, when added up, determine the intensity of depression (the minimum score being zero and maximum being 63).<sup>19</sup> It has a Cronbach’s alpha value between 0.75 and 0.92<sup>20</sup>, and BAI based on 4-point Likert scale consists of 21 items for assessment of anxiety as a disorder apart from depressive ailment. Calculation and criteria for BAI is the same as that for BDI, with a range of 0–3 for severity of features.<sup>21</sup> It has a Cronbach’s alpha value of 0.92<sup>22</sup> scales were utilized while percentage of academic score (AS) achieved in last professional exam was considered as an indicator of academia.

The data was entered in IBM SPSS-25 and it was analysed first for normality distribution via Shapiro-Wilk and Kolmogorov Smirnov tests. Most of study parameters were non normally distributed and hence non parametric tests were chosen for inferential statistics. Mann-Whitney U Test was applied to compare [Median (IQR)] scores of anxiety, depression and academic performance (of both groups) while Spearman’s rho correlation was used to derive correlations between psychiatric and anthropometric parameters.

### RESULTS

General characteristics of both the study groups have been presented in Table-1. The AKUADS and BDI scores of Group B subjects were higher ( $p=0.018$  and  $p=0.030$  respectively) than AKUADS and BDI scores of Group A subjects while academic score (AS) of Group B subjects was lesser than academic score of Group A subjects ( $p=0.000$ ). This comparison, drawn through application of Mann-Whitney U Test has been represented in Table-2.

**Table-1: Median (IQR) of (non-normally distributed) study parameters**

| Parameter      | Group A (Non-Obese)<br>n=53 | Group B (Obese)<br>n=53 |
|----------------|-----------------------------|-------------------------|
| Age (Year)     | 19.0 (19.0–23.0)            | 22.0 (19.0–23.0)        |
| Height (meter) | 1.59 (1.48–1.67)            | 1.58 (1.47–1.70)        |
| Weight (Kg)    | 50 (39–64)                  | 65 (55–79)              |
| BMI            | 19.50 (16.2–24.0)           | 26.4 (25.0–31.1)        |
| WC (Cm)        | 72 (52–80)                  | 86 (77–96)              |
| HC (Cm)        | 97 (80–109)                 | 101 (94–106)            |
| WHR            | 0.75 (0.64–0.80)            | 0.84 (0.80–0.92)        |

**Table-2: Comparison of AKUADS, BDI, BAI and academic scores of non-obese and obese subjects [Median (IQR)]**

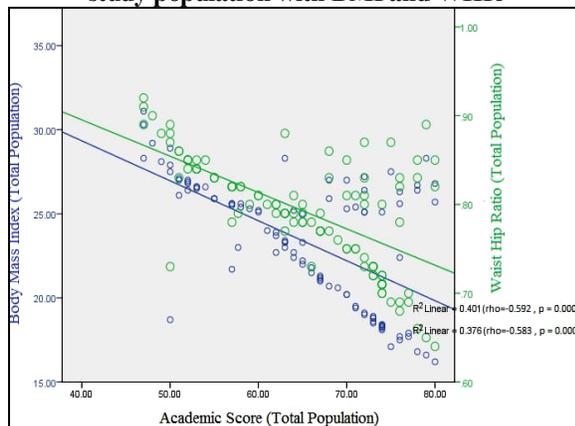
| Parameter | Group A (Non Obese) | Group B (Obese) | p     |
|-----------|---------------------|-----------------|-------|
| AKUADS    | 19 (1–60)           | 29 (1–64)       | 0.018 |
| BDI       | 14 (1–48)           | 26 (1–50)       | 0.030 |
| AS        | 71 (50–80)          | 57 (47–80)      | 0.000 |
| BAI       | 15 (1–60)           | 10 (1–53)       | 0.137 |

Within the subjects of Group A, AKUADS and BDI scores were positively correlated to BMI and WHR and inversely to AS and so was true for Group B (Table-3).

**Table-3: Correlation of AKUADS, BDI and BAI scores with BMI, WHR and academic score within the groups**

| Parameter | Group A (Non Obese) |          |            |          |            |          | Group B (Obese) |          |            |          |            |          |
|-----------|---------------------|----------|------------|----------|------------|----------|-----------------|----------|------------|----------|------------|----------|
|           | BMI                 |          | WHR        |          | AS         |          | BMI             |          | WHR        |          | AS         |          |
|           | <i>rho</i>          | <i>p</i> | <i>rho</i> | <i>p</i> | <i>rho</i> | <i>p</i> | <i>rho</i>      | <i>p</i> | <i>rho</i> | <i>p</i> | <i>rho</i> | <i>p</i> |
| AKUADS    | 0.397               | 0.003    | 0.389      | 0.004    | -0.295     | 0.032    | 0.366           | 0.007    | 0.383      | 0.005    | -0.440     | 0.001    |
| BDI       | 0.407               | 0.002    | 0.408      | 0.002    | -0.305     | 0.026    | 0.328           | 0.017    | 0.342      | 0.012    | -0.355     | 0.009    |
| BAI       | -0.208              | 0.135    | -0.191     | 0.170    | 0.183      | 0.190    | 0.160           | 0.254    | 0.189      | 0.176    | -0.254     | 0.066    |

Academic scores of the subjects in Group A had a negative correlation with both the indices of obesity in use, i.e., BMI and WHR ( $rho = -0.884$ ,  $p = 0.000$ ) and ( $rho = -0.880$ ,  $p = 0.000$ ) respectively, and so was observed within Group B ( $rho = -0.463$ ,  $p = 0.000$ ) and ( $rho = -0.486$ ,  $p = 0.000$ ) respectively. Also for the whole of study population a negative correlation was seen between academic performance and indices of obesity (Figure-1).

**Figure-1: Correlation of academic score of total study population with BMI and WHR**

BAI scores were neither significantly different between Group A [15 (1–60)] and Group B [10 (1–53)] subjects ( $p = 0.137$ ), nor showed a significant inverse correlation with academic performance in either of the groups ( $rho = 0.183$ ,  $p = 0.190$ ) and ( $rho = -0.254$ ,  $p = 0.066$ ) respectively. BAI scores neither within Group A nor within Group B had a significant correlation with BMI and/or WHR ( $rho = -0.208$ ,  $p = 0.135$ ), ( $rho = -0.191$ ,  $p = 0.170$ ) and ( $rho = 0.160$ ,  $p = 0.254$ ), ( $rho = 0.189$ ,  $p = 0.176$ ) respectively. Even for the whole of study population put together, a significant correlation of BAI with BMI, WHR and AS could not be derived ( $rho = -0.131$ ,  $p = 0.182$ ), ( $rho = -0.119$ ,  $p = 0.223$ ), and ( $rho = -0.026$ ,  $p = 0.792$ ) respectively.

## DISCUSSION

AKUADS and BDI scores of obese individuals of Group B were markedly higher than the scores of non-obese individuals of Group A, a fact which has been highlighted by others<sup>23</sup>. The former did not show as good a performance on academic front as the latter indicating that depression caused by obesity-induced

pathophysiological changes affect academic performance in a negative fashion.<sup>24</sup>

Some studies have been trying to correlate anthropometric parameters of obesity (such as BMI, WC, HC and WHR) with scores of depression and anxiety in females as an enhanced adiposity status adversely affects their psychiatric wellbeing in several ways. One of several probable pathophysiological causes of these is deranged oestrogen level in obese females which lowers the levels of mood related neurotransmitters (like serotonin and beta-endorphins) in them and hence reduces the feeling of generalized wellbeing and content which in turn can result in an enhanced degree of depression and/or anxiety.<sup>25</sup>

AKUADS and BDI scores (in individual study groups) were positively related to both the indices of obesity, i.e., BMI and WHR. It has been reported that oestrogen within the serotonergic pathways affects the productivity and/or responsiveness of serotonergic receptors within mood controlling centres, e.g., in raphe nucleus. Since obesity is associated with reduced levels and/or resistance to oestrogen, a reduced serotonergic push on mental wellbeing of obese females is evitable, providing a fertile ground for emergence of common mood disorders like depression and anxiety.<sup>25</sup>

An enhanced adiposity status leads to deranged levels of leptin as well as leptin resistance<sup>26</sup> which in turn can reduce the effects of leptin on both NMDA (N-methyl D-aspartate) and  $\alpha$ -amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA) receptors within the mood controlling pathways.<sup>27</sup> This is most likely to result in the development of depressive disorders within obese females. This postulate, could have been the reason for the results of our study where we found that indices of obesity are positively correlated to indices of psychiatric wellbeing.

Indices of psychiatric wellbeing (AKUADS and BDI) as well as indices of obesity (BMI and WHR) had a negative correlation with academic performance, both within individual study groups as well as within whole of study population. This is in line with results of another study that projects that enhanced WHR and BMI (through intricate pathways already described) lead to an enhanced degree of stress disorders which makes obese individuals to cope with academic stress in a poorer way hence leading to poor academic scores.<sup>28</sup>

As the fat mass enhances, it affects neuroendocrine<sup>29</sup>, hypothalamo-pituitary adrenal<sup>30</sup> and serotonergic axis<sup>31</sup> in a negative fashion which becomes

the base over which obese females do develop stress disorders which puts them in a vicious circle of derangements of homeostatic pathways that keep on affecting their mental capacities and hence their academia in the long run.

Though studies have found that BAI scores are positively correlated to indices of obesity<sup>32</sup> and are negatively associated with academic performance of students<sup>33</sup>, we could not derive such a finding. BAI scores, as per our results, neither had a positive correlation with BMI and WHR nor a negative one with AS. Since we could detect anxiety through AKUADS score and link that negatively to academic performance of study subjects, we conclude that BAI (most likely) is not a sound parameter to judge anxiety, and that AKUADS is a better and accurate indicator of degree of anxiety in the aforementioned population.

## CONCLUSION

Obese students harbour significantly higher degree of depression and/or anxiety, as compared to their age and ethnicity matched non-obese counterparts, and they are more likely to collapse under academic and non-academic stress. Parents and educationists should be made aware to keep a vigilant eye on the mental wellbeing of their obese female students so that psychiatric collapses in them could be prevented.

## LIMITATIONS & RECOMMENDATIONS

Our study was based on a single time observation, limited to a small sample size comprising of female subjects only. Cohort studies with enhanced samples comprising of both genders for future researchers are recommended.

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**HH:** Conception, commencement, supervision of field work, statistical analysis and referencing

**MA:** Fieldwork, scripting and referencing

**HN:** Fieldwork, scripting and referencing

**AM:** Fieldwork, scripting and referencing

**MS:** Fieldwork, scripting and referencing

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