The Impact of Body Weight on Blood Pressure and Some Laboratory Tests among Females at Different Ages in Cairo

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Abstract: Background: Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems. Micronutrient deficiencies have been found in obese individuals across age groups worldwide. **Objective:** To examine the effect BMI on blood pressure and various laboratory parameters among females at different ages in Cairo. **Methods:** Subjects of our study were females living in Cairo governorate from 6 years up to 60 years. The data was collected as cross sectional study from 21 randomly selected elementary & secondary schools of Cairo governorate, and clinics of NNI for adult females. Weight and height were determined and body mass index (BMI) was calculated for each age category according to the World Health Organization classification (WHO). Blood hemoglobin, fasting blood glucose, Total blood lipids which include (serum cholesterol, serum triglyceride, high density lipoprotein and low density lipoprotein), and vitamin A & E were determined for each participants. **Results:** Among all age groups the mean levels of systolic & diastolic blood pressure increased with increased body weight categories. The mean glucose level showed higher statistical level among obese females aged 12-18 years compared to normal body weight. Lipid profile mean levels showed no statistical differences in relation to body weight categories among age groups 6-12 and12-18years. Among age >18years the level of Cholesterol and low density lipoprotein (L.D.L) showed statistical rise among obese compared to overweight females. Triglycerides levels were found to increase with the increase in body weight category although not significant. While the mean levels of vitamin A and vitamin E showed no statistical differences in relation to body weight categories among age groups 6-12yand12-18years, the mean levels of vitamin A and vitamin E among age >18years showed lower serum levels among over weights compared to normal body weight females which was statistically significant with vitamin A but not with vitamin E. **Conclusion:** Obesity increase morbidity and affect the quality of life among females of different ages and that effect increased with increasing the age. This ranks obesity among the major determinants of health care costs.

[Sahar A. Khairy; Hala M. Abdelsalam; Wafaa A. Fahmy; Sahar A. Ibrahim and Maysa A.Samy. **The Impact of Body Weight on Blood Pressure and Some Laboratory Tests among Females at Different Ages in Cairo**. *Nat Sci* 2012;10(12):241-246]. (ISSN: 1545-0740). http://www.sciencepub.net/nature. 36

Key words: obesity, Females, Children, Adults, Adolescents, Cairo, Vitamin A & E, Blood pressure, Anaemia

1. Introduction

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health, leading to reduced life expectancy and/or increased health problems **WHO, 2000** [**1**]**.** Children body fatness changes over the years as they grow. In addition, girls and boys differ in their body fatness as they mature [**2**]. Obesity increases the risk of many physical and mental conditions. These co-morbidities are most commonly shown in metabolic syndrome,[**3**] a combination of medical disorders which includes: diabetes mellitus type 2,high blood pressure, high blood cholesterol, and high triglyceride levels [**4**]**.** Complications are either directly caused by obesity or indirectly related through mechanisms sharing a common cause such as a poor diet or a sedentary lifestyle. The strength of the link between obesity and specific conditions varies. One of the strongest is the link with type 2 diabetes. Excess body fat underlies 64% of cases of diabetes in men and 77% of cases in women [**3**]**.** Health consequences fall into two broad categories: those attributable to the effects of increased fat mass (such as osteoarthritis, obstructive sleep apnea, social stigmatization) and those due to the increased number of fat cells (diabetes, cancer, cardiovascular disease, non-alcoholic fatty liver disease) [**4**]**.** Increases in body fat alter the body's response to insulin, potentially leading to insulin resistance. Increased fat also creates a pro inflammatory state, and a prothrombotic state [**5**]. The presence of nutritional deficiencies in overweight and obesity may seem paradoxical in light of the evidence of excess caloric intake, but a growing body of literature has documented that several micronutrient deficiencies may be higher in prevalence in overweight and obese adults and children, particularly in those suffering from extreme obesity (BMI > 40kg/m2 in adults and ≥ 99th percentile in children).

2. Subjects and Methods

Ethical considerations

This study is a part of a larger study, that included other age groups, which was carried out in collaboration with Academy of Scientific Research and Technology& Research Unite of Ministry of Health & National Nutrition Institute from 2003-2007. Written informed consent from all participant families was sort prior to their enrolment into the study.

Participants

Subjects of our study were females living in Cairo governorate from 6 years up to 60 years. The data was collected as cross sectional study from 21 randomly selected elementary & secondary schools of Cairo governorate, and clinics of NNI for adult females. Total number of the examined sample was 1029, the number of children (6-12 y) was 453, the number of adolescents (12-18 y) was 576 and adult females in the sample were 730. Weight and height were determined and BMI was calculated for each age category according to the WHO. For children under 12 years weight for height Z- scores was assessed and the following categories of weight status were determined: Wasting <-2SD.Normal – 2 to + 2SD.Overweight > + 2SD. For adolescents from 12-18 years old the percentile body mass index "BMI"/age were used. The following categories of weight status were determined: Underweight: $<5^{th}$ percentile Normal weight: 5^{th} - $<85^{th}$ percentile Overweight: 85^{th} - $<95^{th}$ percentile Obese: $\geq 95^{th}$ percentile Height status for adolescents was assessed [6]. Weight and height for adults were used to compute BMI {wt (kg)/Ht2 (meter)} and classification of weight status was used according to **WHO, 2000** [**1**]**.** The following categories of weight status were determined; based on the value of BMI: Underweight: <18.5 Normal: 18.5 – 24.9, Pre-obese: > 25-29.9, Obesity: ≥30 Class I: 30-34.9; Class II: 35-39.9; Class III: > 40. Under weight category were excluded from the study. Hypertension was diagnosed if systolic was more than 140 mmHg and diastolic more than 90 mmHg.

The attendance of the National Nutrition Institute clinics were convinced by the name of the project, so they were mostly within body weight category overweight and obese subjects with least percentage of normal weight subjects exposing the sample among adult females to selection bias.

Biochemical Parameters Determination: Blood Samples:

A venous blood sample of 5 ml was collected in heparinized tubes from 50% of total selected subjects. Blood hemoglobin was immediately determined and the rest of the blood was centrifuged to obtain the plasma. The plasma was divided into aliquots in five Ependorf vials and stored at – 20'c for the analysis, according to **Wintrobe, 1965** [**7**] **and Miale, 1982** [**8**]**.** On each vial the ID and the name of the subject was recorded. With the collected plasma, the following parameters were determined. Determination of hemoglobin was done according to the kit of stanbio procedure No. 0320, 0321 and 0325. Quantitative colorimetric determination of hemoglobin in the whole blood. WHO's Hemoglobin thresholds used to define anemia **WHO , 2008** [**9**]**.** . Determination of blood sugar was done according to **enzymatic** Colorimetric method of **Trinder, 1969** [**10**]**.**. Reference range for fasting blood glucose is 75 – 115 mg/dl [**11**]**.**

Total blood lipids which include (serum cholesterol, serum triglyceride, high density lipoprotein and low density lipoprotein).Cholesterol levels determination were done by using cholesterol oxidase of bacterial origin. Reference range for total cholesterol is as follows: For child 120- 200 mg/dl, adolescent 120 - 210 mg/dl and for adult 140 - 310 mg/dl [**12**]**.** Serum triglycerides were determined according to the colorimetric method of **Fossati and Principe, 1982** [**13**]**,** using the Biocon enzymatic kit. Reference range for Serum triglycerides is 30 – 150mg/dl [**13**]**.**

High density lipoprotein was determined according to the method of **Gordon, *et al.*, 1977** [**14**]**.** using Biocon enzymatic kit. Its reference ranges for females in different ages are considered according to [**12**]**.** Low density lipoprotein were calculated through this equation: (Total cholesterol – HDL – TG / 5) (Normal range :150 -190 mg / dl) [**15**]**.Vitamins: Vitamin A,** was determined by using high pressure liquid chromatography (HPLC) technique according to **WHO/UNICEF,1994** [**16**]**. and Bieri *et al.*, 1979** [**17**]**.** The reference values for vitamin A (RETINOL) in different age groups were determined according to **(Ross ,2006)** [**18**]**.**. **Vitamin E**, (α-Tocopherol) was determined according to **Bieri *et al.*, 1979** [**17**]**..**The reference values for vitamin E in different age groups were determined according ot **Traber , 2006** [**19**]**.**

Statistical Analysis

Statistic analysis was performed using the Statistical Package for Social Sciences (SPSS, version 17.0) for Windows. Controls and obese patients were compared using chi-squared (χ^2) test. The strength of the association between the substances was estimated by Pearson correlation coefficient.

3. Results:

Table (1) demonstrated that the examined sample were 1759 females, the number of children (6-<12 y) were 453, the number of adolescents (12-18 y) were 576 and, the number of adult females were 730. Obesity represented 40% among primary school children in the studied group and it was 47.8 % for adolescent females and the highest percent was for adult females (88.3%) among the studied group. Table

(2) demonstrated that in all age groups ,there were significance difference between subgroups(normal, overweight and obese) as regards weight ,waist and hip circumference(*p* value < 0.0005). Waist and hip circumference increased with increased weight status.

1-Blood pressure status

Table (3) showed that the mean levels of systolic & diastolic blood pressure increased with increased body weight categories in females above age of 12 years.

2-Haemoglobin and glucose status

Mean levels of haemoglobin was more or less the same among different age and body weight categories.

The mean levels of glucose showed statistical higher level among obese females aged 12-18years compared to normal body weight females. (Table 4)

3-Lipid profile status

Lipid profile mean levels showed no statistical differences in relation to body weight categories among age groups 6-12yand12-18years. While among age >18years the level of Cholesterol and low density lipoprotein (LDL) showed statistical rise among obese compared to overweight females. Triglycerides levels were found to increase with the increase in body weight category although not significant. (Table 5)

4-Vitamin A and E

Mean levels of vitamin A and vitamin E showed no statistical differences in relation to body weight categories among age group 6-12yand12-18years. While among age >18years vitamin A mean level showed statistically lower level among over weights compared to normal body weight females, also statistically lowered level of mean serum vitamin E was detected among overweight and obese compared to normal body weight females. (Table 6)

Table (1): Percent distribution of the studied sample by age and body weight categories

Age categories	Normal		Overweight		Obese		Total	
	No.	**%**	No.	%	No.	%	No.	**%**
6 - 12	**139**	30.6	132	29.1	182	40.1	453	100.0
12- 18	124	21.5	171	29.6	281	48.7	576	100.0
>18	11	1.5	74	10.1	645	88.3	**730**	100.0
Total	274	15.5	377	21.4	1108	62.9	1759	100.0

Table (2): Mean anthropometric measures of the studied sample by age and body weight categories.

Anthropometric measurements	Normal		Overweight		Obese		*P* – value
	Mean	±SD	Mean	±SD	Mean	±SD	
6-12years							
Weight	41.6	±8.10	48.6	±11.40	48.5	±13.26	0.000*
Height	138.1	±8.55	139.4	±11.72	137.7	±12.63	0.094
Waist	68.91	±10.41	75.4	±7.8	80	±2.62	0.000*
Hip	81.70	±10.4	88.50	±	92.6	±17.3	0.000*
Weight/ Height (Z- score)	1.14	±0.75	2.501	±0.28	4.5	±	0.000*
12-18years							
Weight	55.5	±8.15	69.9	±10.88	87.1	±18.18	0.000*
Height	160.1	±6.16	158.8	±6.09	158.7	±8.67	0.043*
Waist	69.6	±13.7	83.6	±8.9	99.7	±12.6	0.000*
Hip	90.6	±13.7	103.8	±8.4	115.5	±11.3	0.000*
Percentile BMI	21.6	±2.81	27.7	±4.11	34.8	±6.75	0.000*
>18years							
Weight	56.2	±11.43	72.3	±8.72	99.6	±17.11	0.000*
Height	153.8	±12.65	159.1	±8.71	159.0	±6.21	0.000*
Waist	80.3	±7.0	86.8	±7.5	100	±13.94	0.000*
Hip	100	±6.5	106.1	±13.6	125	±16.1	0.000*
BMI	23.4	±1.52	28.4	±1.20	39.5	±7.30	0.000*

Tab(3): Mean blood pressure (±SD) among the studied sample by age and weight categories

Variables	Weight categories (Mean±SD)			*P*–value
	Normal	Overweight	Obese	
6-12years				
• Mean systolic B.P. ±SD	104.94±16.6	101.97±23.5	104.01±19.7	0.964

• Mean diastolic B.P. ±SD	68.96±11.64	67.27±16.66	68.54±18.3	0.934
12-18years				
• Mean systolic B.P.±SD	106.67±15.8	111.32±14.1	115.91±13.98	0.000*
• Mean diastolic B.P. ±SD	68.33±11.12	73.88±10.2	77.11±10.11	0.000*
>18years				
• Mean systolic B.P. ±SD	105.0±13.23	113.6±12.59	121.8±18.24	0.000*
• Mean diastolic B.P. ±SD	70.5±11.06	75.5±8.34	81.0±12.41	0.000*

Tab(4): Mean level(±SD) of haemoglobin and blood glucose among the studied sample by age and body weight categories

Variables	Body weight categories			*P* value
	Normal	Overweight	Obese	
6-12years	Mean (±SD)	Mean (±SD)	Mean (±SD)	
• Haemoglobin	12.71± 1.1	12.35± 1.33	12.38± 1.28	>.05
• Glucose	101.9± 52.1	101.1± 31.1	94.7± 39.5	>.05
12-18years				
• Haemoglobin	12.52±1.37	12.5±1.2	12.6±1.2	>.05
• Glucose	85.4±12.9*	94.8±20.9	97.6±28.4±*	<.05*
>18years				
• Haemoglobin	12.3± 1.3	12.6± 1.6	12.5± 1.5	>.05
• Glucose	89.3 ± 19.5	101.7±34.3	110.3±50.6	>.05

Tab(5): Mean level(±SD) of lipid profile among the studied sample by age and body weight categories

Variables	Body weight categories			*P* value
	Normal	Overweight	Obese	
6-12years	Mean (±SD)	Mean (±SD)	Mean (±SD)	
• Cholesterol	162.2± 23.2	159.5± 22.5	155.9±19.96	> 0.05
• H.D.L	45.02±11.2	44.16±11.1	46.7± 11.1	> 0.05
• L.D.L	94.7± 20.03	91.4± 19.95	88.4± 15.7	> 0.05
• Triglycerides	106.05±47.6	118.9±51.3	107.4±43.4	> 0.05
12-18years				
• Cholesterol	158.4 ±19.9	160.9 ±18.5	167.95 ±21.4	> 0.05
• H.D.L	48.1 ±9.7	49.3 ±9.7	47.3 ±10.4	> 0.05
• L.D.L	91.97 ±19.8	91.5 ±16.8	95.4 ±21.3	> 0.05
• Triglycerides	96.1 ±38.4	102.9 ±38.1	108.6 ±41.7	> 0.05
>18years				
• Cholesterol	203.3±4.6	183.4±41.3 *	194.7±37.9 *	<0.05 *
• H.D.L	51.5±15.9	50.3±11.6	50.3±12.2	> 0.05
• L.D.L	130.7±13.9	108.4±36 *	119.3±35.7 *	<0.05 *
• Triglycerides	103.7±38.5	118.4±56.5	124.6±48.9	> 0.05

Tab(6): Mean level(±SD) of vit A and vit E among the studied sample by age and body weight categories.

Variables	Body weight categories (Mean ±SD)			*P* value
	Normal	Overweight	Obese	
6-12years	Mean (±SD)	Mean (±SD)	Mean (±SD)	
• Vit A	41.1± 10.9	42.03± 10.4	39.9± 12.8	> 0.05
• Vit E	1270±373	1413±454	1378±325	> 0.05
12-18years				
• Vit A	58.1 ±6.82	40.2 ±22.5	46.6 ±18.04	> 0.05
• Vit E	1034 ±57.8	1044 ±329	1069.8 ±493	> 0.05
>18years				
• Vit A	78±4.3 *	48.6±18.9 *	52.4±19.7	<0.0005 *
• Vit E	1803±556 *	1002±448 *	1077±501 *	<0.0005 *

4. Discussion:

1-Blood pressure status

Additional fat tissue in the body needs oxygen and nutrients in order to live, which requires the blood vessels to circulate more blood to the fat tissue. This increases the workload of the heart because it must pump more blood through additional blood vessels. More circulating blood also means more pressure on

the artery walls. Higher pressure on the artery walls increases the blood pressure. In addition, extra weight can raise the heart rate and reduce the body's ability to transport blood through the vessels.

In our study the mean levels of systolic & diastolic blood pressure increased with increased body weight categories in females above age of 12 years to reach up a mean of 115.91±13.98 systolic over 77.11±10.11 diastolic among obese females aged 12-18 years and 121±18.24 systolic over 81.0±12.41 diastolic among obese adult females. In children, blood pressure (BP) and risk for hypertension are proportional to degree of adiposity [**20**]. **Isabel *et al.*,** study provided data on the association of increased weight status and WC with BP elevation in adolescents [**21**]**.** Also in a across sectional study in morbid obese female patients with mean BMI 45 ±7 higher mean systolic blood pressure level was found, although their diastolic blood pressure was also higher yet not significant [**15**]**.**

2-Haemoglobin and glucose status

The present study revealed that mean levels of haemoglobin was more or less the same among different age and body weight categories. **Erlend et al.,** concluded that haemoglobin increased significantly among females with morbid obesity [**22**]**.**

Obesity is the major cause of type 2 diabetes. This type of diabetes usually begins in adulthood but, is now actually occurring in children. Obesity can cause resistance to insulin, the hormone that regulates blood sugar. When obesity causes insulin resistance, the blood sugar becomes elevated. Even moderate obesity dramatically increases the risk of diabetes.

The present study showed that the mean levels of glucose were higher among all obese females above12 years but it was statistically significant among females aged 12-18years compared to normal body weight females. Meta-analysis of the data of systematic review of 89 studies on weight-related diseases showed that diabetes was at the top of the risk list: Compared with men and women in the normal weight range (BMI lower than 25), men with BMIs of 30 or higher had a sevenfold higher risk of developing type 2 diabetes, and women with BMIs of 30 or higher had a 12-fold higher risk. [**23**]**.**

3-Lipid profile status

The National Cholesterol Education Program USA (NCEP) has suggested that total cholesterol less than 200 mg/dl and Low density lipoprotein cholesterol (LDL) less than 130 mg/dl are desirable levels for any individual.

In this study the mean serum cholesterol and LDL levels were found to be significantly higher in obese females aged above 12 years than overweight. Also triglycerides levels were found to increase with the increase in body weight category although not significant. **Guh *et al.*, 2009** studied serum lipids of overweight and obese adolescents and concluded that they had higher total cholesterol (TC), LDL, triglycerides (TRG) and lower high density lipoprotein (HDL) values which correlated with body mass index (BMI), and other measures of fatness, and showed that in both sexes the prevalence of impaired lipid profile increased relative to chronological age in both overweight and obese subjects [**23**]**.**

On the contrary the study of Erlend et al., demonstrated a significantly higher triglyceride level among morbid obesity [**22**]**.**. The NCEP guidelines recommend the therapeutic manipulations of LDL to levels below 100 mg/dl and preferentially to levels of 70 mg/dl in patients at high risk of cardiac events. It is important to note that a recent study confirmed that pure reduction of LDL is insufficient for the amelioration of cardiac disease (CAD); rather, obesity and hypertriglyceridaemia must also be adequately and concurrently treated to prevent cardiac events [**24**]**.** Similarly, lifestyle changes regarding diet and exercise are important cornerstones for the control of LDL [**25**]**.**

4-Vitamin A and E

Because vitamin A and E were fat soluble and were readily stored in adipose tissue, they could be sequestered in the larger body pool of fat of obese individuals.

We observed that the mean serum level of vitamin A was lower in obese females than normal in the age group 6-<12 years but with no significant difference, and also among obese adult females but with significant difference (p <0.0005). Serum level of vitamin E showed no significant difference among females aged from 6-18 years but it was low in adult obese females with significant difference across all weight categories (p <0.0005).

The low vitamin concentrations observed in the obese patients could have been caused by several mechanisms. Dietary and lifestyle habits may be the most important contributors.

Joel et al., showed that among women, increasing BMI category was associated with low biochemical micronutrient levels including vitamin A and E [**26**]**.**

Conclusion:

This study confirmed that increased BMI among Egyptian females increased the risk of presenting abnormal glucose and lipid profiles predisposed to developing diabetes and cardiovascular diseases and that risk increased with increased age. Also the study confirmed the low vitamin A and E among obese Egyptian females which appeared more in the older age group.

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