Body Composition and its relation to Cardio-Respiratory Fitness of Pre-school children.

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Introduction:

Noncommunicable diseases (NCDs) are by far the leading cause of death in the world and their impact is steadily growing. This largely invisible epidemic is more serious in low- and middle-income countries, where 80% of all NCDs occur. The main causes of NCDs are a small set of modifiable risk factors like unhealthy diet, physical inactivity and tobacco use. Elimination of these modifiable risk factors would prevent 80% of premature heart disease, 80% of premature stroke, 80% of type 2 diabetes and 40% of cancer.[1] Children are not immune to this burden. Overweight children, and obesity and type 2 diabetes in children and adolescents are increasing problems. Overweight and obese children are likely to stay obese in adulthood and more likely to develop diabetes and cardiovascular diseases at a younger age.[2] Many low- and middle-income countries are now facing a "double burden" of infectious diseases and undernutrition. Children in those countries are exposed to high-fat, high-sugar, high-salt, energy-dense, and micronutrient-poor foods, which tend to be lower in cost but also lower in nutrient quality. These dietary patterns, in conjunction with lower levels of physical activity, result in sharp increases in childhood obesity while undernutrition issues remain unsolved.[3] In Eastern Mediterranean Region (EMR), the prevalence of overweight among children aged 0–5 years was higher in most low- and middle-income countries compared to high income countries. [4] In Egypt, The proportion of children under-five years, who are overweight in both genders during 2014; was 14.9% while the proportion of moderately and severely underweight was 5.5%. For children under 5 years of age, overweight is weight-for-height greater than 2 standard deviations above WHO Child Growth Standards median; and obesity is weight-for-height greater than 3 standard deviations above the WHO Child Growth

Standards median.[5] Promoting healthy physical activity (PA) behaviors in children between the ages of 0 to 5 years has immediate impacts on the health and well-being of children and serves as a powerful strategy to prevent or minimize the occurrence of chronic diseases in later life Although children are naturally active, their PA levels generally fall below the current WHO recommendations[6] .

Body composition(BC)(fatness) are key components that influence health outcomes, and its measurement is increasingly considered valuable in clinical practice. Anthropometry is considered a simple, inexpensive and easy-to-use method in epidemiological studies. BMI and skinfolds measurements provide excess weight information, but BMI indicates total BF and the sum of skinfolds indicates BF distribution. [7] Nowadays assessments are more often based on the analyses of body composition and fat distribution. [8-13] Reliable and valid approach for estimation of human body composition is a technique known as bioelectrical impedance (BIA). This method is safe, noninvasive, provides rapid measurements, requires little operator skill and subject cooperation, and is portable. [14] Cardio-respiratory fitness denotes the general extent of metabolic processes occurring in the human body .[15] CRF is indicated by maximal oxygen uptake per minute (VO_2max) as the international standard and primarily determined by the efficiency of mechanisms supplying active muscles with oxygen from the air. [16] The basic unit of measuring maximal oxygen uptake is its absolute value expressed in liters or milliliters per minutes. However, the absolute value is highly affected by body mass (BM), so it is often expressed as relative value in milliliter/kg/minutes .[17] Other factors affecting CRF include BM and BC. [18] BC and VO_2max are essential indicators of good physical fitness. [19] The relationship between Muscle Mass(MM) and VO_2max is directly proportional and inversely proportional to BF%. [20] Improvement in some BC components such as the body mass index (BMI), body MM and BF% as result by the exercise can improve VO_2max .[21] In epidemiological studies involving young people, the most common test for assessing cardiorespiratory fitness was the 20-m shuttle run test (Beep Test), or modifications of this test. [22] The 20-m shuttle run can provide accurate predictions of VO_2max with very strong correlations with actual VO_2max. [23] The VO_2max can then be estimated from the score obtained in this test from the published tables in Ramsbottom, Brewer, & Williams. [24] The study rational is to identify the physical composition and its relation to the CRF of pre-school children.

Methodology:

It is a correlational cross-sectional study to investigate the relationship between body composition of pre-school children and their CRF. The study comprised (400) children chosen randomly by cluster sampling technique . Qalyubiya governorate includes (12) educational directorates and we selected two (Benha & Toukh) randomly. Pre-school children in both directorates represent 16.7% of total pre-school children in the governorate . Each directorate includes number of governmental Kindergartens . Finally , we selected 8 Kindergartens and our sample unit was a class from each one . Three hundred children from six governmental Kindergartens in Benha (Urban), and one hundred from Toukh (semi-urban).

Inclusion criteria:

1. All selected children are a pre-school ones with age range (4 to less than 6 years).
2. All included children are under umbrella of health insurance.

Exclusion criteria:

1. Children with positive family history of hereditary disease
2. Children with chronic cardiac or respiratory disorders (congenital heart disease , allergy & asthma)
3. Handicapped or children with bone fractures

Ethical consideration:

Administrative approval was obtained from related educational directorates before study conduction and written informed consents were obtained from children guardians before participation in the study. They were informed about the study aim and procedures. We emphasized confidentiality of data and safety of children.

Measurements procedures:

All variables were measured between (8 - 11 am) by trained researchers using the following equipment:

A. **Calibrated weight & height scales:** Weight was measured using a digital anthropometric scale, graded from 0 to 150 kg. The children were lightly dressed and without shoes. Height was measured using a metric tape fixed on the wall and extended from the bottom upwards, with the children kept in a vertical position, with feet and trunk leaning against the wall.

B. **Digital Blood Pressure Monitor :** Diastolic and systolic blood pressure levels (DPB and SBP) were determined by an automatic blood pressure monitor. The children must be sitting, at least 5 minutes rest, with the arm supported. Mean arterial pressure (MAP) was calculated using the following formula: DBP+[0.333 × (SBP-DBP)].

C. **Bodystat QuadScan 4000 :** To monitor body composition parameters like Fat mass, Fat free mass, BMI,….etc. by measuring hand-to-foot whole body electrical impedance. Children were instructed to remove their shoe and sock from their right foot, remove any watches or bracelets on the right wrist which may impede the correct placing of electrodes and to lie in the supine position for 5 minutes before taking the measurements. Legs and arms are separated out so they are not in contact with any other part of the body. The area of the skin where the electrodes are to be attached was thoroughly wiped using alcohol wipes[25]

D. **Ergospirometry:** To assess the efficiency of the circulatory & respiratory systems, especially the maximum oxygen consumption.

E. **Complete Spirostik :** To measure vital capacity, Forced Vital Capacity& Forced Expiratory Volume in the 1st second & Peak Expiratory Flow.

Pilot study:

The researchers carried out body composition measurements and cardio-respiratory measurements on the sample of (60) children in the period from 1/10/2019 to 14/10/2019, with the aim of:

1. Ensure the safety of the used devices.
2. Determine the time required for each measurement.
3. Determine the optimal system for the sequence of measurements.
4. Determine the variables needed by the researchers of measurements (physical composition, cardio-respiratory fitness).

The Experience of Basic Research

The researchers conducts the body composition and cardio-respiratory measurements on the sample of (400) children in the period from in the period from 20/1/2019 to 19/12/2019.

Data management:

Data were analyzed using SPSS, v.25.0 for Windows (SPSS Inc, Chicago, USA), and the significance level was set at $p<0.05$.The data are shown in descriptive statistics for mean and standard deviation (SD). Tests of normal distribution and homogeneity (Kolmogorov–Smirnov and Levene's, respectively) were conducted on all data before analysis. Differences between sex and age groups were analyzed using analysis of variance (ANOVA) adjusting by Bonferroni test; additionally, differences between weight status were analyzed with ANOVA using as covariables: age and sex. Finally, a Pearson correlation analysis was performed between physical fitness tests with BMI adjusted for age ,Body fat, fat %. Multilinear regression analysis for detection of significant predictors of CRF will be done.

Results: The study included 400 (200 boys & 200 girls) pre-school children with mean age 4.7 ± 0.7 years , height 115.2±5.9 cm, weight 23.3±3.2 kg and BMI17.5±1.7 kg/m^2 and according to WHO classification of BMI for pre-school children with adjusted age & sex using “CDC: BMI Percentile

Calculator for Child and Teen” we found that 172 out of 400 (43 %) of the study group were obese (94 boys & 78 girls), 86 (21.5%) over-weight (31 boys & 55 girls) while 21 (5.3 %) under-weight (9 boys &12 girls).The remaining children 121 (30.2%) normal weight (67 boys & 54 girls).There were significant differences between boys & girls regarding body composition variables . girls were taller (115.8±6.3 *vs.* 114.5±5.4) with more body fat content (5.8±1.23 *vs.* 4.9±1.25) ($p<0.05$) & higher body fatness % (24.6±2.6 *vs.* 21.3±2.7) ($p<0.01$). while boys had higher lean weight (18.2 ±2.1 *vs.* 17.7 ±2.1) & dry lean weight (3.96±5.4 *vs.* 3.94±5.7) ($p<0.05$) , in addition to higher water content (14.2±1.6 *vs.*13.7±1.6) & lean weight % (78.7±2.8 *vs.* 75.4±2.6) ($p<0.01$) . Regarding BMI classification ,girls represented (64%) of over-weight category while boys represented (54.7%) of obese category. The higher percentage of under- weight was among girls (57.1%).All the previous finding were statistically significant(X^2 test:10.7 & $p<0.05$). **Table (1) & Figure (1)**

Table (1): Physical body composition measurements

Variables	Mean ± SD	Boys (200)	Girls (200)	T-test	P value
Age(Y)	4.7± 0.7	4.7±0.77	4.6±0.64	0.48	>0.05
Height(cm)	115.2 ± 5.9	114.5±5.4	115.8±6.3	1.96	*<0.05
Weight(kg)	23.3 ± 3.2	23.1±3.2	23.5±3.24	0.99	>0.05
BMI(kg/m2)	17.5 ± 1.7	17.6±1.8	17.5±1.6	0.62	>0.05
Body Fat (kg)	5.4 ± 1.3	4.9±1.25	5.8±1.23	6.6	*<0.05
(lean weight)(kg)	17.9± 2.2	18.2±2.1	17.7±2.1	2.34	*<0.05
Water content (L)	3.9± 0.6	14.2±1.6	13.7±1.6	3.0	**<0.01
dry lean(kg)	14± 1.6	3.96 ±5.4	3.94±5.7	0.39	*<0.05
Body fatness%	22.97±3.1	21.3±2.7	24.6±2.6	12.2	**<0.01
Body lean %	77.03±3.1	78.7±2.8	75.4±2.6	12.2	**<0.01
Waist circum.(cm)	62.6± 4.4	62.8±4.6	62.4±4.2	1.03	>0.05
Hip circum.(cm)	67.63±4.1	67.8±4.2	67.5 ±4.1	0.95	>0.05

W/H ratio	0.92 ± 0.04	0.928±0.046	0.927±0.048	0.1	>0.05

*significant ($p<0.05$) ** Highly significant($p<0.01$)

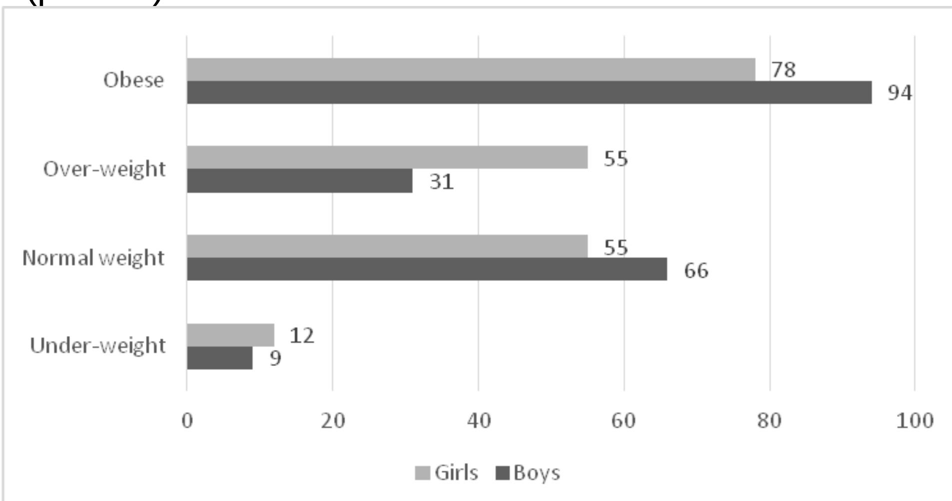

Fig.1 Classification of the studied group according to BMI

(X^2 test:9.6 & *$p<0.05$)

Table (2) shows comparison between boys & girls regarding CRF. VO_2max which is essential indicator of good physical fitness was lower than the normal range for the same age group, which reflects poor CRF of the studied children especially girls. Moreover, girls showed significantly higher systolic ,diastolic and mean arterial pressure than boys even if their findings were within the normal reference ranges for the same age group .

Table (2): Cardio- respiratory measurements of the studied group

Cardio-respiratory variables	**Total (400) Mean ± SD**	**Boys (200) Mean ± SD**	**Girls (200) Mean ± SD**	**T-test**	**P value**
(IVC)($_L$)	1.2 ± 0.6	1.66±0.49	0.72±0.15	25.6	**<0.01
(FVC) $_{(L)}$	1.2 ±0.4	1.47±0.34	0.83±0.10	25.2	**<0.01
$FEV_{1(L)}$	1 ± 0.4	1.32±0.3	0.76±0.11	24.4	**<0.01
PEF	1.3±0.4	1.56±0.29	1.02±0.11	24.1	**<0.01
Vo_2 max. (ml/Kg/min)	20.7±3.9	23.87±2.8	17.5±1.33	28.9	**<0.01
SBP (mm Hg)	102.4 ± 5.2	98.3±4.2	106.5±1.4	28.7	**<0.01
DBP(mm Hg)	70.8 ±4.4	67.3±3.1	74.4±1.5	25.9	**<0.01
MAP(mm Hg)	81.4±4.6	77.6±3.5	85. 1±1.4	27.1	**<0.01

Resting Pulse (beat/min.)	95 ±11.7	85.88±9.8	104.00±3.1	24.7	**<0.01

ΦNormal figures for (3-5 years) according to PALS Guidelines, 2015 (SBP:89-112(mm Hg) , DBP:46-72 (mm Hg) , Resting Pulse:80-120(beat/min.)

ΦVo2 max. (ml/Kg/min): 51.3±8.9 for boys & 41.49±6.51 mL/kg/min in girls(Daniel et al.,2015)

Table (3) shows lower (IVC),(FVC),(FEV1),(PEF)&(VO_2max) among obese group in comparison to other groups. Also, they shows the highest (SBP),(DBP),(MAP) & resting pulse ,that means that obese group was the worst regarding cardio-respiratory fitness.

Table (3): Comparison between different categories of BMI regarding Cardio- respiratory measurements .

Variables	**Normal weight(121)**	**Under weight(21)**	**Over-weight(86)**	**Obese (172)**	**P value of f-test**
IVC	1.9±0.3	2.03±0.2	1±.07	0.67±0.09	**<0.00
FVC	1.65±0.2	1.7±0.08	1±0.05	0.8±0.09	**<0.00
FEV_1	1.47±0.19	1.5±0.11	0.91±0.08	0.74±0.11	**<0.00
PEF	1.69±0.22	1.82±0.08	1.2±0.08	1±0.08	**<0.00
Vo_2 max.	25.35±1.5	26±0.83	20±0.76	17.11±0.89	**<0.00
SBP (mm Hg)	96.17±2.6	95.04±1.1	104±0.8	106.9±0.9	**<0.00
DBP (mm Hg)	65.66±1.95	64.95±1.4	71.44±1.0	74.9±0.96	**<0.00
MAP(mm Hg)	75.8±2.1	74.97±1.2	82.28±0.7	85.56±0.95	**<0.00
Resting Pulse (beat/min.)	80.47±5.6	79.33±2.9	99.67±1.8	104.66±2.9	**<0.00

Table (4) shows strong inverse relationship between body fatness and respiratory function tests on one hand and strong direct relationship with SBP,DBP,MAP & resting pulse on the other hand($p<0.01$). On the contrary there was positive correlation between body water content and (IVC),(FVC)& (VO_2max) and negative correlation with (SBP),(DBP),(MAP)& resting pulse($p<0.05$).No significant association could be found between BMI and any of CRF measurements.

Table (4): Correlation between Body Composition measurements(BC) & Cardio- Respiratory Fitness(CRF) of the total group

BC / CRF	Age	Weight	Height	Waist	Hip	Body fat	Fat %	BMI	L w
(IVC) (L)	0.024	**0.56-	0.01-	**0.36-	**0.35-	**0.26-	**0.41-	**0.77-	**
(FVC) (L)	-0.007	**0.57-	0.03-	**0.35-	**0.36-	**0.26-	**0.42-	**0.76-	**
$FEV_{1(L)}$	0.005	**0.55-	0.003	**0.34-	**0.35-	**0.26-	**0.41-	**0.76-	**
PEF	0.033	**0.54-	0.007	**0.33-	**0.33-	**0.26-	**0.40-	**0.76-	**
Vo_2 max. (ml/Kg/min)	0.029	**0.59-	0.016-	**0.36-	**0.34-	**0.27-	**0.44-	**0.79-	**
SBP (mm Hg)	0.013-	**0.58	0.012	**0.34	**0.35	**0.25	**0.41	**0.78	**
DBP(mm Hg)	0.038-	**0.57	0.001-	**0.34	**0.32	**0.27	**0.43	**0.79	**
MAP(mmHg)	0.029-	**058	0.004	**0.34	**0.34	**0.26	**0.43	**0.79	**
Resting Pulse (beat/min.)	0.004	**0.56	0.005	**0.34	**0.37	**0.25	**0.42	**0.77	**

Table (5): Correlation between Body Composition measurements(BC) & Cardio- Respiratory Fitness(CRF) of the male & female

BC / CRF	Body fat		Fat %		BMI		Lean weight	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
(IVC) (L)	**0.66-	**0.75-	**0.68-	**0.55-	**0.62-	**0.27-	**0.39-	0.05-
(FVC) (L)	**0.67-	**0.30-	**0.68-	**0.44-	**0.62-	0.05-	**0.40-	0.07-
$FEV_{1(L)}$	**0.64-	**0.31-	**0.64-	**0.32-	**0.61-	**0.23-	**0.41-	0.09
PEF	**0.64-	**0.44-	**0.68-	**0.49-	**0.59-	**0.19-	**0.32-	0.01-
Vo_2 max. (ml/Kg/min)	**0.68-	**0.54-	**0.68-	**0.50-	**0.64-	**0.27-	**0.43-	0.07-

SBP (mm Hg)	**0.66	**0.84	**0.68	**0.51	**0.62	**0.32	**0.40	0.05
DBP(mm Hg)	**0.62	**0.77	**0.64	**0.57	**0.61	**0.35	**0.37	0.07
MAP(mmHg)	**0.65	**0.80	**0.67	**0.56	**0.62	**0.35	**0.38	0.07
Resting pulse(beat/min.)	**0.67	**0.27	**0.68	**0.27	**0.62	**0.22	**0.39	0.04-

Table(6): Multiple linear regression analysis predictors of VO_2 max & MAP for the total sample.

Model	(1) VO_2max			(2) MAP		
	Beta	**t**	**P**	**Beta**	**t**	**P**
Constant	55.3	19.87	**<0.000	41.3	12.38	**<0.000
Waist	0.021	0.475	>0.05	-0.048	-1.088	>0.05
Hip circumference	-0.056	-1.14	>0.05	0.075	1.522	>0.05
Body fatness	-0.044	-0.609	>0.05	0.066	0.902	>0.05
Lean weight	-0.038	-0.761	>0.05	0.015	0.300	>0.05
BMI	-0.667	-11.46	**<0.000	0.669	11.43	**<0.000
Fat %	-0.156	-4.82	**<0.000	0.140	4.27	**<0.000

(1) R=0.81 R^2 =0.656 SEE=2.2 F=125.1 p <0.000
(2) R=0.80 R^2 =0.651 SEE=2.7 F=122.4 p <0.000

Discussion:

Early childhood has emerged as a critical period for assessing the beginnings of obesity and instituting preventive measures; given the evidence linking excessive weight gain in the first years of life to obesity and chronic disease in later years[26]

The current study examined the BC of pre-school children and its association with CRF. The anthropometric measures of our sample showed that girls were significantly taller with more body fat and fat %,while boys had more lean weight, dry lean , dry lean % and water content. No significant differences could be found between both sexes regarding body weight & BMI. Similar results were obtained by Tanaka et al., 2012[27] and Vameghi et al., 2013[28].

According to BMI classification, we found that (43 % obese, 21.5% over-weight , 5.3% under-weight & 30.2% normal weight) . Our findings did not come in agreement with another Egyptian study conducted in Alexandria on similar age group, their findings were (23% obese ,14% overweight , 6% underweight and 57% normal weight for age) [29] . A similar study conducted on 500 children, 2–5 years old, in kindergartens of Birjand, Iran; found that prevalence of obesity (7.6%) & overweight (10.6%)[30]. Our findings were higher than previous studies due to lack of nutritional awareness & physical activity in the community of the study. Gender specific prevalence of obesity in our study was (54.7% for boys *vs.* 45.3% for girls) ,over-weight (36% for boys vs. 64% for girls) .That means boys were more obese ,while girls were more over-weight. These findings agreed with the national data [5]. and with other several studies in Alexandria[29] ,China[31] , Iran[30], Bahrain[32] and Kuwait[33]. According to a systematic review by Musaiger AO, the prevalence of overweight among preschool children of the EMR countries ranged from 1.9% to 21.9%. Predicting factors determining obesity in this region are frequent snacking, and massive marketing promotion of high fat foods[34].

Our study found a significant differences between boys and girls regarding CRF measurements. Boys had better findings than girls but still all findings below normal for this age group, that is mean poor CRF of preschool children. Our findings came in agreement with Pedro et al., 2016 [35].The aim of his study was to determine the physical fitness in children 3 - 6 years old, discriminating performance by sex, age and BMI. His main finding was that sex differences in physical fitness were evident at an early age. These differences could be explained because of the fact that preschool girls present a more sedentary lifestyle and lower levels of moderate to vigorous physical activity than boys[27]

Boys showed significantly higher (IVC), (FVC), (FEV1) and (PEF) than girls. Also,(VO_2max) which was found to be the most widely used indicator of CRF, was significantly higher among boys but still below normal for the same age group.

The results obtained from simple correlation coefficients indicate a significant negative correlation between (weight , waist circumference, hip circumference, BMI, body fat, fat %) and PFTs (IVC, FVC,FEV_1 , PEF & VO_2max). Correlation Coefficients (r) for (body fat ,fat %, BMI) and (FVC, FEV_1 , PEF & VO_2max) were higher for boys than for the girls except for (IVC). These results supports the findings of the study by de Andrade Goncalves et al., 2017[36] .No significant correlation could be detected between lean weight in girls & PFTs.

On contrary, girls had significantly higher (SBP, DBP , MAP& Resting Pulse) than boys. Similar study [37] was done in Spain for estimation of prevalence of high blood pressure in children < 6 years old, the mean SBP of total group was (102 ±10.2) and this was similar to our findings (102.4 ± 5.2) , Egyptian boys had lower SBP (98.3±4.2 *vs.* 102.7±10.3) & Egyptian girls had higher SBP (106.5±1.4 *vs.* 101.6±9.9) .Regarding DBP, the mean DBP for the total Spanish group and that of boys &girls was lower than Egyptian children (62.3 ±8.5 *vs.* 70.8 ±4.4 for total group, 61.68 ± 8.26 *vs*. 67.3±3.1 for boys & 62.89 ± 8.74 *vs.* 74.4±1.5 for girls).Similarly, MAP of Spanish children was lower than Egyptian children whether the total mean or means of boys & girls (75.55 ± 8.36 *vs.* 81.4±4.6 / 75.33 ± 8.21 *vs.* 77.6±3.5 / 75.78 ± 8.50 *vs.* 85. 1±1.4).

According to BMI classification ; (SBP , DBP & MAP) were significantly higher among Spanish obese children in comparison to other BMI categories and this is consistent with our findings. Moreover Egyptian obese showed higher (DBP & MAP) than Spanish ones (74.9±0.96 *vs.* 67.43 ± 0.47 & 85.56±0.95 *vs.* & 81.92 ± 0.67).When investigating the correlation between BC parameters & (SBP, DBP , MAP & Resting Pulse) , we found a strong positive relationship. Correlation Coefficients (r) for boys were higher except for the relation between body fat and (SBP, DBP & MAP). The relationship between adiposity with different body compositions in children has been shown in several studies. Eisenmann et al.,2005[38] reported that BMI, WC, sum of skinfolds and %FM (measured via dual energy X-ray absorptiometry) were moderately and positively correlated with SBP, DBP and MAP, as found in other studies in which BMI were associated with SBP and DBP.

Our results, are in line with other studies , supporting that children with more adiposity are more likely to have higher risk of hypertension. Our findings also suggest that children in the higher categories of BMI and %FM have higher levels of SBP, DBP, MAP in both boys and girls, as reported in other studies in the same age group and different ethnicities [39-43]

Multilinear regression analysis revealed that only BMI & fat % are the significant predictors of CRF . Our findings are supported with Maciejczyk et al., 2014 [18] and Ortega et al., 2008 [22] ,they stated that obese and overweight persons, whose high BM is caused by high body adiposity, display a considerably lower VO_2max relative to their BM. Also, reduced VO_2max as BMI increased. The negative impact of obesity on physical fitness has been documented in youth. There are inverse relationships between physical fitness and overweight[37]. However, Lopes et al., 2011[44] found no correlation between BMI and physical fitness. Hence, the data on the relationship between physical fitness and BMI are inconsistent in preschool children. However, we indicated that BMI alone could not be considered as an indicator for physical fitness in preschool-age children. BMI alongside fat % are important indicator for CRF.

Conclusions:

1. Pre-school children under study suffer from increased physical composition (weight, Fat Mass, waist / hip ratio & BMI) in comparison to reference measurements . Also we found a decrease in the value of Fat–Free Mass (Lean Weight).
2. 69.8 % of pre-school children are of abnormal weight (43% obese,21.5% over-weight & 5.3% under-weight).
3. Poor CRF of pre-school children, whether respiratory-related measures such as (VC, FVC, FEV1, the PEF and VO2max).
4. Strong inverse correlation between body composition measurements like (body fat , BMI & Waist /hip ration) and respiratory fitness measurements like (VC, FVC, FEV1, the maximum effluent flow and maximum oxygen consumption).On the contrary , there is strong direct correlation between body composition and SBP & DBP at rest & resting pulse rate).

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