

IMPACT OF PEM ON HEART STRUCTURE

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ABSTRACT

Objective

1. Assess the heart size, and structure, in malnourished children in comparison with those without malnutrition.
2. Estimate the association between anthropometric indicators and cardiac measurements.

Methods

- Design, this is a community-based case control study.
- Setting, it was conducted in Baghdad Aljadida sub district.
- Subjects, The sample included 37 malnourished and 42 normal school children.
- Measures of Outcome, Clinical examination, and echocardiography have been done for the two groups.

Results: Echo-cardiographic measurements showed significantly lower values for cases than for controls. Cardiac measurements also showed positive linear correlation with anthropometric indicators. Heart mass, IVSD, PWD, and PWS showed very high correlation with both HAZ, and WAZ.

Conclusion: Heart structure is significantly affected among physically active malnourished children. This affection of the heart is highly correlated with nutrition status; in severe malnutrition one may see severe heart abnormalities.

Keywords: PEM, Echocardiography, Heart mass, Interventricular thickness, Posterior wall thickness.

INTRODUCTION

Malnutrition is a suboptimal (deficient or excessive) supply of nutrients that interferes with an individual's growth, development, and maintenance of health [1]. The World Health Organization defines malnutrition as "the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions [2].

Malnutrition, defined as underweight, is a serious public-health problem that has been linked to a substantial increase in the risk of mortality and morbidity [3].

Malnutrition is still a big problem in Iraq, despite its wealth and high resources. About one in every five children was underweight (low weight for age) in 2000, and almost one third of children under 5 were chronically malnourished (low height for age) [4].

Earlier concepts that the heart is spared in malnutrition have been shown to be incorrect. Inadequate intake of protein and energy results in proportional loss of skeletal and myocardial muscle[5-6].

At the beginning, researchers depended on postmortem studies of individuals died because of malnutrition by comparing their left ventricle mass with other subjects died from other causes as in Costa Rica study [7].

Other researchers used the experimental animals [8-12] by exposing them to programmed food deficient with protein and energy and matched them with control group with normal nutrition. The hearts of the two groups were studied structurally and functionally by intracardiac implantation of instruments and the postmortem study.

Relatively recently researchers studied effect of malnutrition on hospitalized malnourished children and matched them with control group.

The current research is a community-based case control study. Malnourished primary school children with normal daily activity have been compared with a control group, nutritionally normal from the same environment.

MATERIAL AND METHODS

Subjects

Seventy nine children were enrolled in this community-based case-control study. Cases were composed of thirty seven malnourished children(11 males and 26 females), aged 113.49 ± 19.15 months. Controls were composed of forty two children with normal nutrition status indicators (14 males and 28 females), aged 116.74 ± 18.93 months. Gender and age of cases and controls showed non-significant difference.

For both cases and controls, exclusion criteria included, presence of congenital heart disease, as approved by clinical and/or echocardiography examination; high blood pressure and pulse rate; significant murmur; significant wheezes, rhonchi and crepitation; hepato-splenomegaly; severe anemia; jaundice; splitting heart sounds; cyanosis; absence of peripheral pulses; non cooperatives; those with physical or possible mental abnormalities; and obesity.

Anthropometric measurements, included weight and height. Weight was measured by digital scale to the nearest 100 gram, with very light clothes and bare feet. Height was measured by microtoise measuring equipment to the nearest millimeter. Standing straight against the wall, where the instrument was hanged at 2 meters from the floor. The head, shoulders, back, legs, and feet were touching the wall. Bare feet were emphasized. Name and sex of every child was written at her/his form, birth date as taken from child ID and examination date were also written and used for calculating the exact age. Weight for age and height for age Z-score have been

calculated using EPI-info version 3.4.3. Malnutrition is considered when the Z-score is below -2SD for any indicator.

Echocardiography

Echocardiography has been performed to all children who attended the place of examination with their parents. Inter observer differences [11] were avoided because all children have been examined by the same doctor (echocardiographer). Multi-probe frequency and size included Cardiac probe for adult, neonatal, coronary, vascular, M-mode, 2 D, and Doppler P and C waves. This was of three frequencies, 2.5, 3.5, and 5 KHz.

These echocardiographic variables were

- 1- Inter- ventricular septum thickness during systole (IVSS)
- 2- Inter- ventricular septum thickness during diastole (IVSD)
- 3- Posterior left-ventricular (LV) wall thickness during systole (PWS)
- 4- Posterior left-ventricular (LV) wall thickness during diastole (PWD)
- 5- Left-ventricular end diastolic dimensions (LVEDD)

From these measurements, heart (left-ventricular) mass has been calculated manually by using the following equation

$$\text{Left-ventricular mass (gm)} = 0.8[1.04\{(\text{IVSD} + \text{PWD} + \text{LVEDD})^3 - \text{LVEDD}^3\}] + 0.6$$

Statistical methods

Statistical Package for Social Sciences SPSS-16 was used for data entry and analysis. Descriptive statistics including frequencies, measures of dispersion and measures of central tendency have been calculated. Cross tabulations (with Chi-square testing) for demographic characteristics, and for some morbidity variables were done. Comparisons between means of two independent groups, one way ANOVA testing. As it is always the case in observational studies P value of less than 0.05 was considered significant.

Regression and linear correlation have been done for the assessment of the strength of the association between anthropometric indicators and all the echocardiographic variables.

Tables and figures have been prepared as needed.

Another soft ware, EPI-info version 3.4.3 has been used for the Z-score calculations of anthropometric indicators.

RESULTS

Age and gender characteristics of the sample are summarized in table 1. Both showed no significant difference between malnourished group (cases) and normal group (controls).

Means and standard deviations of height for age z-score (HAZ) and weight for age z-score (WAZ) are shown in table 1. Both were significantly lower in malnourished group than in normal group.

Minimum and maximum values, medians, means and standard deviations of six echocardiographic variables are shown in table 2. These variables are:

1. Interventricular septum thickness during systole (IVSS)
2. Interventricular septum thickness during diastole (IVSD)
3. Posterior wall thickness during systole (PWS)
4. Posterior wall thickness during diastole (PWD)
5. Left-ventricular end diastolic dimensions (LVEDD)
6. Heart (left ventricle) mass.

Their means were significantly lower in malnourished children than in normal children (Table 2).

All of these echocardiographic are positively correlated with anthropometric indicators, both weight for age and height for age (figures 1-12).

Table 1: Demographic, anthropometric characteristics of the studied sample

Parameter	Cases	Controls	P value
Age (months)	113.49±19.154	116.74±18.938	0.74
Gender(male/female)	11/26	14/28	0.46
Z-score height/age (HAZ)	-2.4111±.49146	.3114±.54764	0.000
Z-score weight/age (WAZ)	-2.0473±.56771	.4771±.43380	0.000

Table 2: Comparison of Echocardiographic parameters between cases and controls

Group		IVSD (cm) P= .000	PWD (cm) P= .000	IVSS (cm) P= .001	PWS (cm) P= .000	LVEDD (mm) P= .000	heart mass (g) p= .000
case	Mean	.5311	.5157	.8746	.7892	3.559	44.308
	N	37	37	37	37	37	37
	Std. Deviation	.05646	.05905	.10418	.11369	.3700	7.2445
	Median	.5200	.5100	.8800	.7900	3.600	44.000
	Minimum	.41	.42	.62	.50	3.0	30.0
	Maximum	.62	.61	1.10	1.10	4.4	62.0
control	Mean (cm)	.6771	.6717	.9848	.9738	3.864	71.905
	N	42	42	42	42	42	42
	Std. Deviation	.08256	.08439	.16760	.11605	.3553	17.9539
	Median	.6850	.6750	.9800	1.0000	3.800	67.300
	Minimum	.52	.52	.48	.62	3.2	48.7
	Maximum	.89	.80	1.50	1.30	4.7	113.0
Total	Mean	.6087	.5986	.9332	.8873	3.722	58.980
	N	79	79	79	79	79	79
	Std. Deviation	.10215	.10719	.15111	.14711	.3911	19.6398
	Median	.6000	.6000	.9200	.8800	3.700	55.000
	Minimum	.41	.42	.48	.50	3.0	30.0
	Maximum	.89	.80	1.50	1.30	4.7	113.0

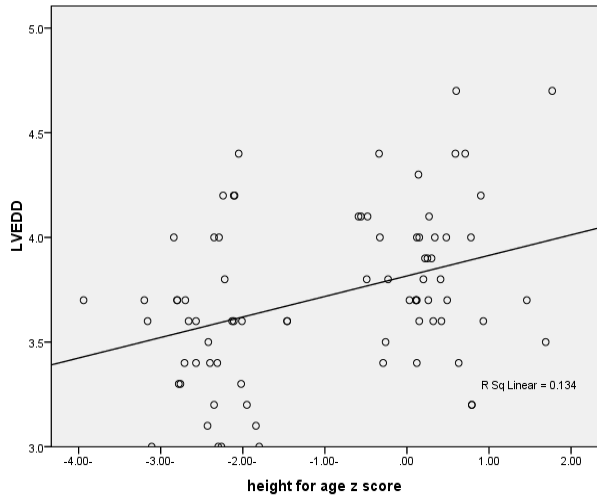


Fig. 1: Correlation between LVEDD and HAZ $R=0.367$ $p=0.001$

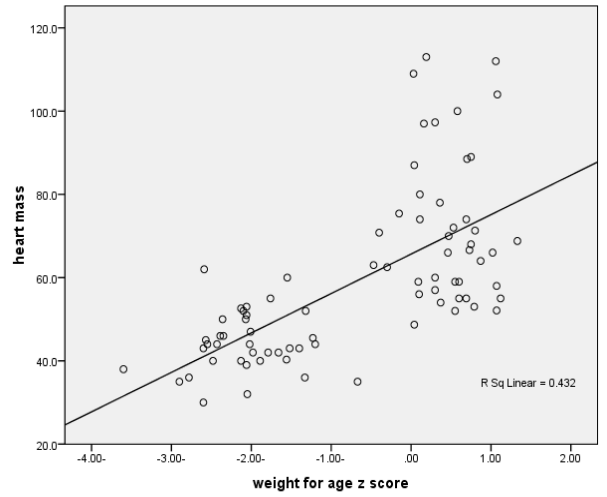


Fig. 4: Correlation between heart mass and WAZ $R=0.657$ $p=0.000$

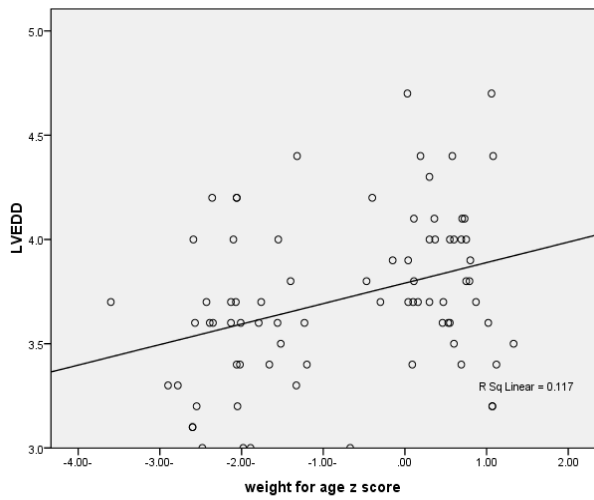


Fig. 2: Correlation between LVEDD and WAZ $R=0.342$ $p=0.002$

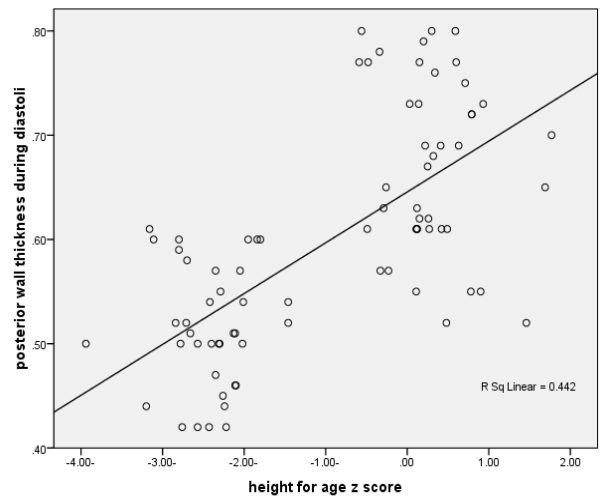


Fig. 5: Correlation between PWD and HAZ $R=0.665$ $p=0.000$

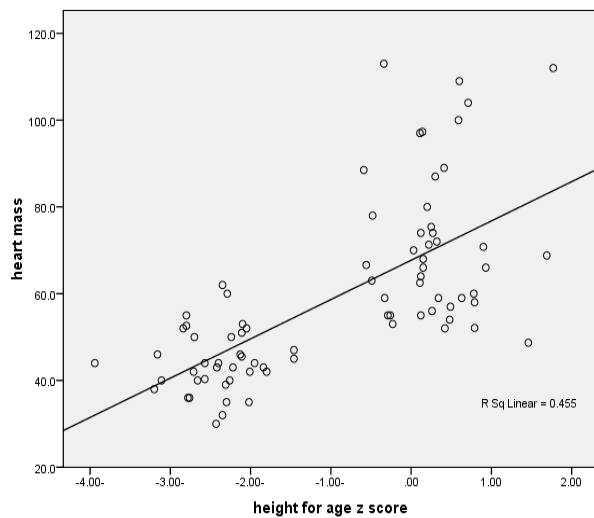


Fig. 3: Correlation between heart mass and HAZ $R=0.675$ $p=0.000$

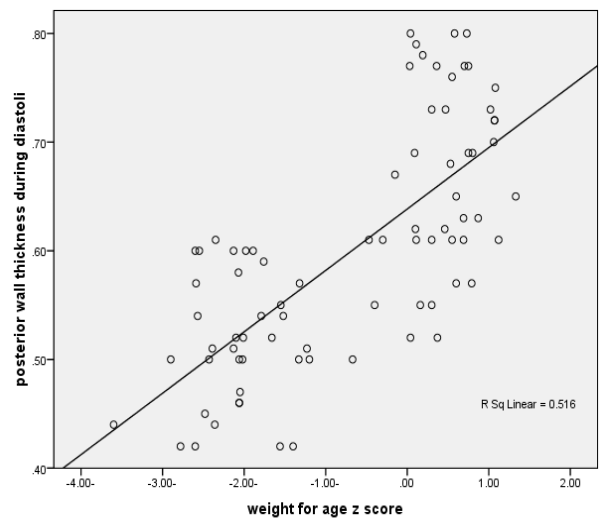


Fig. 6: Correlation between PWD and WAZ $R=0.718$ $p=0.000$

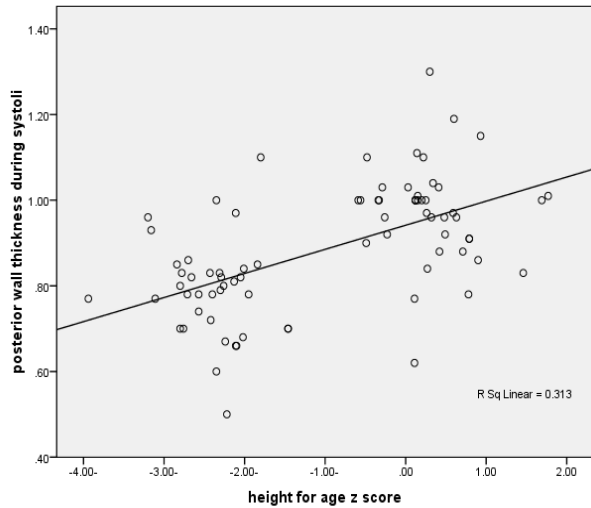


Fig. 7: Correlation between PWS and HAZ R=0.559 p=0.000

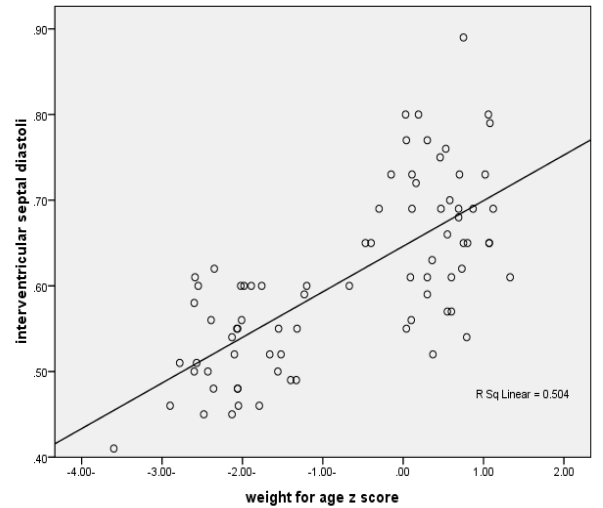


Fig. 10: Correlation between IVSD and WAZ R=0.710 p=0.000

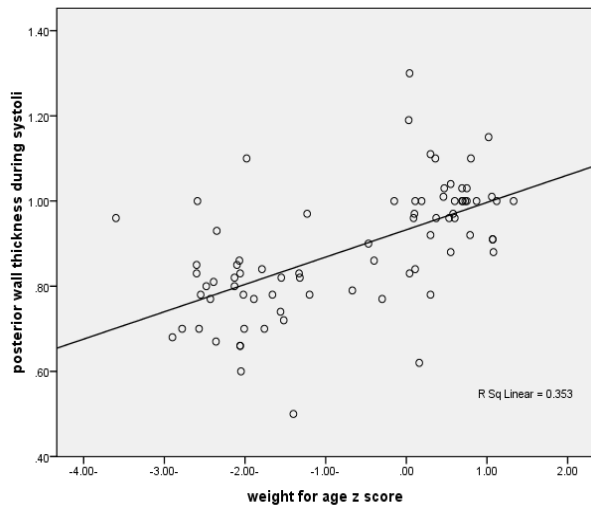


Fig. 8: Correlation between PWS and WAZ R=0.594 p=0.000

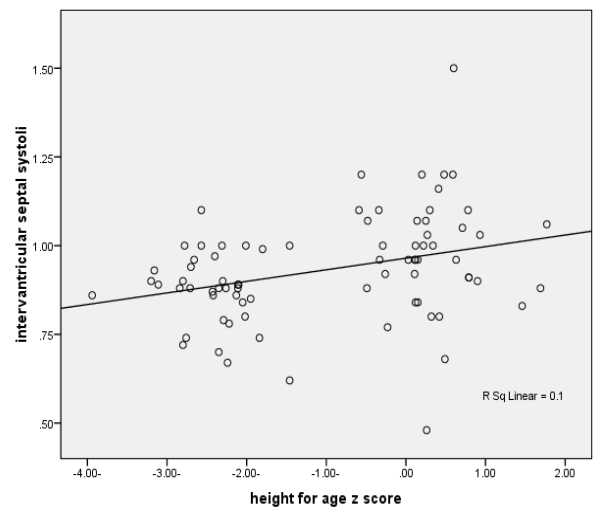


Fig. 11: Correlation between IVSS and HAZ R=0.316 p=0.005

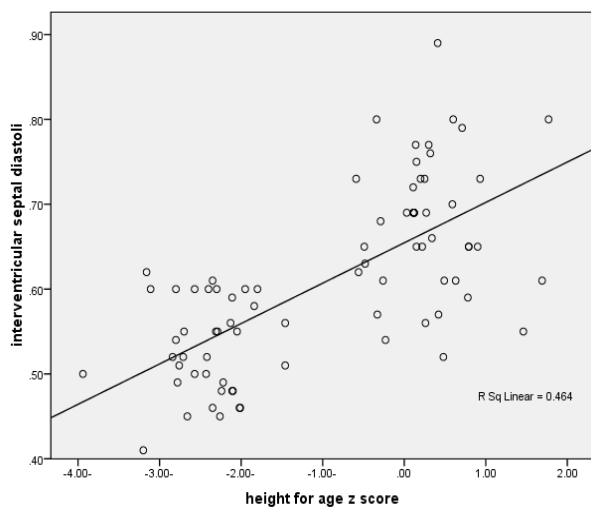


Fig. 9: Correlation between IVSD and HAZ R=0.681 p=0.000

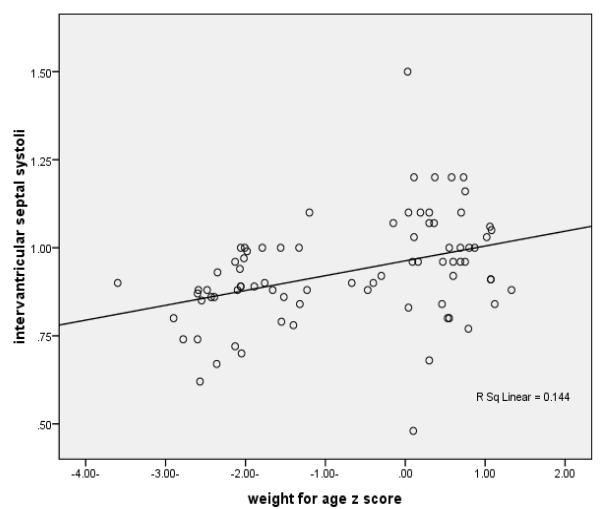


Fig. 12: Correlation between IVSS and WAZ R=0.379 p=0.001

DISCUSSION

The IVSD, IVSS, PWD, PWS and heart (left ventricle) mass were significantly lower in the case group. Similar results have been found by Egyptian, Turkish and Spanish researchers [13-16].

They were reduced in proportion of decrease in weight and height of children, as these four variables are strongly and positively correlated with both anthropometric indicators HAZ and WAZ. Heart mass is significantly lower in cases than in controls. Heart mass is highly correlated with both anthropometric indicators HAZ and WAZ. These findings are consistent with the findings of all the available researches related to the subject [17-18].

Nagla Hassan Abu Faddan found that, Echocardiographic evaluation of children with PEM in her study revealed a significantly lower LV septal thickness, posterior wall thickness and LVM than the control group [14].

Elayed found that, echocardiographic changes showed that cardiac mass index was significantly lower in cases compared to the controls [13].

Olivares found that, left ventricular mass, ventricular mass index were significantly lower in malnourished children than in controls [16].

In the malnourished dogs, cardiac mass was lost in proportion to total body mass loss [11].

Morphometric data showed that the cardiac muscle mass growth was impaired to the same extent as body weight [19].

LV end-diastolic dimension was also studied and revealed significant difference between the cases and controls with clear lower values in case group. It was positively correlated with both anthropometric indicators HAZ and WAZ. These findings are in agreement with Jose L. Olivares study results. Olivares stated that, children with primary third-degree malnutrition not only have cardiac wasting, but also have inherent ventricular dysfunction. LVED, LVEs, LVM, LVmi and cardiac output are all lower in malnourished children than in controls of our study; and there is a positive correlation between LVmi and BMI and body weight [16].

CONCLUSION

Heart is not spared; its structure is affected by malnutrition.

This affection of the heart is highly correlated with nutrition status; in severe malnutrition one may see severe heart abnormalities.

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CONFLICT OF INTERESTS

Declared None

REFERENCES

1. Stallings VA, Hark L: Nutrition assessment in medical practice. In Morrison G, Hark L: Medical Nutrition and Disease; 1st ed; Cambridge Blackwell Science Inc. pp 2-31, 1996
2. WHO (2000) Is malnutrition declining? An analysis of changes in levels of child malnutrition since 1980
3. WHO (2005), Malnutrition Quantifying the health impact at national and local levels.
4. Alwan A., (2004), Health in Iraq The Current Situation, Our Vision for the Future and Areas of Work, 2nd ed, Iraq.
5. Drott C, Lundholm K, Cardiac effects of caloric restriction-mechanisms and potential hazards. *Int J Obes Relat Metab Disord* 1992 Jul;16(7):481-6.
6. Webb JG, Kiess MC, Chan-Yan CC; Malnutrition and the heart. *CMAJ*, 1986 Vol.135, Oct 1, pp:753-8
7. Regan T.J. (1985) The Heart, Alcoholism, and Nutritional Disease. In: Hurst J.W., Logue R. B., Rackley C. E., Schlant R.C., Sonnenblick E.H., Wallace A.G., Wenger N.K. The heart, 6th Edition, McGraw-Hill Book Company pp:1446-51
8. Pissaia O, Rossi MA, Oliveira JS. The heart in protein-calorie malnutrition in rats: morphological, electrophysiological and biochemical changes. *J Nutr.* 1980 Oct;110(10):2035-44
9. Freund H.R, Holroyde J. (1986) Cardiac function during protein malnutrition in the isolated rat heart. *Journal of Parenteral and Enteral Nutrition* 10:470-73.
10. Vandewoude M.F.J., Cortvrindt R.G., Goovaerts M.F., Van Paesschen M.a., Malnutrition and the heart: a microscopical analysis. *Infusion therapy* (1988) Vol.15 No.5:217-20.
11. Vandewoude M.F.J., (1995) Morphometric Changes in microvasculature in rat myocardium during malnutrition. *J Parenteral Enteral Nutrition* Vol.19 No. 5:376-80
12. Alden P. B., Madoff R. D., Stahl T. J., Lakatua D. J., Ring W. S., Cerra F. B., Left ventricular function in malnutrition, *American journal of physiology*; (1987) Aug, Vol. 253 no.2:380-87
13. El-Sayed H.L.; Nassar M.F.; Habib N.M.; Elmasry O.A.; Gomaa S.M. Structural and functional affection of the heart in protein energy malnutrition patients on admission and after nutritional recovery. *Eur J Clin Nutr*; 60(4):502-10
14. Abu Faddan N.H., El Sayh K.I., Shams H., Gomaa H., Myocardial dysfunction in malnourished children. *Annals of Pediatric Cardiology* (2010) Vol.3 Issue 2
15. Öcal B, Ünal S, Zorlu P, Tezic HT, Oğuz D, Echocardiographic evaluation of cardiac functions and left ventricular mass in children with malnutrition *Journal of Paediatrics and Child Health* Volume 37, Issue 1, pages 14–17, February 2001
16. Olivares J. L., Margarita V., Gerardo R., Pilar S., Jesús F. Electrocardiographic and Echocardiographic findings in malnourished children; *journal of the American College of Nutrition*, (2005) Vol.24, No. 1, 38-43.
17. G de Simone, Daniels SR, RB Devereux, RA Meyer, MJ Roman, O de Divitiis, and MH Alderman, Left ventricular mass and body size in normotensive children and adults: assessment of allometric relations and impact of overweight
18. Kothari SS, Patel TM, Shetalwad AN, Patel TK. Left ventricular mass and function in children with severe protein energy malnutrition.
19. Fioretto J R, Susana S Q, Carlos R P, Luiz S. M., Katashi O., Beatriz B. M. (2001) Ventricular remodeling and diastolic myocardial dysfunction in rats submitted to protein-calorie malnutrition, *American journal of physiology*; April Vol.282 no.4:327-33.