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 intra-cardiac implantation of instruments and the postmortem study.

Relatively recently researchers studied effect of malnutrition on hospitalized malnourished children and matched them with control group.
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, 2D, 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

Left-ventricular mass (gm) = 0.8[1.04{(IVSD +PWD + LVEDD)\(^2\)} - 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 measures of dispersion and measures of central tendency have been entry and analysis. Descriptive statistics including frequencies, 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 group than in normal group (Table 2). All of these echocardiographic variables are positively correlated with anthropometric indicators, both weight for age and height for age (figures 1-12).

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**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cases</th>
<th>Controls</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>113.49±19.154</td>
<td>116.74±19.38</td>
<td>0.74</td>
</tr>
<tr>
<td>Gender(male/female)</td>
<td>11/26</td>
<td>14/28</td>
<td>0.46</td>
</tr>
<tr>
<td>Z-score weight/age (WAZ)</td>
<td>-2.411±.49146</td>
<td>-3.114±.54764</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Table 2: Comparison of Echocardiographic parameters between cases and controls**

<table>
<thead>
<tr>
<th>Group</th>
<th>IVSD (cm)</th>
<th>PWD (cm)</th>
<th>IVSS (cm)</th>
<th>PWS (cm)</th>
<th>LVEDD (mm)</th>
<th>heart mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>.5311</td>
<td>.5157</td>
<td>.8746</td>
<td>.7892</td>
<td>3.559</td>
<td>45.108</td>
</tr>
<tr>
<td>N</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.05646</td>
<td>.05905</td>
<td>.10418</td>
<td>.11369</td>
<td>.3700</td>
<td>7.2445</td>
</tr>
<tr>
<td>Median</td>
<td>.5200</td>
<td>.5100</td>
<td>.8800</td>
<td>.7900</td>
<td>3.600</td>
<td>44.000</td>
</tr>
<tr>
<td>Minimum</td>
<td>.41</td>
<td>.42</td>
<td>.62</td>
<td>.50</td>
<td>3.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>.62</td>
<td>.61</td>
<td>.110</td>
<td>1.10</td>
<td>4.4</td>
<td>62.0</td>
</tr>
<tr>
<td>control</td>
<td>mean</td>
<td>.6771</td>
<td>.6717</td>
<td>.9848</td>
<td>.9738</td>
<td>3.864</td>
</tr>
<tr>
<td>N</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.08256</td>
<td>.08439</td>
<td>.16760</td>
<td>.11605</td>
<td>.3553</td>
<td>17.9539</td>
</tr>
<tr>
<td>Median</td>
<td>.6850</td>
<td>.6750</td>
<td>.9800</td>
<td>1.0000</td>
<td>3.800</td>
<td>67.300</td>
</tr>
<tr>
<td>Minimum</td>
<td>.52</td>
<td>.52</td>
<td>.36</td>
<td>.62</td>
<td>3.2</td>
<td>48.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>.89</td>
<td>.80</td>
<td>1.50</td>
<td>1.30</td>
<td>4.7</td>
<td>113.0</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>.6087</td>
<td>.5986</td>
<td>.9332</td>
<td>.8873</td>
<td>3.722</td>
</tr>
<tr>
<td>N</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.10215</td>
<td>.10719</td>
<td>.15111</td>
<td>.14711</td>
<td>.3911</td>
<td>19.6398</td>
</tr>
<tr>
<td>Median</td>
<td>.6000</td>
<td>.6000</td>
<td>.9200</td>
<td>.8800</td>
<td>3.700</td>
<td>55.000</td>
</tr>
<tr>
<td>Minimum</td>
<td>.41</td>
<td>.42</td>
<td>.48</td>
<td>.50</td>
<td>3.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>.89</td>
<td>.80</td>
<td>1.50</td>
<td>1.30</td>
<td>4.7</td>
<td>113.0</td>
</tr>
</tbody>
</table>
Fig. 1: Correlation between LVEDD and HAZ $R=0.367$ $p=0.001$

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

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

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

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

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

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

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

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

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 LVMI than the control group [14].

Elsayed found that, echocardiographic changes showed that cardiac mass index was significantly lower in cases compared to the controls [15].

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.

ACKNOWLEDGMENT

My great thanks and high appreciation to all families who brought their kids for participation in this research work. I am grateful to all school managers and teachers who were really cooperative.

CONFLICT OF INTERESTS

Declared None

REFERENCES


17. 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 adolescents: assessment of allometric relations and impact of overweight

18. Kothari SS, Patel TM, Shethawad AN, Patel TK. Left ventricular mass and function in children with severe protein energy malnutrition.