# Evaluation of left ventricular thickness and function in malnourished child

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## Abstract

Malnutrition is an important problem ion the third world. Cardiac complications is an important cause of mortality and morbidity among the children with poor nutrition. A case control study was done on 54 child aged 2-5 years with malnutrition attending Tikrit teaching hospital during the period from 1st of February 2007 to the 1st of February 2008 to evaluate the effect of malnutrition on the cardiothoracic ratio on plain CXR . Similar number of normal children were taken as a control with same age range during the period of the study. The total number of cases was 54 , males 37 (68.5%) and females were 17 cases (31.5%). According to the Welcome classification . most of the study cases were marasmic 22 cases (40.7%0) while the least were marasmic kwashiorkor category 8 cases (14.8%). according to the CTR in regard to the water law classification in regard to the total number of cases , most of the cases have CTR between 20-40% 27 case (50%). All the cases with mild malnutrition have normal CTR 8 cases (100%) , most of the cases with moderate malnutrition have CTR between 20-40% , 22 case (59.5%) while for the sever malnutrition , most of the cases have also CTR between 20-40% , 5 case (55.6%). according to the Welcome classification. Regarding the marasmus cases , 9 case (40.9%) have CTR between 20-40% and 8 cases (36.4%) were between 40-50%. Most of the kwashiorkor patients have CTR between 20-40 % , 8 cases (66.7%) which is similar to the marasmus kwashiorkor category 6 cases (75%0. most of the under weight patients have CTR between 40-50% , 7 cases (58.3%). In diasystole .there is significant decrease in the left ventricular wall thickness for septum 38(70.3%) and posterior wall 39(72.2%) as compared o the control cases (0%). In systole, there is significant decrease in the left ventricular thickness for septum 48(88.9%) and posterior wall 47(87%) as compared to the control cases (0%). Most of the malnutrition cases had increased heart rate 38(70.4%) as compared to the control cases 3(5.6%). There is significant decrease in the stroke volume in the malnutrition cases 44(81.5%) as compared to the control cases (0%). There is significant decrease in the cardiac output in the malnutrition cases 44 (81.5%) as compared to the control cases (0%). As well as there is significant decrease in the cardiac contractility in malnutrition cases 53 (98.1%) as compared to the control cases (0%).Regarding the fractional shortening and ejection fraction, there is significant decrease in the fractional shortening in the malnutrition cases 44 (81.5%) as compared to the control cases (0%) as well as there is significant decrease in the ejection fraction in malnutrition cases 44(81.5%) as compared to the control cases (0%). There was no significant difference regarding the left ventricular function or mass in patients with marasmus as compared to those with kwashiorkor or marasmic kwashiorkor. The study concludes that malnourished patients have smaller CTR compared with well nourished ones with significant decrease in the left ventricular thickness and function.

## Introduction

Malnutrition is the condition that occurs when a person's body is not getting enough nutrients. The condition may result from an inadequate or unbalanced diet, digestive difficulties, absorption problems, or other medical conditions. (1) Worldwide, malnutrition continues to be a significant problem, especially among children who cannot fend adequately for themselves. Poverty, natural disasters, political problems, and war all contribute to conditions -- even epidemics -- of malnutrition and starvation, and not just in developing countries.(2) Symptoms vary with the specific malnutrition-related disorder. However, some general symptoms include fatigue, dizziness, weight loss and decreased immune response.(3)

Marasmus is a form of severe protein-energy malnutrition characterized by energy deficiency.(4)Marasmus is 1 of the 3 forms of serious protein-energy malnutrition (PEM). The other 2 are kwashiorkor (KW) and marasmic KW. These forms of serious PEM represent a group of pathologic

conditions associated with a nutritional and energy deficit occurring mainly in young children from developing countries at the time of weaning. Marasmus occurrence increases prior to age 1, whereas kwashiorkor occurrence increases after 18 months. The prognosis is better than it is in kwashiorkor. (5)

Kwashiorkor is a type of malnutrition with controversial causes, but it is commonly believed to be caused by insufficient protein consumption. It usually affects children aged 1–4 years, although it also occurs in older children and adults. (5) Symptoms of kwashiorkor include a swollen abdomen known as a pot belly, as well as alternating bands of pale and dark hair (flag sign) and weight loss. Common skin symptoms include dermatitis and depigmented skin.(5)

Marasmic kwashiorkor a condition in which there is a deficiency of both calories and protein, with severe tissue wasting, loss of subcutaneous fat, and usually dehydration. The most severe form of protein-energy malnutrition in children, with weight for height less than 60% of that expected, and with edema and other symptoms of kwashiorkor. (4)

Undernutrtion is usually thought of as a deficiency primarily of calories (that is, overall food consumption) or of protein. Deficiencies of vitamins and minerals are usually considered separate disorders. (5)

Cardiothoracic ratio: This is the transverse cardiac diameter (the horizontal distance between the most rightward and leftward borders of the heart seen on a postero-anterior (PA) chest radiograph) divided by the transverse chest diameter (measured from the inside rib margin at the widest point above the costophrenic angles on a PA chest film).(10) A cardiothoracic ratio of more than 50% is considered abnormal in an adult; more than 66% in a neonate.(6) The cardiac diameter itself can also be measured and, in normal individuals, is less than 15.5 cm in males, and less than 14.5 cm in females. A change in diameter of greater than 1.5 cm between two X-rays is significant.(6) Sometimes the heart can be smaller than 50% of the cardiothoracic ratio but still be an abnormal heart. This occurs when there is something obstructing the flow of blood from the ventricles since the ventricles respond at first by undergoing hypertrophy, which does not produce cardiomegaly.

Echocardiography is provides a great deal of anatomical and hemodynamic information regarding the heart chamber size, function( systolic and diastolic) valvular motion and function, intracardia or extra cardiac masses or fluids and the direction of the flow. (7) The normal echo ranges vary with a number of factors like the height, sex, age, physical training, in general values are higher in taller individuals, males and athletes. Some of these factors corrected to the body surface area. The effects of acute protein-calorie malnutrition on cardiac function had been recently studied on smaller accounts . it had been found that malnutrition had significant effect on the cardiac mass and function . Acute protein-calorie malnutrition causes significant cardiac atrophy that is reflected in decreased cardiac output and slightly reduced contractility but not in intrinsic properties of the myocardium. This indicates that depressed contractility was due to loss of cardiac muscle mass rather than any change in the myocardium per se. (7)

The aim of this study is to evaluate the effect of malnutrition on the cardiac size, left ventricular thickness and function

## Patients and Method

A case control study was done on 54 child aged 2-5 years with malnutrition attending Tikrit teaching hospital during the period from 1st of February 2007 to the 1st of February 2008 . Similar number of normal children were taken as a control with same age range during the period of the study. Each case (patients and control) was assessed by a prepared questioners including name, age, sex, residence. Each case examined for weight , height and full systematic examination to exclude the presence of any chronic illness. Centile charts assessment including weight for age, height for age and weight for height were done for all the cases (patients and control). The patient was diagnosed as malnutrition if the weight is decreased less than 90% and weight for height less than 95% of ideal for age and sex. (4)

The patient diagnosed as mild, moderate and sever malnutrition according to

the Waterlaw classification.(5) The patient classified as marasmus, kwashiorkor, marasmic-kwashiorkor and undernutrtion according to the Welcome classification.(5)

All the cases (patients and control) were send for plain CXR , posteroanterior view, erect posture, full inspiration, good penetration . Cardiothoracic ratio was assessed by the standard way by measuring the cardiac horizontal diameter divided by the internal thoracic diameter with the line passed over the dome of the right diaphragm multiplied by 100.(6)

Left ventricular thickness . using the motion or the M-mode by echocardiography is produced by the transmission and reception of an ultrasound signals along only one line . measurement of the size and thickness of the cardiac chamber can be made on the TV screen using the computer soft ware. The normal value for left ventricular dimensions were :

Internal diameter: end systolic 2-4 cm End diastolic 3.5-5.6 cm

Wall thickness: diastolic septum 0.6-1.2 cm Post wall 0.6-1.2 cm

Systolic

septum 0.9-1.8 cm Post wall 0.9-1.8 cm (7).

Heart rate ( through a stethoscope) and pulse rate from the radial artery) were measured in full one minutes for those with regular rhythm . those with irregular rhythm were excluded from the study as they may have had underlying cardiac disease. Normal values for HR is infancy was 120-150 beats/min and for those 1-4 years age was 110-140 beats/min . (7)

Cardiac output: cardiac output can be measured by echocardiography by the following equation: Cardiac output= stroke volume x heart rate. normal value for Cardiac output was 4-7 L/min.

Stroke volume is delivered by echo from a measure known as the flow velocity integral (FVI)this is calculated by the computer of the echo machine as the area under the curve from the continuous wave Doppler of aortic out flow in the apical 5-chamber view .FVI is given from the peak aortic flow velocity in cm/sec and aortic ejection time in second /beat:

Stroke volume = FVI x cross sectional are for the aortic valve (AV diameter measured either from M- mode of the AV tracing or from the parasternal long axis view measured in the aortic root just above the tip of the aortic cusps).normal values for stroke volume was 70-140 mL/beat .(7 )

Ventricular contractility was observed directly by the 2- D echo through the Lf parasternal view. (7)

The systolic function indices like ejection fraction, percentage fractional shortening,. M-mode can be used for assessment of Lf ventricular cavity dimensions, wall motion and thickness. LV internal dimensions measurement in end-systole( LVESD)and end diastole (LVEDD)are made at the level of the mitral valve leaflet tips in the parasternal long axis view. The normal rage for LVEDD is 3.5-5.6 cm. the normal range for LVESD is 2-4 cm. (7)

The LVESD and LVEDD measurements can be used to calculates the LV fractional shortening , LV ejection fraction which give further indications of LV systolic function.

Fractional shortening (FS) is a commonly used measures and is the % change in the LV internal dimensions ( not volume) between systole and diastole:

FS= LVEDD-LVESD/LVEDD x 100% (normal range is 30-45 %.

The ejection fraction is the % change in LV between systle and diastole and is :

EF = ( LVEDD) 3 – (LVESD) 3 / (LVEDD) 3 x100%. Normal range is 50-85%. (7)

Exclusion criteria: patients less than 1 year age and those with history of chronic cardiac problem All the results are put in tables and statistical analysis was done using the P-value . P- value less than 0.05 considered as significant.

## Results

The total number of cases was 54 , males 37 (68.5%) and females were 17 cases (31.5%). While the control cases , males were 16 (29.6%) and females 38 (70.4%).

Most of the study cases were from rural areas 39 cases (72.2%) , while the rest from urban areas 15 cases (27.7%) . While most of the control cases were also from rural areas 38 cases (70.4%) and the rest from urban areas 16 cases (29.6%).

Most of the malnourished cases were between the ages of 25-48 months 28 cases (51.9%), which is the similar distribution for the control cases 33 (61.1%).

Most of the cases have moderate decrease in the weight and height for age 37 cases (68.5%) and 35 cases (64.8%) respectively while regarding the weight for height most of the cases have mild decrease in the weight for height 33 cases (61.1%). Most of the study cases were marasmic 22 cases (40.7%0) while the least were marasmic kwashiorkor category 8 cases (14.8%).

Table (1) shows the distribution of cases according to the CTR in regard to the water law classification in regard to the total number of cases , most of the cases have CTR between 20-40% 27 case (50%). All the cases with mild malnutrition have normal CTR 8 cases (100%) , most of the cases with moderate malnutrition have CTR between 20-40% , 22 case (59.5%) while for the sever malnutrition , most of the cases have also CTR between 20-40% , 5 case (55.6%). All the control cases have a CTR between 40-50%.

Table (2) shows the distribution of cases according to the Welcome classification. Regarding the marasmus cases , 9 case (40.9%) have CTR between 20-40% and 8 cases (36.4%) were between 40-50%. Most of the kwashiorkor patients have CTR between 20-40 % , 8 cases (66.7%) which is similar to the marasmic kwashiorkor category 6 cases (75%0. most of the under weight patients have CTR between 40-50% , 7 cases (58.3%). All the control cases have a CTR between 40-50%.

Table (3) distribution of the study cases according to the left ventricular mass in regard to the control cases (in diastole).there is significant decrease in the left ventricular wall thickness for septum 38(70.3%) and posterior wall 39(72.2%) as compared o the control cases (0%). regard to the control cases (in systole). There is significant decrease in the left ventricular mass for septum 48(88.9%) and posterior wall 47(87%) as compared to the control cases (0%). Table (5) distribution of the study cases according to the heart rate in

regard to the control cases. Most of the malnutrition cases had increased heart rate 38(70.4%) as compared to the control cases 3(5.6%) Table (6) distribution of cases according to the stroke volume in regard to the control cases. There is significant decrease in the stroke volume in the malnutrition cases 44(81.5%) as compared to the control cases (0%).

Table (7) distribution of cases according to the cardiac output in regard to the control cases. There is significant decrease in the cardiac output in the malnutrition cases 44 (81.5%) as compared to the control cases (0%). Table (8) distribution of cases according to the myocardial contractility in regard to the control cases. There is significant decrease in the cardiac contractility in malnutrition cases 53 (98.1%) as compared to the control cases (0%).

Table (9) distribution of cases according to the fractional shortening in regard to the control cases. There is significant decrease in the fractional shortening in the malnutrition cases 44 (81.5%) as compared to the control cases (0%). Table (10) distribution of cases according to the ejection fraction in regard to the control cases. There is significant decrease in the ejection fraction in malnutrition cases 44(81.5%) as compared to the control cases (0%).

There was no significant difference regarding the left ventricular function or mass in patients with marasmus as compared to those with kwashiorkor or marasmic kwashiorkor

## Discussion:

Malnutrition can occur because of the lack of a single vitamin in the diet, or it can be because a person isn't getting enough food.(1)

Most of the malnourished cases were between the ages of 2-4 years . This is similar to other studies by Berkley J,(5) and Buchanan N (8) which shows that most of the malnutrition cases are presented after the

age of 2 years. This may be due to the fact that most of the malnutrition cases occur after the 1st year of life because most of the cases are usually received their enough calories during the 1st year of life (whether it is by breast or bottle feeding) and after the 1st year (and during weaning time) , if the child does not received enough calories for his rapid growth , malnutrition will ensue.

Regarding the distribution of malnourished cases according to the Water law classification, most of the cases have moderate decrease in the weight for age and height for age . This is similar to the results by Golden M study (9) which shows that moderate malnutrition are more prevalent mild or sever cases. This may de due to that most of the cases present in the moderate form of disease because mild cases are usually passed unnoticed by the family that discover only accidentally.

Regarding the weight for height most of the cases have mild decrease in the weight for height . This is similar to the results by Long J (10) who shows that most cases of malnutrition and in spite of sever cases of malnutrition , have normal or only mild decreased weight for height. This is due to the fact patients with sever malnutrition have nearly comparable decrease in both weight and height which by the end leads to normal weight for height or slight decreased in the ratio (in case of acute illness over a chronic case of malnutrition).

According to the Welcome classification , most of the study cases were marasmic while the least were marasmic kwashiorkor category . This is similar to that results by Gomez F (11) and Listernick R (12) which show that marasmus is more prevalent than that of kwashiorkor. This is a well known fact that marasmus is more prevalent than kwashiorkor. (4)

In regard to the CTR in respect to the water law classification , most of the cases have CTR between 20-40%. All the cases with mild malnutrition have CTR between 40-50%, most of the cases with moderate and sever malnutrition have CTR between 20-40% . This significant decrease in the CTR between the mild cases and moderate to sever malnutrition may be due to the fact that malnutrition is a disease of protein and calories deficiencies and as the heart is a muscle it is affected by the generalized wasting that affect the hole body of patient with malnutrition. In fact some patients with malnutrition presets with cardiomegaly due to many cases such as anemia (due to any cause ) or cardiomyopathy (due to deficiency of one or more essential element or vitamins) (6) or the cardiomegaly may be the cause of malnutrition ( such as CHDS or chronic heart failure ). (7)

Regarding the distribution of cases according to the Welcome classification. Most of the marasmus cases , have nearly equal results in CTR between 20-40% and 40-50%.while most of the kwashiorkor patients have CTR between 20-40 % (66.7%) and a similar results for the marasmus kwashiorkor category (75%). This significant decrease in CTR among the cases of kwashiorkor and marasmus kwashiorkor as compared to the marasmic patients is due to the fact that the main deficiency in kwashiorkor and marasmus kwashiorkor was the protein by which its deficiency leads to wasting mainly and as the heart is also a muscle it affected by wasting as well.

In diasystole , there is significant decrease in the left ventricular wall thickness for septum and posterior wall as compared o the control cases with similar findings in systole . This is similar to the findings by P. B. Alden et al (7) which show significant decrease in the cardiac mass in malnourished cases. Twenty-one dogs were chronically instrumented with ultrasonic left ventricular dimension transducers and micro manometers to elucidate the effects of acute protein-calorie malnutrition on cardiac function. Ten dogs received a regular diet for 3 wk, whereas 11 dogs received a protein-calorie-deficient diet designed to achieve a mean weight loss of 20-25% over a 3-wk period. Studies of cardiac function were performed in awake intact animals at base line (1 wk postoperatively) and after 3 wk. In the malnourished dogs, cardiac mass was lost in proportion to total body mass loss. Mean cardiac mass fell from 115 to 91 g. This was largely due to wall thinning in this group. This may be due to that acute protein-calorie malnutrition causes significant cardiac atrophy that is reflected in decreased cardiac output and slightly reduced contractility but not in intrinsic properties of the myocardium. Other study by El-Sayed HL et al(13) shows

decrease in the cardiac mass with relative cardiac "sparing" ( the cardiac mass to the total body mass ratio is spared occurs in patients with severe protein energy malnutrition. We studied 25 children, aged 1–5 years (mean 2.65 ± 0.8 years) with severe protein energy malnutrition, and compared their left ventricular mass and function to those of 26 healthy, age- and sex-matched normal children. The mean left ventricular mass in the patients was lower than that in the controls (25.75 ± 8.09 g vs. 32.44 ± 11.64 g; $P < 0.05$, C.I. 2.08 to 11.30). However, left ventricular mass (g)/kg body weight was significantly increased in the patients (4.44 ± 1.45 vs. 2.42 ± 0.87; $P < 0.001$, C.I. 1.28 to 2.76) suggesting relative cardiac "sparing". Other study by Yadav D (14) shows also decrease in the cardiac mass in malnourished cases. Amongst the 25 patients with malnutrition, however, 5 patients (20%) had an ejection fraction of less than 50%. Compared to the other 20 patients, these 5 patients had lower left ventricular mass (18.4 ± 4.3 g vs. 27.5 ± 7.8 g, $P < 0.05$ C.I. 1.63 to 16.75), lower left ventricular mass (g)/kg body weight and a worse prognosis. These 5 patients did not differ from the rest of the patients in any other identifiable respect. Further characterization of such patients may have wider physiological implications. In conclusion: (1) relative cardiac "sparing" occurs in patients with severe protein energy malnutrition; (2) the systolic functions are preserved in the atrophic hearts in most of the patients; and (3) in a small number of patients (20%), with equally severe malnutrition, more myocardial atrophy, reduced ejection fraction and a worse prognosis are seen.

Most of the malnutrition cases had increased heart rate 38(70.4%) as compared to the control cases 3(5.6%). This is similar to the findings by Yadav D (14) which shows increased in the heart rate. This may be due to the fact that malnutrition cases are usually suffer from anemia that manifest as tachycardia or the heart try to compensate for the decrease in the contractility as well as decrease in the cardiac output to maintain good blood supply to the vital organs. In addition patient with malnutrition usually had associated with dehydration of a variable degree with tachycardia as a manifestation of moderate to sever malnutrition. Other study by P. B. Alden et al (7)shows significant decrease in the hear rate in dog after sever acute protein energy malnutrition Heart rate dropped from 125 to 79 beats/min with malnutrition and ejection fraction increased from 29.8 to 34.6%.. this may de due to the difference sample type and size.

There is significant decrease in the stroke volume in the malnutrition cases as well as there is significant decrease in the cardiac output in the malnutrition cases as compared to the control cases .Other study by Alden et al (7) which shows that cardiac output fell from 2.98 to 2.38 l/min, but cardiac index normalized to body surface area was unchanged. No significant changes in hemodynamic were observed in the control group. other study by Yadav D (14) stated that the systolic functions are preserved in the atrophic hearts in most of the patients; and in a small number of patients (20%), with equally severe malnutrition, more myocardial atrophy, reduced ejection fraction and a worse prognosis are seen.

There is significant decrease in the cardiac contractility in malnutrition cases 53 (98.1%) as compared to the control cases (0%). This is similar to the findings by Alden et al (7) which shows that in the malnutrition group, global ventricular contractility, as measured by the load-independent index of systolic function or the slope of linear relationship between end-systolic pressure and end-systolic volume (EmaxPV), decreased slightly from 3.56 to 2.81 mmHg/ml ($P = 0.07$). However, Emax calculated from circumferential stress and strain data was unchanged. This indicates that depressed contractility was due to loss of cardiac muscle mass rather than any change in the myocardium per se. Response to beta-adrenergic stimulation was unchanged with starvation.. This may be due to that acute protein-calorie malnutrition causes significant cardiac atrophy that is reflected in decreased cardiac output and slightly reduced contractility but not in intrinsic properties of the myocardium. stroke volume may be decreased as part of dehydration associated with malnutrition.

Regarding the fractional shortening and ejection fraction, there is significant decrease in the fractional shortening in the

malnutrition cases as well as there is significant decrease in the ejection fraction in malnutrition cases as compared to the control cases. This similar to the findings by Yadav D (14) which shows that there is significant decrease in the fractional shortening and ejection fraction, the fractional shortening and ejection fraction of the heart. This may be due to the same reason above in which there is significant cardiac muscle atrophy in patient with malnutrition. The El-Sayed HL et al study (13) shows that systolic function indices like ejection fraction, percentage fractional shortening, and velocity of circumferential fiber shortening were not significantly different in the patients and in the normal children. The left ventricular end-diastolic volume, stroke volume and cardiac output were reduced in proportion to decrease in body size in the patients, so that the cardiac index was not reduced but slightly increased in the patients. (5.95 ± 1.9 l/min/m2 in patients, 4.97 ± 1.4 l/min/m2 in controls; $P < 0.05$, C.I. 0.04 to 1.92).

There was no significant difference regarding the left ventricular function or mass in patients with marasmus as compared to those with kwashiorkor ar marasmic kwashiorkor. This is similar to the Yadav D study (14) which shows that there was no significant difference in any of these parameters of left ventricular function or mass in patients with marasmus, as compared to those of patients with marasmic kwashiorkor.

The study concludes that malnourished patients have smaller CTR compared with well nourished ones with significant decrease in the left ventricular thickness and function.

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**Table (1)** shows the distribution of cases according to the CTR in regard to the water law classification in regard to the total number of cases.

| Total | CTR | | | Classification |
|---|---|---|---|---|
| | >50% | 40-50% | 20-40% | |
| 8(100%) | 0(0%) | 8(100%) | 0(0%) | Mild |
| 37(100%) | 3(8.1%) | 12(32.4%) | 22(59.5%) | Moderate |
| 9(100%) | 3(33.3%) | 1(11.1%) | 5(55.6%) | Sever |
| 54(100%) | 6(11.1%) | 21(38.9%) | 27(50%) | Total |
| 54(100%) | - | 54(100) | - | control |

p- value< 0.05 (significant)

**Table (2)** shows the distribution of cases according to the Welcome classification.

| Total | CTR | | | Total |
|---|---|---|---|---|
| | >50% | 40-50% | 20-40% | |
| 22(100%) | 5(22.7%) | 8(36.4%) | 9(40.9%) | marasmus |
| 12(100%) | 0(0%) | 4(33.3%) | 8(66.7%) | kwashiorkor |
| 8(100%) | 0(0%) | 2(25%) | 6(75%) | Marasmic kwashiorkor |
| 12(100%) | 1(8.3%) | 7(58.3%) | 4(33.3%) | Under nutrition |
| 54(100%) | 6(11.1%) | 21(38.9%) | 27(50%) | Total |
| 54(100%) | - | 54(100%) | - | control |

p- value< 0.05 (significant)

**Table (3)** distribution of the study cases according to the left ventricular mass in regard to the control cases (in diasystole).

| P-value | Control | | Malnutrition | | Left ventricular wall thickness (cm) | |
|---|---|---|---|---|---|---|
| | 0.6-1.2 | <0.6 | 0.6-1.2 | <0.6 | | |
| <0.05 | 51(94.4%) | 3(5.6%) | 16(29.7%) | 38(70.3%) | septum | Diastole |
| <0.05 | 53(98.1%) | 1(1.9%) | 15(27.8%) | 39(72.2%) | Post wall | |

**Table (4)** distribution of the study cases according to the left ventricular mass in regard to the control cases (in systole)

| P-value | Control | | Malnutrition | | Left ventricular wall thickness(cm) | |
|---|---|---|---|---|---|---|
| | 0.9-1.8 | <0.9 | 0.9-1.8 | <0.9 | | |
| <0.05 | 54(100%) | -(0%) | 6(11.1%) | 48(88.9%) | Septum | Systole |
| <0.05 | 54(100%) | -(0%) | 7(13%) | 47(87%) | Post wall | |

**Table (5)** distribution of the study cases according to the heart rate in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Heart rate(beats/min) |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| <0.05 | 94.4 | 51 | 29.6 | 16 | Normal * |
| <0.05 | 5.6 | 3 | 70.4 | 38 | Increased * |
| | 100 | 54 | 100 | 54 | Total |

* normal values for HR is referred to the reference range (7) because it is differ according to the age and sex.

**Table (6)** distribution of cases according to the stroke volume in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Stroke volume (ml/beat) |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| >0.05 | 0 | - | 0 | - | >140 |
| <0.05 | 100 | 54 | 18.5 | 10 | 70-140 |
| <0.05 | 0 | - | 81.5 | 44 | <70 |
| | 100 | 54 | 100 | 54 | Total |

**Table (7)** distribution of cases according to the cardiac output in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Cardiac output (L/min) |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| >0.05 | 1.9 | 1 | 0 | - | >7 |
| <0.05 | 98.1 | 53 | 18.5 | 10 | 4-7 |
| <0.05 | 0 | - | 81.5 | 44 | <4 |
| | 100 | 54 | 100 | 54 | Total |

**Table (8)** distribution of cases according to the myocardial contractility in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Contractility |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| <0.05 | 100 | 54 | 1.9 | 1 | Good |
| <0.05 | 0 | - | 98.1 | 53 | Poor |
| | 100 | 54 | 100 | 54 | Total |

**Table (9)** distribution of cases according to the fractional shortening in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Fractional shortening (%) |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| >0.05 | 1.9 | 1 | 0 | - | >45 |
| <0.05 | 98.1 | 53 | 18.5 | 10 | 30-450 |
| <0.05 | 0 | - | 81.5 | 44 | <30 |
| | 100 | 54 | 100 | 54 | Total |

**Table (10)** distribution of cases according to the ejection fraction in regard to the control cases.

| P-valeu | Control | | Malnutrition | | Ejection fraction (%) |
|---|---|---|---|---|---|
| | % | No. | % | No. | |
| >0.05 | 1.9 | 1 | 0 | - | >85 |
| <0.05 | 98.1 | 53 | 18.5 | 10 | 50-85 |
| <0.05 | 0 | - | 81.5 | 44 | <50 |
| | 100 | 54 | 100 | 54 | Total |