*Original Article*

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# Assessment of Cardiac Function in Malnourished Children of Central India

**Umesh V. Biyani*, Amar M. Taksande****

*Resident **Professor and Head, Department of Pediatrics, JNMC and Acharya Vinoba Bhave Rural Hospital, Paloti Road, Sawangi (Meghe); Wardha 442002.

**Abstract**

*Background:* Malnutrition is a widespread public health problem and the child is the chief victim of interplay of nutritional, socioeconomic and health factors that cause malnutrition. It affects the potential for growth of the child and causes high mortality in the later years of life. There is increased risk of diseases and deaths in the adults who have been undernourished in their childhood. *Aim*: Assessment of cardiac function in malnourished children of Central India. *Materials and Methods*: The present study was conducted to compare cardiac dysfunction between a group of malnourished children and a control group of the same age and sex and to investigate the variables like xray,ECG,2D ECHO and Cardiac troponin among study group. *Results:* Mean among the cases for QT interval was 332.2 $\pm$44.59 msec and controls were 293.4 $\pm$28.54 msec. (P<0.001). Mean among the cases for QTc interval was 426.7 $\pm$27.5 msec and controls was 379.5$\pm$24 msec. (P<0.0001).Mean LVM among cases was 31.58$\pm$13.6 and control was 47.14$\pm$15.68. There was significant difference in LVM among cases and control (P<0.0001). *Conclusion*: Malnutrition has a definite effect on cardiac volume, muscle mass, as well as the electrical properties of the myocardium. The electrocardiographic findings showed increased QT and QTc intervals. The echocardiographic examination shows decreased interventricular septal thickness, decreased left ventricular dimensions, decreased left ventricular posterior wall thickness, decreased fractional shortening and left ventricular mass suggesting cardiac atrophy and impaired left ventricular systolic functions.

**Keywords:** Malnutrition; ECG; 2D Echo; Xray; Cardiac TroponinI.

## Introduction

Malnutrition is a widespread public health problem and the child is the chief victim of interplay of nutritional, socioeconomic and health factors that cause malnutrition [1]. The quality of nation's health is mainly determined by the investment made for development of child population. The three of eight millennium development goals emphasise on child health, reduction of child mortality and improved maternal health, indirectly leading towards a healthy nation [2]. Malnutrition has adverse effects on the child's health. It decreases the life expectancy of the child. It affects the potential for growth of the child and causes high mortality in the later years of life. There is increased risk of diseases and deaths in the adults who have been undernourished in their childhood [3,4]. Nutritional status of the child depends indirectly on the various factors such as level of employment, food availability, food consumption pattern, purchasing power of people, distribution of income, food distribution in the household amongst the family members, level of knowledge, literacy and government schemes. Improved economic development contributes to improved nutrition and vice versa [5].

In India, there is prevalence of wasting and stunting, causes being lack of food, poor hygiene, poor

**Corresponding Author: Umesh V. Biyani,** S12, Yashodha PG Boys Hostel, AVBRH Campus; Acharya Vinoba Bhave Rural Hospital, Paloti Road, Sawangi (Meghe); Wardha 442002.
Email: umeshbiyani303@gmail.com

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sanitary practice in the household, poverty, illiteracy amongst the mothers and lack of health care facilities. These problems prevail more commonly in rural India. Since independence, agricultural production has increased by many folds, however the infant mortality rate and death rate have come down by one–third, and malnutrition has come down by one–fifth only. This means that despite of adequate food production there is prevalence of malnutrition

It has been found out that heart failure and cardiac arrhythmias are amongst the few causes of death in malnutrition. The risk of death increases with mild undernutrition and as the severity of undernutrition increases, the risk increases exponentially.In most children with third-degree malnutrition, cardiac mass is decreased. Cardiac troponins are regulatory proteins of the thin actin filaments of the cardiac muscle. Myocardial cell injury results in the release of cardiac troponin, which differs from troponin isoforms of the skeletal muscle, and thus is a highly sensitive and specific biomarker of myocardial damage [6]. It is a common and serious problem in the developing countries mainly in the rural areas. The present study was conducted to compare cardiac dysfunction between a group of malnourished children and a control group of the same age and sex and to investigate the variables like X-ray, ECG, 2D ECHO and Cardiac troponin among study group.

## Materials and Method

*Study Design*

The present study was a case control study and was done at Tertiary care hospital, Jawaharlal Nehru Medical College & Acharya Vinoba Bhave Rural Hospital (AVBRH) Sawangi,Wardha. The AVBRH, Sawangi is the rural medical college located in Maharashtra. This study was conducted in the Pediatric Department at AVBRH. The sample Size was 100 (50 cases & 50 controls) and study period was from September 2014 to September 2016.

*Method of Collection of Data*

Parents of all the subjects (cases as well controls) were interviewed using study questionnaire. The content of the questionnaire included:

***A: History***

Following details were interviewed

- Demographic characteristics: child's name, sex, address and religion.
- Subject's conditions at birth: gestational age, birth weight
- A detailed dietary history was taken by interviewing the child's mother using a 24-hour recall method.

***B:Physical Examination***

- General physical examination: Temperature, pulse, respiratory rate, cyanosis, clubbing, lymph nodes, pallor etc.
- Systemic examination: cardiovascular system, respiratory system, abdomen etc was done to exclude the presence of any chronic illness.

***C. Anthropometry***

- All subjects undergone an anthropometric evaluation at presentation. Anthropometric indices were recorded as recommended of weight to the nearest 0.1 kg by weighing scale machine and height to the nearest 0.5 cm using measuring tape.
- Body mass index (BMI) was calculated by the formula:

  $BMI = weight\ (kg) / height\ (m)^2$.

*Inclusion Criteria*

- Cases: Children with Malnourished
- Controls: Consisted of age and sex matched subjects without malnourished who were visiting Pediatric OPD and admitted in the Pediatrics ward during the study period.

*Exclusion Criteria*

- Not willing to participate in the study
- Pre-term infants or intrauterine growth retardation at birth.
- Any documented cardiothoracic event (congenital heart disease, pericarditis, cardiomyopathy, acute severe lower respiratory tract infection, etc.).
- Severe anemia (Hemoglobin level ≤6 g/dl).

*Operational Definition*

- The WHO recommends the use of standard definitions and classifications for malnutrition (undernutrition) based on calculated Z scores for anthropometric indices [28-29].

Z scores for weight for age (WAZ), weight for height (WHZ) and height for age (HAZ) were recorded.

The WHO global database on child growth and malnutrition (undernutrition) recommends a cut-off z score of ≤-2 to classify low WAZ (underweight), low HAZ (stunting) and low WHZ (wasting) as moderate malnutrition, and a z score of ≤-3 SD to define severe malnutrition.

A z score of ≤-2 indicates that a child's WAZ, WHZ or HAZ is 2 SD below the age- and gender-specific median for the normal population, and 3 SD below the median cut-off if the z score is ≤-3. Normal nutrition is indicated by a WAZ z score of between >-2 and ≤2.

***Following Investigations were done in the Subjects***

Assessment of cardiac troponin I (**cTnI)** by electrochemiluminescence immunoassay (ECLIM)

*Chest X-ray (CXR)*

- 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.

*Electrocardiogram (ECG)*

- The 12-lead surface electrocardiograms of all the subjects were obtained using a single channel electrocardiography machine.
- The heart rate, RR interval, QT interval was measured, and corrected QT (QTc) was calculated from all the electrocardiograms.
- QTc was calculated by applying Bazett's equation and the QTc was considered prolonged when it was greater than 440 ms.

$$(QTc = QT/\sqrt{RR})$$

*Echocardiography (ECHO)*

Transthoracic echocardiography examination was done by using Phillip Echocardigraphy machine with phased array transducers with a frequency of 8 MHZ. M-mode echo is a standard method for assessment of LV function in the absence of segmental wall motion abnormalities.

- *LV Dimensions*
- *Fractional Shortening (FS):* FS was calculated using the following formula:
- *FS=EDD - ESD/EDD X 100*

EDD is the end diastolic diameter of the left ventricle and ESD is the end systolic diameter of the left ventricle

- *Ejection fraction (EF):* EF was measured from the "cubed equation":
- *EF=(EDD)-(ESD)/(EDD) X 100*
- *LV diastolic function:* Using E/A ratio of the mitral flow by pulsed wave Doppler across the mitral valve.
- *Left ventricular mass (LVM) and Left ventricular mass index (LVMI) [7]* to body surface area estimated by LV cavity dimension and wall thickness and end diastole.
- $LVM\ (g) = 0.8\{1.04[([LVEDD+IVSd+PWd]^3 - LVEDD^3)]\}*0.6$

*Statistical Analysis*

The data was entered, validated and analyzed using STATA 10 software. The numerical data was represented as mean±SD. Comparisons was made between the two main study groups (controls and cases). Continuous variables were expressed as means and SDs if they were normally distributed and as median and range if skewed. Two sample (unpaired) Student t tests, and one way analysis of variance logistic regression analysis was used to compare means and test the relationships between covariates. Each of the variables associated with malnutrition was studied and analyzed. A p value of <0.05 was considered to be statistically significant and p value of <0.001 as highly significant.

**Results**

The mean age for cases and control was 43.94 ± 39.9 months and majority of the patients were in the age group of 1 to 24 months and there were 64% males and 36% female.The mean weight (kg) of cases was 8.96 ± 4.98 kg and mean weight of controls was 15.37 ±8.16 kg (P < 0.005) and mean WFA among cases was -4.13 ±1.01 and controls were 0.02 ± 0.66 (P value <0.00001). Mean height in cm of cases was 82.08 ± 23.04 cm and mean height in cm of controls was 92.56 ±26.4 cm. (P < 0.03) and mean HFA among cases was -3.21 ± 1.38 and mean HFA among controls was -0.46 ± 0.80 (P <0.00001). Mean BMI for cases was 12.33± 1.98 and controls were 16.83±1.58 (P value <0.0001) and Mean BMI for age among cases was -

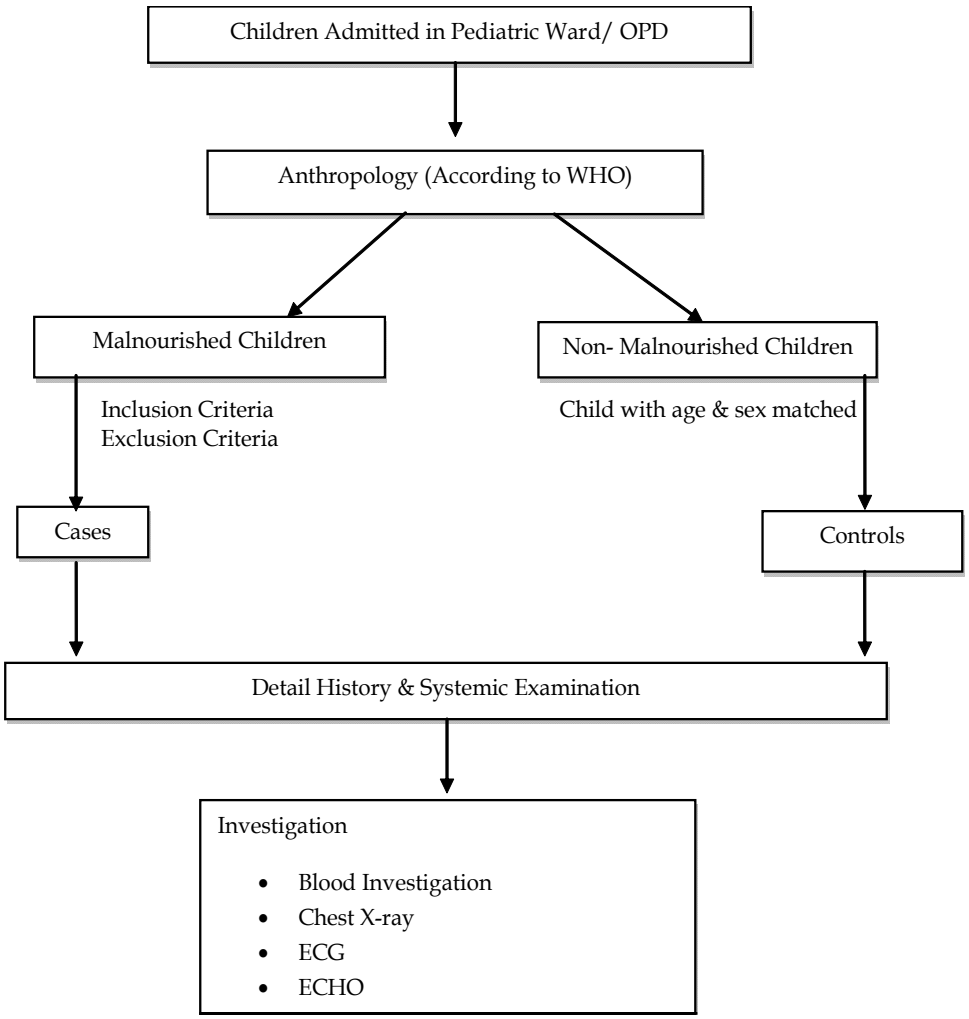


**Fig. 12:** Flowchart of study

3.09 ± 1.78 and controls were 0.4 ± 0.97.(P value was <0.00001). WHO classification among the cases (n=50), where majority 29(58%) had stunted growth, followed by 14 (28%) had stunted and wasted growth and only 7 (14%) had wasted growth. IAP classification among the cases (n=50), where majority (40%) had IAP grade 2 and 3 respectively and only 20% had IAP grade 4.

Mean CT ratio for cases was 0.47± 0.03 months and controls was 0.49 ± 0.02months (P<0.005) and according to WHO classification, CT ratio among Stunted was 0.48±0.03, wasted was 0.47±0.35 and stunted and wasted was 0.46±0.02 (P>0.10) which was not stastically significant among cases.

Mean troponin I for cases was 0.015 ±0.02mcg/lit and for controls was 0.01 ±0.02mcg/lit(P>0.2) and according to WHO classification,Cardiac troponin I among Stunted was 0.01±0.007 mcg/lit,wasted was 0.01±0 mcg/lit and stunted and wasted was 0.01±0 mcg/lit (P=0.89) which was not stastically significant among cases and control and also among cases.

In ECG, mean HR among cases was 102.1± 17.8 per min and control was 101.5±17.2.(P>0.8) per min.Mean RR interval among cases was 0.6±0.094 secs and control was 0.6±0.099 secs (P>0.7). Mean among the cases for QT interval was 332.2 ±44.59 msec and controls were 293.4 ±28.54 msec. (P<0.001). Mean among the cases for QTc interval was 426.7 ±27.5 msec and controls was 379.5±24 msec. (P<0.0001) There was significant difference in QT interval and QTc interval among cases and controls but according to WHO classification among cases mean QTc among Stunted was 422.4±20.5 msec, wasted was 445.5±52.5 msec and stunted and wasted was 426.0±20.88 msec (P=0.13) which was not stastically significant.

Table 1 shows mean LVIDs among cases was 16.28 ±3.23 and control was 18.28±3.38(p<0.03). Similarly, there was significant difference found in LVIDd, LVPWs, LVPWd, LVIVSs, LVIVSd and FS among cases and controls ( P <0.05). Mean LVM among cases was 31.58±13.6 and control was 47.14±15.68. There

was significant difference in LVM among cases and control (P<0.0001). But no significant difference in LVMI among cases and control.

In Table 2 we compared the echocardiographic finding among the cases according to WHO, we found the LVIDd, LVPWs and LVIVSd were significant difference among different types of WHO (p<0.005). Whereas the LVIDs, LVIDd, LVIVSs, LVIVSd, EF and FS were not having significant difference among the type of WHO. There was statistically significant difference was found in LVM among the different type of malnutrion according to WHO (p<0.005) whereas LVMI was not significant among the different type of malnutrion.

Diastolic function shows mean E among cases 0.88±0.12 and mean E among controls 0.93±0.10.(p<0.02). Mean A among cases 0.52±0.11 and controls were 0.58±0.11. (p<0.005). Mean E/A among cases 1.75±0.41and mean E/A among controls 1.63±0.21(p>0.05). There was significant difference in E and A but no difference in E/A ratio among cases and controls and according to WHO classification in cases E/A ratio among Stunted was1.7±0.4 ,wasted was 1.8±0.5 and stunted and wasted was 1.7±0.3 (P=0.70) which was not stastically significant.

**Table 1:** Echocardiography Findings

| Variables | Cases | Controls | P value |
|---|---|---|---|
| LVIDs (mm) | 16.28 ± 3.23 | 18.28±3.38 | P= 0.03 |
| LVIDd(mm) | 25.52±4.97 | 29.92±5.49 | P <0.001 |
| LVPWs(mm) | 8.57±1.85 | 9.56±1.65 | P=0.05 |
| LVPWd(mm) | 5.78±1.04 | 6.76±0.62 | P<0.0001 |
| LVIVSs(mm) | 7.64±1.49 | 9.08±1.67 | P<0.0001 |
| LVIVSd (mm) | 5.96±1.28 | 6.6±0.8 | P= 0.03 |
| FS (%) | 35.61±6.28 | 38.75±4.8 | P= 0.005 |
| EF (%) | 67.5± 7.09 | 68.05± 5.11 | P=0.6 |
| LVM (gm) | 31.58±13.6 | 47.14±15.68 | P<0.0001 |
| LVMI (gm/m$^2$) | 73.64± 24.2 | 79.26± 14.63 | P=0.1 |

**Table 2:** Echocardiography finding among the study cases according to WHO classification

| Variables | Stunted | Wasted | Stunted and wasted | P value |
|---|---|---|---|---|
| LVIDs (mm) | 16.89±3.00 | 15.4±2.9 | 15.4±3.7 | 0.29 |
| LVIDd(mm) | 26.7±4.7 | 24.14±5.6 | 23.57±4.5 | 0.09 |
| LVPWs(mm) | 9.34±1.8 | 7.14±1.77 | 7.69±0.99 | 0.001 |
| LVPWd(mm) | 6.03±1.05 | 5.2±0.95 | 5.51±0.99 | 0.12 |
| LVIVSs(mm) | 7.96±1.5 | 7.42±1.1 | 7.07±1.38 | 0.17 |
| LVIVSd (mm) | 6.33±1.3 | 5.28±1.1 | 5.52±1.0 | 0.04 |
| FS (%) | 35.9±6.2 | 35.5±4.3 | 34.9±7.3 | 0.88 |
| EF (%) | 68.5±7.33 | 66.54±5.0 | 65.8±7.4 | 0.46 |
| LVM (gm) | 36.34±14.3 | 24.8±12.2 | 25.07±8.18 | 0.01 |
| LVMI (gm/m$^2$) | 75.13±24.5 | 72.1±12.4 | 71.2±28.7 | 0.87 |

## Discussion

Malnutrition is a complex phenomenon resulting in body composition alterationscomplicated by electrolytic disorders and mineral or vitamin deficiencies. Protein- energy malnutrition (PEM) is frequently located in less-developed countries due to inadequate food intake, socioeconomic or political factors or, at times, due to natural disasters. Malnourished children suffer cardiac abnormalities as hypotension, cardiac arrhythmias, myocardiopathy, cardiac failure and sudden death. It is difficult to find out whether these abnormalities are primary phenomena of malnutrition or secondary to other alterations associated with malnutrition.

In present study mean age for cases was 43.94±39.9. Study by Nagla Hassan Abu F et al [8] showed that forty-five malnourished infants and young children (mean±SD of age was 11.24 ±7.88 months) were matched with 25 apparently healthy controls (mean±SD of age was 10.78±6.29 months). Jose LO et al [10] in their study showed that mean age for malnourished group was 2.40 ±1.82 and control group was 2.52 ±1.75 (P> 0.8). In the present study in both groups majority were males with M:F ratio was 1.8:1. Study by Munde A et al [9] showed that M: F ratio was 1.5:1. Study by AL-Samerraee AS et al [17] shows M:F ratio among cases was 0.4:1 and among control was 0.5:1(P value=0.46).Present study shows mean weight of cases was 8.96 ±.98 kg and in controls was 15.37 ±8.16 kg (P< 0.005) Study by Divya S et al [11] showed that mean body weight for malnourished group was 15.47±4.45 and among control group was

30.60 ±9.70 (P<0.003).

Study by Divya S et al [11] showed that mean height for malnourished group was 107.65±14.27 and among control group was 129.5±14.49 (P=0.003). In present study, we found that mean height in cm of cases was 82.08 ±23.04 cm and of controls was 92.56 ±26.4 cm (P value<0.03).

Present study shows mean BMI for cases was 12.33±1.98 and for controls was 16.83±1.58 (P <0.005). Jose LO et al [10] in their study showed that mean BMI for malnourished group was 13.58 ±1.09 and control group was 16.22 ±0.82 (P < 0.00)

Study done by Abu Fadan et al [8] reported that cardiac troponin among cases was 0.01±0.01 and controls was 0.009±0.001 which is statistically significant difference in cardiac troponin among cases and controls. In present study, mean cardiac troponin among cases was 0.015±0.02 and controls was 0.01±0.02 which is not significant difference among cases and controls. Troponin I is a contractile protein found almost solely in the myocardium. Based on the previous data it is clear that there is no place for cardiac protein to be released massively in a detectable way in circulation except in severe acute cases or in the presence of complication as severe hemodynamic disturbances or sepsis [85].

Olowonyo et al. [18] found the mean CT ratio in cases was 49.39+ 4.0 and in controls was 55.4+ 3.5. There was a statistical significant difference (p<0.005) found among the cases and controls. Similar finding was present in our study also.

Abdel J F et al [13] study QT parameter showed significant difference(p=0.03), in Hl El Sayed et al [12] study QT among cases was 0.27±0.03 secs and among control was 0.21± 0.04 and QTc among cases was 0.46±0.03 secs and control was 0.41±0.07 secs and both parameters showed significant differences (p=<0.01), in Divya S et al [11] study QTc among cases was 0.455± 0.021 sec and control was 0.419± 0.020 sec which was significant(p=0.0007), in Neeraj Kumar et al [14] study also QTc was significant (p=0.0001) and in present study also QT and QTc showed significant differences.

In study by Abu Fadan et al [6] reported that LVSD, PWD, FS and EF had significant difference among cases and controls(p<0.05). AL-Samerraee AS et al [17] found that LVIDd, LVPWs, LVPWd, LVIVSs and LVIVSd had significant difference among cases and control(p=0.00). In present study LVIDs, LVIDd, LVPWs, LVPWd, LVIVSs, LVIVSd and FS had significant difference but EF did not have significant difference among cases and control

In study by Kothari SS et al [16] LVM among cases was 25.75 + 8.09 gm and control was 32.44 + 11.64 gm had significant difference(p<0.05), Ocal B et al [80] in their also showed significant difference in LVM(p<0.05), study by Amna A et al [15] showed LVM among cases 11.38 + 7.74 gm and among cases 22.35 +12.03 gm(p=0.002) as well as LVMI among cases was 32.34+20.38 and control was 47.58+ 23.45(p= 0.024) similarly in present study also LVM and LVMI had significant difference.

In our study, we found E had significant differences and E/A ratio had no significant difference among the cases and controls, this was similar to those observed by Amna A et al [15] were E among cases was 0.80± 0.21m/s and among control was 1.00 ±0.25m/s(p=0.006) and E/A among cases was 1.79 ±0.99 and control was2.03± 1.13. ( p=0.443). In our study, we found E/A had no significant differences found among the cases and controls.

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