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Serum Selenium Values and Its Association with Severity of Heart Failure Among Under-5 Children with Congenital Heart Disease in Anambra State- Nigeria.

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ABSTRACT *Original research paper*

Selenium is an essential micronutrient, known for its antioxidant property and its role in multiple signaling pathways needed for proper physiologic cardiac muscle function. The analysis of serum selenium level among children with Congenital Heart Defect (CHD) becomes important since current studies have shown that these children are more prone to malnutrition and detrimental consequences of micronutrient deficiency.

Aim and Objectives

This study was designed to determine the serum selenium values and its association with Ross severity grade of heart failure among under five year old children with CHD in Anambra state- Nigeria.

Methodology

This is a cross sectional comparative study that enrolled under five year old children with CHD in Anambra State and equal number of sex, age and SEC matched controls. Information of their sociodemographics like age, gender, Socio-economic class (SEC) and Ross severity grade of heart failure was gotten using a pretested, interviewer administered questionnaire. Also 2mls of blood used in analyzing serum selenium level was collected from the participants, while observing universal precaution. The data was analyzed using Statistical Package for Social sciences (SPSS) version 25.0. The association of serum selenium values with the categorical independent variables were determined and p-value for statistical significance set at <0.05 and at 95% confidence level for clinical significance.

Result

A total of 80 subjects of under- fives with CHD and 80 age, gender and SEC matched normal controls without CHD were enrolled into the study. There were preponderance of females 50(62.5%) in each of the subjects and control groups. The mean serum selenium value of the subject group was 43.25± 10.4 which was statistically significant when compared with the mean serum

selenium value of the matched Controls 83.75±16.8, with t-test of 17.23 at p <0.001.

The serum selenium values of the subjects were significantly associated with age, SEC and Ross severity grades of heart failure. Though the mean serum selenium value was higher among males than the females in the subject group, the noted difference was not statistically significant.

Conclusion

Prompt treatment of heart failure to avert very severe grade of heart failure, can ameliorate the impact of deficient serum selenium level among under fives with CHD. Furthermore, early introduction of selenium supplementation especially among 0 to 2 year old, may improve the prognosis of heart failure among children with CHD in Anambra State, Nigeria.

INTRODUCTION

Selenium is an essential trace element known to be a component of 25 seleno-proteins and co-factors required in modulating immunologic, cardiovascular and metabolic functions in the body through its anti-inflammatory, anti-cancer and anti-oxidant effects.[1,2,3] Normal plasma selenium concentration in healthy children is between 50-150mcg/L and estimated daily requirement of selenium in children is 2.5mcg/kg/day with a bioavailability of 80%. [2,4]This daily requirement is known to maintain the normal serum level of selenium with no fear of excess levels.[1,3] Selenium is available in most sea foods like fish, crabs and food crops like, onions, cabbage, wheat, yeast especially when grown in soil at geographical areas known to have high selenium level like Venezuela, Canada, Japan and North America.[1] The first evidience of selenium deficiency noted in 1960, resulted in rare form of fatal dilated cardiomyopathy (Keshan disease).[5] This keshan disease is restricted to geographical regions with very low selenium concentration in the soil, regions like Africa, Europe, Asia and some parts of South America.[6,7]There is low dietary content of selenium in food crops and grains grown in such area, making a child's dietary intake of selenium in these areas to be very poor.[6,8] Keshan heart disease occurs because selenium deficiency causes disruption of mitochondrial electron transport chain function which results in low production of Adenosine Tri-Phosphate (ATP) and increased release of Reactive Oxygen Species (ROS) which causes intracellular oxidative damage of cardiomyocytes.[9], Keshan disease is known to be easily reversed with dietary supplementation with selenium.[10] Furthermore, studies have established that low serum selenium level in the pregnant mother is associated with increased risk of developing CHD on their babies,[11]and use of selenium supplementation on pregnant mothers reverses this risk.[12] This may be because of important biological roles selenium plays in protecting the cardiac cells against lipid peroxidation, aiding thyroid hormone metabolism and improves mitochondrial functions in the developing cardiomyocytes. [13,14]

Selenium is known to be depleted quickly with rapid growth that usually occur in children and more so in children with increased metabolic demands like children with Congenital heart Disease (CHD).[15,2] These children with congenital heart disease are prone to malnutrition with associated micronutrient deficiency like selenium.[16] Selenium deficit state is known to be associated with oxidative injuries on the cardiac cells causing different forms of cardiomyopathies and diseases like sepsis and bronchopulmonary dysplasias.[4] These conditions can easily lead to congestive heart failure on its own, and or can worsen the severity of heart failure, where the child have already developed heart failure.[17] Heart failure (HF) occurs when the heart cannot pump enough blood to meet the metabolic needs of the body.[17,18] According to American heart association, HF is a complex clinical syndrome that results from any functional or structural cardiac disorder which decreases the ability of ventricles to fill or eject blood enough to meet the metabolic demands of the body organs and systems.[19] The exact assessment of the severity of signs and symptoms of heart failure in children is quite challenging. Previously there was no standardized method of assessing the severity of heart failure in children, the New York Heart Association classification (NYHA) used in adult was not validated for use in children, more over NYHA, measures functional capacity and not heart failure severity. NYHA is not appropriate to use in children because responses of children to heart failure is different from adult, since they have different cardiac physiology, clinical presentation and compensatory mechanism. Also causes of heart failure and response to heart failure state in children are different from that of adult. Because of these reasons, Ross et al developed a scale for grading heart failure severity in infants and has been in use for over 25 years for this purpose though was modified to be used for same purpose among older children. Since in use, it has undergone different modifications.[20,21]The modified Ross scoring of heart failure in children ranges from score 0- No heart failure, through mild, moderate and severe heart failure as score of 1,2 and 3respectively using the severity of clinical features of heart failure manifested by the child.[20,21]This was used in index study to establish the relationship between serum selenium status and severity of heart failure in the subjects. Aetiology

of heart failure is multi factorial and frequently occurs in children with CHD and this can be worsened by low levels of some micronutrients like selenium, which is commonly seen in children with malnutrition.

Children with CHD are prone to recurrent congestive heart failure following various heamodynamic instability of the blood flow through shunting of blood through the defective holes in the heart, thus leading to dysfunctional systolic and diastolic functions of the heart.[22] These children with CHD are also prone to malnutrition and micronutrient deficiency and this can worsen the severity of heart failure in these children.[16] Hence the need to establish the relationship of serum selenium level and severity of heart failure among under five year children with CHD in Anambra state, Nigeria. The information gotten from this study will help to establish the need to institute selenium supplementation among these children as this may help improve their prognosis and out come after the surgical correction of the heart defect.

METHODOLOGY

STUDY SITE

The study sites comprise of three Paediatrics Cardiology referral centers in Anambra State. These included NAUTH, Nnewi where an average of 3-5 new cases of children with CHD are seen monthly; Chukwuemeka Odumegwu Ojukwu University Teaching Hospital (COOUTH), Amaku, Awka where an average of 2-3 cases of children with CHD are seen monthly and Dame Irene Okwuosa Heart Center Oraifite in Anambra State, where 8-10 cases of children with CHD are seen monthly.

These are the Paediatric Cardiology referral centers in Anambra State. The cases seen in these centers, represent the bulk of Paediatric Cardiology cases present in Anambra State, Southeast, Nigeria. Since cases seen in state mission hospitals, General hospitals and private hospitals are referred to these three tertiary cardiac centers in the state.

STUDY DESIGN

The study was a cross- sectional comparative study involving under-fives with CHD as the subjects/cases. Control group were equal number of age, sex and socio-economic (SEC) matched healthy children- corresponding with cases in each center.

STUDY POPULATION

This included all under-fives that satisfied the inclusion criteria from the three Paediatric referral cardiac centers in Anambra State.

INCLUSION CRITERIA

A) Under- five child that has CHD with or without heart failure, that presented to the study centers and whose parents/care givers signed/thumb printed on the informed consent form, (were included as the subjects).

B) Under-fives who were apparently healthy with no CHD and whose parents/care givers signed/thumb printed on the informed consent form; were included as the control group. These children were recruited from immunization units and well child clinics of the study centers.

EXCLUSION CRITERIA

A) Preterm babies, as they are known to be depleted of serum selenium level than the term babies because of poor storage of immature liver.

B) Children with CHD that have other co-morbidities that can cause or lead to selenium depletion, like chronic kidney disease (CKD), diarrhea, malignancy/cancer, and other chronic disease conditions that may affect the serum selenium level, were excluded. These children were identified from the history, physical examination findings, documented laboratory tests results and the provisional diagnosis of the patients.

SAMPLE SIZE CALCULATION

The sample size was calculated using the formulae for cross sectional comparative study using the difference in mean value of serum selenium from a previous study:[23]

Minimum sample size formulae[24] = $\frac{\delta_1^2 + \delta_0^2}{e^2}$

Where δ_1 = standard deviation of the subjects from previous study which is ± 21.6,[25]

δ_0 = standard deviation of the control group from previous study which is ±18.3[25]

e = standard error from previous study (standard deviation of the cases, divided by square root of the number of the cases) calculated from previous study, which is = 3.375,

Applying these values to the formulae for calculating the minimum Sample size for a cross sectional comparative study

$$= \frac{(21.6)^2 + (18.3)^2}{(3.375)^2}$$

Therefore, the minimum sample size = $\frac{466.56 + 334.89}{11.4}$

$= 70.3 \approx 71$

Minimum sample size= 71cases + 71 controls which was

= 142

Taking a response rate of 90%, the adjusted sample size = 142/0.9 = 158

Adjusted sample size was 158.

Therefore 79 or ≈ 80 children with CHD was recruited as cases and 79 or ≈ 80 age, sex, and SEC matched healthy children were recruited as control.

SAMPLING TECHNIQUE AND RECRUITMENT OF PARTICIPANTS

All eligible participants with CHD whose parents/caregivers signed/thumb printed informed consent were recruited consecutively into the study from the three study sites, until the required sample size was obtained. And equal number of age, sex, and SEC matched healthy children without CHD were recruited as the control group.

ETHICAL CONSIDERARTIONS DATA COLLECTION

Five research assistants that included two house officers and three junior residents were properly trained and they assisted the investigator during data collection. The research assistants administered questionnaires, took anthropometric measurements and also participated in blood sample collection.

Before enrolment into the study, written informed consent was obtained from each subject's parents/care giver after providing adequate information about the study including its benefits and possible harms.

Standardized structured questionnaire was used by the investigator and research assistant to collect relevant information such as socio demographic data, clinical presentation, the drugs child have been on and how long child has been on them. The questionnaire was interviewer administered.

A thorough physical examination was carried out by the investigator to identify signs of heart failure and to grade its severity using the modified Ross score. The heart failure severity was graded as-A) No limitation of activity for a score of 0-2, B)Mild Congestive Cardiac failure(CCF) for a score of 3-6, C)Moderate CCF for a score 7-9,and D) Severe CCF for a score of 10-12. The participants had a thorough systemic examination particularly looking for signs of CHD such as finger clubbing, cyanosis, suffused conjunctiva, abnormal heart sound (such as fixed and wide splitting of the second heart sound and presence of cardiac murmur). A profoma was used to collect information on bio data like age, gender, socioeconomic class (SEC) and other relevant information. The SEC was determined by the method described by Oyedeji.[26]

The diagnosis of CHD was made on clinical grounds using history, physical examination findings, typical findings on chest radiograph and electrocardiogram. The diagnosis was confirmed by echocardiography done by the Paediatrics cardiologist at the point of recruitment into the study.

The control group was age, gender, and SEC matched healthy children recruited from the immunization/well child clinic of the three centers used for the study. Echocardiography was also done for the control groups at the point of recruitment to exclude presence of any CHD or any cardiac diseases.

WEIGHT

Calibration of the scales using 2 standardized weights was done each day before recruitment. Zero adjustment was done before weighing each subject. Infants were weighed naked using an infant weighing scale (bassinet) whereas older children were weighed wearing light clothing and no shoes using an Analytical flat health scale. Each participant was weighed two times and the average of the two values were taken and recorded as the child's weight. The weight was recorded to the nearest 0.1kg.

BLOOD SAMPLE COLLECTION

A sample of venous blood was collected from the participants (subjects and controls) by the investigator with the help of the trained research assistants. During the process of blood sample collection, the universal precaution and additional COVID-19 precaution were observed; as sterile gloves were worn after proper hand washing technique was done. N95 face mask was worn by the researcher and assistants, while the participants and care givers were properly masked. The identified dorsal vein or antecubital vein, for the venepuncture was cleaned with sterile gauze soaked with savlon, tourniquet was tied proximal to the vene-puncture site, and 5mls syringe and needle was used to collect 2mls of blood. The blood sample was poured inside the well labeled sterile plain bottle. The tourniquet was untied after the blood sample collection and the site was held with minimal pressure using sterile dry gauze to enhance hemostasis at the puncture site.

All the specimens were collected in well labeled sterile plain containers kept in an ice box at 0^0C to -4^0C and sent to chemical pathology laboratory of NAUTH Nnewi each day after collection. There, the serum was obtained from the blood sample of each participant by centrifugation. After centrifugation, the serum was decanted and stored in a refrigerator at a temperature of minus 40 degrees centigrade. Hemolyzed samples were discarded.

When the sample collection was completed, the researcher transported the whole sample to Springboard research laboratory in Awka, Anambra state .The researcher allowed the serum samples to defreeze and serum selenium of each specimen was analyzed by the researcher assisted by the lab scientist using the Agilent FS 240 AA Atomic Absorption Spectrophotometer according to the methods of APHA 1995(American Public Health Association).[27]

Three separate analysis for serum selenium was done on each sample and the mean of the three values was recorded.[28]

TREATMENT

The drug treatment of each participant was recorded. The number and types of diuretics each of the participants were placed on for management of heart failure was documented on the profoma. The patients were counseled on the need to be regular with their follow up visits and compliant with the medical management as they await definitive surgical

intervention. Those that had heart failure were identified and managed accordingly depending on the severity of the heart failure using anti-failure regimen like frusemide, enalapril etc. Antibiotics was instituted in those noted to have sepsis.

DATA ENTRY AND STATISTICAL ANALYSIS

All completed questionnaire were coded before entry into the statistical package. Data was analyzed using the SPSS software version 25.0 for windows. Descriptive statistics was used to describe the frequency, mean, median (where appropriate) and standard deviation of continuous variables like the serum selenium values for the case and control groups.

Categorical variables like,-(Gender, age groups, socioeconomic status and heart failure severity grade using Ross scoring method were gotten. These categorical variables were tested for association with serum selenium status using Pearson's Chi-square (and Fisher's exact test where appropriate), for bivariate analysis and multivariate analysis where indicated-for the cases and controls to know the odds ratio for each of the variables, as well as predictor variables while taking care of the confounders.

Student's t-test was used to compare the differences in mean of continuous variables like, serum selenium values of the cases and controls.

Multiple linear analysis was used to evaluate the association of the categorical variables to serum selenium level among under-fives with CHD. Odds ratio was used to determine the magnitude of the relationship at 95% confidence level for the cases and controls. One-way ANOVA was used to determine the association of the mean serum selenium values and the Ross severity grades of heart failure among the subjects at 95% confidence intervals. Furthermore, the Post Hoc test was done since the one-way ANOVA test was statistically significant. Post Hoc test, where multiple comparisms of mean serum selenium values was done among different groups of Ross severity grades of heart failure to determine which of the compared groups' mean serum selenium differences were statistically significant. The mean plot was used to show the relationship of the serum selenium values when compared to the different Ross severity grades of heart failure among the subjects. P-value of <0.05 was considered as statistically significant and 95% confidence interval was used to establish clinical significance.

RESULTS

A total of 166 under-five children were screened for enrolment into the study. Six children
were excluded from analysis because 3 blood samples from the subjects were lysed. So they
were excluded with their corresponding 3 matched control samples. So a total of 6 samples
were excluded from the study, while a total of 160 under fives were enrolled for final
analysis.

The 160 participants comprises of 80 subjects and 80 controls that met the inclusion criteria
for both subjects and controls respectively.

There was preponderance of female subjects 50(62.5%). The number of subjects and controls
in each age group were 0-2years 53(66.3%), >2 - <5years 27(33.8%). Majority of the
subjects and controls were of middle and low SEC.
These were shown in table I.

TABLE 1: SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE SUBJECTS AND CONTROLS.

Characteristics	Subjects n= 80 (100%)	Controls n= 80 (100%)
Gender		
Male	30(37.5)	30(37.5)
Female	50(62.5)	50(62.5)
Age		
0-2years	53(66.3)	53(66.3)
>2 -<5years	27(33.8)	27(33.8)
Social class		
High	16(20.0)	16(20.0)
Middle	38(47.5)	38(47.5)
Low	26(32.5)	26(32.5)

THE SERUM SELENIUM VALUES OF THE STUDY POPULATION

The mean serum selenium level of the subjects was 43.25±10.4 microgram/dl, this was significantly lower when compared to the mean serum selenium level of age, sex and SEC class matched controls which was 83.1±17.9microgram/dl at p value < 0.001. This is shown on table 2

TABLE 2 SERUM SELENIUM VALUES OF THE SUBJECTS AS COMPARED TO THE MATCHED CONTROLS.

Selenium value	Normal	Deficient	χ	Mean±SD	t-value	p-value
SUBJECTS	39	41	48.4	43.25±10.4	17.2	<0.001
CONTROLS	80	0		83.1±17.9		

χ = chi square value, SD= Standard deviation, t = t-test value

The mean serum selenium level among the subjects was marginally higher in males than females, though not significant. The mean serum selenium level was significantly higher among the >2 to 5years age group than the younger age group. The mean serum selenium level was significantly higher among the high SEC than the middle and low SEC among the subjects. These are shown in table 3 below.

TABLE 3: THE ASSOCIATION OF SERUM SELENIUM LEVEL ANDSOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG THE SUBJECTS.

Selenium value	**Normal (39)**	**Deficient(n=41)**	**χ**	**Mean±SD**	**t-test**	**pvalue**
Characteristics						
Gender(N=80)						
Male(n=30)	15	15	0.03	45.3±11.7	1.95	0.17
Female(n=50)	24	26		42.0±9.5		
AGE (N=80)						
0 to 2years(n=53)	14	39	31.4	39.6±10.2	24.8	<0.001*
>2 to <5years(n=27)	25	2		50.4±6.5		
SEC (N=80)						
High(n=16)	16	0	22.5	50.0±0	4.6	0.013*
Medium(n=38)	16	22		41.58±11.5		
Low(n=26)	7	19		41.54±10.5		

χ = chi-square, * statistically significant

All the control groups had normal serum selenium level that is above 50microgram/dl. The mean serum selenium level was higher among the females than males in the control group, though is not significant statistically. The mean serum selenium level was higher among the older study age group, though not statistically significant. Moreover, the mean serum selenium was significantly higher in the high SEC class than in the lower SEC. These were shown in table 4 below.

TABLE4: THE ASSOCIATION OF SERUM SELENIUM LEVEL AND SOCIODEMOGRAPHIC CHARACTERISTICS AMONG THE CONTROLS

Serum Selenium value	**Mean±SD**	**t-test**	**pvalue**
Characteristics			
Gender			
Male(n=30)	80.0±18.6	2.44	0.12
Female(n=50)	86.0±15.38		
AGE			
0 to 2years(n=53)	82.26±18.0	1.23	0.27
>2 to <5years(n=27)	86.67±13		
SEC			
High(n=16)	90.0±13.7	4.5	0.01*
Medium(n=38)	86.32±15.3		
Low(n=26)	76.2±18.35		

* statistically significant

The mean serum selenium level was significantly lower among the subjects with severe limitations of heart failure when compared with those with mild, moderate and No limitations of heart failure at P < 0.001 and Anova = 22.76.These were shown in table 5 below.

TABLE 5 SERUM SELENIUM VALUES AND SEVERITY OF HEART FAILURE AMONG THE SUBJECTS.

Descriptives

Serum Selenium Value

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No limitation	30	40.6667	11.42693	2.08626	36.3998	44.9336	20.00	70.00
Mild limitation	12	50.0000	.00000	.00000	50.0000	50.0000	50.00	50.00
Moderate limitation	20	52.0000	4.10391	.91766	50.0793	53.9207	50.00	60.00
Severe limitation	18	33.3333	4.85071	1.14332	30.9211	35.7455	30.00	40.00
Total	80	43.2500	10.40630	1.16346	40.9342	45.5658	20.00	70.00

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
SELVALUE	Based on Mean	4.799	3	76	.004
	Based on Median	3.882	3	76	.012
	Based on Median and with adjusted df	3.882	3	45.211	.015
	Based on trimmed mean	4.461	3	76	.006

ANOVA

SELVALUE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4048.333	3	1349.444	**22.757**	**.000***
Within Groups	4506.667	76	59.298		
Total	8555.000	79			

The Post Hoc test shows that the mean serum selenium level was significantly lower when, No limitation group was compared with the groups with mild, moderate and severe limitations of heart failure at $p < 0.001$ among the subjects. These are shown in the table below.

Multiple Comparisons

Dependent Variable: SELVALUE

	(I) SEVERITYOFHF	(J) SEVERITYOFHF	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	No limitation	Mild limitation	-9.33333*	2.63023	.004*	-16.2424	-2.4242
		Moderate limitation	-11.33333*	2.22295	.000*	-17.1726	-5.4941
		Severe limitation	7.33333*	2.29586	.011*	1.3026	13.3641
	Mild limitation	No limitation	9.33333*	2.63023	.004*	2.4242	16.2424
		Moderate limitation	-2.00000	2.81184	.892	-9.3861	5.3861
		Severe limitation	16.66667*	2.86982	.000*	9.1282	24.2051
	Moderate limitation	No limitation	11.33333*	2.22295	.000*	5.4941	17.1726
		Mild limitation	2.00000	2.81184	.892	-5.3861	9.3861
		Severe limitation	18.66667*	2.50185	.000*	12.0948	25.2385
	Severe limitation	No limitation	-7.33333*	2.29586	.011*	-13.3641	-1.3026
		Mild limitation	-16.66667*	2.86982	.000*	-24.2051	-9.1282
		Moderate limitation	-18.66667*	2.50185	.000*	-25.2385	-12.0948
Tamhane	No limitation	Mild limitation	-9.33333*	2.08626	.001*	-15.2225	-3.4442
		Moderate limitation	-11.33333*	2.27917	.000*	-17.6489	-5.0178

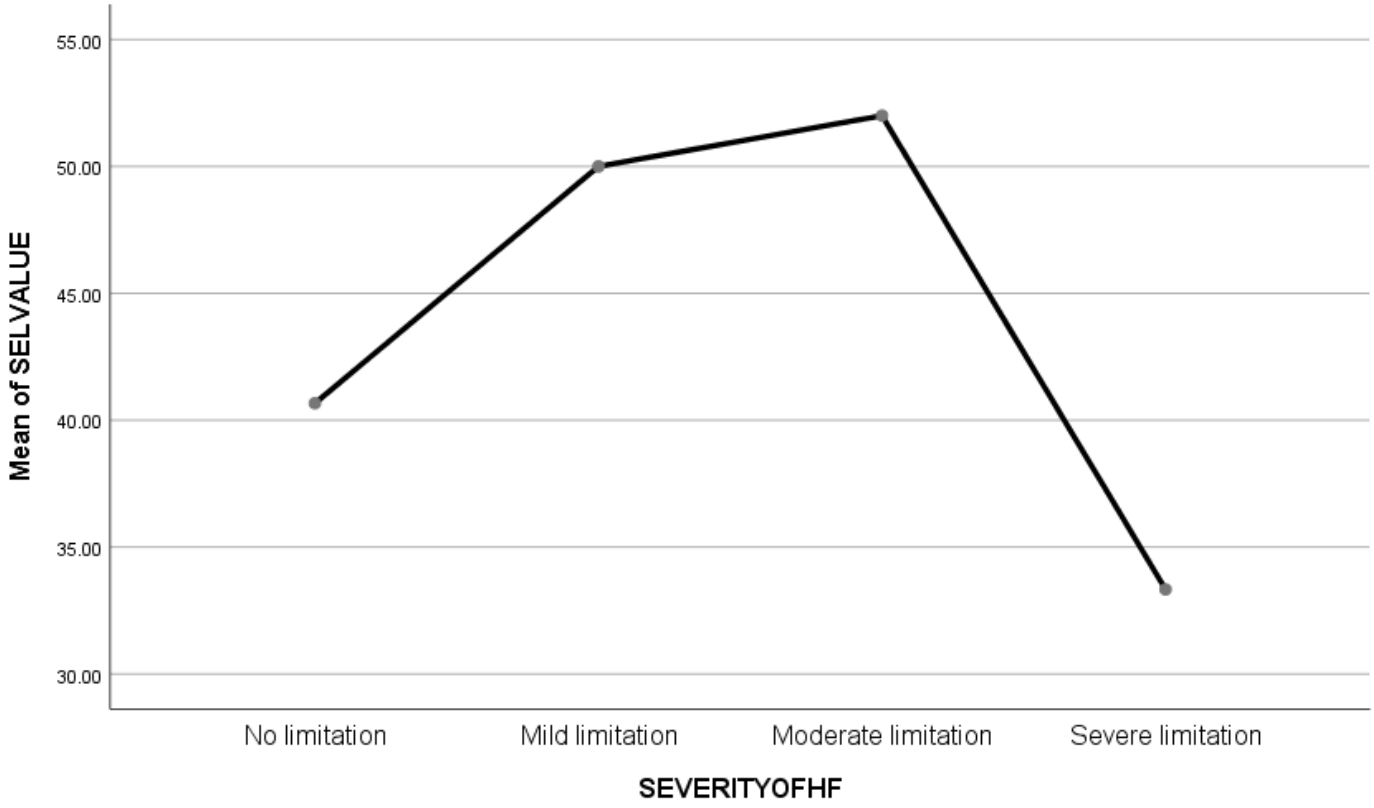
		Severe limitation	7.33333*	2.37901	.021*	.7692	13.8975
	Mild limitation	No limitation	9.33333*	2.08626	.001*	3.4442	15.2225
		Moderate limitation	-2.00000	.91766	.227	-4.6926	.6926
		Severe limitation	16.66667*	1.14332	.000*	13.2664	20.0670
	Moderate limitation	No limitation	11.33333*	2.27917	.000*	5.0178	17.6489
		Mild limitation	2.00000	.91766	.227	-.6926	4.6926
		Severe limitation	18.66667*	1.46605	.000*	14.5683	22.7650
	Severe limitation	No limitation	-7.33333*	2.37901	.021*	-13.8975	-.7692
		Mild limitation	-16.66667*	1.14332	.000*	-20.0670	-13.2664
		Moderate limitation	-18.66667*	1.46605	.000*	-22.7650	-14.5683

*. The mean difference is significant at the 0.05 level.

Post Hoc Tests

The mean plot shows that the mean serum selenium level increased initially from mild to moderate severity of heart failure, but the mean serum selenium later decreased sharply with increasing severity of heart failure among the subjects.

Means Plots



DISCUSSION

This study determined the association of serum selenium values and the severity of heart failure among under five year old children with congenital heart defect in Anambra state Nigeria. The study found that the mean serum selenium level in the subjects was significantly lower than that of the control group. This is because the subjects has CHD and this condition poses high demand on basal metabolic rate both for growth and to combat constant systemic inflammation from recurrent sepsis and heart failure these children are prone, hence depletion in the mean serum selenium among the subjects. Similar findings was noted by Manar et al[10] and Ismail et al[13], though contrasting result was gotten by Sahin et al[14] where there was not difference between the subjects with CHD and the normal control group. This findings may be because, the soil of the geographical region of the study may be rich in selenium and so the dietary intake of these children from the food crops grown there may be same and optimum among the subjects and control groups. Further more the subjects may have been in there stable state during the study, hence the noted difference.

From the index study, all the control groups had normal selenium levels while about 51.3% of subjects were noted to have deficiency of serum selenium.

This study showed that the mean serum selenium was marginally higher in males than the females among the subject group, though this finding was not statistically significant. This finding is similar to the report from other researchers on similar study.[29,30] This may be because female gender are known to mount stronger immune response to inflammation than males,[31] since serum selenium level have been known to reduce during inflammatory conditions that the subjects usually have, like recurrent infection, heart failure etc.[13] Further more, the mean serum selenium level among the control groups from this study is higher among the females than the males.

From this study, the mean serum selenium was significantly higher in older age group than the younger age groups in the subjects. Similar findings was gotten by Muntan AC et al, [4] Furthermore, Serum selenium level has been shown to be higher in older children than the younger children,[4] this was true for the control groups in this study. This may be because of increase in dietary diversity and nutritional changes from complementary feeds to full adult family food seen in older children, that may have accounted for increased availability of dietary selenium to older children.

The mean serum selenium level was significantly higher among children from higher SEC among the subjects and control groups. This may be because of higher purchasing power of parents of children from higher SEC, hence these children have better chances of increased availability of dietary selenium, also children from higher SEC are known to have higher household food security and higher dietary diversity in their meals,[32,33] hence more chances to have higher dietary selenium availability in their meals. This finding is similar to the report from other researcher.[34]

This study found that the mean serum selenium was significantly lower in subjects with severe limitations of heart failure when compared to those subjects with mild, moderate and No Limitations of heart failure. This finding is same with similar research done by Ali et al,[7], Jujic et al,[8] and Al-Mubarak et al.[35] This occurs because selenium deficiency usually contributes to direct myocardial malfunction by imparing mitochondrial functions of the cardiomyocytes with oxidative phosphorylation resulting in increasing intracellular ROS levels which results in unit myocardial failure. The severity of this myocardial failure increases in severity with poorer prognosis with increasing deficiency of serum selenium values. Further more, low serum selenium values are associated with very sever forms of heart failure in children, especially those more prone to selenium deficiency like children with CHD that usually have associated malnutrition with micronutrient deficiency.[18],[22] This shows that selenium supplementation may be very essential for better prognosis in heart failure among under five children with CHD in Anambra State, Nigeria.

CONCLUSION

This study have shown that mean serum selenium level was significantly lower in under five year- old children with CHD than their matched controls. The mean serum selenium level was also significantly lower among the subjects that are males, subjects from lower age groups and subjects from lower SEC. moreover there was significant association of serum selenium level and severity of heart failure grades among the subjects, as there was increasing severity of heart failure with increasing deficits in serum selenium level. So there is need for proper selenium supplementation among these under five children with CHD especially the males, those that are 0-2year old, those from lower SEC and those with various severity grades of heart failure. As this practice promises a better prognosis in these children.

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