Nutritional Assessment of Children and Adolescents with Isolated Ventricular Septal Defects after Closure

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KEYWORDS
Isolated Ventricular Septal Defects; Nutritional Assessment.

ABSTRACT

Background: Children with congenital heart disease, including VSD, often start life with a normal birth weight. However, malnutrition and growth failure become apparent within the first few months. The energy intake and nutritional status of these children directly impact their growth, necessitating regular and meticulous follow- up from the moment of diagnosis, and extending for years after the defect has been corrected.

The Aim: this study aimed to evaluate the nutritional status of children who have undergone surgical or interventional closure of isolated ventricular septal defects 6 to 12 months after closure.

Methods: This study is a cross sectional observational included 50 patients were recruited form post cardiac interventional clinic (PCIC), Pediatric department Cairo university and October 6 university. All patients were subjected to Nutritional Assessment including objective and subjective global assessment, assessing length/height, weight, head circumference, BMI, skin fold thickness, and mid upper arm circumference. These parameters were plotted on WHO Z scores to detect malnutrition's type and degree. Nutritional Assessment by using the Subjective Global Assessment (SGA) form, that considers weight changes, food intake, functional status, and body composition, providing a holistic view of the child's nutritional health.

Results: The mean age of the studied cases was 4.5 (±1.4 SD) with range (2.1-7.8) years, with 29 (58%) males. According to VSD size there were 8 (16%) moderate VSD and 42 (84%) large VSD. Membranous VSD was the most common type of VSD in 15 (30%). The mean age of VSD closure was 3.98y (±1.35 SD), according to method of closure. most of them were surgical 33 (66%) and 17 (34%) were interventional, The mean time interval between closure and assessment was 8 months (±2.14 SD). Among the studied cases according to subjective global assessment there were 8 (16%) A, 30 (60%) B and 12 (24%). Regarding weight for age on Z score 19 (38%) of the patients had moderate malnutrition lying bet (-2 to -3) and 1 patient (2%) had severe malnutrition less than (-3) on Zscore. Regarding MUAC 12 (24%) were moderately acute malnourished lying bet -2 to -3 and 10 (20%) were severely acute malnourished for age less than -3 on Z score. Regarding Ht for age on Z score 29 (58%) of the patients were above -2 on Z score while 42% were malnourished divided into 17 (34%) who suffers moderate stunting lies bet -2 to -3 on Z score and 4 (8%) had severe stunting for age less than -3.

Conclusion: this study concludes that Malnutrition is still prevalent in patients after successful VSD closure and ongoing nutritional assessment is needed and SGA is a relevant tool in assessment of nutritional status of these children also Malnutrition in these patients is palpably multifactorial and not only due to the effect of VSD.

1. Introduction

Ventricular septal defect (VSD) is the most common congenital cardiac anomaly in children. An abnormal communication between the right and left ventricles and shunt formation is the main mechanism of hemodynamic compromise in VSD (Hopkins et al., 2018).

Isolated VSD accounts for 37% of all congenital heart disease in children and its incidence is about 0.3% of newborns (Hoffman et al., 1995)

Large septal defects are particularly serious during the early years but that spontaneous closure occurs in about one third of all cases. (Kaplan et al., 2002)

Defects in the ventricular septum are generally classified on the basis of their location in the inter-ventricular septum and are divided into perimembranous (situated in the membranous ventricular septum in the subaortic region), supracristal (located in the conal septum in the subpulmonary region), atrioventricular (AV) septal (positioned in the inlet septum), and muscular (sited in the muscular and apical areas of the ventricular septum). The indications for intervention are largely based on the size and type (location) of the VSD. There is great natural tendency for spontaneous closure of the VSD and this should be kept in mind when considering treatment of VSDs (Rao, 2013).

Unrestricted ventricular septal defects are severe. Due to the presence of several left-to-right shunts, pulmonary hypertension, even congestive heart failure can occur in the early stage. children with malnutrition due to ventricular septal defects (VSD) have been shown to have a 40% elevation in total energy expenditure (TEE) (Arodiwe et al., 2015).

(Cantinotti et al., 2014) Defects that cause significant hemodynamic changes, or those defects that don't show signs of closure, are now closed either by intervention or surgically.

There is an association between energy intake, consumption of energy, nutritional status, and growth in infants and children with VSD (Nicholson et al., 2013). Although children born with congenital heart disease have normal birth weight, malnutrition and growth failure often appears in the first months of life.

So, patients with these defects need regular follow up in the cardiac and nutrition clinics, starting from the time of first diagnosis and for years even after closure of their defects.

2. AIM OF THE WORK

Aim of this study is to evaluate the nutritional status of children who have undergone surgical or interventional closure of isolated ventricular septal defects 6 to 12 months after closure.

3. PATIENTS AND METHODS

This study was a cross sectional observational study that was performed in post cardiac interventional clinic (PCIC), Pediatric department Cairo University. This study included 50 patients with post VSD surgical or trans-cath. closure. Each patient was subjected to full history taking, cardiac examination, imaging, investigations, biochemical analysis and nutritional assessment. Time of study about 6 to 12 months after closure. Patients with Isolated VSD, Complete closure of the VSD surgically or interventional and No associated genetic, metabolic or chronic disease were included in the study. While patients who have isolated Ventricular Septal Defects with any other cardiac anomaly were excluded from the study.

Statistical Analysis: Statistical analysis done using IBM SPSS software package version 24.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Then, proper statistical analyses were used. In All tests, p-Value less than 0.05 considered significant.

4. RESULTS

This study was a cross sectional observational study that was performed in post cardiac interventional clinic (PCIC), Pediatric department Cairo University and 6 of October University.

This study included 50 patients with post VSD surgical or trans-cath. closure.

Table (1): Distribution of the studied cases according to demographic data

	Subjects (n = 50)	
Age (years)		
Range.	2.1– 7.8	
Mean ± SD.	4.5 ± 1.4	
Sex	No.	%
Female	21	42.0
Male	29	58.0
Residence	No.	%
Rural	26	52.0
Urban	24	48.0
Child Order	No.	%
1	7	14.0
2	25	50.0

3	11	22.0
4	5	10.0
5	2	4.0
Parents Education	No.	%
Bachelor's degree	33	66.0
High school	10	20.0
Less than high school	7	14.0

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.The mean age of the studied patients was 4.7 (±1.4 SD) with range (2-8) years, with 29 (58%) males, most of them were rural residents (52%), moderate socio-economic class was the most common class in 25 (50%), according to order of child the most common order was second in 25 (50%) of cases and according to parents' education there were 33 (66%) with bachelor's degree as shown in Table 1

Table (2): Distribution of the studied patients according to preoperative echo data

	Subjects (n = 50)	
VSD Size (mm)		
Range.	4 – 10	
Mean ± SD.	7.79 ± 1.61	
Small	0	0.0%
Moderate	8	16.0%
Large	42	84.0%
VSD Type	No.	%
Inlet	7	14.0
Membranous	16	32.0
Muscular	14	28.0
Outlet (conoventricular)	13	26.0
P-HTN	No.	%
No	0	0
Yes	50	100.0
PSAP		
Range.	36 – 71	
Mean ± SD.	57.69 ± 8.67	

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

The mean VSD size was 7.79mm (±1.61 SD), The mean PSAP was 57.69 (±8.67 SD), according to VSD size there were 8 (16%) moderate VSD and 42 (84%) large VSD.

Membranous VSD was the most common type of VSD in 15 (30%) as shown in Table 2.

Dakkak et al. (2024) demonstrated that although VSDs are classified based on their location, they may also be identified based on their size. The diameter of the aortic annulus is used as a comparison when describing the size. When they measure less than or equal to 25% of the diameter of the aortic annulus, they are categorized as tiny. They are classified as medium if they measure more than 25% but less than 75%, and they are categorized as large if they measure more than 75% of the diameter of the aortic annulus.

Table (3): Distribution of the studied cases according to data of patients regarding VSD closure

	Subjects (n = 50)	
Age of VSD Closure (years)		
Range.	1.5 – 5	
Mean ± SD.	2.98 ± 1.25	
Method of closure	No.	%
Interventional	17	34.0
Surgical	33	66.0
Time Interval Between Closure and Assessment (month)		
Range.	6 – 12	
Mean ± SD.	8.84 ± 2.14	
	No.	%
Hospitalization after closure for 72 hours	40	80

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

The mean age of VSD closure was 3.98y (±1.35 SD), according to method of closure. most of them were surgical 33 (66%) and 17 (34%) were interventional, The mean time interval between closure and assessment was 8 months (±2.14 SD) and there were 40 (80%) who were hospitalized after closure for more than 72 hours as shown in Table 3.

Table (4): Comparison between Weight on Z Score before and after VSD closure

	Before	After	Paired t test	p-value
Weight On Z Score				
Range.	-3.6 – 0.9	-3.1 – 0.9	6.925	<0.001*
Mean ± SD.	-1.59 ± 1.33	-1.31 ± 1.28		

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

There was statistically significant difference between weight on Z-Score before and after VSD closure. Higher weight on Z score was found in patients after VSD closure as shown in Table 4

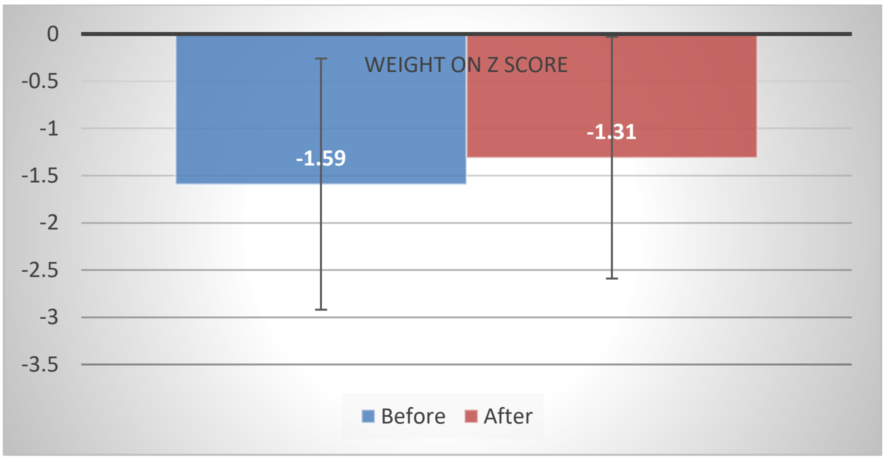

Figure (1): Comparison between weight on Z-Score before and after VSD closure.

Table (5): Distribution of the studied cases according to anthropometry after closure

	Subjects (n = 50)
Weight on Z Score	
Range.	-3.1 – 0.9
Mean ± SD.	-1.31 ± 1.28
Height/Length on Z Score	
Range.	-3.1 – 1
Mean ± SD.	-1.48 ± 1.29
Skin fold thickness on Z Score	
Range.	-3.3 – 1.2
Mean ± SD.	-1.58 ± 1.31
Mid upper arm circumference on Z Score	
Range.	-3.8 – 1.4
Mean ± SD.	-1.71 ± 1.3
BMI on Z score	
Range.	-1.28 – 3.2 13.2 – 25
Mean ± SD.	18.29 ± 3.34

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

The mean weight on Z score was -1.31 (1.28 SD),The mean height/length on Z score was -1.48 (± 1.29 SD), The mean skin fold thickness on Z score was -1.58 (±1.31 SD), The mean midupper arm circumference on Z score was -1.71 (± 1.3 SD), The head circumference on Z score -1.74 (± 1.21SD) and the mean BMI was 18.29. As shown in Table 5

Table (6): Distribution of anthropometric data of the studied patients after closure

Anthropometric data	Subjects (n = 50)
Wt (k) Range. Mean ± SD.	 8 – 20.9 14.93 ± 3.38
Ht (cm) Range. Mean ± SD.	 74 – 118 99.85 ± 10.76
MUAC Range. Mean ± SD.	 10.8 – 17.9 14.32 ± 1.68
Wt/Ht Range. Mean ± SD.	 -1.5 – 3 0.85 ± 0.73

Table (7): Classification of the studied patient's malnutrition degree before closure according to Z score

Classification according to Z score		Subjects (n = 50)	
		No.	%
Weight On Z Score	> -2 (-2 to -3) < -3	30 19 1	60.0% 38.0% 2.0%
Height/Length On Z Score	> -2 (-2 to -3) < -3	29 17 4	58.0% 34.0% 8.0%
Mid upper arm circumference On Z Score	> -2 (-2 to -3) < -3	28 12 10	56.0% 24.0% 20.0%
Wt/Ht z-score	> -2 (-2 to -3) < -3	50 0 0	100.0% 0.0% 0.0%

Regarding Ht for age on Z score 29 (58%) of the patients were above -2 on Z score while 42% were malnourished divided into 17 (34%) who suffers moderate stunting lies bet -2 to -3 on Z score and 4 (8%) had severe stunting for age less than -3

Regarding Wt/Ht for age on Z score 50 (100%) of the patients were above -2 on Z score showing normal to mild malnutrition

Regarding weight for age on Z score 30 (60%) of the patients were above (-2) while 19 (38%) of the patients were moderate underweight lying bet (-2 to -3) and 1 patient (2%) were severe underweight less than (-3) on Z score.

Regarding MUAC 28 (56%) of the patients were above -2 on Z score while 12 (24%) were moderately acute malnourished lying bet -2 to -3 and 10 (20%) were severely acute malnourished for age less than -3 on Z score. As shown in Table 7

Table (8): Distribution of the studied cases according to biochemical results after closure

	Subjects (n = 50)	
HGB		
Range.	7.5 – 13	
Mean ± SD.	11.2 ± 1.9	
HCT		
Range.	29 – 44	
Mean ± SD.	36.24 ± 3.56	
S.ALB		
Range.	3.4 – 5.4	
Mean ± SD.	4.64 ± 0.59	
S. Ferritin		
Range.	14 – 141	
Mean ± SD.	68.64 ± 33.19	
Anemia	No.	%
No	36	72.0
Yes	14	28.0

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

There were 14 patients (28%) with anemia while there were only 2 patients with hypoalbuminemia. as shown in Table 8.

Table (9): Distribution of the studied cases according to subjective global assessment

	Subjects (n = 50)	
Subjective Global Assessment	No.	%
A (Well-nourished)	8	16.0
B (Mildly to Moderately malnourished)	30	60.0
C (Severely malnourished)	12	24.0

Data are presented as frequency (%) unless otherwise mentioned.

Among the studied cases according to subjective global assessment there were 8 (16%) A, 30 (60%) B and 12 (24%) C as shown in Table 9

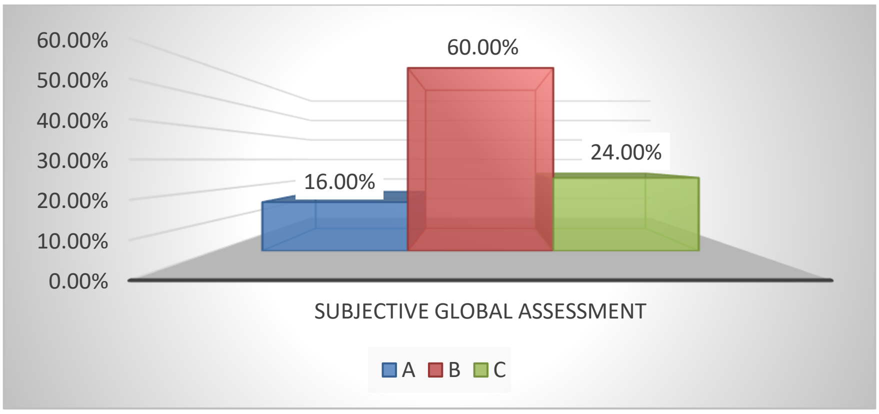

Figure (2): Distribution of the studied cases according to subjective global assessment.

Table (10): Comparison between subjective global assessment categories regarding demographic data

	Subjective Global Assessment			p-value
	A (n=8)	B (n=30)	C (n=12)	
Age				
Range.	2– 7	3 – 7	6 – 8	<0.001*
Mean ± SD.	4.38 ± 0.74	4.47 ± 1.04	6.17 ± 1.75	
Post-hoc	p1<0.001*, p2<0.001*, p3=0.472			
Sex				
Female	3 (37.5%)	11 (36.7%)	7 (58.3%)	0.421
Male	5 (62.5%)	19 (63.3%)	5 (41.7%)	
Residence				
Rural	3 (37.5%)	16 (53.3%)	7 (58.3%)	0.641
Urban	5 (62.5%)	14 (46.7%)	5 (41.7%)	
Child Order				
1	0 (0.0%)	5 (16.7%)	2 (16.7%)	0.528
2	7 (87.5%)	12 (40.0%)	6 (50.0%)	
3	1 (12.5%)	7 (23.3%)	3 (25.0%)	
4	0 (0.0%)	4 (13.3%)	1 (8.3%)	
5	0 (0.0%)	2 (6.7%)	0 (0.0%)	
Parents Education				
Bachelor's degree	6 (75.0%)	19 (63.3%)	8 (66.7%)	0.918
High school	1 (12.5%)	6 (20.0%)	3 (25.0%)	
Less than high school	1 (12.5%)	5 (16.7%)	1 (8.3%)	

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

p1: p-value for comparing A and B; p2: p-value for comparing A and C; p3: p-value for comparing B and C

There was statistically significant P value with age <0.001*

As lower age in patients of group A was noticed compared to group B and in group B compared to group C as shown in Table 10

Table (11): Comparison between subjective global assessment categories regarding anthropometric measurements

	Subjective Global Assessment			p-value
	A (n=8)	B (n=30)	C (n=12)	
Weight on Z Score				
Range in kg	15.8 – 20.4	9.5 – 20.9	8 – 16.5	<0.001*
Range. On z-score	-1.9 – 0.7	-3.1 – 0.9	-3 – -2	
Mean ± SD.	-0.81 ± 1.01	-0.94 ± 1.26	-2.58 ± 0.36	
Post-hoc	p1=0.773, p2=0.001*, p3<0.001*			
Height/Length on Z Score				
Range. In cm	105.5 – 118	82.4 – 116.5	74 – 105.5	<0.001*
Range. On z-score	-2.1 – 0.9	-3.1 – 1	-3.1 – -2.1	
Mean ± SD.	-0.83 ± 1	-1.14 ± 1.26	-2.78 ± 0.34	
Post-hoc	p1=0.460, p2<0.001*, p3<0.001*			
Skin fold thickness on Z Score				
Range.	-2.1 – 0.4	-3.2 – 1.2	-3.3 – -2.1	<0.001*
Mean ± SD.	-0.96 ± 0.88	-1.24 ± 1.34	-2.83 ± 0.35	
Post-hoc	p1=0.541, p2=0.001*, p3<0.001*			
Mid upper arm circumference on Z Score				
Range in cm	14.6 – 16.7	11.7 – 17.9	10.8 – 15.7	<0.001*
Range. On z-score	-2.1 – 0.2	-3.2 – 1.4	-3.8 – -2.4	
Mean ± SD.	-1.04 ± 0.79	-1.33 ± 1.24	-3.1 ± 0.43	
Post-hoc	p1=0.480, p2<0.001*, p3<0.001*			
HC On Z Score				
Range.	-1.9 – -0.4	-3.2 – 1.2	-3.6 – -2.1	<0.001*
Mean ± SD.	-1.06 ± 0.58	-1.4 ± 1.19	-3.03 ± 0.38	
Post-hoc	p1=0.385, p2<0.001*, p3<0.001*			
BMI on z Score	0 – 3.2	-1.28 – 3.1	-1.25 – 1.64	
Range.	16 – 24.9	13.2 – 25	13.5 – 16.5	<0.001*
Mean ± SD.	20.6 ± 3.4	18.83 ± 3.23	15.4 ± 1.07	
Post-hoc	p1=0.131, p2<0.001*, p3<0.001*			

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

p1: p-value for comparing A and B; p2: p-value for comparing A and C; p3: p-value for comparing B and C

There was statistically significant correlation seen in weight with P value <0.001* .and in Height with P value <0.001* .and in MUAC and HC with P value <0.001* and also in weight change with P value <0.001*.

There was statistically significant correlation between subjective global assessment categories regarding anthropometry as shown in Table 11.

Table (12): Comparison between subjective global assessment categories regarding objective anthropometric assessment

	Subjective Global Assessment			P-value
	A (n=8)	B (n=30)	C (n=12)	
Wt (k)				
Range.	15.8 – 20.4	9.5 – 20.9	8 – 16.5	<0.001*
Mean ± SD.	18.64 ± 1.66	15.14 ± 2.87	11.93 ± 2.76	
Post-hoc	p1=0.002*, p2<0.001*, p3=0.001*			
Ht (cm)				
Range.	105.5 – 118	82.4 – 116.5	74 – 105.5	<0.001*
Mean ± SD.	112.56 ± 4.15	100.17 ± 8.38	90.57 ± 10.4	
Post-hoc	p1= 0.001, p2= <0.001, p3= 0.002			
Height/Length On Z Score				
> -2	7 (87.5%)	22 (73.3%)	0 (0.0%)	<0.001*
(-2 to -3)	1 (12.5%)	7 (23.3%)	9 (75.0%)	
< -3	0 (0.0%)	1 (3.3%)	3 (25.0%)	

Post-hoc	p1=0.675, p2<0.001*, p3<0.001*			
MUAC				
Range.	14.6 – 16.7	11.7 – 17.9	10.8 – 15.7	<0.001*
Mean ± SD.	15.79 ± 0.66	14.47 ± 1.45	12.98 ± 1.79	
Post-hoc	p1=0.028*, p2<0.001*, p3=0.004*			
MUAC				
>12.5	8 (100.0%)	27 (90.0%)	6 (50.0%)	<0.001*
11.5 to 12.5	0 (0.0%)	3 (10.0%)	3 (25.0%)	
< 11.5	0 (0.0%)	0 (0.0%)	3 (25.0%)	
Post-hoc	p1=0.648, p2=0.057, p3=0.005*			
Wt/Ht				
Range.	-0.9 – 1.4	-1.5 – 3	0.8 – 1.08	0.862
Mean ± SD.	0.74 ± 0.73	0.85 ± 0.87	0.93 ± 0.09	
Wt/Ht				
> -2	8 (100.0%)	30 (100.0%)	12 (100.0%)	NA
(-2 to -3)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
< -3	0 (0.0%)	0 (0.0%)	0 (0.0%)	
BMI on Zscore				
Range	0 - 3.2	-1.28 - 3.1	-1.25 - 1.64	NA
> -2	8 (100.0%)	30 (100.0%)	12 (100.0%)	
(-2 to -3)	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	
< -3	0 (0.0 %)	0 (0.0 %)	0 (0.0 %)	

There was statistically significant difference between subjective global assessment categories regarding objective assessment except for in weight/height was non-significant as shown in Table 12

Table (13): Comparison between biochemical results before and after VSD closure

	Before	After	Paired t test	p-value
HGB				
Range.	6.5 – 14.8	7.5 – 15	10.043	<0.001*
Mean ± SD.	10.49 ± 2.02	11.2 ± 1.9		
HCT				
Range.	27 – 44	29 – 44	7.877	<0.001*
Mean ± SD.	34.76 ± 3.93	36.24 ± 3.56		
S.ALB				
Range.	2.8 – 5.3	3.4 – 5.4	10.143	<0.001*
Mean ± SD.	4.29 ± 0.66	4.64 ± 0.59		
S.Ferritin				
Range.	6 – 134	14 – 141	7.617	<0.001*
Mean ± SD.	64.4 ± 33.82	68.64 ± 33.19		

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

There was high statistically significant difference between biochemical results before and after VSD closure higher levels were found in patients after VSD closure more than before as shown in Table 13

Table (14): Comparison between subjective global assessment categories regarding biochemical results

	Subjective Global Assessment			p-value
	A (n=8)	B (n=30)	C (n=12)	
HGB				
Range.	8.6 – 14.3	7.5 – 15	7.6 – 12.8	0.524
Mean ± SD.	11.48 ± 2.18	11.34 ± 1.9	10.65 ± 1.77	
HCT				
Range.	34 – 43	31 – 44	29 – 40	0.103
Mean ± SD.	37.5 ± 3.66	36.63 ± 3.52	34.42 ± 3.18	
S.ALB				
Range.	3.6 – 5.3	3.4 – 5.4	3.6 – 5.3	0.833
Mean ± SD.	4.64 ± 0.52	4.61 ± 0.64	4.73 ± 0.52	
S. Ferritin				
Range.	15 – 124	14 – 141	15 – 95	0.135
Mean ± SD.	60.88 ± 34.04	76.5 ± 34.3	54.17 ± 25.04	
Anemia				
No	6 (75.0%)	23 (76.7%)	7 (58.4%)	0.918
Yes	2 (25%)	7 (23.3%)	5 (41.6%)	
Hypoalbuminemia				

No	8 (100.0%)	28 (93.3%)	12 (100.0%)	0.499
Yes (< 3.5)	0 (0.0%)	2 (6.7%)	0 (0.0%)	

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

There was no statistically significant difference between subjective global assessment categories regarding biochemical results in the three groups as shown in Table 14

Table (15): Comparison between subjective global assessment categories regarding preoperative echo data

	Subjective Global Assessment			p-value
	A (n=8)	B (n=30)	C (n=12)	
VSD Size				
Range.	6.2 – 9.2	4 – 10	4.5 – 9.6	0.569
Mean ± SD.	7.79 ± 1.12	7.96 ± 1.74	7.37 ± 1.59	
VSD size				
Mild	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.113
Moderate	0 (0.0%)	4 (13.3%)	4 (3.3%)	
Severe	8 (100.0%)	26 (86.7%)	8 (66.7%)	
VSD Type				
Inlet	3 (37.5%)	2 (6.7%)	2 (16.7%)	0.309
Membranous	1 (12.5%)	10 (33.3%)	4 (33.3%)	
Muscular	3 (37.5%)	10 (33.3%)	2 (16.7%)	
Outlet (conoventricular)	1 (12.5%)	8 (26.7%)	4 (33.3%)	
P-HTN				
No	0 (0.0%)	0 (0%)	0 (0.0%)	–
Yes	8 (100.0%)	30 (100.0%)	12 (100.0%)	
PSAP				
Range.	51 – 68	36 – 71	36 – 66	0.156
Mean ± SD.	58.38 ± 6.48	59.18 ± 8.76	53.50 ± 9.02	

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

There was no statistically significant difference between subjective global assessment categories regarding preoperative echo data as shown in Table 15

Table (16): Comparison between subjective global assessment categories regarding VSD operative data

	Subjective Global Assessment			p-value
	A (n=8)	B (n=30)	C (n=12)	
Age of VSD Closure (years)				
Range.	1.5 – 4	2 – 5	4 – 5	0.003*
Mean ± SD.	3.38 ± 0.74	3.83 ± 1.18	4.42 ± 1.51	
Post-hoc	p1=0.002*, p2=0.001*, p3=0.319			
Method of closure				
No	3 (37.5%)	2 (6.7%)	2 (16.7%)	0.309
Yes	1 (12.5%)	8 (26.7%)	4 (33.3%)	
Time Interval Between closure and Assessment (month)				
Range.	6 – 12	6 – 12	6 – 12	0.077
Mean ± SD.	10.38 ± 2.07	8.63 ± 2.04	8.33 ± 2.15	
Hospitalization After Closure				
No	16.8 – 23.2	17.4 – 51.6	17 – 25.7	0.111
Yes	20.15 ± 2.5	25.75 ± 9.03	22.33 ± 2.78	

Data are presented as frequency (%) unless otherwise mentioned, SD: Standard deviation.

p1: p-value for comparing A and B; p2: p-value for comparing A and C; p3: p-value for comparing B and C

There was statistically significant difference between subjective global assessment categories regarding age of VSD closure with significant lower age in Group A compared to Group B and lower age at operation in Group B compared to Group C as shown in Table 16

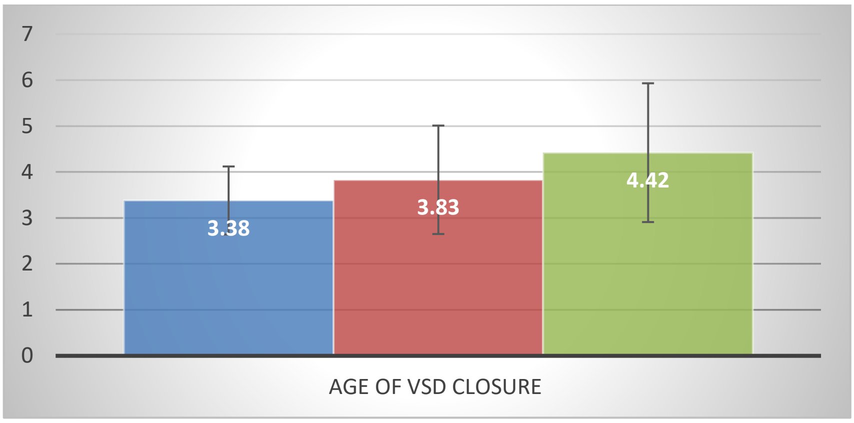

Figure (3): Comparison between subjective global assessment categories regarding age of VSD closure.

5. DISCUSSION

Isolated VSD accounts for 37% of all congenital heart disease in children. Its incidence is about 0.3% of newborns, because as many as 90% may eventually close spontaneously (Pinto et al., 2018).

Large septal defects are particularly serious during the early years but spontaneous closure occurs in about one third of all cases (Hoffman, 1995).

Children with congenital heart disease, including VSD, often start life with a normal birth weight. However, malnutrition and growth failure become apparent within the first few months. The energy intake and nutritional status of these children directly impact their growth, necessitating regular and meticulous follow-up from the moment of diagnosis, and extending for years after the defect has been corrected (Edraki et al., 2023).

There are multiple factors that contribute to growth retardation in infants and children who have VSD. These factors include inadequate intake, increased oxygen consumption, increased mean total daily energy expenditure, impaired absorption as a result of chronic venous congestion of the bowel, and inefficient utilization of nutrients by the tissues (Okoromah et al., 2011).

Our study's objective is to evaluate children's nutritional status after VSD closure by surgery or trans-catheter intervention. It included 50 patients recruited from the post cardiac interventional and surgery clinic (PCIC) Pediatric department Cairo University and 6 of October University.

The mean age of the studied cases was 4.7 years (±1.4 SD) with range (2-8) years, all of them were on anti-failure measures, most common sex were males in 29 patients (58%), while females were 21 patients (42%). This is in accordance to the research conducted by Noori et al. (2019) who demonstrated that there is no discernible changes in the prevalence or hemodynamics of VSD between males and females.

Our pre-operative echo findings showed that 16 patients (32%) had perimembranous VSD which was the most common type in accordance to the finding of (Aydemir et al. (2013) who stated that the most common VSD type in his study was perimembranous.14 patients (28%) had muscular VSD and 13 patients (26%) had Outlet (conoventricular) VSD and 7 patients (14%) had inlet VSD.

The mean VSD size was 7.79mm (±1.61 SD), the size was classified according to (Dakkak et al. (2024) who used the diameter of the aortic annulus as a comparison when describing the size.

Among the studied cases according to VSD size there were 8 patients (16%) had moderate VSD and 42 patients (84%) had large VSD and most of the patients had PH with mean PSAP was 57.69mmHg (±8.47 SD)

In our study the mean age of VSD closure was 3.98 years (±1.35 SD), this time interval before closure had marked impact on the patient nutritional state.

It was demonstrated by (Roman et al. (2011) that patients who have a delay in surgical treatment may experience malnutrition and a delay in their growth than other patients. Unfortunately, the surgeons at our center prefer to perform total repair on patients who have ventricular septal defect (VSD) and have a body weight of more than 6 kilograms. This is because, in the majority of these cases, it is very difficult to achieve due to the patients' poor nutritional status. Therefore, it is essential for those patients to receive nutritional support in order to undergo surgical correction before they undergo surgery.

Also (Cheung et al. (2003) stated in his study that the benefits of surgical repair on long term growth in such children have been variable. Surgery undertaken beyond infancy has often been associated with a residual degree of growth impairment. On the other hand, normal birth weight children with isolated cardiac malformations such as ventricular septal defect (VSD) and transposition of the great arteries (TGA) that are amenable to complete and early surgical repair usually grow normally after the operation.

Our study showed that according to the method of closure most of the patients had surgical closure 33 patients (66%) who have many disadvantages and 17 patients (34%) by trans-catheter closure with fewer complications, and there were 40 patients (80%) who were hospitalized after closure for more than 72 hours.

The study conducted by (El-Kadeem et al. (2019) showed that surgical closure of VSD is preferred in young children, particularly in cases characterized by low birth weight and large defects. However, surgical closure has many disadvantages such as pain, scar, psychological trauma, prolonged hospital stay, and more need for blood transfusion. Recently, the emergence of trans-catheter closure of VSD has been attracting considerable attention. Intervention closure offered several such as advantages rapid recovery, less trauma, less need for blood transfusion, shorter duration of hospital stay, and fewer complications.

Our study showed that there was high statistically significant difference between weight for age on Z-Score before and after VSD closure by the objective nutritional assessment but height gain didn't have this significant difference, This may be due to the rather short time interval between closure and nutritional assessment. This was reflected on the statistically significant difference in malnutrition levels before and after VSD closure.

This is in accordance to (Levy et al. (1987) who stated that adequate weight but not height gain may be expected after successful VSD surgical repair.

Looking for biochemical results there was statistically significant difference between biochemical results before and after VSD closure as there were only 14 (28%) of the postoperative patients with anemia in contrast to (Tokel et al., 2010) who found that ninety-six percent of postoperative patients had anemia, which is a larger percentage than what was reported by other researchers.

Our nutritional assessment by objective assessment after closure showed that regarding weight for age on Z score 19 patients (38%) were moderate underweight and 1 patient (2%) was severe underweight for age, regarding Height For age on Z score 42% of our patients were suffering stunting divided into 17 patients (34%) who suffer moderate stunting and 4 patients (8%) who suffer severe stunting for age, regarding MUAC For age 12 patients (24%) were moderate underweight and 10 (20%) were severe underweight for age on Z score, and Regarding BMI on Z score 50 (100%) of the patients were showing normal to mild malnutrition for age.

Our nutritional assessment by Subjective global assessment that was also assessed by (Detsky et al. (1984) and his colleagues showed that there were 8 patients (16%) A, 30 patients (60%) B and 12 patients (24%) C according to SGA score.

Regarding biochemical results after closure There were 14 patients (28%) with anemia who were categorized as following 2 SGA A, 7 SGA B and 5 SGA C while there were only 2 patients with hypoalbuminemia who were categorized SGA B and there was no statistically significant difference between subjective global assessment categories regarding biochemical results in the three groups

Following a comparison of the various groups of FTT, it was shown that there was no variation in the percentage of patients who were suffering from anemia. The fact that Egyptian children have a high prevalence of iron deficiency anemia is one possible explanation for this phenomenon (Tawfik et al., 2015).

Our study showed that there was statistically significant difference between subjective global assessment categories regarding anthropometric measurements of the patients including Weight, height, skin fold thickness, MUAC and BMI on Z score.

When comparing the nutritional assessment by objective and subjective global assessments it was proved that by SGA 84% of the patients were malnourished 30 patients (60%) SGA B had moderate malnutrition and 12 patients (24%) SGA C had severe malnutrition while by objective nutritional assessment on z score 19 patients (38%) were moderate underweight and 1 patient (2%) was severely underweight for age and 42% were suffering stunting divided into 17 patients (34%) who suffer moderate stunting and 4 patients (8%) who suffer severe stunting for age and regarding MUAC For age 12 patients (24%) were moderate underweight and 10 patients (20%) were severe underweight for age on Z score. There was statistically significant difference between subjective global assessment categories regarding objective assessment.

This is in accordance to (Bell et al. (2020) who stated that The SGNA identified more potentially malnourished children including children classified as well nourished by the single measurements such as BMI, height, and weight. The SGNA provided a clinically useful multidimensional approach to nutritional assessment.

Our assessment showed that the catch up growth after VSD closure by improvement of anthropometric measurements yet still 84% of our patients suffer moderate to severe malnutrition by SGA.

This delay in catch-up growth is presumed to be multidimensional and involving multiple patient-related and surgery-related factors but so far remains largely uninvestigated (Li et al., 2019).

It’s worthy to highlight that there was statistically significant correlation between subjective global assessment categories regarding age, with lower age in patients of group A compared to group B and group C.

This study concludes that Malnutrition is still prevalent in patients after successful VSD closure so ongoing nutritional assessment is needed and that SGA is a relevant tool in assessment of nutritional status of these children as it is a quick bedside method, taking about 15 minutes, yet it provides valuable insights that can improve a child's nutritional state. This method considers weight changes, food intake, functional status, and body composition, providing a holistic view of the child's nutritional health

6. CONCLUSION

This study concludes that Malnutrition is still prevalent in patients after successful VSD closure so ongoing nutritional assessment is needed SGA is a relevant tool in assessment of nutritional status of these children Malnutrition in these patients is multifactorial and not only due to the effect of VSD.

Our study demonstrated a substantial and statistically significant disparity in weight and height for age, as measured by Z-Score, before and after VSD closure and also showed significant and statistically meaningful change in the biochemical data observed before and after Closure.

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