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Research Article
Dietary Profile and Z-Scores of Down Syndrome Children with and without Associated Congenital Heart Defects

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Abstract
Background and Objective: Children with Down syndrome (DS) are prone to feeding difficulties, congenital heart defects (CHDs) and defective energy intake though they are often overweight when compared to contemporaries. This study was designed to evaluate the nutritional status of DS children with and without associated CHD. **Materials and Methods:** This study included 80 patients with DS recruited from the Genetic and Pediatric Cardiology Clinics at the Children's Hospital, Ain Shams University. Patients were classified into two groups according to the presence (group I) or absence (group II) of CHD. Dietetic history was taken using a 24 h dietary recall and food frequency questionnaire. Data were analyzed into macro- and micro-nutrients and referred to as a percentage from the recommended daily allowance (RDA). Anthropometric measurements were interpreted using Z scores. **Results:** Malnutrition, stunting and wasting were detected in 23.8, 45 and 11.3% of patients, respectively. Their prevalence rates were significantly higher among the group I (34.2, 55.3 and 21.1%) when compared to group II (14.3, 35.7 and 2.4%), respectively (p<0.05). Group I had significantly lower mean values of daily intake of energy, carbohydrates, fat, proteins, iron, calcium, sodium, potassium, phosphorous, selenium, vitamin B1 and vitamin D when compared to group II (p<0.05). **Conclusion:** Children with DS associated with CHD are more prone to nutritional complications. Nutritional rehabilitation strategy, including multiple micronutrient supplementations, is crucial in the management of those children with early involvement of dietitians and caregivers.

Key words: Recommended daily allowance, down syndrome, congenital heart disease, Z scores, malnutrition, dietary intake

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Down syndrome (DS) is one of the most common genetic causes of intellectual disability among humans[1] with an estimated prevalence of 14 per 10,000 live births in the US[2] and an incidence of 1/800 live births worldwide[3] and 1/600 live births in Egypt[4]. Congenital heart disease (CHD) is encountered in 40-63.5% of DS patients[5] and is considered to be the most common cause of mortality among them[6]. Growth delay is one of the cardinal signs featuring children with DS[3], characteristically the short stature[7]. However, about 30% of DS children suffer from obesity[8]. In general, around two-thirds of the mortality among the pediatric age group is related to nutritional deficiencies worldwide[9]. Inadequate nutrition and feeding problems are characteristically present in DS children[10]. In addition, the presence of other associated comorbidities such as CHDs increases the risk of malnutrition and failure to thrive among those children. On the other side, parental overprotection and the restricted pattern of their physical activity can aggravate their overweight[11]. Though there are some studies that addressed the nutritional status of DS children[10], scanty studies had assessed it via a detailed micro- and macro-nutrient intake[12] and fewer studies had assessed it among DS children with associated cardiopathies[13] but up to our knowledge, those type of studies are almost absent among Egyptian children. Hence, this study aimed to evaluate the nutritional status of a group of Egyptian DS children through studying their dietary macro- and micronutrient intake and assessing their anthropometric measurements. Furthermore, we sought to study the effect of associated co-morbidities such as CHDs on the nutritional status of DS children by comparing those associated with congenital cardiopathies with their contemporaries without associated cardiopathies.

MATERIALS AND METHODS

This is a cross-sectional study that included 80 DS patients (48 males and 32 females). Based on the presence or absence of associated CHDs, the study population was classified into group I (with CHDs) and group II (without CHDs). All diagnoses were confirmed by transthoracic echocardiography. Infants below six months and children above five years of age, those with thyroid disorders and other associated anomalies that interfere with feeding, were excluded. This research protocol followed the principles of the Declaration of Helsinki and it was approved by the ethics committee of the Pediatric Department, Ain Shams University. Informed consent was obtained from the parents prior to participation in the study. Careful history was taken stressing on symptoms of cardiac disease, feeding difficulties, weight gain and anti-failure treatment given. In the 24 h dietary recall, the caregiver provided us with the approximate amount of every food item and beverage taken in the past 24 h (three main meals and snacks in between). In the food frequency questionnaire, the caregiver reported the quantities of food consumption based on household measures and the frequency of consumption of specific food items based on a multiple response grid in which the caregivers were asked to estimate how often a particular food or beverage was consumed. Categories used ranged from 'never' or 'less than six a week' to 'four per month.' Using our National Nutrition analysis software program and the Egyptian food composition tables, the nutrient value for each type and quantity of food item was analyzed and converted into calories, macro-nutrients (carbohydrates, proteins and fat) and micronutrients (iron, calcium, sodium, potassium, phosphorous, selenium, vitamins A, B1, B2, C and D). The values were referred to as a percentage from the recommended daily allowance (RDA) and dietary intake was considered unsafe (<50% RDA), unacceptable (50≤75% RDA), acceptable (75≤100% RDA), adequate (100≤120% RDA) or overconsumption (>120% RDA) based on the corresponding age and sex[14,15].

Clinical examination was done for signs of heart failure, pulmonary hypertension and anthropometric measurements, which included the weight, height, occipitofrontal circumference and the left mid-upper arm circumflex. The weight was measured on a digital electronic scale. The scale was set at zero before the patient was placed on the scale and was checked weekly with known calibration weights. The height was measured by a tape measure permanently fixed to a wall or a door frame. The head was held firmly at the top of the board. The knees were flattened firmly to extend the legs entirely. The feet were together and flexed to a 90° angle with the child fully stretched. The child stood erect with the heels, buttocks and back of the head against the wall and the arms down and relaxed. The occipitofrontal circumference was measured using a non-stretchable plastic-coated tape that was placed superior to the supraorbital ridge adjusted around the occiput until the maximum circumference was obtained. The plane of the tape was the same on both sides of the head. Care was taken that the tape was placed evenly flat against the skull. Three measurements were obtained and the mean recorded. The left mid-upper arm circumference was measured while the patient is upright and the arm down in a fully relaxed position with the tape measure perpendicular to the long axis of the arm. Care was taken so that there was no pinching or gaping of the tape as it encircled the arm. Interpretation of weights and heights was made using the Z scores[16]. Three measurements were assessed; weight for age score (WAZ), height for age score (HAZ) and weight for height score (WHZ). According to the WHO global database on child growth and malnutrition[17], a Z-score cut-off point of $\leq$ -2SD defined WAZ as underweight, HAZ as stunting and WHZ as wasting and a cut-off point of >+2 SD defined high WHZ as overweight in children.

Statistical analysis: All statistical analyses were performed using the Statistical Package for Social Science (SPSS) version 22.0 for windows (SPSS Inc., Chicago, IL, USA). Numerical data was presented as Mean±standard deviation (SD). Non-numerical data was presented as frequency and percentage. The student's t-test was used for parametric quantitative data. A Chi-Square test was used to detect the relationship between two qualitative variables. The differences were considered significant if the probability (p) values were less than 0.05.

RESULTS

This study was conducted on 80 DS children. They were 48 (60%) boys and 32 (40%) girls. Their ages ranged from 7-57 months with a mean and SD of 21.66±12.01 months. Of the studied population, underweight, stunting and wasting were detected in 23.8, 45 and 11.3%, respectively, while 20% of them were overweight (Table 1). The studied population was divided into two groups; group I (38 children with associated CHDs) and group II (42 children without CHDs). Types of CHDs encountered in group I were atrioventricular septal defects (16, 42%), atrial septal defects (10,26.3%), ventricular septal defects (8, 21%) , combined aortic stenosis and patent ductus arteriosus (2, 5.5%), tetralogy of Fallot (1, 2.6%) and combined ventricular septal defect and patent ductus arteriosus (1, 2.6%). Group I children were significantly underweight, stunted and wasted when compared to group II (Table 2).

Table 1: Anthropometric characteristics of the total (n = 80) DS children

Parameters		Mean±SD	Range
Weight (kg)		9.65±3.36	4.2-22
Height (cm)		76.51±8.76	54-96
OFC (cm)		44.38±4.37	30-60
Arm circumflex (cm)		13.65±2.46	9-22
Parameters		Frequency	Percentage
WAZ	<-2	19	23.8%
	-2 to 2	61	76.3%
	>2	-	-
HAZ	<-2	36	45.0%
	-2 to 2	31	38.8%
	>2	13	16.3%
WHZ	<-2	9	11.3%
	-2 to 2	55	68.8%
	>2	16	20.00%

OFC: Occipitofrontal circumference, WAZ: Weight for age score, HAZ: Height for age score, WHZ: Weight for height score, DS: Down syndrome, SD: Slandered deviation

Table 2: Comparison between groups (I) and (II) as regards to population characteristics and anthropometric measurements

Parameters		Group (I) n = 38	Group (II) n = 42	p-value
Gender	Girls	20 (62.5%)	12 (37.5%)	0.049**
	Boys	18 (37.5%)	30 (62.5%)	
Age (months)	Mean±SD	19.95±11.36	22.71±12.97	0.361*
	Range	7-53	7-57	
Weight (kg)	Mean±SD	8.33±3.31	10.75±3.59	0.003*
	Range	4.2-22	5-19	
Height (cm)	Mean±SD	73.32±8.54	79.39±8.01	0.002*
	Range	54-94	66-96	
OFC (cm)	Mean±SD	42.2±4.62	46.36±3.02	0.001*
	Range	30-60	39-59	
Arm circumflex (cm)	Mean±SD	13.79±2.79	15.41±2.29	0.011*
	Range	9-22	10.5-20	
WAZ	<-2	13 (34.2%)	6 (14.3%)	0.030**
	-2 to 2	25 (65.8%)	36 (85.7%)	
	>2	-	-	
HAZ	<-2	21 (55.3%)	15 (35.7%)	0.029**
	-2 to 2	15 (39.5%)	16 (38.1%)	
	>2	2 (5.3%)	11 (26.2%)	
WHZ	<-2	8 (21.1%)	1 (2.4%)	0.030**
	-2 to 2	23 (60.5%)	32 (76.2%)	
	>2	7 (18.4%)	9 (21.4%)	

*Independent t- test, **Chi-square test, p<0.05 is Significant, p<0.01 is highly significant, OFC: Occipitofrontal circumference, WAZ: Weight for age score, HAZ: Height for age score, WHZ: Weight for height score, DS: Down syndrome, SD: Slandered deviation

Table 3: Distribution of the daily dietary intake of calories, macro- and micro-nutrients in relation to the RDA among the studied population

Nutrient	<50%	50 to ≤75%	75 to ≤100%	100 to ≤120%	>120%
Energy (kcal)	54 (67.5%)	11 (13.8%)	10 (12.5%)	3 (3.8%)	2 (2.5%)
Carbohydrates (g)	8 (10%)	13 (16.3%)	19 (23.7%)	19 (23.7%)	21 (26.3%)
Proteins (g)	5 (6.3%)	16 (20%)	17 (21.3%)	16 (20%)	26 (32.5%)
Fats (g)	2 (2.5%)	18 (22.5%)	16 (20%)	22 (27.5%)	22 (27.5%)
Iron (mg)	36 (45%)	20 (25%)	14 (17.4%)	5 (6.3%)	5 (6.3%)
Calcium (mg)	25 (31.3%)	21 (26.3%)	21 (26.3%)	3 (3.8%)	10 (12.5%)
Sodium (mg)	1 (1.3%)	1 (1.3%)	1 (1.3%)	14 (17.5%)	63 (78.8%)
Potassium (mg)	17 (21.3%)	24 (30%)	17 (21.3%)	11 (13.8%)	11 (13.8%)
Phosphorous (mg)	38 (47.5%)	19 (23.8%)	16 (20%)	5 (6.3%)	2 (2.5%)
Selenium (mcg)	59 (73.8%)	9 (11.3%)	5 (6.3%)	-	7 (8.8%)
Vitamin A (IU)	56 (70%)	5 (6.3%)	2 (2.5%)	9 (11.3%)	8 (10%)
Vitamin B1 (mg)	20 (25%)	28 (35%)	7 (8.8%)	15 (18.8%)	10 (12.5%)
Vitamin B2 (mg)	15 (18.8%)	7 (8.8%)	10 (12.5%)	11 (13.8%)	37 (46.3%)
Vitamin C (mg)	46 (57.5%)	4 (5%)	3 (3.8%)	5 (6.3%)	22 (27.5%)
Vitamin D (IU)	42 (52.5%)	4 (5%)	10 (12.5%)	7 (8.8%)	17 (21.3%)

Table 4: Percentage distribution of food frequency among the studied population

Food items	Daily (%)	Weekly (%)	Monthly (%)
Cereals	45.4	23.7	21.0
Sugars and sweet	20.5	16.0	19.0
Milk and dairy products	18.6	10.0	7.7
Fat and oil	4.7	5.3	1.7
Legumes	3.8	14.3	27.6
Tubers	3.6	9.2	11.1
Vegetables and fruits	1.6	6.5	1.1
Meat, poultry and fish	1.3	8.5	8.5
Egg	0.4	2.9	2.3

Table 3 shows the distribution of the dietary intake of energy, macro- and micro-nutrients in relation to the RDA among the studied population. Table 4 shows the percentage of food frequency among the studied population.

In terms of the RDA, the frequency of children who received an unsafe intake of carbohydrates, proteins, fat, calcium, vitamins A, B2 and D was significantly higher among the group I when compared to group II. Group I children showed significantly lower mean values of the daily intake of calories, macronutrients, minerals and vitamins B1 and D (Table 5 and 6).

DISCUSSION

In general, the intake of unhealthy snacks and peaky eating pattern usually observed in children render them more susceptible to various nutrient deficiencies[18]. Feeding a child with DS can be considered a challenge due to several obstacles that include anatomical considerations related to the small oral cavity, relative macroglossia, oral hypotonia, uncoordinated suckling and swallowing, teeth decay and defective saliva production resulting in poor chewing, food pocketing, recurrent chocking and nasal aspiration[19].

Concerning the RDA, the unsafe intake of calories, carbohydrates, proteins and fat was encountered in 67.5, 10, 6.3 and 2.5% of the studied population respectively, while overconsumption of calories, carbohydrates, proteins and fat was observed in 2.5, 26.3, 32.5 and 27.5%, respectively. The discrepancy observed between the percentage of children receiving the unsafe level of daily calories (67.5%) and those receiving the unsafe level of daily carbohydrates (only 10%) suggests that carbohydrates are no more the major dietary source of energy among them. This is in agreement with Huynh *et al.*[20], who found that fat and protein intake is currently replacing the carbohydrates in the diet of their studied preschool Vietnamese children. The contribution of each type of macronutrient intake to the total caloric intake though not studied in this work, yet it seems to be influenced by the food frequency pattern seen among the studied population. In the current study, cereals were the most daily consumable food staff (macaroni, belila, cerelac, rice, bread and corn popped); consumed daily by 45.4% of the studied population; followed by sugars and sweets (20.5%), milk and dairy products (18.6%), fat and oils (4.7%), legumes (3,8%), tubers (3.6%), vegetables and fruits (1.6%), meat, poultry and fish (1.3%) and finally eggs (0.4%). Luke *et al.*[21], Hopman *et al.*[22] and Grammatikopoulou *et al.*[23] observed lower caloric intake in DS children. Samarkandy *et al.*[12] found that DS children had a significantly lower intake of proteins and fat when compared to their normal siblings but there were no differences in the caloric and the carbohydrate intake between the two groups. In relation to the RDA, 26.3% of the total population showed overconsumption of carbohydrates. This could be explained by the food frequency pattern observed among them as 20.5% of our studied children were used to consume sugars and sweets on a daily basis. This is supported by Chad *et al.*[24],

Table 5: Comparison between group I and II as regards to the percentage distribution of energy and macro- and micro-nutrient intake in relation to the RDA

Nutrient	Groups	<50%	50 to≤75%	75 to≤100%	100 to≤120%	>120%	p-value
Energy (kcal)	G I	25 (65.8%)	7 (18.4%)	4 (10.5%)	2 (5.3%)	0 (0.0%)	0.454
	G II	29 (69%)	4 (9.5%)	6 (14.3%)	1 (2.4%)	2 (4.8%)	
Carbohydrates (gm)	G I	6(15.8%)	10(26.3%)	12(31.5%)	7(18.4%)	3(8%)	<0.001**
	G II	2(4.7%)	3(7.1%)	7(16.8%)	12(28.6%)	18(42.8%)	
Proteins (g)	G I	4(10.5%)	12(31.6%)	10(26.3%)	6(15.8%)	6(15.8%)	0.005*
	G II	1(2.4%)	4(9.5%)	7(16.7%)	10(23.8%)	20(47.6%)	
Fats (g)	G I	2(5.2%)	13(34.2%)	6(15.8%)	10(26.4%)	7(18.4%)	0.050*
	G II	0(0%)	5(11.9%)	10(23.8%)	12(28.6%)	15(35.7%)	
Iron (mg)	G I	20(52.6%)	11(28.9%)	5(13.2%)	1(2.6%)	1(2.6%)	0.267
	G II	16(38.1%)	9(21.4%)	9(21.4%)	4(9.5%)	4(9.5%)	
Calcium (mg)	G I	18(47.4%)	12(31.6%)	7(18.4%)	0(0%)	1(2.6%)	0.002*
	G II	7(16.7%)	9(21.4%)	14(33.3%)	3(7.1%)	9(21.4%)	
Sodium (mg)	G I	0(0%)	1(2.6%)	0(0%)	8(21.1%)	29(76.3%)	0.479
	G II	1(2.4%)	0(0%)	1(2.4%)	6(14.3%)	34(81%)	
Potassium (mg)	G I	11(28.9%)	14(36.8%)	5(13.2%)	3(7.9%)	5(13.2%)	0.126
	G II	6(14.3%)	10(23.8%)	12(28.6%)	8(19%)	6(14.3%)	
phosphorous(mg)	G I	22(57.9%)	7(18.4%)	6(15.8%)	3(7.9%)	0(0%)	0.260
	G II	16(38.1%)	12(28.6%)	10(23.8%)	2(4.8%)	2(4.8%)	
Selenium (mcg)	G I	31(81.6%)	4(10.5%)	0(0%)	0(0%)	3(7.9%)	0.156
	G II	28(66.7%)	5(11.9%)	5(11.9%)	0(0%)	4(9.5%)	
Vitamin A (mg)	G I	31(81.6%)	0(0%)	1(2.6%)	5(13.2%)	1(2.6%)	0.039*
	G II	25(59.5%)	5(11.9%)	1(2.4%)	4(9.5%)	7(16.7%)	
Vitamin B1 (mg)	G I	12(31.6%)	14(36.8%)	1(2.6%)	8(21.1%)	3(7.9%)	0.210`
	G II	8(19%)	14(33.3%)	6(14.3%)	7(16.7%)	7(16.7%)	
Vitamin B2 (mg)	G I	11(28.9%)	2(5.3%)	8(21.1%)	2(5.3%)	15(39.5%)	0.008*
	G II	4(9.5%)	5(11.9%)	2(4.8%)	9(21.4%)	22(52.4%)	
Vitamin C (mg)	G I	24(63.2%)	1(2.6%)	1(2.6%)	2(5.3%)	10(26.3%)	0.808
	G II	22(52.4%)	3(7.1%)	2(4.8%)	3(7.1%)	12(28.6%)	
Vitamin D (mg)	G I	28(73.7%)	2(5.3%)	3(7.9%)	3(7.9%)	2(5.3%)	0.003*
	G II	14(33.3%)	2(4.8%)	7(16.7%)	4(9.5%)	15(35.7%)	

Chi-square test, $p< 0.05$ is significant, $p<0.01$ is highly significant

Table 6: Comparison between group (I) and (II) as regards to the mean values of daily dietary intake of calories, macro- and micro-nutrients

Parameters	Group (I)	Group (II)	p-value
Calories (kcal)	543.28±194.14	821.82±299.94	0.000
Carbohydrates (g)	69.28±29.91	97.82±41.98	0.001
Proteins (g)	21.41±9.00	31.27±15.98	0.001
Fat (g)	20.06±8.44	33.94±13.53	0.000
Iron (mg)	2.45±1.95	3.72±2.42	0.005
Calcium (mg)	344.47±203.49	459.08±187.82	0.004
Sodium (mg)	324.51±114.36	376.49±113.41	0.025
Potassium (mg)	641.68±276.33	874.90±376.91	0.001
Phosphorous (mg)	328.72±144.48	445.04±198.62	0.001
Selenium (mcg)	5.64±4.39	7.91±4.74	0.014
Vitamin A (IU)	195.46±212.75	254.71±205.74	0.160
Vitamin B1(mg)	0.27±0.12	0.35±0.16	0.006
Vitamin B2 (mg)	0.55±0.36	0.60±0.28	0.515
Vitamin C (mg)	19.38±21.15	25.23±21.37	0.172
Vitamin D (IU)	4.31±5.54	8.10±5.82	0.001

who attributed this tendency to the intake of good quantities of easily chewable starches and sweets as a behavioral rewarding for a good attitude in such a group of children.

Based on the United Nations International Emergency Children's Fund (UNICEF) definition of micronutrients, they are substances that play essential roles in the growth, development and function of multiple body systems including the immune system as they help the production of hormones, enzymes and other biochemical substances that mediate different metabolic pathways in the body[18]. Micronutrient deficiencies render the child susceptible to mental retardation, decreased learning capabilities, recurrent severe infections and eventually death[25].

In this study, based on the RDA; unsafe intake of iron, calcium, phosphorous, selenium, vitamins A, B1, C and D were observed in 45, 31.3, 47.5, 73.8, 70, 25, 57.5 and 52.5%, respectively of the studied population. A low intake of calcium and vitamin A in DS children was observed in some studies[26]. Samarkandy *et al.*[12] found that DS children had a significantly lower intake of retinol, riboflavin, sodium, potassium and calcium when compared to their normal siblings.

Patients with associated CHDs are more prone to feeding difficulties and nutritional deficiencies due to decreased appetite, exertional dyspnea, gut failure, increased metabolic demands and fluid restriction[27]; in addition to the detrimental effect of tissue hypoxia, pulmonary hypertension and the cardiac compromise on the energy intake and consequently on growth[28]. In this study, the group I had significantly lower mean values of daily intake of energy, all macronutrients (carbohydrates, fat and proteins), iron, calcium, sodium, potassium, phosphorous, selenium, vitamin B1 and vitamin D when compared to group II. Also, in relation to the RDA, the frequency of children who received an unsafe intake of carbohydrates, proteins, fat, calcium, vitamins A, B2 and D was significantly higher in group I when compared to group II. We were not able to compare our results with others due to the rarity of similar studies in the literature.

As recommended by the WHO, Z-scores for anthropometric indices is recommended to be used for the identification and classification of malnutrition[29]. In this study, underweight (23.8%), stunting (45%), wasting (11.3%) and overweight (20%) were detected in all DS children (with and without associated cardiopathies). On the other hand, normal ranges for WAZ, HAZ and WHZ were found in 76.3, 38.8 and 68.8%; respectively of the total population. Samarkandy *et al.*[12] detected overweight in 20.4% of their studied population and found that DS children were significantly shorter when compared to their siblings. Giaretta and Ghiorzi[30] detected malnourishment in 33.3% and overweight in 33.3% of their studied DS children. Pierce *et al.*[31] detected overweight and obesity in 23 and 20.6% of their studied DS population; respectively.

The mean values of weight, height, occipitofrontal and left mid-arm circumferences were significantly lower in group I when compared to group II and the prevalence rates of underweight, stunting and wasting were significantly higher in the former (34.2, 55.3 and 21.1%); respectively; when compared to the later (14.3, 35.7 and 2.4%); respectively. Benato *et al.*[32] reported that DS children with associated CHDs fail to achieve the expected weight gain. Similarly, Rodrigues *et al.*[13] detected low weight in 31% of their studied DS population with congenital cardiopathies. On the other hand, they detected short stature in only 17% of their studied population. Regardless of the differences in the used methodologies for anthropometric assessment in both studies, the prominent difference in the results related to the short stature could be attributed to the age differences between both studies as the most frequently encountered age group in their study was the adolescent age (10-18 years) and this supports their conclusion that DS children show improvement in stature growth as their ages increase. Also, 50% of their studied population had already undergone some corrective cardiothoracic procedures, which might have improved their growth potential. Our study showed that in Group I, 18.4% were overweight. Also, Rodrigues *et al.*[13] detected that 22% were overweight in their studied children with DS and CHDs. In general, the differences found in the various studies could be attributed to the differences in the ages of the studied groups, the used anthropometric methodologies, presence or absence of associated comorbidities such as CHDs and whether these CHDs were repaired or not.

Though the sex-related prevalence of congenital cardiopathy in our DS children as well as the type of encountered CHD were not intended to be studied, it was observed that DS associated with CHD was more common in girls (62.5%) when compared to boys (37.5%). These figures are in line with previous studies conducted by Moura *et al.*[33] (66.6% girls vs 33.3% boys) and Rodrigues *et al.*[13] (56.1% girls vs 43.9% boys). Atrioventricular septal defect was the most prevalent type of CHD (42%) in our population. This matches with most of the previous studies[13,34,35].

Study strengths and limitations: Up to the best of our knowledge, studies targeting the nutritional evaluation of DS children with associated cardiopathies; as one of the prominent co-morbidities encountered; are very scanty in literature and this adds to the novelty of this study. In this study, the dietary assessment was done in detail in terms of macro- and micronutrients intake. Moreover, we used a control group (DS children without congenital cardiopathies) for comparison but on the other hand, our results were not supported by measuring the serum biochemical levels of different micro- nutrients.

Conclusion and recommendations: Nowadays, the life expectancy and survival rate of DS children with CHD is increasing; thus, children with DS associated with CHDs deserve to be studied thoroughly and to be offered a better quality of life from all health aspects, including the nutritional one.

This study showed that DS children with CHD are more vulnerable to nutritional deficiencies. Their dietary intake of nutrients is not sufficient to achieve the RDA and should not be relied on alone. Hence, early nutritional intervention should be offered to them by an expert dietician who should be involved in the multidisciplinary team management of those children.

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