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Research Article
Assessment of Nutrient and Energy Intakes Among Children with Down Syndrome

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Abstract
Background and Objective: Down's syndrome (DS) is one of the disability conditions that can reduce productivity especially if coming with nutritional problems. Malnutrition as revealed by anthropometric variables and micronutrient deficiency is highly prevalent among children and adolescents with DS compared to normal controls. This study assessed the nutrient and energy intake of children with DS. A cross-sectional study included 100 boys' and girls' cases 8-18 years. **Materials and Methods:** The sample was divided into two age groups, 8-12 and 13-18 years old. Anthropometric measures of body weight, height and calculated body mass index were performed. Three 24 hrs recall was conducted to evaluate daily dietary intake. **Results:** The mean weight and height of the studied participant were 39.5±11 kg and 126.00±0.1 cm, respectively. The mean body fat percent (BFP) was 37.1±9.1. 73% of the participants were of normal weight, while less than 21% were overweight, mean differences showed that total calories, protein, carbohydrate and fat intakes were higher than the RDA. Sugar and saturated fat intake were higher than the DGA, sodium intake was higher than UL. Omega 3, omega 6, vitamin K and potassium showed lowered intake when compared to AI level. While, vitamin A, D, E and folate, magnesium, zinc, copper and selenium showed lower intake when compared to the RDA. **Conclusion:** Children with Down syndrome tended to excessively consume food. It triggered excessive energy, protein and carbohydrate intake in most children with DS and at risk for vitamin and mineral deficiencies.

Key words: Down syndrome, children, energy intake, nutrients deficiency

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

INTRODUCTION

Down's syndrome (also known as trisomy 21), is mental retardation caused by the additional genetic material in chromosome number 21. This disorder occurs when there is an abnormal cell division and it is described as non-disjunction, which is the unequal distribution of a single chromosome to the daughter cell during cell division. The reason for the extra chromosome is unknown yet, the only reason that can be correlated to this syndrome is maternal age, whereas the opportunity of conceiving a child with Down syndrome increases with maternal age according to the World Health Organization[1].

The worldwide prevalence ranges from 1 per 1,000 to 1 per 1,100 births according to the World Health Organization making it the ultimate common reason for chromosomal intellectual disability. Down syndrome occurs in all nations of all economic statuses and races according to the National Down Syndrome Society (2020). There are three cytogenetic forms: Free Trisomy 21, that accounts for 95% of the cases, mosaicism 1% and translocation which occurs in 2-4% of the cases[2].

In the mid-1800s, a group of physicians started epidemiological studies, where they examined patients, who were diagnosed with short stature, specific facial characteristics and mental retardation[3]. Down syndrome (trisomy21) was given its name after John Langdon Down, a British physician, was the first to explain the syndrome. In 1866 he gave a description of many of its features in "Observations on the Ethnic Classification of Idiots"[4].

Children with Down syndrome have distinguishable physical features that make them identifiable to others[5]. Moreover, children with Down syndrome experience medical conditions and health problems that have been recorded broadly. Besides mental retardation, they have a high risk of congenital heart disease (approximately 50%) and gastrointestinal malformations (10% of children with DS). Furthermore, children with Down syndrome are well-known to have a high incidence of thyroid conditions, sleep apnea, hearing difficulties, poor vision and a high risk of leukaemia in children with DS[6]. Celiac disease is also increased in DS (3-17%) in different studies and juvenile diabetes is present in 2%, also children with DS have an increased possibility of infections[7]. As well as diabetes mellitus that occurs at a higher frequency compared with non-DS children[8].

Malnutrition occurs with frequent increases among children with DS and increases with age and poor economic status as revealed by micronutrient deficiency and anthropometric measurements[9]. Down syndrome patients are suggested to have poor nutrition in comparison to non-disabled children, also they are more susceptible to poor nutritional care[10]. Feeding habits assessment for children with Down syndrome is considered a necessity, as their food intake may be affected by any abnormal development. Decreased food intake due to poor diet or problems with feeding will leads to decreased fat and muscle mass or poor growth. Whereas overeating and low physical activity will result in over nutrition status[11]. About 20-50% of normal children and 70-89% of children with special needs are suffering from feeding difficulties[12]. These feeding problems vary from food preferences to severe problems like food dysphagia and rejection[4]. Moreover, bad food habits are associated with improper choices of food, food intolerance or malabsorption[13].

Children with DS are considerably shorter than normal children according to the National Center for Health Statistics (NCHS) growth charts[4]. Moreover, shorter stature and increase in bodyweight in the DS children and adolescents emphasize the necessity of balanced diets and healthy eating habits[5]. Different studies have suggested that DS children need fewer calories than normal children of the same age[14], while a few reports have suggested that DS and normal children require similar calories[15]. On the other hand, DS patients showed poor nutritional status as a result of low intakes of dietary fiber, vitamins E, A, C, niacin, thiamin, zinc, pyridoxine and calcium. Mainly, vitamin A, pyridoxine and zinc have received the most awareness due to their influence on the growth and development of children with DS. Vitamin A intake is inadequate because vegetables and fruits may be refused. Furthermore, DS children have a high intake of carbohydrates because of the consumption of high-sugar food, sweets for their good attitude and the high intake of fruit juices[12].

There are insufficient data on what children with down syndrome are eating due to the difficulties of diet assessment. Dietary evaluation practices for people with impairment give more complications due to difficulties with awareness, reminiscence and connection. Several studies on adolescents and children with Down syndrome have applied different dietary assessment methods[11,14,15]. Majority of these studies, parents have answered the questionnaires instead of the young children with Down syndrome[15].

Appropriate assessment methods, early diagnosis and timely proper intervention/treatment are the key to managing the life and quality of life of a patient with Down's syndrome[16]. Accordingly, assessment of food and energy intake and feeding problems in children are of concern to be investigated. There are no scientific studies on nutrient and energy intake among children with DS in Amman. Therefore, this study aimed to provide scientific information about the nutritional status of DS children in Amman to determine the relationship between anthropometric measurements and the growth of these children using the DS growth charts, to evaluate the nutrition and energy intakes of Down syndrome children including adolescents in Amman and Assess the nutrition and energy intakes and compare them with the recommended dietary allowance according to WHO tables.

MATERIALS AND METHODS

Study design and setting: A cross-sectional study of 100 children with DS was conducted in Amman, the capital of Jordan, with the approval of the Jordan University Ethics Committee, from May, 2020 to November, 2020. Among group ages between 8-12 and 13-18 years old selected from different Down syndrome centers.

Study sample: The sample consisted of girls and boys with Down's syndrome, aged 8-18 years. Subjects were recruited through schools that provided education to children with mental disabilities. All participants were living with their families and were not on any medication or hormonal therapy. All parents were aware of the study's objectives and gave their written consent before participating in the study.

Ethical considerations: This study was approved by the committee of research at the Faculty of Agriculture and the Deanship of Scientific Research and International Review Board (IRB).

Data collection tools

Anthropometric measurements: Anthropometric measurements were performed early in the morning. bodyweight (BW) was measured with an accuracy of 0.1 kg, using a portable digital scale (Seca diva 788). Stature was measured to the nearest cm with a portable stadiometer (LEICESTER PORTABLE HEIGHT MEASURE TANITA HR 001), with subjects standing barefoot. Percentage body fat (%BFP) was estimated.

Dietary assessment

3-day food record: The researcher explained to parents how to record the food intake of their children for 3 consecutive days (a Thursday, a Friday and a Saturday), by estimating the consumed portions with the use of standard food models (National Dairy Council, 1990). Data were analyzed with Food Processor 7.40 for Windows (ESHA Research, Portland, Oregon) and the mean of the 3 days was compared to the latest age- and sex-specific recommended dietary allowances (RDA), to diagnose possible nutrient deficiencies. Intakes below 70 % of the RDA were considered inadequate. Intake of nutrients was compared with the dietary reference intake (DRI)[13] according to age and gender. The percentages of energy provided by protein, carbohydrate and total fat were analyzed according to the acceptable macronutrient distribution range (AMDR), fibers (g), n-3 fatty acids and n-6 fatty acids (g) were analyzed according to adequate intake (AI). The adequacy of intake of micronutrients was calculated according to the reference values of the estimated average requirement (EAR), except for vitamin B5, potassium and sodium, which were analyzed according to AI. Sodium was classified as excessive when greater than the reference value[15].

Statistical analysis: Independent samples t-tests were performed between the age groups and $p<0.05$ were considered significant. Values (boy/girl), (different age group) are Means±SD. Data were analyzed using one-way ANOVA. The Tukey HSD ("honestly significant difference" or "honestly significant difference") test is a statistical tool used to determine if the relationship between two sets of data is statistically significant $p<0.05$. Data collected were analyzed using SPSS for Windows verse 16.

RESULTS

Anthropometrics measurements: The mean weight and height of the study participant was 39.5±11 kg and 126.00±0.1 cm, respectively. The mean body fat percent (BFP) was 37.1±9.1. The mean body fat mass was 21.27±8.99 kg in Table 1.

Age, gender and body mass index characteristics: The present study was carried out on 100 participants. The age of the studied participants was divided into two main age groups, the first one ranged between 8-12 years with (61%) of total study participants, while the other one ranged between 13-18 years with (39%) of the total study participant. The vast majority (69%) of the participants were boys, while (31%) of the participants were girls. Two-third (about 73%) of the participants were normal weight, while less than one-third (21%) were overweight in Table 2.

Table 1: Participants' anthropometric measurements (n = 100)

Characteristics	
Anthropometrics	(Mean ±SD*)
Height (cm)	126±0.1
Weight (kg)	39.5±11
Body fat percent	37.1±9.1

*SD: Standard deviation

Dietary intake: Table 3 and 4 show the mean differences of macronutrients which describes the higher intake of 3 days than the RDA as follows (3073.5 kcal energy intake, 145.5 g protein, 446 g carbohydrate, 79.8 grams fat). Moreover, simple sugars and saturated fat intake were higher than the DGA (116.2 and 25.7 g) respectively which are explained by the high intake of junk and processed food which was approved by high sodium intake that reached the upper limit of the recommendation UL (6316.5). On the other hand, the healthy fatty acids intake omega 3, omega 6showed lowered intake when compared to adequate intake AI level (-0.3 and -1.9 g) respectively.

The fat-soluble vitamins shown in Table 5 vitamin A, D, E showed lower intake when compared to the RDA (–325 IU, 104.4 IU and 0.94 IU), respectively.

The mean differences to compare between energy intake among boys (2800 kcal), girls (3680 kcal) and RDA (2200 kcal) were higher.

The intake of protein among boys was (106.6 g) while the protein intake of girls was (232 g), which is triple the RDA recommendation (43 g). However, the intake of carbohydrates was similarly matched between genders but unfortunately fourth times the RDA (130 g). Fat intake was higher among girls who showed to eat 114 g per day while boys ate 64 g per day. Both of which were higher than the RDA (44 g) sugar g and saturated fat g intake were higher than the RDA ($p \leq 0.05$) while the healthy fatty acids omega 3, omega 6 intakes were lower in both genders with no significant differences between both groups in Table 6.

Table 7 Fortunately shows that vitamins B (1, 2, 3, 6 and 12) matched the RDA recommendation for both genders. While fat-soluble vitamins were lower might reflect some fat malabsorption defects although their fat intake was high. Vitamin A intakes were less than half of the RDA among both genders. For Vitamin C girls' intake (147 g) was double the boy's intake (61.6 g), the intake of vitamin D and vitamin E needs attention in both genders as it was far from the RDA.

In Table 8 no differences between both gender among mineral intakes. However, magnesium, potassium, zinc, copper, manganese and selenium showed lower intake when compared to the RDA.

The mean differences compared between age groups (8-12 years old), (13-18 years old) RDA showed that carbohydrate and saturated fat intake were higher in (8-12) than the RDA ($p \leq 0.05$) with no significant differences between both groups in Table 9.

On the other hand, vitamin A, K, D, E showed lowered intake when compared to RDA levels with no differences between age groups in Table 10. While, magnesium, zinc, copper and selenium showed lower intake when compared to the RDA with no differences between age groups in Table 11.

Table 2: Participants' age, gender and body mass index characteristics (n = 100)

Characteristics	Percentage
Age (years)	
(8-12)	61
(13-18)	39
Gender	
Boys	69
Girls	31
BMI	
Underweight	1
Normal	73
Overweight	21
Obese	5

**BMI: Body mass index

Table 3: Macronutrient 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (n = 100)

Variables	Means (intake)±SD
Calories (kcal)	3073.5±9186.6
Protein (g)	145.5±721.7
Carbohydrate (g)	446.1±1430.6
Fiber (g)	38.7±182.7
Sugar (g)	116.2±416.7
Fat (g)	79.8±237.3
Saturated fat (g)	25.7±43.4
Omega 3 (g)	0.37±1.2
Omega 6 (g)	2.04±3.8

Table 4: Minerals 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (n = 100)

Variables	Means (intake)±SD	Means differences from RDA	p-value
Calcium (mg)	1258±4717.9	-41.9±272.2	0.877
Iron (mg)	15.77±78.44	4.86±4.51	0.284
Magnesium (mg)	151.18±709.3	-179±41.69**	≤0.001
Phosphors (mg)	911.7±3286	-338.2±186.9	0.073
Potassium (mg)	2183.6±11720.6	-2316.4±671.5**	≤0.001
Sodium (mg)	6316.5±26197.2	4116.5±1485.3**	0.006
Zinc (mg)	4.59±12.4	-4.47±0.73**	≤0.001
Copper (g)	0.74±5.08	-771.5±9.28**	≤0.001
Manganese (mg)	1.01±5.38	-0.89±0.31	0.005
Selenium (mg)	19.01±29.35	-26.77±1.67**	≤0.001

Table 5: Vitamins 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (n = 100)

Variables	Means (intake)±SD
Vitamin A (IU)	325.1±928.9
B1 (mg)	0.84±2.9
B2 (mg)	1.28±4.03
B3 (mg)	9.47±36.6
B6 (mg)	0.88±7.19
B12 (mcg)	2.32±9.72
Vitamin C (mg)	88.08±628.9
Vitamin D (IU)	104.48±816.40
Vitamin E (IU)	0.94±1.20

Table 6: Macronutrient 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (boys/girls)

Variables	Boys	Girls	RDA
Calories (kcal)	2800.9±4338.8[ab]	3680.2±6697.5[a]	2200.0±0.0[b]
Protein (g)	106.6±124.4	232.1±720.8	42.9±7.7
Carbohydrate (g)	451.0±864.0[a]	435.1±667.1[ab]	130.0±0.0[b]
Fiber (g)	42.8±110.4	29.5±89.4	26.9±2.6
Sugar (g)	110.4±235.5[a]	129.1±251.8[a]	15.5±4.5[b]
Fat (g)	64.2±56.4[ab]	114.7±224.5[a]	44.0±8.1[b]
Saturated fat (g)	23.7±16.5[ab]	30.2±35.5[a]	15.5±4.5[b]
Omega 3 (g)	0.3±0.3[b]	0.5±1.2[b]	1.3±0.2[a]
Omega 6 (g)	1.9±1.3[b]	2.3±3.4[b]	13.3±2.2[a]

Superscript alphabets showed different significance levels

Table 7: Vitamins 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (boys/girls)

Variables	Boys	Girls	RDA
Vitamin A (IU)	353.7±628.4[b]	261.4±172.4[b]	722.0±147.5[a]
B1 (mg)	0.9±2.1	0.7±0.5	0.9±0.0
B2 (mg)	1.1±0.6	1.7±3.9	0.9±0.0
B3 (mg)	10.1±25.3	8.1±9.8	13.6±1.9
B6 (mg)	1.1±5.1	0.4±0.4	1.0±0.0
B12 (mcg)	2.6±6.6	1.6±1.2	2.1±0.3
Vitamin C (mg)	61.6±152.3	147.1±614.4	57.4±14.8
Vitamin D (IU)	123.5±570.8 [b]	62.5±37.2[b]	600.0±0.0[a]
Vitamin E (IU)	0.4±0.8 [b]	0.8±0.3[b]	12.7±1.9[a]
Folate (mcg)	250.1±997.6	117.1±61.3	400.0±0.0

Table 8: Minerals 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (boys/girls)

Variables	Boys	Girls	RDA
Calcium (mg)	114.6±2226.9	1506.4±3620.7	1300±0.0
Iron (mg)	14.9±42.3	17.6±51.7	10.7±2.6
Magnesium (mg)	145.4±417.4[b]	163.9±400.0[ab]	334.4±77.0[a]
Phosphors (mg)	883.2±1600.2	975.4±2391.2	1250.0±0.0
Potassium (mg)	2040.6±6639.6[b]	2502.0±6980.5[ab]	4500±0.0[a]
Sodium (mg)	6326.2±14486.7	6294.8±15883.5	2200±0.0
Zinc (mg)	5.3±8.8[b]	3.1±1.4[b]	9.2±1.5[a]
Copper (g)	0.9±3.5[b]	0.2±0.1[b]	779.8±94.7[a]
Manganese (mg)	1.2±3.8[ab]	0.5±0.3[b]	1.9±0.2[a]
Selenium (mg)	20.9±19.0[b]	14.6±7.0[b]	46.3±7.5[a]

Table 9: Macronutrient 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (different age group)

Variables	(8-12)	(13-18)	RDA
Calories (kcal)	3545.3±6014.5	2335.7±3391.6	2200±0.0
Protein (g)	177.8±524.8	94.9±87.3	42.9±7.7
Carbohydrate (g)	506.0±882.6[a]	352.5±665.7[ab]	130.0±0.0[b]
Fiber (g)	42.7±119.7	32.4±74.2	26.9±2.6
Sugar (g)	141.8±304.0[a]	76.2±29.1[ab]	15.5±4.5[b]
Fat (g)	91.6±166.8	61.5±49.4	44.0±8.1
Saturated fat (g)	27.5±29.8[a]	22.9±9.4[ab]	15.5±4.5[b]
Omega 3 (g)	0.4±0.9[b]	0.3±0.3[b]	1.3±0.2[a]
Omega 6 (g)	2.0±2.5[b]	2.1±1.4[b]	13.3±2.2[a]

Table 10: Vitamins 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (different age group)

Variables	(8-12)	(13-18)	RDA
Vitamin A (IU)	330.9±672.4[b]	315.9±144.3[b]	722±147.5[a]
B1 (mg)	0.9±2.0	0.8±1.3	0.9±0.0
B2 (mg)	1.4±2.9	1.1±0.5	0.9±0.0
B3 (mg)	10.3±27.0	8.1±8.3	13.6±2.0
B6 (mg)	1.1±5.3	0.6±1.3	1.0±0.0
B12 (mcg)	2.5±7.1	2.0±0.8	2.1±0.3
Vitamin C (mg)	113.5±463.9	48.3±35.4	57.4±14.8
Vitamin D (IU)	129.8±607.3[b]	65.2±36.3[b]	600±0.0[a]
Vitamin E (IU)	0.9±0.5[b]	1.0±0.9[b]	12.7±2.0[a]

Table 11: Minerals 3 days mean intakes and mean difference compared to the recommended daily allowance (RDA) (different age group)

Variables	(8-12)	(13-18)	RDA
Calcium (mg)	1498.5±3469.6	881.9±228.3	1300±0.0
Iron (mg)	18.3±54.4	11.8±24.6	10.7±2.6
Magnesium (mg)	167.8±481.4[b]	125.2±267.1[b]	334.4±77.0[a]
Phosphors (mg)	973.3±2163.2	815.6±1302.9	1250±0.0
Potassium (mg)	2751.4±8301.5	1295.5±2708.7	4500±0.0
Sodium (mg)	7267.2±16589.8	4829.5±11680.8	2200±0.0
Zinc (mg)	3.9±5.3[b]	5.7±9.9[b]	9.2±1.59[a]
Copper (g)	0.8±3.5[b]	0.6±1.8[b]	779.8±94.7[a]
Manganese (mg)	0.9±2.8	1.2±3.7	1.9±0.2

DISCUSSION

This study was done to assess the nutritional status of children with down syndrome based on anthropometric parameters and dietary intake, to establish baseline data about their nutritional status and to provide insight into their nutritional needs. To our knowledge studies focusing on the nutritional status of children with Down syndrome (DS) In Jordan, are scarce.

Normal weight rates were high in the study group, with 73% of the participants being normal and 21% overweight according to growth charts. Children are more likely to consume healthy foods[16] as they rely on food provision by their parents and opinion in food consumption is limited[17]. The low intakes of cholesterol and fat of the children could also be explained by the advocacy of a parental effort to limit food intake, a habit reported to occur in parents of children with DS[14].

Compared to the healthy population, participants affected by Down's syndrome are retarded in physical development and are characterized by greater abnormalities in both body mass and height. The common stunted growth or growth retardation in DS belongs to one of its clinical symptoms. In the conducted survey, in the case of girls and boys with clinically diagnosed DS, body height values often diverged from the value at the 50 percentiles of the centile chart. In the case of participants with DS, excessive body mass may be due to the frequently occurring hypothyroidism that induces retardation or disorders of metabolism[18].

There are no known nutritional requirements specific to Down syndrome. Eating a healthy and balanced diet is as important for people with Down syndrome as it is for all people. Health guidelines for individuals with Down syndrome recommended that total caloric intake should be below the recommended daily allowance for other children of similar height and age and that physical recreation activities should be established early. Importantly, individuals with Down syndrome still need as many nutrients as everyone else, which means that food choices are very important to maintain a delicate balance of nutritional requirements and weight management. It is important that all the calories consumed also contribute important nutrients, otherwise by limiting calorie intake there is a risk of deficiency of some important nutrients. The food guide pyramid is a good basis to guide food selection for a healthy diet[19].

In light of concern about macronutrient intake, study revealed that the overall daily protein, carbohydrate and total fat intake of Down syndrome participants were significantly higher than that of the RDA. An increase of fiber intake is needed for almost all of the subjects and in particular for Down syndrome as they are susceptible to constipation because of overall low tone followed by a lack of fiber and fluid in the diet[20].

Children with Down syndrome tended to excessively consume food. When interviewed, several parents complained about their children's non-stop eating habits before all of the food was eaten (especially snack eating). It triggered excessive energy, protein and carbohydrate intake in most children with Down syndrome.

Individuals with DS have significantly lower reported intakes of several micronutrients than RDA, levels that may put them at risk for vitamin or mineral deficiencies[21,22]. In the current study, vitamin and mineral intakes were lower overall in subjects with Down syndrome than in the RDA, except for vitamin B3, B12 and D. This finding may be related to the feeding difficulties in a patient with Down syndrome making them unable to consume adequately the fresh natural sources. While "Serum vitamin A levels have been reported to be below in individuals with Down syndrome" this is possibly due to malabsorption. For vitamin C, Down syndrome individuals significantly consumed more vitamin C than the recommended daily allowance, the same result was reported in a study on institutionalized children with Down syndrome[19]. However, some studies found that many children with Down syndrome had a deficiency of vitamin C according to serum tests which correlated to dietary intakes[20]. Consumption of calcium in our study was significantly unsafe among Down syndrome subjects. On the contrary, a small study found that children with Down syndrome tended to consume more calcium than the recommended daily allowance[21]. Zinc deficiency is one factor that may influence the growth and development of children with DS since this nutrient plays an important role in child development and growth. According to a study[22] zinc supplementation in children with mild deficiency increases appetite, growth velocity and GH, somatomedin and IGF-1 levels and improves immunity. the studied Down syndrome individuals were consuming adequate iron compared to the RDA. The daily folate intake of Down syndrome cases in our study was significantly lower than RDA. Children with Down syndrome often have below normal levels of folate. Erythrocyte macrocytosis is more common in children and adults with Down syndrome and may be due to an alteration of the folate remethylation pathway. As those with Down syndrome age, further declines in folate levels seem to occur[12]. It is important to note that, in the present study, nutrient intake was assessed through food diaries, a method that might not always be accurate[21].

CONCLUSION

In conclusion, in this study, the percentage of children with Down syndrome and overweight and obese nutritional status is alarming. In general, most children with Down syndrome tended to not consume the recommended energy, nutrients and fiber intake. Therefore, efforts to improve the condition must be made. Increased focus on nutritional measures is important for the health and wellbeing of children with Down syndrome. Specific clinical features of Down syndrome have nutritional relevance and need to be addressed systematically. Both low and excessive weight gain is a concern for many children with Down syndrome aged 4-5 years and above. This concern calls for early prevention to avoid later comorbidities. The switch between preventing the risk of undernutrition in the child's first year of life and obesity in later life is a challenge to treatment. A need exists for more research on nutritional aspects in the prevention and treatment of obesity in Down syndrome.

SIGNIFICANCE STATEMENT

This study will help the researchers to uncover the critical areas of down syndrome children that many researchers were not able to explore. Thus a new theory on their nutrients and obesity problems may be managed at the point of more research.

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