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The Prevailing Nutritional Problems among Children with Down Syndrome; Case-Control Study.

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Abstract

Down syndrome (DS) is the most common hereditary intellectual disability. This study aimed to determine the adequacy of nutrient intakes and DS children's most common food habits. This case-control study recruited 126 children aged 6 to 12 (42 with DS and 84 non-DS) from Menoufia and Gharbia governorates. Data about socioeconomic status and health history were collected. BMI was calculated using body weight and height measurements. Diet and eating habits were also investigated, and 24-hour food recalls for three days were used to determine nutrient intake. Results revealed that most of the studied children were from rural areas; most non-DS mothers had university degrees, while most DS mothers' children were illiterate. Obesity was found among 85.7% of DS and 28.6% of non-DS children. Cholesterol and LDLc levels were comparable in both groups. The IQs of non-DS exceeded 98, while those of DS fell below 52. Children with DS prefer fatty meats and chicken with skin over tea and spicy foods. Non-DS and DS groups met less than 80%, 70%, 90%, 20%, 60%, and 60% of caloric, carbohydrate, fat, fiber, calcium, and vitamin A requirements, respectively. The deficiency was prevalent in DS children. In conclusion, none of the DS children had a healthy weight and may have dyslipidemia. IQ scores of DS were in the middle of those of non-DS children. Children with DS ate more meals and preferred fatty meats and chicken with skin. Both groups' essential nutrients were deficient, but DS children were more likely to be affected.

Keywords: DS, Diet , Food Habits, IQ, Nutrient, LDH.

1. Introduction:

Down syndrome (DS), also known as trisomy 21, is a chromosomal abnormality that is the most common hereditary intellectual disability in humans, with a global frequency of one in every 1100 live births[1]. Children with Down syndrome have slanted eyes, thick lips, a large tongue, wide and small hands with short fingers, and a short and thick neck[2]. Many problems are linked to DS, including metabolic disorders, tissue dimorphism, internal organ abnormalities, cerebral difficulties, and phenotypic characteristics[3,4]. This phenomenon causes structural and functional Central Nervous System (CNS) disorders, cardiovascular defects, musculoskeletal system dysfunction, digestive system disorders, metabolic disorders, nutritional deficiencies, abnormal immune function, and endocrine disruption (hypothalamic-pituitary-thyroid axis), and intellectual disabilities[5]. Intellectual disability/mental retardation, early Alzheimer's disease start and the appearance of other phenotypic traits such as narrow slanted eyes, a flat nose, and short stature are all symptoms[6]. Thyroid problems, immunological disturbances, and growth abnormalities are some serious effects that may influence the health of people with DS[7]. Children with Down syndrome can have a considerable intellect or a modest mental handicap. Intelligent quotient (IQ) scores can range from 50 to 70 on a medium scale to 35 to 50 on a low scale[2].

Children with DS have a high rate of overweight and obesity [8,9]. Obese-DS had significantly higher waist circumference (WC), percent body fat, total fat mass, trunk/appendicular-fat mass ratio, triglycerides, insulin, and HOMA-IR values, and significantly lower HDLc values[10]. Furthermore, obese-DS had a greater prevalence of metabolic syndrome (MetS) and its components, which was evident at a younger age [10]. Triglyceride levels were significantly higher in DS patients, but blood HDL cholesterol, apo AI, and the HDL cholesterol/total cholesterol ratio were significantly lower[11].

Obesity and overweight can develop as a result of a lack of physical activity [12], which may be associated with poor physical fitness in children with DS due to associated musculoskeletal system abnormalities and muscular and osteoarticular system dysfunction [13,14,15]. Metabolic diseases, aberrant blood leptin levels, and comorbidities such as hypothyroidism are among the causes of this occurrence[13,16,17].

Numerous nutritional errors are produced in children with Down syndrome, resulting in nutritional problems [18]. According to existing evidence, children with DS prefer simple carbohydrate diets that are easier to chew and swallow. Their diet lacks fresh vegetables and fruit, resulting in a variety of dietary deficiencies — vitamins, minerals, and fiber [19, 20]. Saghazadeh et al [21] found some pieces of evidence that the elements Cu, Se, Zn, Ca, and Na had variable micronutrient status in patients with DS. Nutrient deficiencies in DS patients may be caused by amino acid imbalances and elevated parathyroid hormone (PTH) levels. Furthermore, there is a link between biomarkers and dietary intakes, particularly for vitamin C, potassium, and phytoestrogen-like foods [22]. Early dietary interventions by parents or guardians of DS children reduce the risk of or postpone the onset of various DS-associated disorders, improving their quality of life [7].

The risk factors for poor nutritional status in children with Down syndrome have not been thoroughly investigated, and research in this area in Egypt is limited; thus, the primary goal of this study was to evaluate the adequacy of diets of children with Down syndrome and define the major food habits of DS children. The risk factors of poor nutritional status in children with DS have not been comprehensively examined, and research in this area conducted in Egypt is scarce; therefore, the major objectives of this study was to (1) evaluate the adequacy of diets of children with Down syndrome and (2) define the major food habits of DS children.

2-Subjects and methods:

2.1 Subjects:

In this case-control study, Egyptian children with Down Syndrome (DS) (42 children, 24 boy and 18 girl) were chosen as cases and children without Down Syndrome (84 children, 48 boy and 36 girl) as controls. Children with Down syndrome were recruited from Egyptian medical facilities (Special centers for children with down syndrome) in the governorates of Menoufia and Gharbia. Non-DS children were also recruited from the same societies to be matched and similar.

The inclusion criteria were (1) age between 6 and 11 years, (2) males and females, (3) being born and residing in Egypt, (4) being diagnosed with down syndrome, and (5) consenting to participate and signing a consent form (Parents or guardian). Children with the following criteria were excluded from the study (1) DS without obesity, (2) serious diseases that may interfere with DS, (3) rigorous athletes, (4) girls who began menstruation, and (5) children who take medications that may interfere with DS measures, (6) hospitalized DS children, (7) children with severe down syndrome, and (8) disabled DS children.

2.2 Methods

2.2.1 Study Design

This retrospective, cross-sectional study recruited 42 children with Down syndrome (DS) as the cases group and 84 without down syndrome as the control group. The age of studied children ranged from 6 to 12 years, boys and girls, born and live in Egypt (Gharbia and Menoufia Governorates).

2.2.2 Data collection

2.2.2.1 Socioeconomic and health data

Age, residency, school grade, parents' education, parents' job, family size, room number, parents' familial relation, house sanitation, and monthly income were all collected using a particular form. In addition, data on disease history was gathered, such as the type of disease, the etiology of the disorder, blood type, surgery, parasitic infection, appetite, body weight status, and medication use.

2.2.2.2 Anthropometric and biochemical parameters

Bodyweight and height were measured using a stadiometer scale nearest 0.1 kg for weight and nearest 0.5 cm for height. In addition, BMI was calculated by dividing body weight (kg) by body height (m)2. A non-stretchable measuring tape was used to measure arm circumference (AC). Thickness skin fat (TSF) was measured at the point of meddle of arm by plastic caliber. AC and TSF were used to calculate the mussels of arm circumference according to formula AMC=AC-(TSF X 0.314). Anthropometric measures (i.e. body weight, body height, and BMI) were compared with standard measures for Egyptian children age 5-19 years given by El Shafie et al [23].

2.2.2.3 Food Habits and nutrients intakes

Special form were used for collecting data about food habits and dietary pattern of studied children, the data include meal number, skipped meals, fast foods, sweets, sugar, pickles, nut, caffeine containing drinks, fish and carbonated beverages. Nutrients intakes were determined using the 24 hr food recall, in which the respondents were asked to recall the food and drink items that were consumed in the last 24 hours (obtained for 3 different days, including one holiday).

Using the 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, macronutrients (carbohydrates, proteins and fat) and micronutrients (iron, calcium, zinc, phosphorous, vitamins A, B1, B2, and C).

2.2.2.4 Standards of Nutrients Intakes

The adequacy of intakes of energy and other nutrients was compared with standard dietary requirements. The requirements were as follows:

a. Energy (kcal/day) and macronutrients (g/day):

Calculated individually by equations (Harries Benedict Equations) given by the Institute of Medicine, Food and Nutrition Board [2002] [24]. Those equations were based on sex, age (yr.), physical activity, body weight (kg), and body height (m).

Protein (gram/day) calculated as 19 g for 4-8 years and 34 for 9 to 13 years [24]. Fat (gram/day) calculated as 25% of total energy for both non-DS and DS group [25] and carbs (gram/day) calculated by differences [24].

e. Minerals and vitamins

The requirements for minerals and vitamins were calculated by using the adequate intakes (AI) given in Dietary Refence Intakes [26].

2.2.3 Biochemical analysis

Blood samples were collected from all studied children and used for determination of total cholesterol (TC), high-density lipoprotein (HDL), triglycerides (TG), and lactate dehydrogenase (LDH). Moreover, very low-density lipoprotein (VLDLc), and low-density lipoprotein (LDLc) were calculated according to formula given by Lee and Nieman (1996) [27].

2.2.4 Intelligence quotient (IQ) Test

The IQ for children with DS and children without DS were carried out by professional psychologist using The Stanford-Binet and the Wechsler intelligence scale for children[28].

2.2.5 Data Analysis

The collected data were statistically analyzed using Statistical Package of Social Sciences (SPSS) ver. 23, and the outcomes have been presented in tabular form as frequency and percentage or mean ± SD. The study has targeted to evaluate the deficiencies and the reasons behind the nutrient deficiencies of down syndrome, which could easily be observed through descriptive statistics. The significant differences for numerical variables were calculated by one sample t-test.

2.2.6 Ethical considerations

Parents of Down syndrome children recruited in this study were agreed to participate voluntarily and were fully informed about the objectives and methods of the study. Consent was obtained from parents.

3. Results

Table 1 revealed that the majority of the non-DS and Down syndrome (DS) groups (61.9 %) lived in rural areas and that 100% of the DS group and 95.2 % of the non-DS children attended elementary school. Regarding mother education, the majority of non-DS children mothers (76.3%) had university certificates, whereas the majority of DS group mothers were illiterate, with a significant minority having preparatory certificates (47.6%, and 23.8%, respectively). In terms of fathers' occupation, the results revealed that most non-DS children fathers (57.1 %) were teachers, whereas most DS fathers were employees (57.1%). Similarly, the majority of non-DS children mothers worked as housewives, whereas the majority of DS group mothers worked (57.1% and 57.1% %, respectively). The majority of the non-DS and DS groups had 5 to 6 persons per family (47.6 %, and 61.9 %, respectively). As indicated, the non-DS children had three rooms (71.1%), while the majority of the DS group had two rooms (81.0%). The findings revealed that the majority of parents in the non-DS and DS groups were not relatives (52.4 %, and 61.9 %, respectively). While 100% of the non-DS children had healthy homes, most DS subjects had unhealthy homes (61.9%). In terms of income, it was obvious that the non-DS group's monthly income was much more than the DS group's (10714.3±6550.0 vs. 3047.6±1912.0 EGP, at P=0.000).

Table 1 : Frequency distribution of non-DS and DS subjects according to demographic data.

		Non-DS	DS	Chi^2 test	
		no (%)	no (%)	value	Sig
Residency	Rural	52(61.9%)	26(61.9%)	0.00	1.000
	Urban	32(38.1%)	16(38.1%)		
	Total	84(100.0%)	42 (100.0%)		
School grade	Primary	80(95.2%)	42(100.0%)	2.07	0.151
	Preparatory	4(4.8%)	0(0.0%)		
	Total	84(100.0%)	42 (100.0%)		
Mother education	Illiterate	0(0.0%)	20(47.6%)	81.84	0.000***
	Primary	0(0.0%)	2(4.8%)		
	Preparatory	8(9.5%)	10(23.8%)		
	Secondary	0(0.0%)	2(4.8%)		
	High institute	8(9.5%)	6(14.3%)		
	University	68(81.0%)	2(4.8%)		
	Total	84(100.0%)	42 (100.0%)		
Father job	Worker	0(0.0%)	24(57.1%)	65.23	0.000***
	Employee	8(9.5%)	4(9.5%)		
	Teacher	48(57.1%)	14(33.3%)		
	High job	28(33.3%)	0(0.0%)		
	Total	84(100.0%)	42 (100.0%)		
Mother job	Housewife	48(57.1%)	12(28.6%)	59.66	0.000***
	Worker	0(0.0%)	24(57.1%)		
	Employee	36(42.9%)	6(14.3%)		
	Total	84(100.0%)	42 (100.0%)		
Family size	<5 person	36(43.4%)	16(38.1%)	16.44	0.006**
	5–6 person	40(47.6%)	26(61.9%)		
	>6 person	8(9.5%)	0(0.0%)		
	Total	84(100.0%)	42 (100.0%)		
Rooms number	2 rooms	4(4.80%)	34(81.0%)	78.13	0.000***
	3 rooms	60(71.4%)	8(19.0%)		
	>3 rooms	20(23.9%)	0(0.0%)		

		Non-DS	DS	Chi^2 test	
		no (%)	no (%)	value	Sig
	Total	84(100.0%)	42 (100.0%)		
Parents relatives	No	44(52.4%)	26(61.9%)	1.03	0.310
	Yes	40(47.6%)	16(38.1%)		
	Total	84(100.0%)	42 (100.0%)		
Home sanitation	Healthy	84(100%)	16(38.1%)	65.52	0.000***
	Unhealthy	0(0.0%)	26(61.9%)		
	Total	84(100.0%)	42 (100.0%)		
		mean±SD	*mean±SD*	*t.value*	*Sig*
Income (EGP/month)		10714.3±6550.0	3047.6±1912.0	9.916	0.000***

*** P<0.01, and *** P<0.001. SD: Standard deviation.*

Table 2 showed that the majority of the non-DS children (95.2%) is disease-free, whereas the majority of the DS group had one or more disorders (81.0 %). Some respondents of the DS group only have cardiovascular disease (42.2 %), whereas others have both cardiovascular and gastrointestinal disorders (58.8 %). The majority of DS groups (57.1 %) use medications to manage other illnesses. In terms of sports, the majority of both non-DS and DS groups participate in sports (90.5 % , 85.7 % , respectively). The majority of the non-DS children (71.4 %) had blood type A, while 42.9 %, 33.3 %, and 23.8 % of the DS group had blood types A, AB+, and B, respectively. The most remarkable fact is that nobody has investigated children with blood type O. The same table 2 results demonstrate that modest percentages of non-DS and DS had surgery (14.3%, 23.8 %, respectively). Parasitic infection (hookworm) is extremely common in both the non-DS and DS groups (81.0 % , 90.5 % , respectively). No DS participants had lack of appetite, although a significant proportion of the non-DS children did (47.6 %). The majority of the non-DS children (47.6 %) lost body weight for various reasons, whereas no one in the DS group did. The majority of participants in either the non-DS or DS groups do not have food allergies (95.2 % , and 95.2 % , respectively).

Table 2 : Frequency distribution of non-DS and DS children according to health history.

		Non-DS	DS	Chi^2 test	
		no(%)	no(%)	value	Sig
Suffer from Diseases	None	80(95.2%)	8(19.0%)	77.17	0.000***
	CVD	0(0.0%)	14(33.3%)		
	Anemia	4(4.8%)	0(0.0%)	42.00	0.000***
	CVD & GI	0(0.0%)	20(47.6%)		

		Non-DS	DS	Chi^2 test	
		no(%)	no(%)	value	Sig
	Total	84(100.0%)	42 (100.0%)		
Medications use	No	80(95.2%)	18(42.9%)	44.45	0.000***
	Yes	4(4.8%)	24(57.1%)		
	Total	84(100.0%)	42 (100.0%)		
Practice sports	No	76(90.5%)	36(85.7%)	0.64	0.423
	Yes	8(9.5%)	6(14.3%)		
	Total	84(100.0%)	42 (100.0%)		
Blood groups	A	60(71.4%)	18(42.9%)	31.93	0.000***
	B	24(28.6%)	10(23.8%)		
	AB+	0(0.0%)	14(33.3%)		
	Total	84(100.0%)	42 (100.0%)		
Had surgery	No	68(81.0%)	30(71.4%)	7.78	0.051
	Yes	12914.3%)	10(23.8%)		
	Total	84(100.0%)	42 (100.0%)		
Had parasitic infection	Ascaris	16(19.0%)	4(9.5%)	1.90	0.168
	Hookworm	68(81.0%)	38(90.5%)		
	Total	84(100.0%)	42 (100.0%)		
Loss of appetite	No	44(52.4%)	42(100.0%)	29.30	0.000***
	Yes	40(47.6%)	0(0.0%)		
	Total	84(100.0%)	42 (100.0%)		
Suffer from weight loss	No	44(52.4%)	42(100.0%)	29.30	0.000***
	Yes	0(0.0%)	0(0.0%)		
	Total	84(100.0%)	42 (100.0%)		
Suffer from Food Allergy	No	80(95.2%)	40(95.2%)	0.000	1.000
	Yes	4(4.8%)	2(4.8%)		
	Total	84(100.0%)	42 (100.0%)		

**** P<0.001. SD: Standard deviation. CVD: Cardiovascular Diseases, GI: Gastrointestinal Diseases*

Table 3 showed that both the DS children and the non-DS children were approximately the same age (9.02±1.5 vs. 9.07±1.8 years, P=0.877). However, the body height of the non-DS children was significantly higher than that of the case group, measuring 133.9±12.3 cm vs. 120.0±11.0 cm, respectively, at P= 0.000. Although the non-DS group's body weight was lower than the DS group's, but statistical analysis revealed no significant differences between the two groups (38.0±10.0 vs. 39.6±13.4 kg, P= 0.480). Other anthropometric parameters in the DS group (such as BMI, arm circumference, TSF, and arm muscle circumference) were significantly higher (P=0.000) than the non-DS group, particularly BMI, which was 20.9±3.3 kg/m^2 in the non-DS children and 26.8±5.03 kg/m^2 in the DS group.

Table 3: Anthropometric indices (mean±SD) of non-DS and DS children

	Non-DS (n=84)	DS (n=42)	Independent sample t-test	
	mean±SD	mean±SD	value	Sig
Age (Year)	9.02±1.5	9.07±1.8	-0.155	0.877
Height (cm)	133.9±12.3	120.0±11.0	6.3.6	0.000***
Weight (kg)	38.0±10.0	39.6±13.4	-0.708	0.480
BMI (kg/m^2)	20.9±3.3	26.8±5.03	-7.847	0.000***
Arm circumference (cm)	22.8±3.98	28.8±4.2	-7.821	0.000***
TSF (mm)	22.42±3.95	28.47±4.32	-7.609	0.000***
Arm muscle circumference (cm)	15.76±3.0	19.86±3.14	-7.117	0.000***

**** P<0.001. SD: Standard deviation.*

After classifying children according to BMI, Table 4 revealed that none of the children with Down syndrome had normal body weight, whereas 38.1% of the children in the non-DS children had normal body weight. Statistical analysis revealed extremely significant differences between the two groups (P=0.000): 85.7% of DS children were obese, compared to 28.6% of children in the non-DS group.

Table 4: Distribution of non-DS and DS children according to BMI for-age z scores classification (based on age)[ref]

	Non-DS (n=84)	DS (n=42)	Chi^2 test	
	no(%)	no(%)	Value	sig
Normal (-2 to +1 SD)	32(38.1%)	0(0.0%)	15.6	0.000***
Overweight (+1 to +2 SD)	28(33.3%)	6(14.3%)		
Obese (>+2 SD)	24(28.6%)	36(85.7%)		
Total	84(100.0%)	42(100.0%)		

*[ref]: El Shafie et al (2019). *** P<0.001*

Table 5 demonstrated that the mean value of LDH in the DS group was significantly and tremendously higher than the comparable non-DS children (696.0±83.7 vs. 304.8±61.8, P=0.000). The same data, however, revealed no significant differences in total cholesterol and LDL concentrations between the non-DS and DS groups, which were 178.0±11.0 mg/dl and 110.8±8.2 mg/dL, respectively, for the non-DS children vs. 185.5±29.9 mg/dl and 111.7±24.0 mg/dL, respectively, for the DS group. However, the DS group had significantly higher triglyceride concentrations than the non-DS children (158.0±39.8

mg/dL vs. 80.4±18.3 mg/dL, respectively, at P=0.000). In contrast, HDL was considerably higher in the non-DS children than in the DS group (51.4±10.0 mg/dL vs. 42.1±7.3 mg/dL, P=0.000).

Table 5: Blood lipids and LDH parameters (mean±SD) of non-DS and DS children

	Non-Ds (n=84)	DS (n=42)	Independent sample t-test	
	mean±SD	mean±SD	value	Sig
LDH (U/L)	304.8±61.8	696.0±83.7	-21.5	0.000***
Total cholesterol (mg/dl)	178.0±11.0	185.5±29.9	-1.3	0.186
Triglycerides (mg/dl)	80.4±18.3	158.0±39.8	-10.4	0.000***
HDL (mg/dl)	51.4±10.0	42.1±7.4	4.2	0.000***
LDL (mg/dl)	110.8±8.2	111.7±24.0	-0.2	0.828

**** P<0.001, SD: Standard deviation. LDH: Lactate dehydrogenase, HDL: High density lipoprotein, LDL, Low density lipoprotein*

Table 6 showed that the four IQ measures (overall IQ, IQ Nonverbal, IQ Verbal, and IQ Battery) of the non-DS children were significantly higher (approximately two folds) than the corresponding values of DS children, representing 99.3±1.2, 99.0±0.0, 99.3±1.2, and 98.3±1.5 versus 44.3±3.6, 48.1±3.4, 45.8±1.1, and 51.9±2.7, respectively.

Table 6: Intelligent Quotient (IQ) (mean±SD) of non-DS and DS children

	Non-DS (n=84)	DS (n=42)	Independent sample t-test	
	mean±SD	mean±SD	value	Sig
IQ	99.3±1.2	44.3±3.6	40.0	0.000***
IQ Nonverbal	99.0±0.0	48.1±3.4	45.3	0.000***
IQ Verbal	99.3±1.2	45.8±1.1	72.7	0.000***
IQ Battery	98.3±1.5	51.9±2.7	27.6	0.000***

**** P<0.001, SD: Standard deviation*

Table 7 revealed that the majority of the non-DS children ate three meals per day (52.4%), while the majority of DS participants ate four meals per day (47.6 %). However, 85.7% of the children in the non-DS children and 81.0% of the children in the DS group ate breakfast daily. Concerning tea consumption, the results revealed that approximately two-thirds (67.2%) of DS children did not drink tea, whereas 61.9% of the non-DS children did (P=0.000). However, children with Down syndrome preferred tea with a low concentration, whereas the non-DS children preferred moderate or concentrated teas. It was evident that the proportion of DS children keen to drink water regularly was significantly (P=0.008) higher than that of the non-DS children (95.2% vs. 76.7%). The majority of the non-DS children (66.7%) consumed meats without fats regularly, but the majority of DS children (61.9%) preferred low-fat meats; chi2 analysis revealed statistically significant differences between the two groups (P=0.000).

Similarly, 90.5% of children with Down syndrome consumed chicken without the skin, compared to 71.4% of children in the non-DS group, and there were significant differences between the two groups (P=0.014). Regarding fried foods, the same proportion of non-DS and DS children consumed them (95.2 % vs. 95.2 %). Even though the statistical analysis revealed no significant differences between the two groups in terms of fish consumption, it was evident that all DS children ate fish and that 23.8 % ate it two times per week, whereas 90.5 % of the non-DS children ate fish and also 23.8 % of them consumed it twice per week (P=0.134). The most popular method for cooking fish was grilling, and tilapia fish was chosen over other varieties.

As for sugar consumption, among the non-DS group, the greatest number of teaspoons taken was three (61.9%), and no one took four; nevertheless, while 52.4% of DS children use three teaspoons (P=0.000), and about one-fourth of them use four teaspoons in their drinks. Nonetheless, the same proportion of non-DS and DS youngsters consume sweets (95.2 % vs. 95.2 %). Regarding pickles, all non-DS and 95,2% of DS children consume it. The results made it abundantly evident that DS youngsters did not appreciate spicy foods since 90.5% of them did not consume them, compared to 52.4% of the non-DS children (P=0.000). Similarly, 90.5% of children with Down syndrome did not consume nuts, compared to 38.1% of children in the non-DS children (P0.0001). As shown in Table 6, most non-DS and DS group participants consumed carbonated beverages (61.9% and 71.4%, respectively, P=0.290).

Table 7 : Frequency distribution of non-DS and DS children according to food habits.

		Non-DS (n=84)	DS (n=42)	Chi^2 test	
		no(%)	no(%)	Value	sig
Number of meals	Two	12(14.3%)	4(9.5%)	2.52	0.284
	Three	44(52.4%)	18(42.9%)		
	Four	28(33.3%)	20(47.6%)		
	Total	84(100.0%)	42(100.0%)		
Have break fast	no	12(14.3%)	8(19.0%)	0.48	0.490
	yes	72(85.7%)	34(81.0%)		
	Total	84(100.0%)	42(100.0%)		
Drink red tea	No	32(38.1%)	32(67.2%)	16.26	0.000***
	Yes	52(61.9%)	10(23.8%)		
	Total	84(100.0%)	42(100.0%)		

		Non-DS (n=84)	DS (n=42)	Chi^2 test	
		no(%)	no(%)	Value	sig
Drink water regularly	No	20(23.8%)	2(4.8%)	7.049	0.008**
	yes	64(76.2%)	40(95.2%)		
	Total	84(100.0%)	42(100.0%)		
Fat of meat	Without fat	56(66.7%)	14(33.3%)	39.89	0.000***
	Low fat	8(9.5%)	26(61.9%)		
	Full fat	20(23.8%)	2(4.8%)		
	Total	84(100.0%)	42(100.0%)		
Eat skin of poultry	Yes	24(28.6%)	4(9.5%)	5.878	0.015*
	No	60(71.4%)	38(90.5%)		
	Total	84(100.0%)	42(100.0%)		
Eat fried foods	no	4(4.8%)	2(4.8%)	0.000	1.000
	yes	80(95.2%)	40(95.2%)		
	Total	84(100.0%)	42(100.0%)		
Eat fish	None	8(9.5%)	0(0.0%)	4.364	0.113
	Yes	56(66.7%)	32(76.2%)		
	2times/week	20(23.8%)	10(23.8%)		
	Total	84(100.0%)	42(100.0%)		
Amounts of sugar (tsp)	One	4(4.8%)	0(0.0%)	23.28	0.000***
	Two	28(33.3%)	10(23.8%)		
	Three	52(61.9%)	22(52.4%)		
	Four	0(0.0%)	10(23.8%)		
	Total	84(100.0%)	42(100.0%)		
Eat sweets	No	4(4.8%)	2(4.8%)	0.000	1.000
	yes	80(95.2%)	40(95.2%)		
	Total	84(100.0%)	42(100.0%)		
Eat pickles	no	0(0.0%)	2(4.8%)	4.065	0.044*
	Yes	84(100.0%)	40(95.2%)		
	Total	84(100.0%)	42(100.0%)		
Eat spicy foods	No	44(52.4%)	38(90.5%)	17.88	0.000***
	Yes	40(47.6%)	4(9.5%)		
	Total	84(100.0%)	42(100.0%)		
Eat nuts	No	32(38.1%)	38(90.5%)	31.11	0.000***
	Yes	52(61.9%)	4(9.5%)		
	Total	84(100.0%)	42(100.0%)		

		Non-DS (n=84)	DS (n=42)	Chi² test	
		no(%)	no(%)	Value	sig
Drink carbonated beverages	No	32(38.1%)	12(28.6%)	1.12	0.290
	Yes	52(61.9%)	30(71.4%)		
	Total	84(100.0%)	42(100.0%)		

** P<0.05, ** P<0.01. and *** P<0.001, SD: Standard deviation*

The energy intake of the non-DS and DS groups was approximately identical, as shown in Table 8, with 1559.7±363.0 kcal/day vs. 1581.1±269.3 kcal/day. Compared to standard requirements, both groups satisfied fewer than 80.0% of their requirements; nonetheless, statistical analysis found no statistically significant differences between them. The non-DS children also consumes more animal protein, total protein, animal fat, and total fat than the DS group. The non-DS and DS groups met more than 200% of their protein requirements, but the non-DS children met 89.1% of their total fat requirements, compared to 79.4 % for the DS group. However, statistical analysis revealed that the non-DS children consumed significantly more animal protein and fat than the DS group. Although the DS group consumed more than the non-DS group, there were no significant differences between the two groups. Both failed to meet their carbohydrate requirements (59.9 % vs. 68.3 % for the non-DS and DS groups, respectively). The DS group, on the other hand, consumed significantly (P=0.048) more fiber than the non-DS group, but both groups fail to fulfill 20% of their fiber requirements.

Despite the fact that there were no significant differences in total iron intake between the two groups, and both the non-DS and DS groups met 99.6 % and 106.4 % of their requirements, respectively, the intake of animal iron in the non-DS children was significantly higher than in the DS group (P=0.001). Table 8 demonstrates that the zinc, phosphorus, thiamin, riboflavin, and vitamin C intakes of the non-DS and DS groups were nearly comparable and met the needs. On the contrary, the non-DS group's calcium and vitamin A intakes were significantly (P<0.05) higher than the DS group's; however, both groups failed to meet 60% of their calcium and vitamin A requirements.

Table 8: Macronutrients and micronutrients (minerals and vitamins) intakes of down syndrome children and non-DS group.

	Non-DS (n=84)	DS (n=42)	t-test	
	Mean±SD (%Std)	Mean±SD (%Std)	value	Sig
Energy (Kcal)	1559.7±363.0 (75.0%)	1581.1±269.3 (78.2%)	-0.22	0.831
Animal protein (g)	28.0±10.3	21.0±6.4	2.60	0.014*
Total protein (g)	57.1±13.5(215.9%)	54.7±9.8(216.2%)	0.63	0.532

	Non-DS (n=84)	DS (n=42)	t-test	
	Mean±SD (%Std)	Mean±SD (%Std)	value	Sig
Animal fat (g)	26.4±11.2	17.1±6.0	3.30	0.003**
Total Fat (g)	51.7±15.6(89.1%)	44.8±13.4(79.4%)	1.52	0.137
Carbohydrate (g)	216.6±52.4(59.9%)	239.7±43.4(68.3%)	-1.54	0.131
Fiber (g)	4.4±1.4(16.4%)	5.3±1.2(19.6%)	-2.04	0.048
Animal iron (mg)	2.6±1.1	1.7±0.4	3.77	0.001***
Total iron (mg)	8.6±2.6(99.6%)	9.4±2.4(106.7%)	-0.98	0.332
Zinc (mg/dl)	7.8±2.2(118.7%)	7.7±1.7(122.1%)	0.08	0.934
Calcium (mg)	508.4±126.2(43.4%)	427.0±126.4(37.6%)	2.06	0.046*
Phosphorus (mg)	748.0±174.5(92.4%)	746.0±158.5(99.1%)	0.04	0.970
Vitamin A (mcg)	280.7±115.2(55.5%)	215.0±77.4(45.6%)	2.14	0.040*
Thiamin (mg)	1.2±0.6(154.1%)	1.2±0.5(168.7%)	0.02	0.984
Riboflavin (mg)	1.3±0.6(171.6%)	1.1±0.5(160.5%)	1.15	0.258
Vitamin C (mg)	56.9±23.1(158.8%)	65.3±24.0(195.4%)	-1.13	0.264

** P<0.05, ** P<0.01. and *** P<0.001. SD: Standard deviation, % Std= Percentage of intakes from standard requirements.*

4. Discussion:

Most non-DS and DS groups were found to reside in rural areas, and both groups attended elementary school. Regarding mother education, most mothers in the non-DS children earned university degrees. In contrast, most mothers in the DS group were illiterate, with a significant minority having preparatory certificates. One study found a significant correlation between mothers' education and their children's health [29]. Lakshminarayana et al. [30] observed that DS was frequent among rural children born to uneducated women. It was suggested that an educational program be developed for women with limited educational backgrounds. In addition, the current study revealed that DS children had larger families than children without DS.

As demonstrated in the current study, some DS children experience cardiovascular illness. These findings concurred with those of Bello et al. [31], who found that DS subjects suffered from cardiovascular and gastrointestinal diseases in their study. Ram and Chinen [32] hypothesized that gastrointestinal problems in people with DS might be due to metabolic or nutritional variables, including zinc deficiency. In accordance with the present findings, two studies [33, 34] discovered that the prevalence of anemia in children with Down syndrome was higher than in other children. In accordance with our findings, Mehr et al. [35] found extensive parasitic infection in DS children.

As indicated, the body height of the non-DS children in this study was significantly higher than that of the DS group. This finding corresponded with that obtained by Samakandy et al. [36], who discovered that children with DS were shorter than non-DS siblings in Saudi Arabia. In addition, regardless of gender and in line with current findings, one study in Saudi Arabia [36] discovered a high prevalence of overweight and obesity in DS children. More recently, Chaudhary [37] found that obesity was prevalent among 51% of children with DS; moreover, one study [2] found that overweight and obesity were prevalent among 80% of DS subjects in their study.

One of the vital factors that contribute to the development of obesity in these children is their lifestyle choices and dietary habits [37-39]. Persons with DS have a lower resting metabolic rate of 10-15% than the general population, which further predisposes them to weight gain by Kuperminc [37]. Irish Nutrition and Dietetics Institution recommend that a sensible approach to eating and regular exercise will help to encourage a healthy lifestyle and prevent weight gain in childhood and later life.

The researchers [36] ascribed these findings to the mother's poor education level and low income, which drives households to rely on cheap sources of food, particularly carbohydrate-containing foods [40]. However, Niagara et al. [41] assessed the anthropometric indices, studied the association between them in Japanese children with DS, and discovered no difference in the frequency of obesity and overweight among boys and girls. Furthermore, other anthropometric measurements measured in the DS group (such as BMI, arm circumference, TSF, and arm muscle circumference) were significantly higher than in non-DS children, consistent with prior research [9,36]. Metabolic disorders, abnormal blood leptin levels, and comorbidities such as hypothyroidism are among the causes of overweight and obesity in people with Down syndrome [13,16,17].

Lactate dehydrogenase (LDH) is a cytoplasmic enzyme found in all human body cells. During aerobic glycolysis, this enzyme catalyzes the conversion of glucose to pyruvic acid. When the body experiences oxidative stress or damage, LDH may be released, raising its level in serum. This enzyme's extracellular leakage indicates cell damage or death [42]. Consequently, its increased concentration among DS children poses a health risk. The current study revealed that the concentration of LDH in the DS group was significantly higher than in the healthy group. A 1978 study conducted in Russia by Tamarkina et al. [43] and a 2011 study by Troca-Marin et al. [44] yielded the same results.

The results indicated that the total cholesterol and LDLc levels of children with and without DS were identical. Multiple studies, including recent ones [45], discovered that DS patients had elevated LDL and total cholesterol levels. Our subjects with Down syndrome were children, whereas the subjects in these studies were adults, so these discrepancies may be attributable to age. In our study, DS children had significantly lower HDLc levels and higher triglyceride levels. According to previous [12] and more recent [45] studies, individuals with DS had higher triglyceride values and lower HDLc concentrations than non-DS individuals. These findings suggest that DS children possess dyslipidemia, characterized by elevated triglyceride levels, decreased HDLc levels, and relatively normal LDLc levels [44,47]. A previous study [13] comparing 27 prepubertal children with Down syndrome to 31 unaffected siblings found that children with DS had a more dyslipidemic profile than their siblings.

The four IQ measures of children without DS were significantly (approximately twofold) higher than those with DS. People with Down syndrome may have significant cognitive impairments and typically have an intelligence quotient (IQ) between 30 and 70 [46,49]. The four IQ measurements of children with DS in this study ranged from 44,3 to 51,9, which falls within the range of previous studies [48,49], whereas the range for children without DS was greater than 98.

Regarding food habits, there was no significant difference between DS and non-DS children in most studied food habits (i.e., breakfast habits, fried foods, fish consumption, sugar consumption, sweets, pickles, and carbonated beverages). This could be because they share the same lifestyle and diet as other family members [50,51].

Most non-DS children in the current study ate three meals per day, while most DS children ate four. According to Wrzochal et al. [18], children with DS consumed an average of 4.86±0.45 meals daily. In addition, 78% of children with DS parents reported that their children ate five meals per day [52]. However, these results support the conclusion of Doğan et al. [2], who discovered that individuals with DS have positive habits regarding the number of daily meals consumed. Also, this trend of eating more meals may help in explaining the reasons for obesity among children with DS.

Approximately two-thirds of DS children in this study did not consume black tea, whereas the opposite was true for non-DS children. In agreement with these findings, Doğan et al. [2] found that only 5% of individuals with DS consume black tea, while the rest do not. In addition, Wrzochal et al. [18] discovered that the majority of children with DS drank water (44%) and fruit juices (36%), while a small percentage drank tea.

The results of this study demonstrated conclusively that children with Down syndrome dislike spicy foods. It may be due to the effects of spicy foods on DS patients. One study [53] found that individuals with Down syndrome experienced diarrhea and abdominal pain after consuming spicy foods.

About two-thirds of children without DS in this study consumed lean meats and chicken without skin. In contrast, approximately two-thirds of children with DS preferred fatty meats and chicken with skin. In accordance with the findings of some studies [2,18,53], DS patients preferred meat or chicken dishes. This study's preference for meats among DS children highlights that individuals with DS prefer foods of animal origin.

The non-DS and DS groups satisfied fewer than 80.0% of their requirements from calories. The non-DS children also consume more animal protein, total protein, animal fat, and total fat than the DS group. Statistical analysis revealed that the non-DS children consumed significantly more animal protein and fat than the DS group. Both groups need to fulfill 20% of their fiber requirements. The intake of animal iron in the non-DS children was significantly higher than in the DS group. The non-DS group's calcium and vitamin A intakes were significantly higher than the DS group's; however, both groups failed to meet 60% of their calcium and vitamin A requirements.

Concerning the amounts of calories and carbohydrates consumed, some studies' findings are at odds with this study. For instance, the findings of Wrzochal et al. [18], Chaudhary et al. [37], and Magenies et al. [54] showed that children with Down syndrome consume a significant amount of calories and carbohydrates. More recent investigations [54,55,56] found the same results as the current study: children with Down syndrome had high protein and fat consumption. These studies coincided with the findings of the current study.

Numerous investigations [54-59] concurred with the recently uncovered conclusions and discovered large calcium, fiber, and vitamin A deficiencies. However, the lack of certain essential nutrients, such as vitamin A, and the fact that blood vitamin A levels were lower in individuals with DS [57], may worsen their health status.5. Conclusion

DS children had higher BMIs and over 85% of DS children were obese. LDH and triglyceride levels were twice in DS children. TC and LDL serum levels were similar between groups. In this study, DS children had higher TG, decreased HDLc, and normal LDLc. Those with DS have aberrant IQs, around midway between those of children without DS. Most DS and non-DS children eat similarly. DS children ate more daily meals and preferred fatty meats and chicken with the skin. DS children disliked tea and spicy foods. Non-DS and DS children ate less than 80% of their calories. Non-DS children consume more protein, fat, and protein than DS children. Both groups are 20% deficient in fiber. Non-DS children eat more animal iron, calcium, and vitamin A. DS and non-DS children have a deficiency in certain vital nutrients, but it is more widespread in DS children and may have worsened their health.

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المشاكل التغذوية السائدة بين الأطفال ذوي متلازمة داون، دراسة مقارنة (عينة مختبرة – ضابطة).

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الملخص العربي

متلازمة داون هي الإعاقة الذهنية الوراثية الأكثر شيوعا. تهدف الدراسة الحالية إلى تحديد مدى كفاية المأخوذ من العناصر الغذائية والتعرف على العادات الغذائية الأكثر شيوعا بين الأطفال مرضى متلازمة داون. شملت هذه الدراسة 126 طفلا تراوحت أعمارهم بين 6 و12 عاما (42 مصابون و84 غير مصابون) من محافظتي المنوفية والغربية. تم جمع بيانات عن الحالة الاجتماعية والتاريخ الصحي. تم حساب مؤشر كتلة الجسم باستخدام قياسات وزن الجسم والطول. كما تم دراسة العادات الغذائية وتم استخدام طريقة استرجاع 24 ساعة لمدة ثلاثة أيام لتقدير المأخوذ من العناصر الغذائية. اسفرت النتائج عن أن معظم أطفال الدراسة كانوا من الريف ومعظم أمهات الأطفال الغير مصابون جامعيات ومعظم أمهات الاطفال المصابون أميات. انتشرت السمنة بين 85.7 ٪ من المصابين و28.6 ٪ من غير المصابون. تقاربت مستويات الكوليسترول والكوليسترول منخفض الكثافة في كلتا المجموعتين. تجاوزت معدلات الذكاء للأطفال غير المصابون 98 وانخفضت في الأطفال المصابون إلى أقل من 52. يفضل الأطفال المصابون اللحوم الدهنية والدجاج بالجلد ولا يفضلون الشاي والأطعمة الحارة. حصل الأطفال المصابون وغير المصابون على أقل من 80٪ و70٪ و90٪ و20٪ و60٪ و60٪ من احتياجاتهم من السعرات الحرارية والكربوهيدرات والدهون والألياف والكالسيوم وفيتامين (أ) على التوالي. وكان النقص سائدا في الأطفال المصابون بمتلازمة داون. الخلاصة، لم يكن وزن أي طفل من المصابين وزن صحي وقد يكون هؤلاء الأطفال مصابون بخلل في شحوم الدم. انخفضت درجات الذكاء بين المصابون الي نصف تلك الخاصة بالأطفال غير المصابون. تناول الأطفال المصابون عدد وجبات أكثر وكانوا يفضلون اللحوم الدهنية والدجاج بالجلد. حدث نقص في العناصر الغذائية الأساسية لكلتا المجموعتان، لكن النقص كان أكثر انتشارا بين الأطفال المصابين.

الكلمات المفتاحية: متلازمة داون، الحمية، العادات الغذائية، معامل الذكاء، العناصر الغذائية.