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Effect of Nutritional Status on Growth Pattern of Stunted Preschool Children in Egypt

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Abstract: Growth retardation is highly prevalent among children in low-income countries. Infections and inadequate food intake are well-established causes of growth retardation; however, the possible specific role of micronutrient deficiencies in the etiology of growth retardation and other developmental and health outcomes has gained attention recently. The aim of the present study was to provide information about nutritional status of stunted Egyptian preschool children and their dietary intake, which will help in designing a proper nutrition education massages &appropriate preventive strategies to improve linear growth. The study was designed as a case control study included (100) Egyptian children aged 2-<6 years old, with delayed linear growth, proportionate stunted, randomly selected from the stunted outpatient clinic of National Nutrition Institute (NNI) and results were compared to (50) age, sex and socioeconomic matching control. All participants were subjected to the baseline assessment (Full history- clinical examination- anthropometric measurements including weight & height- lab investigation including hemoglobin concentration, serum Ca, Zn, Vit. A, TSH, T4,T3 & albumin and stool analysis - dietary intake including" Twenty four-hour recall" method & food frequency questionnaire. Results showed that mean height for age Z score is significantly lower among the stunted compared to the control group. Dietary intake analysis showed that mean intake of all minerals is significantly lower among stunted children as compared to control group.% intake of RDA from Ca was 57.2% for stunted as compared to 101.7% for control. Nearly the same pattern was noticed for Mg.while intake of all macronutrients was significantly lower among stunted compared to the control group. Vitamin A intake of stunted group represented only 67.5% of RDA as compared to 214.0% of control group; the difference was highly significant between the two groups. All blood values of Albumin,TSH,T3,T4,Ca, Zn& Vit.A were significantly lower among stunted group as compared to control, although within normal range, according to cut off point of each parameter, while both groups were anaemic with no significant differences between the two groups. As a conclusion, It seemed that dietary intake deficiency of several micronutrients of stunted children (primarily Ca, Zn, Mg and vitamin A) & all macronutrients intake may play an important role in their linear growth retardation. Calcium intake level among stunted children was far below the recommended figures. Nutrition education messages encouraging high consumption of dairy products are needed to counteract this pattern of low calcium intake. Preventive strategies to prevent stunting and promote healthy eating & milk consumption are recommended.

Key words: Stunted growth · Body mass index (BMI) · Nutritional status

INTRODUCTION

Stunting is a major health problem worldwide affecting approximately 178 million children under the age of five [1]. While the etiology of stunting is complex, inadequate nutrition and infection are among factors thought to play major role in reducing the child's height-for-age [2]. As a manifestation of chronic under nutrition, stunting has been linked to multiple adverse health outcomes that extend beyond childhood into adult life [3].

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nadequate intake of dietary energy and protein and frequent infections are well-known causes of growth retardation [4-6]. However, the role of specific micronutrient deficiencies in the etiology of growth retardation has gained attention more recently [7-9]. Micronutrient deficiencies are highly prevalent in low-income countries and the most probable causes are low content in the diet and poor bioavailability. More than half of preschool children are anemic and an estimated 75 million and 140 million preschool children have clinical and subclinical vitamin A deficiencies, respectively [10]. Less information is available on the prevalence of zinc deficiency, although it has been estimated recently that about half of the world's population is at risk of inadequate intake of absorbable zinc [11].

Therefore, the aim of the present study was to provide information about the nutritional status of stunted Egyptian preschool children and their dietary intake, which will help in designing a proper nutrition education massages and appropriate preventive strategies to improve linear growth.

MARTERIALS AND METHODS

Case control study that included (100) stunted preschool children aged (2--<5years) attending the stunting outpatient clinic of National Nutrition Institute (NNI), Cairo during the period 6/2011 to 9/2011. All children were clinically free with no complaint apart from short stature. Fifty (50) matching children (with normal height for age) were included as a control group. After taking verbal consent from the parents, each of the studied cases as well as the controls was subjected to the following procedures:

Clinical History: It included socioeconomic status which was done according to El-Sherbeny and Fahmy [12], past history of breast feeding, family history of similar condition among siblings, previous diseases or operations, fractures, history of drug intake including inhaled or topical preparation; Parental heights and family history were reported;

Thorough Clinical Examination: For clinical evaluation of nutritional status was conducted by the medical doctor of the clinic; Anthropometric measurements were assessed according to the standard procedure [13]. Weight was measured using Platform Bath Scale. Height was measured using a Raven millimeter which is permanently fixed against the wall of the stunting clinic and was measured to the nearest 0.1 cm. Z score was calculated for height for age using the computer program ANTHRO [version 1.01 1990].

Laboratory Investigations: Blood samples Collected from fasting children between (9 and 10 a. m). Serum was rapidly separated by centrifugation (3000 rpm 10 min). Separated serum aliquots were removed and stored frozen at -70°C until analysis was done which included:

*Serum Zn, Cut off point 60-110 µg/dl [14].
*Serum Calcium: By Colorimetric determination using the kits from BioMerieux France. Cut off point 10-12 mg/dl [15].
* Serum TSH,T3,and T4: By using BIOSOURCE h-OST ELIZA kit manufactured by BioSource Europe S.A. Rue de I'Industrie, 8 B-1400 Nivelles Belgium. Cut off point of TSH= 0.4-7µlu/ml [16], Cut off point of T 3= 1.2-4.2 pg/ml [17] Cut off point of T4= 7-22 pg/ml [18].
*Serum vit. A: Cut off point < 36-120 µg/dl [19].
*Serum Albumin levels; Cut off point 3.8-5.1g/dl [20].
*Hb concentration: Cut off point 11-14gm/dl [21].
Stool analysis.

Food Intake: Using 24-hour dietary recall and food frequency methods.

24-Hour Dietary Recall: Data were recorded as grams consumed, the conversion of household measures to grams was achieved through use of prepared list of weight of commonly used household measures in Egypt developed by National Nutrition Institute. The energy and main nutrients-content of the 24 hour food intake was computed through the food composition tables of the NNI, 1993 [22]. The vitamin and mineral contents of food and beverages consumed were compared to the recommended nutrient intake based on the report of joint FAO/WHO Expert Consultation on human vitamin and mineral requirements, 2002 [23]. RDA of iron was based on its bioavailability according to the daily diet content of hem iron source in gm : Low bioavailability < 30 gm of hem iron source, Intermediate 30-90 gm of hem iron source and High bioavailability > 90 gm of hem iron source.

Food Frequency Method: This method was used to obtain qualitative descriptive information about usual food and consumption pattern for the children grope of food, including items about : Energy foods as : Cereals and its products, fats, tubers and sweets.

Tissue building foods as: Meat, chicken, fish, eggs, legumes, milk and its produces. Protective foods as: Vegetables and fruits.

Data Analysis: Data were analyzed in the data management and statistical unit of NNI using SPSS (version 5.0.1 Inc Chicago). Data for all variables were presented as means with their standard deviations; Comparison of means was made using unpaired student's t-test. P values of (<0.05) were considered significant.

RESULTS

The total number of enrolled children was (150), 100 (51% males & 49% females) stunted cases compared to 50 (58% males & 42% females) children as controls. Mean ages of the stunted and the control groups were (50.37±15.24 & 47.8±1.79) respectively.

Table (1) showed the socioeconomic characteristic among the studied children. Low social status was representing only 17 and 6% of stunted and control children respectively. As regard history of breast feeding, only 4 and 2% of stunted and control children respectively were not breast fed at all with significant difference between the two groups (p= 0.015).

The results also indicated that 92.7% of stunted boys & 92% of stunted girls showed delayed bone age determined by X ray.

Table (2) showed that the mean height of the stunted boys & girls was (91±8.2 &90.05±7.3 cm) compared to (98.7±7.13 &101.68±9.4 cm) for the control group with highly significant difference between the two groups (p=0.000). To assess the nutritional status of children, Height/Age (Z score was used) WHO 2006 [24].

Mean height for age Z score among the studied stunted males and females children was (-1.76±1.77 and-1.71± 1.81). While mean height for age among the studied control children was (-0.67±0.98 and -0.2±o.96) respectively.

The mean intake of all minerals was significantly lower among stunted children as compared to control group.% intake of RDA from Ca was 57.2% for stunted as compared to 101.7% for control. Nearly the same pattern was noticed for Mg. Otherwise % intake of RDA from other minerals exceeded 100% among both groups except for Zn & Selenium which were 94.15 & 94.3% respectively among the stunted group only (Table 3).

As regard vitamins intake, Table (4) showed that all mean values of vitamins intake were significantly lower among stunted group as compared to control. Most of %

Table 1: Percentage distribution of socio economic characteristics among the studied children

	Case N=100				Control N=50			
	Mother		Father		Mother		Father	
Socio economic characteristics	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Education :-								
Illiterate	6	(6%)	7	7%	2	4%	0	0%
literate	13	13%	8	8%	3	6%	4	8%
Preparatory	18	18%	14	14%	5	10%	1	2%
Secondary	36	36%	44	44%	19	38%	24	48%
Vocational education	7	7%	7	7%	3	6%	4	8%
University	19	19%	20	20%	18	36%	17	34%
Post graduate	1	1%	0	0%	0	0%	0	0%
Occupation:-								
No Occupation	87	87%	1	1%	40	80%	0	0%
Unskilled worker	0	0%	37	37%	1	2%	12	24%
Skilled worker	0	0%	12	12%	0	0%	6	12%
Semi profession	12	12%	36	36%	8	16%	23	46%
Profession	1	1%	14	14%	1	2%	9	18%
Money spent for food:-								
< 50%	42		42%		7		14%	
50 % → <75%	56		56%		40		80%	
>75%	2		2%		3		6%	
*Social Status:-								
Low	17		17%		3		6%	
Middle	67		67%		35		70%	
High	16		16%		12		24%	

Table 2: Mean anthropometric measures of the studied children by sex

Sex	Anthropometric measurements	Case --------------- Mean ± S.D	Control ---------------- Mean ± S.D	P
Boys	Height	91.9±8.2	98.7±7.13	0 .000***
	Height/ age z-score	-1.76±1.77	-0.67±0.98	0 .000***
	Weight/ height z-score	-0.05±1.25	-0.77±1.16	0 .005**
Girls	Height	90.05±7.3	101.68±9.4	0 .000***
	Height/ age z-score	-1.71±1.81	-0.2±0.96	0 .000***
	Weight/ height z-score	-0.19±1.18	-0.99±2.79	0 .005**

*p = < 0.05 **p = <0.01 ***p= <0.001 NS = Not Significant

Table 3: Mean and % intake of minerals in relation to RDA of the studied children

Variables	Case ---------------- mean± SD	Control --------------- mean± SD	P
Mean Calcium (mg) intake	314.6±145.3	559.10±256	0.000***
RDA for Ca.(mg/d)	500-600		
%intake from RDA	57.2↓	101.7↑	
Mean Total Iron (mg) intake	9.08±3.6	7.87±3.28	0.04*
RDA for Iron (mg/d)	6		
%intake from RDA	131.2↑	121.3↑	
Mean Total Zinc (mg) intake	4.71±1.74	5.94±2.62	0.001**
RDA for zinc(mg/d)	4.1-5.1		
%intake from RDA	94.15↓	118.72↑	
Mean Copper (mcg) intake	535.7±227.7	611.5±276.3	0.08(NS)
RDA for Cu. (mcg/d)	340-440		
%intake from RDA	137.4↑	156.8↑	
Mean Selenium (mcg) intake	23.57±7.9	30.5±13.2	0.000***
RDA for Se.(mcg/d)	20-30		
%intake from RDA	94.3↓	121.9↑	
Mean Iodine (μg) intake	114.82±44.51	168.37±93.75	0.000***
RDA for Iodine (μg/d)	75-110		
%intake from RDA	127.58↑	187.08↑	
Mean Phosphorus (mg) intake	489.3±147.2	659.6±233.8	0.000***
RDA for P. (mg/d)	460-500		
%intake from RDA	102↑	137.4↑	
Mean Magnesium (mg) intake	58.9±20.4	102.3±36.7	0.000***
RDA for Mg. (mg/d)	60-75		
%intake from RDI	78.7↓	153.8↑	

Recommended Dietary allowance (RDA) Deficiency ↓ Surplus ↑

Table 4: Mean and percentage of some vitamins intake in relation to RDA of the studied children

Variables	Case --------------- mean± SD	Control --------------- mean± SD	P
Mean Thiamine (mg) intake	0.61±0.25	0.66(±0.25	0.27(NS)
RDA for Thiamine (mg/day)	0.5-0.6		
%intake from RDA	111.7↑	120.4↑	
Mean Riboflavin (mg)intake	1.1±0.79	1.5±0.8	0.009**
RDA for Riboflavin(mg/day)	0.5-0.6		
%intake from RDA	201.5↑	267↑	
Mean Niacin (mg)intake	6.8±2.8	9.0±4.1	0.000***
RDA for Niacin (mg/day)	6-8		
%intake from RDA	97↓	129↑	
Mean Vitamin C (mg) intake	59±67.9	91.3±87.5	0.04*
RDA for Vitamin C (mg/day)	30		
%intake from RDA	196.8↑	291.5↑	
Mean Vitamin A (μg) intake	286.8± 129.9	913.48± 718.9	0.000***
RDA for Vitamin A (μg/d)	400-450		
%intake from RDA	67.5↓	214.0↑	

Source : RDA for Ca, Mg, Zn, FeIodine and Vitamins) [23]

RDA for Cu, P, Se, Carbohydrates and fat)[25]

Table 5: Mean and percentage of macronutrients intake in relation to RDA of the children studied sample

Variables	Case mean± SD	Control mean± SD	P
Mean Energy (Kcal) intake	927.35±276.5)	1265.4±332.8	0.000***
RDA for Energy (Kcal/d)	1047-1467		
% intake from RDA	74.19↓	101.2↑	
Mean Total protein (g) intake	36.03±10.83	47.01±16.51	0.000***
RDA for protein (g/day)	13- 37		
% intake from RDA	96.09↓	125.37↑	
Mean Total fat (g) intake	25.04±10.43	38.09±18.84	0.000***
RDA for fat (g/day)	30		
% intake from RDA	83.48↓	126.97↑	
Mean Carbohydrates (g) intake	114.0±11.3	144.38±54.75	0.000***
RDA for Carbohydrates (g/d)	130		
% intake from RDA	87.7↓	111.1↑	

Source: RDA for energy(FAO/WHO/ UNU)[26]

RDA for protein (Anderson [27]

Table 6: Mean (±SD) of some Lab parameters among the studied children

Age	Parameters	Cut Of Point	Case mean±SD	Control mean±SD	*P
2 → < 6	Hb	11→14g/dl	9.90±0.82	10.24±0.61	0.101(NS)
	Albumin	3.8→5.1g/dl	4.27±.0.43	5±0.32	0.0002 ***
	TSH	0.4→7µlu/ml	2.36±0.77	2.79±0.64	0.003**
	T3	1.2→4.2pg/ml	3.03±1.01	4.07±1.39	0.0003***
	T4	7→22pg/ml	4.17±1.89	5.22±1.14	0.0003***
	Ca.	10→12mg/dl	8.49±1.84	9.66±1.26	0.0008**
	Zn	60→110µg/dl	94.11±32.77	140.83±58.17	0.0009**
	Vit. A	36→120µg/dl	43.71±17.99	63.45±11.94	0.003**

intake of RDA from vitamins among both groups exceeded 100% except for vitamin A intake of stunted group which represented only 67.5% of RDA as compared to 214.0% of control group; the difference was highly significant between the two groups.

Table (5) showed that, there is a significant decrease in mean intake of macronutrients among stunted group as compared to control and their % intake of RDA from energy(Kcal/day), protein(g/day), fat(g/day) & CHO (g/d)were less than100%(74.1, 96.09,83.48 & 87.7%) respectively.

For Lab parameters, all blood values of albumin, TSH, T3, T4, Ca, Zn & Vit. A were significantly lower among stunted group as compared to control, although within normal range, according to cut off point of each parameter, while both groups were anaemic with no significant differences between the two groups (Table 6).

Stool analysis also indicated parasitic infestation & presence of indigestive food in nearly half of the children from both groups.

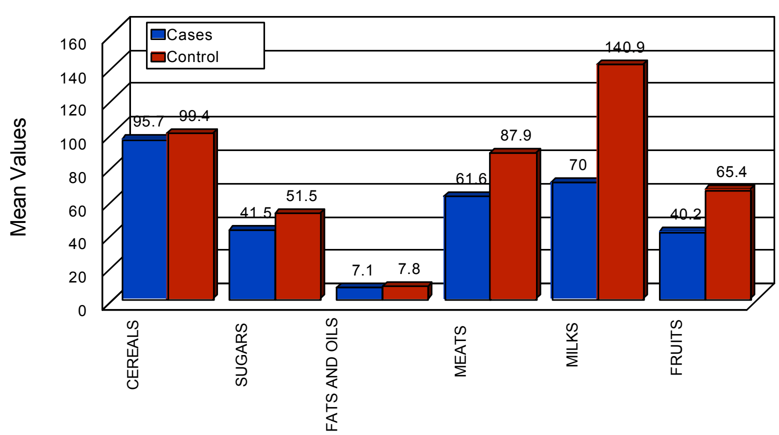

Fig. 1: Mean food frequency pattern from different types of food among the studied children

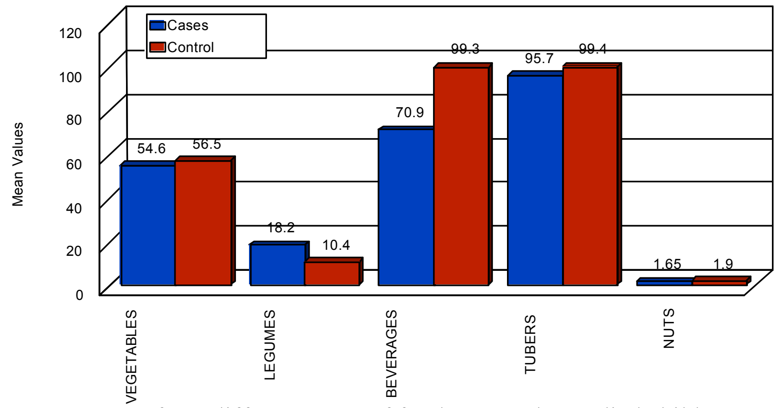

Fig. 2: Mean food frequency pattern from different types of food among the studied children

DISCUSSION

Nutritional status is a primary determinant of a child's health and well-being. The 2008 EDHS [28] found that 29 percent of Egyptian children age 0-4 years shows evidence of chronic malnutrition or stunting. A comparison of the results with the 2005 EDHS [29] Suggested that children's nutritional status deteriorate during the period between the two surveys. For example, the stunting level increased by 26 percent between the surveys.

The height-for-age index provides an indicator of linear growth. Children whose height-for-age measures are below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age, or stunted [30].

The weight-for-height index measures body mass in relation to body length. Children whose weight-for-height measures are below minus two standard deviations (-2 SD) from the median of the reference population are too thin for their height, or wasted [30]. The present study showed that height-for-age and the weight/height for stunted children are significantly low compared to the control group.

The previous data of nutritional assessments (of the control group) clearly reflected the situation of nutrition transition in which both under-nutrition and over-nutrition problems are prevalent in the same community. In fact dietary intake data among those children was a unique situation in which multiple deficiencies (like anemia) existed together with excessive energy, protein, fat & CHO intake and this may reflect the very poor quality of their diet.

A growing number of studies in the third world population indicate an emergence of obesity and or degenerative diseases as a long-term outcome of malnutrition that resulted in stunted growth [31].

This study highlighted the micronutrients and macronutrients consumption among stunted children. Calcium was the lowest minerals intake in relation to % RDA among stunted 57.2% compared to 101.7% for the control, followed by magnesium (78.7%), zinc (94.15%) and selenium (94.3%), while cupper, iron, iodine and phosphorus intakes were higher than % RDA. Also the studied stunting group had low intake of vitamins A & Niacin compared to % RDA (67.5 & 97% respectively), while the intake of Thiamine, Riboflavin and vitamin C were higher than % RDA. These results are in agreement with many studies from different countries [32].

Along with established risk factors such as frequent infection and poor weaning foods, there is a strong evidence that several micronutrients (primarily zinc, iron and vitamin A) played important roles in linear growth and deficiencies in these key nutrients may result in stunting [33]. Zinc directly influences the growth hormone and insulin-like growth factor-I systems [34], affects bone metabolism [35] and is involved in DNA synthesis [36, 37]. Zinc and vitamin A affect immune function [38-40] and thus risk of morbidity and associated growth faltering. And, zinc and iron deficiencies can result in anorexia, leading to decreased intakes of all nutrients, which can also limit growth [41, 42].

The results showed that the mean hemoglobin level is low among the stunted group (9.90±0.82), although the mean albumin, TSH, T3, T4, zinc and vitamin A are within normal levels among stunted children, they were significantly less than the control group. The mean low serum level of calcium was more apparent among the stunted children with significant difference (8.49±1.84 & 9.66±1.26mg/dl respectively).It is firmly established that high calcium intakes promote bone health; the calcium in the skeleton acts as a reserve supply of calcium to meet the body's metabolic needs in states of calcium deficiency, calcium deficiency in turn can be easily induced by deficient intake [43]. Calcium intake in this study was very low among stunted as compared to control (314 ±145.3 and 559±256 mg/day children respectively, denoting more compromised calcium bioavailability.

Mean fat intake was significantly ($P<0.05$) lower among stunted children compared to the control. In addition to its function in absorption and transport of fat soluble vitamins, (some of which are very essential for bone health), fat contains essential fatty acids which are required for normal growth [44].

Mean protein intake was significantly ($P<0.05$) lower among stunted children compared to the control. The quantity and nutritional quality of dietary protein are well known to affect plasma levels of insulin like growth factor I (IGF-I){the mediator of growth hormone} greatly, also the bone matrix proteins and growth factors, which play important roles in bone formation, are affected by dietary proteins [45].

Mean vitamin A intake was highly significantly lower ($P<0.000$) among stunted group than control group (286.8±129.9 & 913±718.9 ìg/day respectively). Stunted group had mean intake far below the recent recommendations. Vitamin A is known to play a role in cellular differentiation, organ growth and perhaps in multiplication and differentiation of cells at growth plates of long bones [46]. There is evidence that intake of this micronutrient is associated with levels of nocturnal growth hormone secretion [47] and new researchers found that vitamin A deficiency reduces serum concentration of IGF-I through gene nutrient interaction and this may explain the growth retardation among stunted group with reduced vitamin A intake.

CONCLUSION

Among the studied Egyptian children, stunted children suffered from more negative impacts, that have profound effects on development of linear growth. It seemed that dietary intake deficiency of several micronutrients of stunted children (primarily Ca, Zn, Mg and vitamin A) & all macronutrients play important roles in their linear growth retardation. Calcium intake level among stunted children was far below the recommended figures. Nutrition education messages encouraging high consumption of dairy products are needed to counteract this pattern of low calcium intake. Preventive strategies to prevent stunting and promote healthy eating and milk consumption are recommended.

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