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Dietary Quality and malnutrition (Stunting) in preschooler

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Abstract

In communities of the poorest countries the children sufferer of malnutrition that is rapidly emerging. Inadequate dietary intake and disease may cause of malnutrition. This study amid to give knowledge about diet quality of stunted some Egyptian preschool children and designing a proper nutrition education massages and suitable prophylactic program to improve linear growth. The study was purposed as included (30) preschooler aged 2 ≤ 6 years old, with delayed linear growth, randomly selected from the stunted outpatient clinic of National Nutrition Institute (NNI) and (30) healthy case in the same age and sex as a control group. All participants were subjected to the baseline assessment (dietary intake including “Twenty four-hour recall “method; anthropometric measurements including ‘weight and height’; lab investigation including hemoglobin, serum Ca, Vit D, Vit A, TSH, T4, T3, concentration. 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 macronutrients and micronutrients was significantly lower among stunted; the difference was highly significant between the two groups.

All blood values of TSH, T3,T4,Ca, &Vit A were significantly lower among stunted group as compared to normal group. Conclusion, it seemed that dietary intake deficiency of several nutrients of stunted children intake may play an important role in their linear growth retardation. Preventive strategies to protective stunting and promote healthy eating consumption are recommended.

Introduction

Dietary patterns that consider the overall eating habits, rather than focusing on individual foods or simple counts of consumed foods, better helps to understand the combined effects of dietary components ***(Melaku et al., 2018).*** Although there are well-established methods, collation and analysis of dietary data have remained challenging in low-income countries (LICs) for various reasons, including high costs, lack of centralized platforms for dietary data, little investment in research, low capacity and technical complexity ***(Coates et al., 2017).*** As a result, dietary assessment is mainly dependent on approaches which require low cost and provide low quality. Dietary diversity assessment has remained the most used method of data collection, analysis, and interpretation approach in LICs. Dietary diversity scores (DDSs) of households, women, and children ***(WHO, 2008;and FAO, 2016)*** are important tools and the most used indicators of assessing the adequacy of nutrient intake. In many studies, it has been also demonstrated that DDSs were useful indicators of micronutrient status ***(Moursi et al., 2008)*** and a higher DDS is associated with a lower risk of stunting. Stunting (inadequate length/height for age) indicates early chronic exposure to undernutrition; is a composite indicator that includes elements of stunting ***(Victora et al., 2010).***

Tanner, (1992) identified growth as a 'mirror of the conditions of society', especially the 'nutritional and hygienic status' of the population. Stunting describe a height-for-age (HA)≥2 SD below the median of the relevant standard ***(Leroy et al., 2014).*** Poor growth in children is currently defined as inadequate height, weight, and weight for height, in relation to growth standards, currently those defined by the ***(WHO, 2006).***The growth potential of an individual in height and overall shape, mainly a function of bone growth, is genetically determined and each individual will follow a growth curve canalized in terms of both extent and time course if conditions are favorable***(Tanner, 1979).***

Although the global burden of stunting decreased between 1990 and 2015 by more than 25%, it has continued to be a major nutrition-related risk factor causing 257 deaths per 100,000 globally ***(Forouzanfar et al., 2015).*** Therefore, this study aimed to use dietary patterns, as an alternative method to dietary diversity scores (DDSs) and investigate their associations with preschool stunting in Egypt **.**

Subjects and methods

This is a cross-sectional comparative study, carried out on 60 preschool children aged (2 ≤ 6 years) attending outpatient clinic of National Nutrition Institute (NNI), Cairo during the period January 2019 to July 2019. Children were divided into two groups: Group I (stunted group): This group comprised 30 patients stunting which was documented by height for age and Group II (control group): This group (30 healthy children) matched age and sex with the group I. After taking verbal consent from the parents, each of the studied cases as well as the controls were subjected to the following procedures.

Dietary Intake: the study participants were assessed by means of two quantitative nonconsecutive 24-hour dietary recalls (one for a weekday and the other for a weekend). Subjects were usually interviewed, along with their parents by a face-to face method. The subjects and their parents were asked to recall all foods and beverages they consumed during the preceding 24-hours. 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 nutrient values were derived from standard reference tables. The energy and main nutrients content of the 24-hour food intake was computed through the food composition tables of the national nutrition institute ***(NNI, 2006).*** The vitamin and mineral contents of food and beverages consumed were compared to the recommended nutrient intake based on the report of jointExpert Consultation on human vitamin and mineral requirements .

Anthropometric measures are measured according to standardized methods of the World Health Organization ***(WHO, 1995).*** Measurements taken included: The Childs weight, length or height, and their Z-score. Z-score (or SD-score) = (observed value – median value of the reference population) / standard deviation value of reference population. Z score was calculated of height for age using the computer program ANTHRO [version 1.01 1990]. Measurement of weight: The body weight was measured using the Platform scale ***(Ghalli et al., 2002).***Measurement of height or length: The height was measured to the nearest centimeter, row data were entered separately to the WHO Growth charts for age and sex ***(Ghalli et al., 2002).***

Laboratory investigations:

Blood samples: Collected from fasting children between (9 and 10 a. m). Serum was separated by centrifugation (3000 rpm 10 min) and were stored frozen at -70º C until analysis was done. Serum Zinc was measured by the colorimetric method, (Crest Biosystems) according to ***(Makino, 1991).*** Serum Calcium: By Colorimetric determination using the kits from bioMerieux France ***(Kaplan, and Pesce, 1996).*** Serum TSH,T3, T4: By immunometric assay using ELIZA kit manufactured by BioSource Europe Belgium. TSH ***(Fisher, 1996),*** T 3 according to ***(Wild,1994)*** and T4***(McComb et al.,1979).*** Serum vit. A: By ***(Bieri et al., 1979).*** Hemoglobin in whole blood concentration: by ***(Drabkin, 1949).***

Statistical data analysis: Data were analyzed by using SPSS (version 16). 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 were identified by ***(Artimage and Berry 1987).***

Results and discussion

Table (1) indicated that there are low significant of growth ideal, weight, height, BMI, Zscore, and percentile between two groups (normal and stunting). Z-score of stunting groups was (-3.2) less than -2SD while normal group was (1.4) in normal range (– 2 to + 2 SD) ***(WHO,1995).*** Stunting described a height-for-age (HA) ≥2 SD below the median of the relevant standard with severe stunting or wasting at ≥3 SD below the standards ***(Leroy et al., 2014).*** The stunting group lower than 5thpercentile but control group was in healthy weight ***(Shypailo 2020).*** In practice, HA Z-score or WH Z-score are calculated: the differences between the observed values and the growth standards as a fraction or multiple of the SD of the mean values of the standards. Because this SD increases with age, the absolute HA difference (cm) has been suggested to be more appropriate in terms of identifying the time course of stunting andappropriate periods for intervention **.** Thus, the levelling off the HA Z-score deficit seen after 24 months in multiregional analyses of stunting up to 5 years is not seen if HA difference deficits are examined ***(Leroy et al., 2014).***Body Mass Index (BMI) in the same tablewas higher in control group than stunting group. Body

Mass Index (BMI) is used as a screening tool to identify possible weight problems in children. BMI is calculated from a person's weight and height.This calculator can help to determine whether a child is at a healthy weight for his/her height, age, and gender. The amounts of body fat, muscle, and bone change with age, and differ between boys and girls. This BMI-calculator automatically adjusts for differences in height, age, and gender, making it is one of the best tools for evaluating a growing child's weight ***(Shypailo 2020).***

Figure (1) showed that stunting group consumed 46%protein, 56% carbohydrate and 60% fat from RDI ***(WHO,2014)*** versus 62% protein, 97% carbohydrate and 91% fat of control/normal group. A protein-stat model of growth control accounts for the accumulation of proteincontaining structures, in which dietary protein provides key regulatory and permissive (substrate) roles.

Within this model, the overall metabolic demand for amino acids for lean tissue growth is linked to dietary intake through an aminostatic appetite mechanism which enables protein intake to meet the demand. Regulation of the demand involves a mechanism in which amino acid intake exerts a largely endocrine-mediated anabolic drive on the growth plate of the long bones which in turn, through passive stretching, activates growth of associated muscles at the level of muscleconnective tissue synthesis and myofibrillar protein deposition. This ensures that skeletal muscle growth occurs at a rate and time course which ensures sufficient muscle mass and strength to allow development of body function with increasing bone

length and associated height, and theprotein deposition in muscle signals increases in appetite ***(Millward1995).***The quantity and nutritional quality of dietary protein, its ability to stimulate the secretion of insulin-like growth factor I (IGF-I){the mediator of growth hormone}, a hormone that stimulates bone and tissue growth ***(Dror and Allen, 2011).*** There was substantial emphasis on protein deficiency as one of the main causes of undernutrition in low income countries ***(Semba, 2016).*** In recent years, however, biological research has argued that the essential amino acids in animal-sourced foods(ASFs) – “essential” because they cannot be synthesized from scratch within the human body – act as catalysts that regulate cellular processes such as growth and differentiation (anabolic processes), including bone and skeletal muscle growth ***(Semba 2016).***

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 ***(Jones and Kubow, 1999).*** Carbohydrate consumed by children stunting was (56%) from RDI compare healthy children (97%). Low percent of carbohydrate associated with reduced height status.

The finding in Figure (2) indicated that the studied stunting group had low intake of vitamins A & D compared to % RDA (59% & 52% respectively). Mean vitamin A intake was highly significantly lower (P<0.000) among stunted than control group (235.2& 337.0 µg/day respectively). Stunted group had mean intake far below the recent recommendations (59%). Vitamin A is known to play role in cellular differentiation, organ growth and perhaps in multiplication and differentiation of cells at growth plates of long bones ***(Melton, 1994).*** Vitamin A affect immune function ***(Black and Sazawal, 2001),*** and thus risk of morbidity and associated growth faltering.Vitamin D participates with parathyroid hormone (PTH) in a functional paracrine feedback loop in the growth plate between 1,25(OH)2D and PTH-related protein (PTHrP). Thus 1,25(OH)2D decreases PTHrP production, while PTHrP increases chondrocyte sensitivity to

1,25(OH)2D by increasing vitamin D receptor production ***(Bach et al., 2014).***

This study highlighted the micronutrients and macronutrients consumption among stunted children. Statistical data in figure (3) showed that the calcium was the lowest minerals intake in relation to % RDI among stunted 12% compared to 85% for the control, followed by phosphorus intake (38%) versus (71%). This result agreed with many studies from different countries ***(Ramakrishnan et al., 2009).*** They also had significantly lower mean values for calcium and phosphorus which have a significant role in bone growth ***(Alshammari et al., 2017).*** Calcium intake in this study was extremely low among stunted as compared to control, denoting more compromised calcium bioavailability. There is some limited evidence for phosphate deficiency occurring through a dietary lack ***(Waterlow, 2006).***

Although phosphate deficiency is likely to be rare. Indeed, average intakes of P and Mg from most diets are usually substantially greater than their biological requirements and, if not, increased absorption.

The present results in figure (4) illustrated that the minerals (Zn and Iron) lower intake of two groups than RDI. linear growth inhibition is an immediate response to their deficiency, include protein and Zn. There is evidence that deficiencies of protein and Zn can occur in the human diet, especially for populations consuming diets based on starchy roots with little or no animal-source foods (ASF); The prevalence of Zn deficiency is widely believed to be widespread in developing countries because of low intakes of Zn-rich animal products, diets high in phytates, which inhibit Zn absorption, and Zn losses due to diarrhoea. However, few nationally representative surveys of Zn status ***(de Benoist et al., 2007)*** or intakes have been conducted in low-income countries, and clear evidence of its role in anetiology of stunting has been difficult to demonstrate. Recently, Zn deficiency prevalence has been modelled from both country-specific absorbable Zn content of the national food supply (from national food balance sheet data), and estimates of physiological requirements for absorbed Zn***(Wessells and Brown, 2012),*** finding 17·3% of the world's population to be at risk of inadequate Zn intake, with estimates ranging from 7·5% in high income regions to 30% in South Asia. Overall, the prevalence of inadequate Zn intake correlated with the prevalence of stunting in children under 5 years of age, explaining almost a quarter of the between-country variation in stunting.

During infancy and childhood, iron deficiency could lead to impaired cognitive and physical functionality and increased risk of mortality ***(Murray et al., 2010).*** Zinc is essential for cellular differentiation and maturation and maternal zinc deficiency could lead to growth retardation and other developmental defects of the fetus ***(Christian and Stewart, 2010).*** Further, zinc deficient infants and young children are prone to infections and growth retardation ***(Hess et al., 2009).*** The major cause of micronutrient malnutrition is a diet consisting mainly of staple foods and lacking in animal sources ***(Bouis 2003).***

Deficiency results from insufficient absorption of iron or excess loss.Absorption is tightly regulated in the intestines,depending on the iron status of the individual, the type of iron, and other nutritional factors. Once iron is absorbed, it is well conserved **.**

The result in table (2) showed that the mean hemoglobin level, TSH, T3, T4, vitamins A, D and serum Ca were low among the stunted group, they were significantly less than the control group. Anemia in young children is a serious concern because it can result in impaired cognitive performance, behavioral and motor development, coordination, language development, and scholastic achievement as well as increased morbidity from infectious diseases ***(IIPS, 2007).***

Adaptive changes in iodine and thyroid hormone metabolism occur with iodine deficiency, initially conserving iodine within thyroid tissue in association with increased TSH and maintaining T4 and T3 levels (subclinical hypothyroidism), eventually followed by reductions in T4 (overt hypothyroidism). Iodine repletion in school-age children who were severely iodine deficient (7- to 10-year-old Moroccan children), moderately iodine deficient (10- to 12-year-old Albanian children) or mildly iodine deficient (5- to 14-year-old South African children) increased IGF-1 levels in each case, and also increased total T4, IGF-1, IGFBP-3 and both WA and HA Z scores in the Moroccan and Albanian children***(Zimmermann et al.,2007).*** This suggests that in communities of low iodine availability where use of iodised salt is limited, if stunting is prevalent, iodine deficiency should be included as a potential part of any nutritional aetiology.

Plausible that vitamin A deficiency plays a critical role in the occurrence of undernutrition. Findings from experimental studies suggest that vitamin A may affect growth through the regulation of growth hormone (GH) and thyroid-stimulating hormone beta genes. Deficiency of retinoic acid is associated with reduced secretion of GH from the pituitary gland, ***(Mallo et al., 1992, and Breen et al., 1995)*** and causes a marked reduction in body weight ***(Xiao et al., 2019).***

Vitamin D is mainly involved in the regulation of calcium and phosphorus metabolism and, consequently, in the processes of bone growth and mineralization ***(Holick, 2007).*** Vitamin D insufficiency may negatively affect bone mineralization during childhood ***(Goltzman, 2018),*** but a severe deficiency is the cause of rickets, a disease characterized by leg deformities, rachitic rosary due to enlarged costochondral joints, frontal bossing and craniotabes, as well as the radiographic widening of the growth plate and metaphyseal cupping and fraying ***(Misra et al., 2008).*** In addition to the effects on calcium–phosphorus metabolism, several studies have shown in recent years that vitamin D also has extra skeletal actions ***(Shaw and Mughal, 2013),*** probably because most organism cells express VDR inside them ***(Hossein-nezhad et al., 2013).***

The calcium and phosphorus 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 ***(Bronner, 1994).***

Conclusion

Among the studied Egyptian children, stunted children suffer from more negative impacts, that have profound effects on development of linear growth.consequent linear growth require adequate nutrition, of which the influences of dietary energy, iodine, amino acids and Zn and evidence for their deficiencies in the etiology of stunting have been discussed here, it remains to be discovered what the minimum nutritional requirements are for acceptable linear growth and especially whether the plant-based diets of the most deprived communities can be sufficiently improved to meet such requirements.

Table (1): Growth ideal, Weight, Hight, BMI, Z-Score, and Percentile (mean ± SE) for age preschool children (under six y)

Parameters/ Groups	Normal Group	Stunting Group	P value
Growth ideal	17.2 ± 0.3	11.5±0.3	7.92E-14
Weight	17.3±0.4	10.3±0.3	1.42E-15
Hight	99.0 ±1.2	89.1±1.3	6.5E-07
BMI	17.7±0.2	13.0±0.2	3.83E-14
Z-Score	1.4±0.1	-3.2±0.4	2.49E-12
Percentile	80.8±1.8	4.5±2.6	1.67E-20

Less than the 5th percentile = Underweight; 5 th to less than the 85th percentile= Healthy Weight; 85th to less than the 95th percentile= Overweight; Equal to or greater than the 95th percentile= Obese; sig. (P< 0.05). Stunting < - 2SD. Normal – 2 to + 2 SD. Tall: + 2 SD (WHO,1995)

Table (2): Mean of hemoglobin (Hb), TSH, T3, T4, Vit. A, D and serum Ca for normal cases and stunting children (No=30/ each)

Parameters	Cut of point	Normal or control group	Stunting Group	P value
Hb g/dl	11-14	12.1±0.1	9.6±0.1	6.34E-20
TSHmIU/L	4.0-7.0	9.4±0.15	3.8± 0.3	1.08E-18
T3mIU/L	0.6-1.85	1.1±0.05	0.5±0.01	3.39E-13
T4mIU/L	4.8- 12.0	7.7±0.3	4.0±0.06	1.55E-11
Vit A µg/dl	11.3-64.7	35.7	8.9	1.31E-12
Vit D ng/ ml	>=30	32.1±0.2	14.2±0.4	4.84E-28
Ca mg/ dl	9-11	10.2±0.1	7.4±0.2	3.95E-15

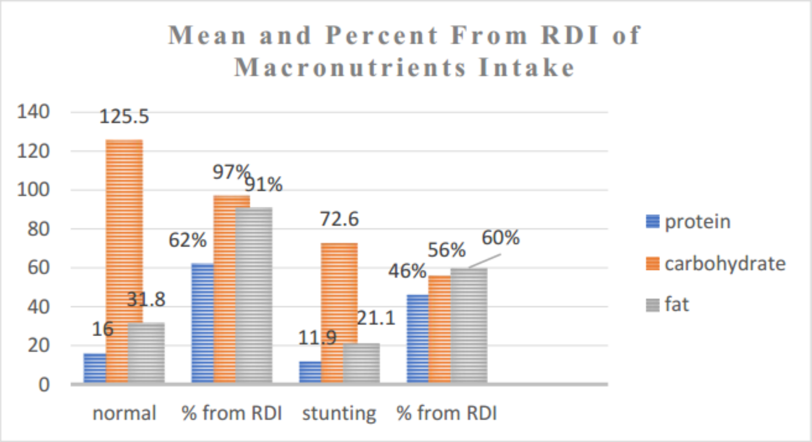

Figure (1)

Mean and percent from RDA of Macronutrients intake for normal cases and stunting children (No=30/each)

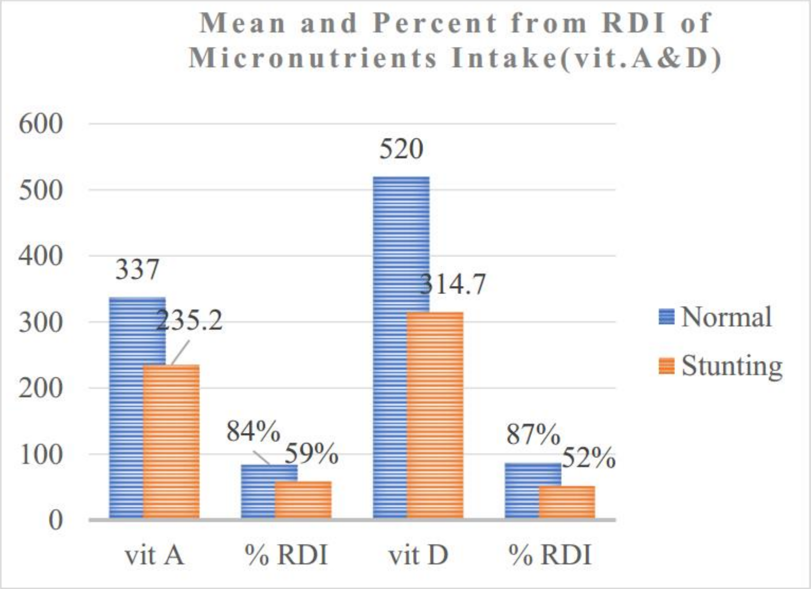

Figure (2)

Mean and percent from RDA of Micronutrients intake (Vit. A and D)for normal cases and stunting children (No=30/each)

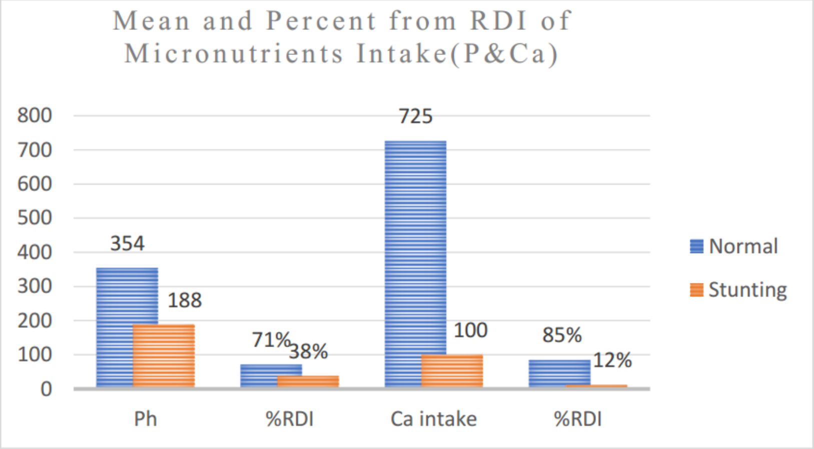

Figure (3)

Mean and percent from RDA ofMicronutrients intake (P and Ca)for normal cases and stunting children(No=30)

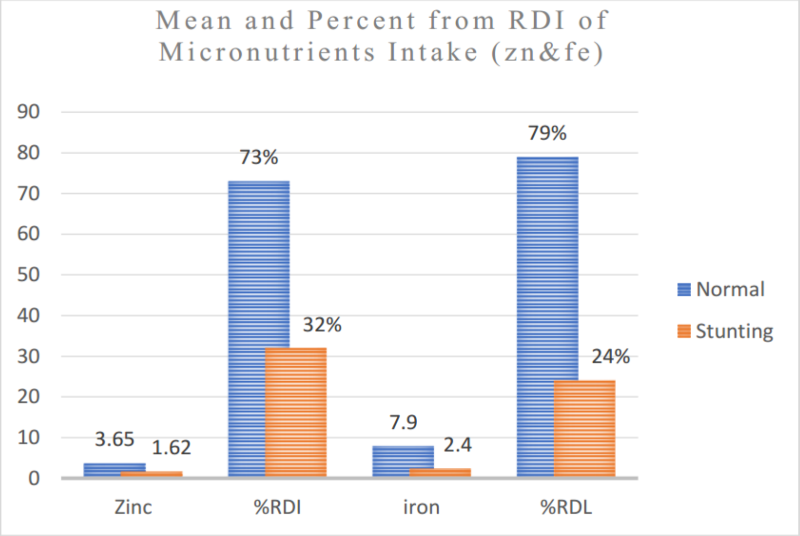

Figure (4)

Mean and percent from RDA of Micronutrients intake (Zn and Fe)for normal cases and stunting children(No=30/each)

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جودة النظام الغذائي وسوء التغذية (قصر القامة) في مرحلة ما قبل المدرسة

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الملخص العربي

يعاني الأطفال في مجتمعات البلدان الفقيرة من ظهور سوء تغذية سريعا. قد يؤدي عدم كفاية المأخوذ الغذائي والمرض إلى سوء التغذية. تهدف هذه الدراسة إلى معرفة جودة النظام الغذائي لبعض الأطفال المصريين الذين يعانون من قصر القامة في مرحلة ما قبل المدرسة لتصميم التثقيف الغذائي السليم والبرنامج الوقائي المناسب لتحسين النمو. *تضمنت* الدراسة (٣٠) طفلا في سن ما قبل المدرسة تتراوح أعمارهم بين ٢ و ٦ سنوات ، مع تأخر في النمو ، تم اختيارهم عشوائيامن عياده قصر القامة الخارجية التابعة للمعهد القومي للتغذية و(٣٠) حالة في نفس العمروالجنس اصحاء كمجموعة ظابطه. خضع جميع المشاركين للتقييم: (المأخوذ الغذائي بما في ذلك طريقة "الأسترجاع لمدة أربع وعشرين ساعة" و "استبيان تكرار الطعام" ؛ القياسات الأنثروبومترية بما في ذلك "الوزن والطول"؛ الفحوصات المعملية التي تضمنت الهيموجلوبين ، مصل الكالسيوم ، فيتامين د ، فيتامين أ. تركيز ، TSH،T4، T3 أظهرت النتائج أن متوسط الطول لدرجة العمر Z أقل بشكل ملحوظ بين المصابين بقصر القامة مقارنة بالمجموعة الضابطه. كذلك تحليل المأخوذ الغذائي ، أن متوسط المأخوذ من جميع المغذيات الكبيرة والمغذيات الدقيقة كان أقل بشكل ملحوظ بين المصابين بقصر القامة. كان الأختلاف معنوي بين المجموعتين لجميع قيم الدم لـ TSH و T3 و T4 وCaو Vit Aكانت أقل بشكل ملحوظ بين المجموعة المصابة بالتقزم.

الخلاصة ، نقص المأخوذ الغذائي للعديد من العناصر الغذائية التي يتناولها الأطفال الذين يعانون من التقزم لعب دورا مهما في تأخر نموهم. توصى الدراسة بعمل الأستراتيجيات الوقائية للحماية من قصر القامة بتعزيز تناول الطعام المتكامل للعناصر الغذائية في حدود التوصيات المطلوبة والصحية .