Psychosocial Problem and Growth Indices Related to Serum Zinc in Egyptian Children

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Abstract: Background: Zinc play important roles in children's physical and behavioral health; however, there is a relative lack of attention given to the effects of specific micronutrient (e.g., zinc) deficiency on behavior problems, including internalizing (i.e., anxiety, depression, withdrawal, somatic complaints), and externalizing disorders (i.e., antisocial, aggressive, and hyperactive behavior). **Aim of the study:** The purpose of this study was to determine growth indices (body weight, height, body mass index) and determine the type of psychosocial problems in relation to serum Zinc level in a random sample of preschool children attending the pediatric clinic at AlZhara University Hospital at the time of the study. **Subjects and methods:** All studied children subjected to full history taking, clinical examination including anthropometric measurement (weight, height, head circumference, and their percentile, BMI) plotted against growth chart, child Psychosocial problems behavior problems using the latest standardized Persian version of the Child Behavior Checklist (CBCL). **Results:** In this study Out of 150 children, 72 (48.0%) were males and 78(52.0%) were females. Age rang (3-6 years) with the main age 4.70±1.05.The mean serum zinc level in 3-6 years old children was 0.82±0.20 µg/ml. There is highly significant decrease of serum Zinc level and decrease (body weight, height, head circumference, body mass index) height centil, weight centil, head circumference centil (p value=0.000) and BMI (p value=0.001). The most common Psychosocial problems among preschool children is social problems(47.3%), rule breaking behavior(28.7%),anxious/depressed(25.3%),aggressive behavior (16.7%), somatic complaints (6.7%), attention problems(4.0%) then thought problems(1.3%), low zinc concentration is positively correlated with total behavior problems, anxious/depressed behavior(P value= 0.000), social problems, aggressive behavior and rule breaking behavior. **Conclusion:** We conclude that there is high correlation between low serum zinc level and growth retardation, presence of Psychosocial problems in preschool children, the most common is social problems.

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1. Introduction

Zinc is a component of enzymes that affect growth in infancy and childhood, sexual maturation, neuromotor development, and immunity. Mental function is improved by zinc's promotion of normal brain development and physiology ***(Liu and Raine, 2006).*** Zinc play important roles in children's physical and behavioral health; however, there is a relative lack of attention given to the effects of specific micronutrient (e.g., zinc) deficiency on behavior problems, including internalizing (i.e., anxiety, depression, withdrawal, somatic complaints), and externalizing disorders (i.e., antisocial, aggressive, and hyperactive behavior) ***(Liu et al., 2014).*** Malnourished children have been shown to have decreased physical activity and endurance, and poorer cognitive function and school performance. Multiple single micronutrient deficiencies, including vitamin B12, thiamin, niacin, zinc and iron, have been associated with poorer cognitive performance. Behavioral problems, including attention deficits, have also been associated with food insufficiency and malnutrition ***(Fanjiang et al., 2007).***

Aim of the study

The purpose of this study was to determine growth indices (body weight, height, body mass index) and determine the type of psychosocial problems in relation to serum Zinc level in a random sample of preschool children attending the pediatric clinic at AlZhara University Hospital at the time of the study.

2. Subject and Methods

Study design

This study is a cross-sectional, observational study. The study was carried out in the Pediatric outpatient clinic of AlZahra University Hospital, That serve an urban area of Cairo government, of a social classes middle to low and very low.

Subject:

Selection of sample

A random sample of 150 children fulfilling the inclusion and exclusion criteria participated in this study. The first three cases were selected from among

children attending the pediatric outpatient clinic on Saturday, Monday and Thursday on a weekly basis over 6-monts duration starting from may 2012 to October 2012. We chose the children age 3-6 years only in each clinic.

Choice of cases

Children were selected from among Egyptian children aged between 3 -6 years irrespective of their sex. Healthy children with no diagnosed physical illness were included in the study. All participants were screened to determine eligibility for participation in the study. Screening was performed using an interview form, which examined demographic data and information on complete medical history.

All studied children subjected to the following:-

1- Full history taking.**2-**Clinical examination including anthropometric measurement (weight, height, head circumference, and their percentile, BMI) plotted against growth chart ***(Feigelman, 2008)***. **3-** Determination of serum zinc level by using the flame less atomic absorption spectrophotometer technique ***(Frenandez and Kahn, 1971).*** **4-**Child Psychosocial problems by the main assessment tool of this study, we used the latest standardized Persian version of the Child Behavior Checklist (CBCL) were measured by general health questionnaire for children: CBCL ***(Achenbach and Rescorla, 2000)***.

It is designed to obtain parents reports of their children's problems. It includes 113 items for behavioral and emotional problems. Items are rated on a 3-point scale as 0=not true, 1=somewhat or sometimes true and 2=very true or often true based on preceding 6 months. The following eight syndromes are scored, Anxious/Depressed, Withdrawn/Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule Breaking Behavior & Aggressive behavior. Anxious/Depressed& Somatic Complaints syndromes comprise an Internalizing group and Aggressive behavior& Rule Breaking Behavior comprise an Externalizing group and total problems is the sum of scores on all problems items. ***(Achenbach and Rescorale, 2000).***

- **Serum zinc measurement:**
  - *Collection and storage of blood samples:* We take 5ml of the blood sample from children then centrifugation was done for serum separation then collected sample stored at -20^{o}C until analysis.
  - *Determination of serum zinc:* It was done in the Central Laboratory of the National Research Center.

Principle:

Atomic absorption spectroscopy is a form of quantitative analysis can measure the concentration of certain elements in a sample depending upon how much of a specific wavelength is absorbed. depend on that certain elements absorb certain wavelengths, and this level of absorption is characteristic ofeach element. Also, electrons in atoms can only exist in particular energy levels and when an electron moves to a higher energy level, electromagnetic radiation of a particular frequency is absorbed. the element being tested must be known because a wavelength must be emitted which is specific to the element being tested, as certain elements only absorb certain wavelengths ***(Smith and Hieftje, 1983).***

Serum Zinc by Flame Atomic Absorption Spectrometer:

Serum Zn level determination had been carried out using Varian Flame Atomic Absorption Spectrometer 220 as described by ***Smith and Hieftje (1983),*** the wavelengths used for Zn determination and the optimum working ranges were as follow: Wavelength (nm) Optimum working range (mg/L) Zinc213.9 0.01 – 2. Sample volume was introduced continuously after serum sample dilution with distilled water (750 ML of serum + 3 ml of distilled water). (Normal serum zinc level is 0.80-1.20 microgram/ml).

The data was entered into a personal computer using MS-Excel. The statistical analysis was accomplished by using SPSS. The descriptive statistics (mean and standard deviation) was used to describe the data. Student's t-test for independent samples and a one-way analysis of variance were used to compare the mean scores of sub-scales in relation to the categorized study variables.

3.Results

In this study out of 150 children, 72(48.0%) were males and 78(52.0%) were females as present in table (1):

Table (1): Distribution of children according to sex & age:

Total		**No. 150**	**100%**
Sex	Female Male	78 72	52.0% 48.0%
Age	Mean ± SD Range	4.70±1.05 3-6	

Table (2): Distribution of children according to Weight(Kg), Weight Percentile(th), Height(Cm), Height Percentile(th), Head Circumference (Cm), Head Circumference Percentile(th), BMI& Serum Zinc Level (µg/ml):

	Range	**Mean ± SD**
Weight(Kg)	12 - 24	17.13 ± 2.86
Weight Percentile(th)	5 - 90	43.80 ± 22.11
Height(Cm)	92 - 120	102.90 ± 6.37
Height Percentile(th)	5 - 85	29.63 ± 18.05
Head Circumference (Cm)	47 - 53	49.21 ± 1.11
Head Circumference Percentile(th)	5 - 90	32.03 ± 18.91
BMI	13.19 - 19.94	16.04 ± 1.07
Serum Zinc Level (µg/ml)	0.509 - 1.32	0.82 ± 0.20

Table (3): Distribution of children according to behavior problems (Anxious/ Depressed, Withdrawn/ Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule Breaking Behavior& Aggressive Behavior):

		No.	**%**
Social Problems	Not present Present	79 71	52.7% 47.3%
Rule Breaking Behavior	Not present Present	107 43	71.3% 28.7%
Anxious/ Depressed	Not present Present	112 38	74.7% 25.3%
Aggressive Behavior	Not present Present	125 25	83.3% 16.7%
Somatic Complaints	Not present Present	140 10	93.3% 6.7%
Attention Problems	Not present Present	144 6	96.0% 4.0%
Thought Problems	Not present Present	148 2	98.7% 1.3%
Withdrawn/ Depressed	Not present Present	150 0	100.0% 0.0%

Table (4): Correlation of serum zinc level (µg/ml) and Age (yrs.), Weight (Kg), Weight Percentile(th) , Height(Cm), Height Percentile(th) , Head Circumference (Cm), Head Circumference Percentile(th) & BMI:

	Serum Zinc Level (µg/ml)	
	r	***P*-value**
Age (yrs)	0.156	0.056
Weight(Kg)	0.372**	0.000
Weight Percentile(th)	0.518**	0.000
Height(Cm)	0.321**	0.000
Height Percentile(th)	0.400**	0.000
Head Circumference (Cm)	0.247**	0.002
Head Circumference Percentile(th)	0.223**	0.006
BMI	0.383**	0.000

** Independent t-test; P > 0.05: NS; P < 0.05: S; P < 0.01: HS*

Table (5): Relation between Serum Zinc Level (µg/ml) and sex:

Sex	**Serum Zinc Level (µg/ml)**		**Independent t-test**	
	Mean	**±SD**	**t**	***P*-value**
Female	0.81	0.21	0.312	0.755
Male	0.82	0.19		

Independent t-test; P > 0.05: NS; P < 0.05: S; P < 0.01: HS

Table (6): Relation between serum zinc level (µg/ml) and behavior problems (Anxious/ Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule Breaking Behavior & Aggressive Behavior):

Behavior Problems		**Serum Zinc Level (µg/ml)**		**Independent t-test**	
		Mean	**±SD**	**T**	***P*-value**
Anxious/ Depressed	Not present Present	0.90 0.59	0.17 0.07	10.855	0.000
Somatic Complaints	Not present Present	0.84 0.56	0.19 0.09	4.485	0.000
Social Problems	Not present Present	0.94 0.69	0.19 0.11	10.149	0.000
Thought problems	Not present Present	0.82 0.74	0.20 0.04	0.568	0.571
Attention Problems	Not present Present	0.83 0.63	0.20 0.14	2.476	0.014
Rule breaking behavior	Not present Present	0.90 0.62	0.17 0.08	10.357	0.000
Aggressive behavior	Not present Present	0.86 0.62	0.19 0.12	6.061	0.000

4.Discussion:

In this study Out of 150 children, 72 (48%) were males and 78(52%) were females. Age rang (3-6 years) with the main age 4.70±1.05.The mean serum zinc level in 3-6 years old children was 0.82±0.20 µg/ml. Zinc is essential for normal growth and development of infants as it has an important role in protein, carbohydrate, fat and vitamin metabolism, so babies born small for gestational age should be received zinc supplementation ***(Nepal et al.,2014).*** In this study we found that there was no significant difference in serum zinc level as regard to sex(*p* value=0.755). Our result is correlated with the result of (Dehghani *et al.,* 2011) they reported that as regard to gender, there was no significant difference in serum zinc level (*p* value =0.142) ***(Dehghani et al., 2011).*** Our result relieved that there was no significant difference in serum zinc level as regard to age(*p* value=0.056). Our result is correlated with the result of ***(Dehghani et al., 2011)*** they reported that there was no significant association between zinc deficiency and age (*p*=0.142) ***(Dehghani et al., 2011).*** In this study we found that low serum zinc level is positively associated with decrease body weight (*p* value=0.000).One of the most studied clinical features related to zinc deficiency is the impairment of physical growth and development ***(Anderson et al., 2004).*** In this study we found that low serum zinc level is positively associated with decrease height (*p* value=0.000).Our result is correlated with the result of ***(Dehghani et al., 2011)*** they reported that the prevalence of mild stunting was significantly higher in zinc deficient children compared to children with normal or high zinc level. As to height for age in zinc deficient children mild to moderate stunted (*p* value =0.029) ***(Dehghani et al., 2011).*** Our result is correlated with the result of (Roohani *et al.,* 2013) they reported that Height-for-age, a measure of nutritional stunting, is the best known and easiest to measure of the adverse outcomes associated with zinc deficiency in populations. Stunting prevalence is expressed as the percentage of children under 5 years of age with height-for-age below the expected range of a reference population ***(Roohani et al., 2013).*** Our result is correlated with the result of (Black, 2014) reported that zinc deficiency increases infectious morbidity and reduces linear growth as well ***(Black, 2014)***. In this study we found that low serum zinc level is positively associated with decrease in BMI (*p* value=0.001). Our result is correlated with the result of ***(Dehghani et al., 2011)*** they reported that the prevalence of mild wasting was significantly higher in zinc deficient children compared to children with normal or high zinc level. In the zinc deficient group mild to moderate wasted (*p* value =0.033) ***(Dehghani et al., 2011).*** The effects of zinc supplementation on children's growth were examined in a completed meta- analysis of 33 randomized intervention trials that were conducted on pre-pubertal children. Zinc produced supplementation highly significant positive responses in linear growth and body weight gain ***(Krebs et al., 2012).***In this study we found that there was no significant difference between behavior problems (i.e., anxious/depressed (*p* value =0.106), somatic complaints (*p* value =0.526), social problems (p value =0.440), thought problems (*p* value =0.276), attention problems (*p* value =0.899) & rule breaking behavior (*p* value =0.086) as regard to age. Our result

is correlated with the result of ***(Amr et al., 2009)*** they reported that we did not find any significant correlations between the presence of psychiatric disorders and a number of factors such as age, gender ***(Amr et al., 2009).*** Our result relieved that the most common behavior problems among preschool children is social problems(47.3%), rule breaking behavior (28.7%), anxious/ depressed (25.3%), aggressive behavior (16.7%), somatic complaints (6.7%), attention problems(4.0%) then thought problems (1.3%). In contrast to our result ***(Egger & Angold, 2006)*** reported that behavioral and emotional psychiatric disorders in preschool children (children ages 2 through 5 years old), focusing on the five most common groups of childhood psychiatric disorders: attention deficit hyperactivity disorders, oppositional defiant and conduct disorders, anxiety disorders, and depressive disorders ***(Egger and Angold, 2006).***In contrast to our result (Fare et al., 2008) reported that Severe behavioral problems related to inattention, poor social adjustment, hyperactivity, depression and anxiety were detected among 6.1 %, 5.6%, 4.1%, 3.6% and 3% of the study population respectively ***(Fare et al., 2008).***Our result is correlated with the result of ***(Abd Elhamid et al., 2008)*** they reported that prevalence of probable psychiatric diagnoses was much lower (Any psychiatric diagnosis 8.5% , emotional disorder 2.0% , conduct disorder 6.6% , hyperactivity disorder 0.7% ***(AbdElhamid et al., 2008)***. In contrast to our result ***(Stadelmann et al., 2010) & (Giannakopoulos et al., 2009)*** reported that common behavioral problems in children is psychosocial disorders, habit disorders, anxiety disorders, disruptive behavior, sleeping problems ***(Stadelmann et al., 2010) & (Giannakopoulos et al., 2009).*** In this study we found that low zinc concentration is positively correlated with total behavior problems.The finding of the association of zinc deficiency with child behavior problems is consistent with previous findings ***(Grantham-McGregor and Ani, 1999).***Our result is correlated with the result of ***(Liu et al.,2014)*** they reported an association between zinc deficiency and total behavior problems. They reported that low zinc concentration is positively correlated with total behavior problems in preschool children ***(Liu et al., 2014).*** Zinc is a component of enzymes that affect growth in infancy and childhood, sexual maturation, neuro-motor development, and immunity. Specifically, zinc acts as the integral enzymatic agent in metabolic processes of proteins, carbohydrates, and lipids and is used as a neurotransmitter or neuromodulator in the central nervous system ***(Bitanihirwe and Cunningham, 2009).*** Mental function is improved by zinc's promotion of normal brain development and physiology ***(Bitanihirwe and Cunningham, 2009).*** In this study we found that low zinc concentration is positively correlated with anxious/depressed behavior(*P* value= 0.000).Changes in zinc concentration were significantly and inversely associated with changes in parent-reported symptoms of depression, anxiety, and internalizing problems in these children ***(DiGirolamo et al., 2010)***. These findings confirm results from studies that noted the relation between low amounts of zinc and symptoms of depression and anxiety. Again, these results suggest that zinc may play a role in depression and anxiety ***(Hubbs-Tait et al., 2007).*** Our result is correlated with the result of ***(Tassabehji et al., 2008) & (DiGirolamoand Ramirez-Zea, 2008)*** they reported that Indeed, animal and human models have suggested a relationship between low serum zinc and anxiety, fear-like behaviors, and depression—implicating the role of the dopaminergic and serotonergic systems ***(Tassabehji et al., 2008) & (DiGirolamo & Ramirez-Zea, 2008).*** Our result is correlated with the result of ***(DiGirolamo et al., 2010)*** they reported that increases in serum zinc concentrations were inversely associated with decreases in depressive symptoms (*P* value= 0.01), anxiety (*P* value= 0.02) ***(DiGirolamo et al., 2010).***Our result is correlated with the result of ***(DiGirolamo et al., 2010)*** they reported that low concentrations of zinc have been associated with symptoms of depression in animals and adult humans. Zinc status is inversely related to anxiety in animals and young children ***(DiGirolamo et al., 2010).*** The study provides some evidence that positive changes in zinc concentrations may be associated with decreases in internalizing symptoms such as those associated with depression and anxiety in children ***(DiGirolamo et al., 2010).***In this study we found that low serum zinc level is positively associated with anxious/depressed, aggression and social problems.Our result is correlated with the result of(Oner et al, 2010) they reported that there is a relationship between low zinc and greater levels of hyperactivity, anxiety, and conduct problems ***(Oner et al, 2010)***. In this study we found that low serum zinc is positively associated with social problems, aggressive behavior and rule breaking behavior. Our result is correlated with the result of ***(Raineand Liu, 2010)*** they reported that at the postnatal level, in a longitudinal study from the Mauritius birth cohort, it was found that children with malnutrition (protein, zinc, iron and vitamin B deficiencies) at age 3 years, compared to controls, have higher externalizing behavior problems (i.e., antisocial, aggressive, and hyperactive behavior) at ages 8 years, 11 years, and 17 years ***(Raineand Liu, 2009).*** In another longitudinal study,***(Galler et al., 2011)***found that children who were malnourished at an early age showed significantly higher parent-reported levels of behavior

problems, particularly aggression, and decreased executive functioning at age 9–15 and again at 11–17, independent of baseline age, sex, household standard of living, and maternal depressive symptoms ***(Galler et al., 2010).*** In this study we found that low serum zinc is positively associated with somatic complaints (*p* value=0.000). Our result is correlated with the result of ***(DiGirolamo et al., 2010)*** they reported that increases in serum zinc concentrations were inversely associated with decreases internalizing symptoms(i.e., anxiety, depression, withdrawal, somatic complaints), (*P* value = 0.02) ***(DiGirolamo et al., 2010).*** In this study we found that low serum zinc is positively associated with social problems (*p* value=0.000).Our result is correlated with the result of ***(DiGirolamo et al., 2010)*** they reported that increases in serum zinc concentrations were inversely associated with decreases social skills (*P* value = 0.01) ***(DiGirolamo et al., 2010).*** Our result is correlated with the result of ***(Oner et al, 2010)*** they reported that there is a relationship between low zinc and greater levels and conduct problems ***(Oner et al, 2010)***.

Conclusion

We conclude that there is high correlation between low serum zinc level and growth retardation, presence of emotional and behavioural problems in preschool children. The most common is social problems.

References

1. AbdElhamid A, Howe A and Reading R(2008): Prevalence of emotional and behavioural problems among 6–12 year old children in Egypt Soc Psychiatry Psychiatr Epidemiol DOI 10.1007/s00127-008-0394-1.
2. Achenbach TM, Rescorla L (2000): Manual for the ASEBA preschool forms & profiles: an integrated system of multi-informant assessment. Burlington, Vt.: ASEBA.
3. Amr M,Bakr A, El Gilany AH, Hammad A, El-Refaey A and El-Mougy A(2009): Multi-method assessment of behavior adjustment in children with chronic kidney disease Pediatr Nephrol; 24:341–347
4. Belfer ML andSaxena S (2006): WHO Child Atlasproject Lancet; 367:551-2 .
5. Black RE(2014):Global distribution and disease burden related to micronutrient deficiencies doi: 10.1159/000354932. Epub 2014 Jan 27.
6. Craig A. Anderson, Leonard Berkowitz, Edward Donnerstein, L. Rowell Huesmann, James D. Johnson, Daniel Linz, Neil M. Malamuthand Ellen Wartella (2004):The influence of media violence on youth. psychological science in the public interest-008-1012-x.
7. Dehghani SM, Katibeh P, Haghighat M, Moravej H andAsadi S (2011): Prevalence of Zinc Deficiency in 3-18 Years Old Children in Shiraz-Iran Iran Red Crescent Med J; 13(1): 4–8.
8. DiGirolamo AM, Ramirez-Zea M, Wang M, Flores-Ayala R, Martorell R, Neufeld L, Ramakrishnan U, Sellen D, Black MM and Stein AD (2010): Randomized trial of the effect of zinc supplementation on the mental health of school-age children in Guatemala. Am J Clin Nutr. 92(5):1241-50.
9. DiGirolamo AM and Ramirez-Zea M (2009): Role of zinc in maternal and child mental health. Am J Clin Nutr; 89:940S–5S.
10. Fanjiang, Gary; Kleinman& Ronald E. (2007): Nutrition and performance in children Current Opinion in Clinical Nutrition & Metabolic Care; 10 (3): 342–347.
11. Fare YA, Abou-Hatab MF and Okasha YA (2008): Behavioral Problems Among A Sample of Preschool Egyptian Children: A Teacher Rating Perspective http: //www .researchgate .net/ publication/255609078.
12. Feigelman S (2008): Growth, Development and Behavior. Nelson Text Book of Pediatrics, 18 th ed. Philadelphia: WB Saunders. pp: 33-100.
13. Galler JR, Bryce CP, Waber D, Hock RS, Exner N, Eaglesfield D, Fitzmaurice G and Harrison R *(2010):* Early childhood malnutrition predicts depressive symptoms at ages 11–17. Journal of Child Psychology and Psychiatry, and Allied Disciplines;51(7):789–798.
14. Giannakopoulos G, Mihas C, Dimitrakaki C and Tountas Y (2009): Family correlates of adolescents' emotional/behavioural problems: evidence from a Greek school-based sample. Acta Paediatr; 98 (8): 1319-23.
15. Grantham-McGregor SM, Fernald LC and Sethuraman K (1999): Effects of health and nutrition on cognitive and behavioural development in children in the first three years of life: Part 1: Low birth weight, breastfeeding, and protein-energy malnutrition. Food Nutr. Bull. 20: 53-75.
16. Hubbs Tait L, Kennedy TS, Droke EA, Belanger DM, Parker JR (2007):Zinc, iron and lead: relations to head start children's cognitive scores and teachers' ratings of behavior. J Am Diet Assoc;107:128–33.
17. Liu G, Seiler H, Wen A, Zars T, Ito K, Wolf R, Heisenberg M, Liu L (2006): Distinct memory traces for two visual features in the Drosophila brain. Nature 439(7076): 551--556.
18. Liu J and Raine A (2006): The effect of childhood malnutrition on externalizing behavior. CurrOpinPediatr.18(5):565-70.

19. Liu J, Hanlon A, Ma CH, Zhao SR, Cao S and Compher C (2014): Low Blood Zinc, Iron, and Other Sociodemographic Factors Associated with Behavior Problems in Preschoolers Nutrients; 6(2): 530–545.
20. Nepal AK, Gelal B, Mehta K, Lamsal M, Pokharel PK and Baral N (2014): Plasma zinc levels, anthropometric and socio-demographic characteristics of school children in eastern Nepal BMC Res Notes; 7: 18.
21. Oner O, Oner P, Bozkurt OH, Odabas E, Keser N, Karadag H, Kizilgün M (2010): Effects of zinc and ferritin levels on parent and teacher reported symptom scores in attention deficit hyperactivity disorder. Child Psychiatry Hum Dev;41(4):441-7.
22. Raine A, Liu J, Venables PH, Mednick SA, Dalais C (2009):Cohort Profile: The Mauritius Child Health Project. International Journal of Epidemiology.
23. Roohani N, Hurrell R, Kelishadi R andSchulin R (2013): Zinc and its importance for human health: An integrative review J Res Med Sci; 18(2): 144–157.
24. Sirvinskiene G, Zemaitiene N, Zaborskis A, Markuniene E and Jusiene R (2012): Infant difficult behaviors in the context of perinatal biomedical conditions and early child environment. BMC Pediatr;12:4.
25. Stadelmann S, Perren S, Groeben M, von Klitzing K (2010): Parental separation and children's World Health Organization (2001): The World Health Report 2001: mental health: new understanding, new hope. Geneva, Switzerland: World Health Organization.
26. behavioral/emotional problems: the impact of parental representations and family conflict. Fam Process;49(1):92-108.
27. Tassabehji NM, Corniola RS, Alshingiti A and Levenson CW (2008): Zinc deficiency induces depression-like symptoms in adult rats. Physiol Behav. 95(3) 365-9.
28. US. Public Health Service (2000): Report of the Surgeon General's conference on children's mental health: a national action agenda. Washington, DC: US Department of Health and Human Services.

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