

Research Article

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Children are victims of industrialization and commercialization of early feeding practices: A review of obesity in preschool children in Egypt

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Abstract

Introduction: Obesity Is Global Problem Which Begins From Early Childhood. Early Exclusive Breastfeeding (EBF) without foods or Milk Formula (MF) before 6 months, with continued breastfeeding for two years are optimal feeding practices.

Aim: To review studies conducted to assess the nutritional status of preschool children with a focus on obesity and stunting and their association with EBF vs MF feeding.

Methods: We used online search engines of the Egyptian university libraries consortium (www.eulc.edu) to search for studies on overweight, obesity stunting and wasting in preschool children. We identified 919 theses that were filtered to 32 studies then to 18 theses fitting the criteria of the study. Analysis of the pooled data was done for the studies with children who were EBF (2 studies) vs children who were exposed to MF (16 studies) by age and sex.

Findings: Pooled analysis for children aged 6-59 months among MF vs. EBF studies as follows: overweight 5.4% vs. 3.45%, obesity 13.8% vs. 5.65%, stunting 21.6% vs. 1.15% and wasting 9.7% vs. 0.85% respectively. Obesity and overweight were higher in males in both studies, whereas stunting and wasting were higher in females in both studies (ages 0-72 months). Early and extended MF feeding, foods before 6 months of life, chips and canned drinks were prominent risk factors for obesity. Large family size was associated with obesity and short birth interval with stunting. Colostrum feeding, longer duration of breastfeeding, fruits and vegetables were protective. Obese children showed clinical signs of anemia, vitamin A and D deficiency, severe asthma and developmental delay.

Conclusions: Obesity and MF feeding beyond 6 months and well into 5 years of age threaten child health. Policies and legislations are needed to control, counter and monitor marketing tactics supported by guiding messages.

Keywords: Obesity; overweight; stunting; wasting; fast foods; breastfeeding; birth spacing; child development; infancy; preschool children; anthropometry; growth.

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Introduction

In 2020, globally, 149.2 million children under the age of 5 years of age were stunted, 45.4 million wasted, and 38.9 million overweight. The number of children with stunting may be declining as UNICEF/WHO/World Bank report that two-thirds of countries in all regions are making some improvements except for Africa. Also 45.4 million children under 5 are affected by wasting, of which 13.6 million are severely wasted and the condition is being exacerbated by the COVID-19 crises [1]. Of concern is the rising problem of overweight and obesity which is more challenging as about half of all countries have experienced no progress or are worsening especially that adiposity persists throughout a lifetime especially with the COVID-19 lockdown that potentiates sedentary life and overeating of unhealthy foods under the effect of marketing. In one country, decrease in physical activity during the pandemic was reported in 28 per cent of children aged 3 to 5 years, while increases in snack with high sugar, salt and fat were reported in 19 per cent of children in the study [2].

Early Exclusive Breastfeeding (EBF) for 6 months and Continued Breastfeeding (CBF) for two years or more are recommended by UNICEF and WHO as the optimal feeding practices [3]. EBF ensures optimal development of the immune system whereas FM predispose to immune diseases leading to high morbidity and mortality [4,5]. Early and prolonged industrialized formula milk (FM) feeding practices have been shown to play an important role in predicting or predisposing to obesity and its associated morbid medical complications [6]. Action has been taken by WHO to limit, control and guide the inappropriate marketing of these product [7,8]. Despite such efforts products as follow-on milks (FOM) after 6 months and growing up formula (GUF) at 1-5 years continue to be consumed as a continuum of early FM. Moreover, MF and baby foods, introduced in the early months of life, before 6 months predispose to health and nutritional problems [9].

Egypt is a developing country situated in the African continent and is the gatekeeper to Asia and Africa, sharing with Mediterranean and African countries common life styles and dietary habits. The nutritional status varies across the country and is influenced by poverty as well as cultural factors. However recent marketing of MF has been the drive to the changing patterns of feeding among children despite poverty. The percent children living in poverty is highest in rural UE (53%) compared to 19.0% in rural Lower Egypt (LE), 12% in urban UE, 4% in urban LE and 9% in urban governorates [10]. UE is a community of rigid traditional cultures who are not open to change and have the highest prevalence of stunting and wasting [11]. Whereas children in LE are open to Westernized lifestyles of marketed fast foods, packed snacks and canned beverages and thereby vulnerable to overweight and obesity, but stunting and wasting remain a problem in poor areas in LE leading to the double burden of malnutrition [10,12]. The challenge in any study is that overweight and obesity are so closely linked and cut offs and difficult to delineate when the adiposity of overweight can be serious and to mimic obesity and cause disease. It remains up to individual habits, susceptibility, hereditary factors and epigenetics to determine the outcome of these conditions. Importantly, numerous recent studies demonstrate that gene regulation of adiposity is influenced by maternal and early postnatal diet [13].

The aim of the present study is to perform an analytical review research on the nutritional status of preschool children Egypt over the past decades, with a focus on obesity and its association with breastfeeding and MF feeding practices in order to guide well informed recommendations for controlling this pandemic.

Subjects and methods

We searched for studies on overweight and obesity (OWOB) in children using online search engines primarily the Egyptian university libraries consortium (www.eulc.edu). Search was done based on the key words of preschool children, obesity, and nutritional status (see Figure 1).

Inclusion criteria: Preschool children or children under five years of age or within this age range who were screened through primary health care centers or day care nurseries through random selection for the purpose of assessing their nutritional status by measuring their weight, height and other parameters and their early feeding and food consumption habits using standardized methods. Children must be Egyptian and regions within Egypt. The study must be approved by the ethical committee of the university from which the research was done and supervised by a professional supervisory board from the faculty staff. The study must follow the standard anthropometric methods of interpretation of the recent WHO standards [11]. The sample includes males and females. Studies considered are those after the year 2009. Studies must be accessed to be qualitatively reviewed.

Exclusion criteria: Studies or data with children included beyond 6 years of age or covering one sex. Studies that consider only sick children or those who are suffering severe or debilitating conditions from early childhood or handicapped or case control studies, or before 2009 or not using Who standards were excluded.

Description of the review study process: The study is both a historical and analytical review that was carried out by the authors in this study. The process of the analytical review is illustrated in figure (1). Online search engines were used. Key words used were overweight, obesity, nutritional status, preschool children and growth. The main search was done through the Egyptian university libraries consortium (www.eulc.edu). Out of the 919 theses that were identified by the key words, 32 theses were initially identified. They were qualitatively evaluated and filtered so that 14 were excluded and 17 theses and one national survey were included [11] that fit the study criteria. The indices considered for stunting, wasting, overweight or obesity. We retrieved the relevant theses studies from Cairo, Ain Shams, Suez Canal, Benha, Alexandria, Mansoura and Menoufia universities. The 17 theses were thoroughly reviewed and their data was pooled and reanalyzed to estimate indices on nutritional status. The studies before 2006 used the NCHS/CDC/WHO International Reference Population and after this year used WHO references standards [14] the Egyptian standards of child growth [15]. The reference child standards that assess overweight and obesity include the Z-scores for weight for height (W/H Z-scores-2SD) and weight for age (W/A+2SD) and the Body mass index (BMI) (85th-95th for overweight and >95th for obesity) standard reference curves. The protocols for measuring weight and height followed the international standards for

valid measurement of both height and weight in which weight is measured to the nearest gram and recumbent length is measured for children under age 2, and standing height is measured for all other children. The measures are fitted to the charts used by standard deviation units (SD) from the median of the international or national reference population. The national and local studies did not include North and South Sinai governorates.

Comparative analysis: Studies classified as per type of feeding: Two types of studies were included in the analysis. Pooled data was reanalyzed separately for studies that included children who were fed mixed breastmilk and/or formula versus studies based on children who were EBF or fully breastfed (i.e. water of decoctions given occasionally by spoon) from birth up to six months and never introduced any bottle or formula up to the date they were examined. The first group included 6 studies for stunting, overweight and obesity and 5 for wasting (including the national EDHS survey) for analysis by age group. The second group included 2 studies with a total of 2000 children aged 6-59 months. Comparative descriptive analysis was made between the groups by age group and sex.

Ethical considerations

Permissions to use the data in the theses was not required as the theses acceptability was regulated by the individual faculty libraries that allowed us to access and review them inside the library but not for public use. The supervisors were acknowledged in this article. Also a team of researchers in Sohag helped us to access theses from their library and they were acknowledged in the study.

Statistical analysis: The data were compiled on excel sheets and the data for stunting, wasting, overweight and obesity were compiled in the sheets. The numbers of cases (not prevalence rates) were pooled and summed to estimate the prevalence of each of the parameters by age group and by gender. Graphic presentations were used to make comparisons and associations of the reanalyzed data from the two types of studies (EBF vs non EBF) under examination.

Results

The theses filtered and fitting with the inclusion criteria of the review are listed in Table (1) which shows the prevalence rates of overweight, obesity, stunting and wasting by age groups of 12-23 months, 24-35 months, 36-47 months 48-59 months and 60-72 months) according to the national and local studies in Egypt. Studies that were included for overweight considered overweight W/A Z-score +2SD (only EDHS), all the other studies BMI 85th to 95th centile as cut-offs. Studies used WHO, 2006 standards. Six studies were included from 2014 to 2020 with an overall prevalence of overweight of 5.4% being highest at age 24-35 months (6.9%) being highest in rural LE in 2020 (14.9%) [16]. Studies that were included for obesity by W/H Z-score +2SD (only EDHS), BMI >95th centile as cut-offs (all other studies). Six studies were included for overall prevalence and 5 studies for analysis by age group from 2014 to 2020 with an overall prevalence of obesity of 12.6% being highest at age 12-23 months (14.1%). Studies that were included for stunting considered overweight H/A (or recumbent length for children under 2yrs) Z-score -2SD for all studies. Six studies were included that followed these guidelines from 2014 to 2020 with an overall prevalence of 21.6% and highest for age group 12-23 months (23%) and lowest for the 48-59 months of age (9.2%) and ranging from 34% (slum Alexandria) to 6.6%. Five studies were analyzed by

age for wasting by W/H Z-score -2SD from 2009 to 2016 with an overall prevalence of 9.3% being highest at 12-23 months being highest in a study in rural LE (36%) compared to the national figure of 7.7% [14]. The values used were interpreted using the WHO growth standards of 2006 [14]. This is also shown in figure (2) which compares the indices by age group and shows the escalating rates in obesity vs the declining rates in stunting and wasting by age group.

Table (2) and figure (2) present the studies from which the data for overweight, obesity, stunting and wasting were extracted and reanalyzed by sex (males and females) which included 15 studies. It showed that prevalence of overweight and obesity was higher in males and that stunting and wasting were higher in females. Table (3) presents a descriptive comparison between the group with studies including children who were not all EBF and the group with the two studies of children who were EBF. The comparison is made for age groups 6-11 months, 12-23 months, 24-35 months, 36-47 months and 48-60 months and for sex (males vs females) in both groups under study. All nutritional indices were several times higher in the non EBF vs. the EBF studies across all age groups and by sex. This is also shown in figures 4, 5 and 6 for obesity, stunting and wasting respectively which also show that the higher figures in the non EBF were running closely with the high MF rates in these studies. Figure 7 illustrates the relationship between nutritional indices and child poverty sourced from UNICEF, 2015 [12].

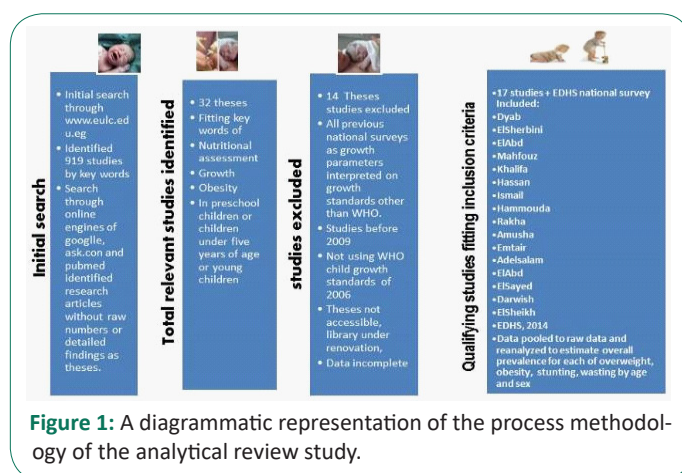


Figure 1: A diagrammatic representation of the process methodology of the analytical review study.

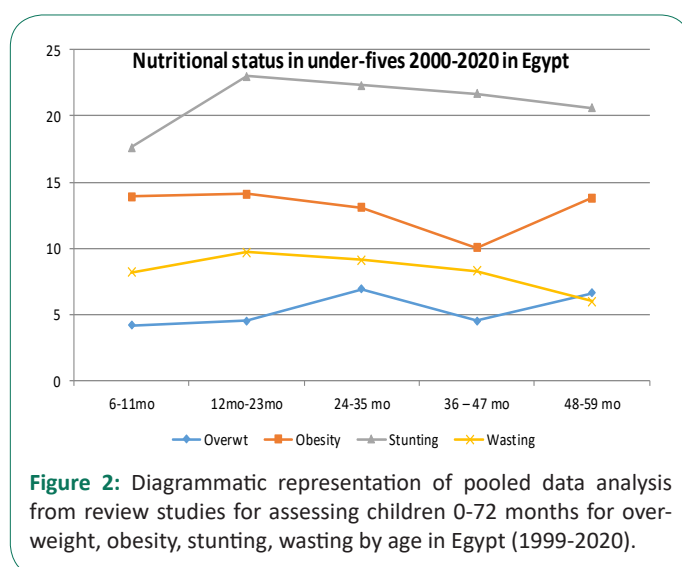


Figure 2: Diagrammatic representation of pooled data analysis from review studies for assessing children 0-72 months for overweight, obesity, stunting, wasting by age in Egypt (1999-2020).

Table 1: List of reviewed literature for nutritional status (Overweight, obesity, stunting and wasting) of children under-five presented by age group after excluding studies before 2009 which did not use the updated WHO growth charts:

Study	6-11 mo		12-23 mo		24-35 mo		36 – 47 mo		48-59 mo		Sample	# overwt	% overwt
	Total	Ovwt	Total	Ovwt	Total	Ovwt	Total	Ovwt	Total	Ovwt			
Overweight W/A Z-Score +2SD (EDHS) BMI 85 th -95 th centile (other studies)													
Ismail, 2014					1119	112	1281	54	51	26	2400	168	7.0
EDHS, 2014	1556	65	2872	132	2810	132	2826	90	2340	77	12404	496	4.0
Amushi, 2016			47	2	89	3	67	4	52	6	300	21	7.0
Emtair, 2016			108	5	62	1	63	2	67	2	300	10	3.3
AbdelSalam, 2016			0	0	0	0	0	0	0	0	311	20	6.4
Megahed, 2020			0	0	59	4	66	15	123	18	248	37	14.9
Total	1556	65	3027	139	4221	295	4373	195	2733	180	15910	874	5.4
Prev by age		4.2		4.5		6.9		4.5		6.6		5.4	
Obesity (BMI>95 th centile) Only EDHS (W/H+2SDS)													
Study	Pop.	#Ob	Pop.	#Ob	Pop.	#Ob	Pop.	#Ob	Pop.	#Ob	Pop.	#Ob	% Ob.
Ismail, 2014					1119	86	1281	28			2400	114	4.8
EDHS, 2014	1556	216	2872	409	2810	438	2826	393	2340	332	12404	1788	14.4
Abdel Salam, 2016			0	0	0	0	0	0	0	0	311	70	22.5
Amushi, 2016			47	1	89	3	67	4	52	6	300	18	6.0
Emtair, 2016			108	17	62	13	63	0	67	12	300	42	14
Megahed, 2020			0	0	59	2	66	7	123	6	248	15	6.0
Total	1556	216	3027	427	4139	542	4303	432	2582	356	15607	1973	12.6
% Obese		13.9		14.1		13.1		10.04		13.8		12.6	
Stunting (St) Z-score +2SD													
Study	Pop.	# St	Pop.	# St	Pop	# St.	Pop	# St.	Pop	# St	Total	Total	% St
Dyab, 2009							184	15	251	12	500	33	6.6
Abdel Salam, 2016			98	13	126	44	59	18	20	8	300	83	27.7
EDHS, 2014	1556	274	2872	660	2810	607	2826	636	2340	503	12404	2680	21.6
Emtair, 2016			108	36	62	25	63	15	16	26	300	102	34
Amushi, 2016			47	10	89	13	67	10	52	4	300	37	12.3
Harraz, 2020			0	0	0	0	0	0	0	0	200	35	17.5
Total	1556	274	3125	719	3087	689	3199	694	2679	553	13646	2929	21.5
% stunted		17.6		23.0		22.3		21.7		20.6		21.5	
Wasting (W/H Z-Score -2SD)													
Wasting	Pop.	# Wt	Pop.	# Wt	Pop.	# Wt.	Pop.	# Wt.	Pop.	# Wt	Total pop	Total wasted	% wasted
Dyab, 2009			0	0	0	0	184	31	251	10	500	51	10.2
EDHS, 2014	1556	127	2872	258	2810	236	2826	217	2340	133	12404	971	7.8
Abdel Salam, 2016			98	12	126	26	59	15	20	3	311	112	36.0
Emtair, 2016			108	33	62	15	63	12	67	16	300	76	25.3
Amushi, 2016			47	9	89	11	67	15	52	9	300	54	18.0
Total	1556	127	3297	322	3230	293	3554	296	3039	183	14676	1340	9.3
% Wasted		8.2		9.7		9.1		8.3		6.0		9.3	

Table 2: Nutritional status assessed for overweight (9 studies), obesity (8 studies), stunting (7 studies) and wasting (7 studies) of children aged 6 to 72 months in males and females in studies including children who were not exclusively breastfed (variable age groups from 0-72 months).

Study		Males			Females			Total		
		Total Sample	# Overwt	% Overwt.	Total sample	Total Overwt.	% Over wt	Total population	Total overweight	% obese
Over weight (W/L Z-score +2SDS) EDHS used W/A for overweight										
Ismail,	2014	1157	69	6.0	1243	99	8.0	2400	168	7
EDHS,	2014	7034	295	4.2	6567	263	4.0	13601	558	4.1
Amusha,	2016	153	11	7.2	147	10	6.8	300	21	7.0
Emtair,	2016	172	5	2.9	128	5	3.9	300	10	3.3
Abdel Salam,	2016	170	8	4.7	141	12	8.5	311	20	6.4
Hassan,	2015	160	24	15	125	18	14.4	285	42	14.7
Mahfouz,	2016	79	24	30.4	76	25	32.8	155	49	31.6
Megahed,	2020	129	10	7.75	119	27	22.7	248	100	
Total		9054	446	4.9	8546	459	5.4	17600	968	5.4
Obesity (Body Mass Index Z-score +2SDS)										
Khalifa,	2012	124	56	45.1	76	44	57.9	200	100	50
Ismail,	2014	1157	82	7.1	1243	32	2.6	2400	114	4.8
EDHS,	2014	7034	1076	15.3	6567	939	14.3	13601	2015	14.8
Hassan,	2015	160	7	4.4	125	10	8.0	285	17	6.0
Mahfouz,	2016	79	31	39.2	76	23	30.3	155	54	34.8
Amusha,	2016	153	10	6.5	147	6	4.08	300	16	5.3
Emtair,	2016	172	29	16.9	128	23	17.9	300	52	17.3
Abdel Salam,	2016	170	43	25.3	141	27	19.1	311	70	22.5
Megahed,	2020	129	12	9.3	119	3	2.5	248	15	6.05
Total		9178	1346	14.7	8622	1107	12.8	17800	2453	13.8
Stunting (height forage H/A Z-score-2SDS)										
Abdel Salam,	2016	170	53	31.2	141	34	24.1	311	87	27.9
EDHS,	2014	7034	1603	22.8	6567	1307	19.9	13601	2910	21.4
Emtair,	2016	172	59	34.3	128	43	33.6	300	102	34
Amusha,	2016	153	17	11.1	147	25	17.0	300	42	14
El-Sherbiny,	2018	165	12	7.3	178	13	7.3	343	25	7.3
Megahed,	2020	129	10	7.75	119	27	22.7	248	100	40.3
Total		7823	1754	22.4	7280	1449	19.9	15103	3266	21.6
Wasting (W/L Z-score -2SDS)										
Dyab,	2009	285	39	13.6	215	12	5.6	500	51	10.2
EDHS,	2014	7034	590	8.4	6567	558	8.5	13601	1148	8.4
Abdel Salam,	2016	170	34	20.0	141	24	17.0	311	58	18.6
Emtair,	2016	172	47	27.3	128	29	22.6	300	76	25.3
Amushi,	2016	153	28	18.3	147	21	14.3	300	49	16.3
Megahed,	2020	129	10	7.75	119	27	22.7	248	100	40.3
Total		7943	748	9.4	7317	671	9.2	15260	1482	9.7

Table 3: Comparison of pooled data for studies with formula fed (FF) children versus studies for children not exposed to FF (exclusively breastfed 0-6 months) with regards overweight, obesity, stunting and wasting by age group and sex of children 6-59 months of age.

Age/months/ sex	6-11	12-23	24-35	36-47	48-59	Males	Females	Population
Type of Study	Pooled population estimates by age and sex:							Total
EBF studies	574	718	247	196	265	996	1004	2000
% Overweight	5.4	2.4	2.4	1.5	4.5	5.5	4.3	3.45
% Obese	4.7	6.3	7.3	5.1	4.5	4.8	3.9	5.6
% Stunting	0.7	1.5	1.6	0.0	1.5	1.6	2.1	1.15
% Wasting	0	1.5	1.2	0.005	0.01	0.9	0.8	0.85
	Pooled population estimates and ranges by age and sex:							
Non EBF	1556	3125	3087	3199	2679			13646
% Overweight	4.2	4.5	6.9	4.5	6.6	5.7	6.06	5.4
% Obese	13.9	14.1	13.1	10.04	13.8	14.7	12.8	13.8
% Stunting	17.6	23.0	22.3	21.7	20.6	20.8	18.4	21.6
% Wasting	8.2	9.7	9.1	8.3	6.0	9.06	8.8	9.7

Percent (%) Overweight: weight for recumbent length or standing height (W/H) Z-score +2SDS, % Obese: Body mass index (BMI) Z-score +2SDS, % Stunting: height forage H/A Z-score-2SDS, % Wasting: W/H Z-score -2SDS according to WHO Child Growth standards, 2006. EDHS used W/H Z-score +2 SDS for obesity as BMI was not estimated. All other studies after 2009 used WHO BMI standards >95th centile for estimating obesity.

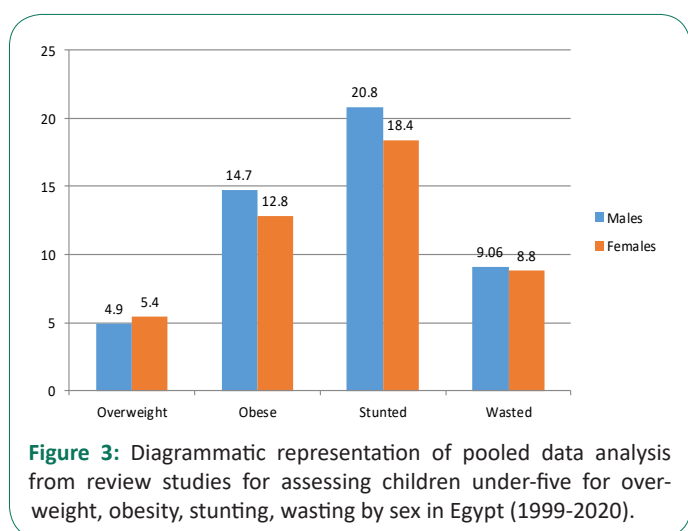


Figure 3: Diagrammatic representation of pooled data analysis from review studies for assessing children under-five for overweight, obesity, stunting, wasting by sex in Egypt (1999-2020).

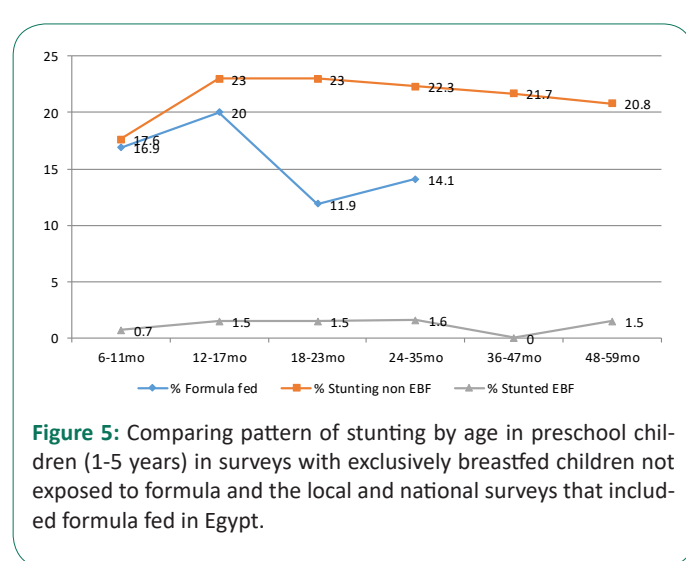


Figure 5: Comparing pattern of stunting by age in preschool children (1-5 years) in surveys with exclusively breastfed children not exposed to formula and the local and national surveys that included formula fed in Egypt.

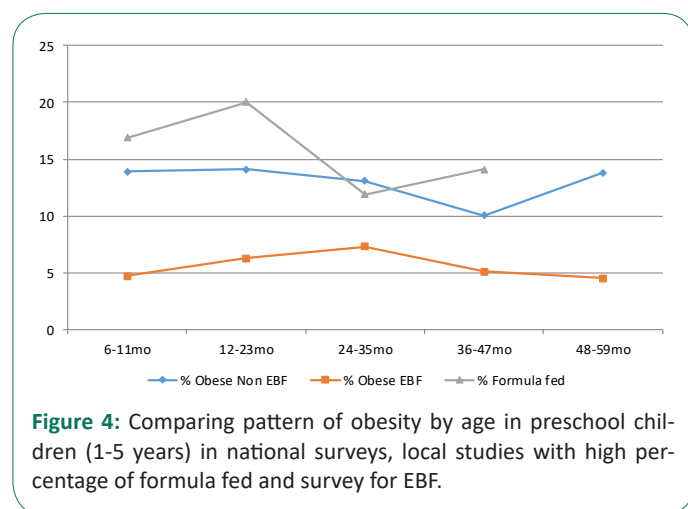


Figure 4: Comparing pattern of obesity by age in preschool children (1-5 years) in national surveys, local studies with high percentage of formula fed and survey for EBF.

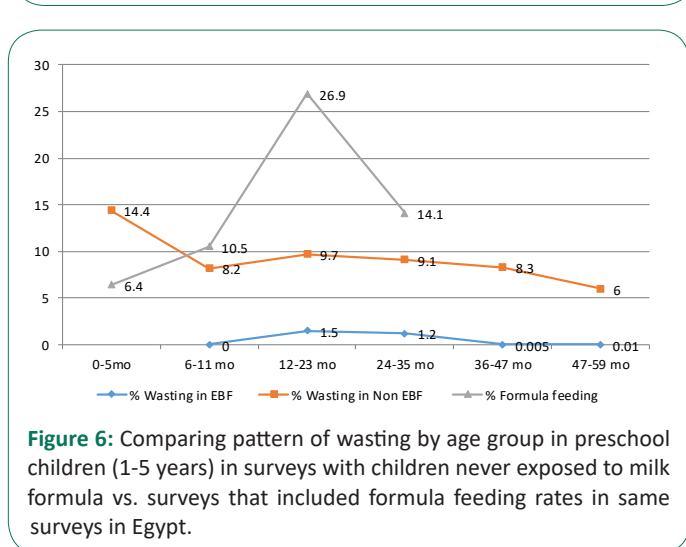


Figure 6: Comparing pattern of wasting by age group in preschool children (1-5 years) in surveys with children never exposed to milk formula vs. surveys that included formula feeding rates in same surveys in Egypt.

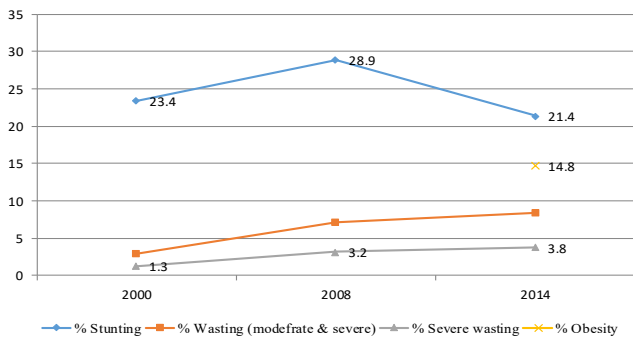


Figure 7: Diagrammatic representation of relationship between percent child poverty in relation to stunting, moderate wasting, severe wasting and underweight in preschool children from the year 1999/2000 to 2013/2014 (source of data UNICEF, 2015).

Discussion

Before presenting the recent review studies that included overweight and obesity, we tried to review research in Egyptian universities that were conducted before the turn of the century. One of the earliest studies in the review process of nutritional status of preschool children in Egypt was conducted by Rantisi in 1976 [17] in Alexandria who used the Wolanski values given by Jellife [18] in 500 preschool children (0-72 months) and showed that underweight was 3.4%. Underweight and wasting were the main concern in this decade. In the 1980s [19] a study of 608 young children attending outpatients in Alexandria showed that stunting was 20.5%, underweight 16.9% and wasting 22.6% using the Boston standards [20]. Underweight and wasting peaked at 12-18 months. In this period, no overweight or obese children were reported. Even in the decade that followed emphasis was not on obesity in this age, but stunting was an emerging problem. With the turn of the century in 2000, a study in Alexandria [21] reported that children with overweight and obesity were 4.2%, rising from 2.5% at 30-47 months to 6.2% at 48-60 months and underweight in 9.7% (6.1% at 30-47 months and 14.2% at 48-60 months). Stunting was detected in 5% of the preschool children 3.0% at 30-47 months and 7.4% at 48-60%. Wasting was 5% (3.0% in the 30-47 months and 7.4% in 48-60 months aged preschoolers). Low socioeconomic status was significant for underweight, wasting and stunting (OR=3.1, 3.62 and 4.96 respectively at $P < 0.05$) [21]. The latter study used the WHO/NCHS growth standards which tend to underestimate overweight and obesity compared to the new growth standards of WHO in 2006. The reported rates of overweight and obesity by EDHS using the NCHS system was 10.2% while it was 15% by the WHO, 2006. Hence the study in 2000 that reported a prevalence of 4.2% may have actually been at least one third higher. Two decades later in 2017, a study in Gharbia [22] reported that prevalence of stunting, wasting and underweight were 31.9%, 2.2% and 9.1% respectively, with severely stunted children ($< -3SD$) being 11.8%, indicating a horrendous rise in stunting probably attributed to the epidemics of the influenza virus, and SARS over this period that deprived children from eating poultry and eggs together with the political up rise in 2011 and the economic demise that followed [22]. The indices for wasting and underweight were higher in preschoolers below 36 months of age, and for stunting which was highest at 36-47 months (36.3%). Stunting was higher in males (33.3%) compared to females (30.3%) while wasting and underweight were much lower in males (2.4% and 9.9%) than in females (2.1% and 8.2% respectively) [22].

The new millennium witnessed a gush of research that took into consideration overweight and obesity among preschool children as an emerging problem in both child health and medical practice. A study in 2008 [23] conducted in Cairo governorate for 513 preschool children aged (3-5 years) retrieved from child care centers reported that the prevalence of overweight by W/H was higher than obesity (11.9% vs. 5.5%). Overweight was higher in males than in females and obesity higher in females than males (12.8% in boys and 10.8% in girls for overweight and 3.5% in boys and 7.8% in girls for obesity). Prevalence of overweight, by BMI, was 10.9% (11% in boys and 10.8% in girls) and prevalence of obesity was 6.6% (4.3% in boys and 9.5% in girls) respectively. Underweight, was 0.6% (0% in boys and 1.3% in girls), wasting was 1.9% (2.5% in boys and 1.3% in girls) and stunting was 4.3% (2.8% in boys and 6.1% in girls) respectively. Overweight and obesity were clearly an emerging problem that had been in the dark for the past decade and had shown a sudden surge paralleling the steep rise in digital technology that grounded and invaded the minds and lives of these children with digital games and toys that interfered with their childhood development and made their bodies and mind captive to this technology [24]. However the low protein intake further encouraged the reliance on dairy products and carbohydrates that were feeding the rise in obesity in this period.

The EDHS [11] in 2014 was the first national survey to report overweight and obesity at 14.9%, as none of the previous EDHS national surveys considered these indices [25]. They reported minimal differences between males (15.3%) and females (14.3%). Stunting was strikingly higher in males (22.8%) than females (19.9%) in their survey. The prevalence of obesity was highest in urban LE (17.3%), urban LE (16.8%), rural LE (16.3%) and 14.7% in urban governorates, but lowest in Frontier (8.3%) and rural UE (11.9%). Stunting was highest in UE (29.8%) vs. Urban LE and urban governorates (19.0%). Wasting was 8.4% being highest in frontier and rural LE governorates (8.3% and 11.9%) vs. LE and urban governorates (17.3% and 14.7% respectively). The findings indicated that the burden of overweight and obesity was mostly in urbanized communities and thereby linked to the technology and digital marketing technologies that were prevailing in these regions [26]. Moreover it was linked with social class that could afford to purchase this technology as it was highest in the children of from families with highest quintiles of wealth (WQ4=15.0% and WQ5=17.7%) and lowest in WQ2 (12.8%). There was no difference in the prevalence of obesity by the level of education of the mothers of these children [11].

A study conducted in Sharkia governorate for 4-6 year old children in the period between 2008-2010 showed that one out of five children exhibited overweight or obesity in rural areas, while one out of four children exhibited overweight or obesity in urban areas [27]. Another study in Sharkia governorate in 2018 reported that prevalence at 24-71 months aged children was as follows: underweight (3%) overweight (19.8%) and obesity (10.6%) using the Egyptian growth standards [28].

A study in Cairo governorate in 2014 [29] for the 3-6 years age group reported that prevalence of stunting was 32.6% and underweight 17.8%. Obesity (assessed by W/H Z-score +2SD) was similar to the EDHS findings at 15% and was linked to higher class and higher maternal education [29].

Another study in the same time [30] in Mansoura City in LE showed that prevalence of obesity and overweight was more than double that reported by the national study being about

one third of the studied sample (33%). Mother's knowledge and feeding habits played an important role in the problem and they recommended that education programs for prevention and control of obesity should target mothers and caregivers [30].

However later in the second decade of the 2000s, obesity started manifesting and rising even in rural areas. This was an alarming sign as it signaled the spread of the epidemic of obesity throughout the country doubling the burden of under and over nutrition in these underprivileged areas. The phenotype of the stunted and stout child and adult became a common finding in the fast food outlets in the urbanized communities. A study by the team in High Institute of Public Health (HIPH) in Alexandria University in the rural area in Kafr ElSheikh governorate in LE (2016) [31] reported that prevalence of obesity was 23.65%, stunting 28%, being moderate in 22.5% and severe in 5.5% of preschool children, thus typifying the stunted stout child phenotype of the new century. Stunting was highest in the 24-35 months with more severe stunting that declined at 36-47 months, so that at 60-72 months there were no severely stunted children and moderately stunted were 5.7%. Males were more stunted than females. Severe wasting was 18.6% and moderate wasting 6.4% and the former was highest in the 4 year old (34.2%), while the latter was highest in the 12-23 months (25%) and 24-35 months (50%) and more in males as shown in tables (1 and 2) [31]. Although it may appear that stunting declines with age, wasting on the other hand potentiates the rebound stunting evident in later childhood and puberty [13]. We postulate that early wasting masks the long standing micronutrient deficiency states which become accentuated with obesity resulting in the short and stout adolescent and adult.

The same team in the HIPH confirmed the above findings. A study in 2016 in an urban area in Alexandria [32] reported prevalence in preschool children of overweight was 3.3% and obesity >95th centile was 17.4% with severe obesity >97th centile 13.7%. Overweight was prevalent more in males (66.1%) and at 24-35 months. Whereas stunting was 19.3% still high and peaked at 12-23 months age group (34.5%) and at 48-59 months (27.6%), mostly in males (63.6%). Moderate wasting still persisted and was 14.3% and peaked at 12-23 months age group (51.2%) and at 48-59 months (20.9%) and severe wasting (-2 to -3 Zscore) was more at age 24-35 months (30.3%). Wasting was more in males (62.8%). Hence the double burden of malnutrition was characteristic of urbanized areas too, with severe forms of obesity starting to emerge even in these very young children with superadded stunting and wasting [32].

On the other hand the same research team in HIPH showed that in rural settings in Alexandria [33] that studied the nutritional status of preschool children reported that both overweight and obesity were 8% and obesity alone >97th centile was 4.3%. One half of the overweight and obese were among the 48-59 months of aged (55.6%) and mostly among the males (66.7%). Stunting was 12% and peaked at 12-23 months age group (27.8%). Wasting was 12% and mostly at 24-47 months (63.9%) and in males (69.2%). These two studies in two different region in Alexandria demonstrated that more severe obesity was a characteristic finding of urban Alexandria (13.7%) vs rural Alexandria (4.3%) reflecting the role of urbanization and differences in exposure to dietary practices between urban and rural communities [32,33].

These patterns brought the attention of research workers in Alexandria later in 2019 [34] to study this pattern in relation to formula feeding. They studied 796 children 3-5 years attending

day care centers in Alexandria. They reported that 14% of the children were wasted and 10% were obese and less than one quarter (22%) overweight. Less than one fifth (17.1%) of them were bottle-fed with a mean duration of 17.08 ± 7.70 months. They concluded that the prolonged MF feeding was linked to the emerging problem of obesity. This is demonstrated by figures (5, 6 and 7) in our results, which demonstrate the link between the increasing use of MF beyond the first and even the second year of life indicating the active marketing of the so called "Growing Milks" to the community as a continuum of MF in infancy leading to the obesity of overconsumption [35].

A study in rural Qalubiya in 2017 showed that the prevalence of stunted growth in preschool children of the studied group was 13.32%. Stunting was more in large sized family (over 3), child order and family history of short stature, maternal anemia during pregnancy and no iron supplementation, cesarean section and incubator care [36].

By the end of the second decade a new alarming trend in obesity emerged as they showed that although prevalence of obesity was 6% and overweight 15% yet prevalence was 13.3% in those aged 2-3 years, 46.7% in those aged 3-4 years of age and 40% in those aged 4-5 years [16]. This indicated that obesity was creeping to rise in older ages. The sample was small (248 2-5 years aged children) in rural Tala district in the north of Menoufia governorate (LE). Prevalence was again higher among males 80% vs females 20% and linked with high levels of education (86.7%) $P=0.003$, middle or low socioeconomic status ($p=0.05$) [16]. The higher rates of obesity among males is documented in other middle income countries in our region, where in Iran prevalence in preschool children was reported as 9.6% in males and 6.3% in females which are close to many of our studies in this period [37].

In 2021, a study [38] in the delta region of LE in Gharbia and Beheira including 445 preschool children <6 years of age showed that overweight and obese (OWOB) were 11.5%, and (8.1%) had stunted growth, while (2%) had double burden of stunted growth and OWOB i.e. stoutness. The majority of children with OWOB and those with the double burden were girls aged 60 - <72 months. On the contrary, stunting was common in boys and in the age group between 48 - <60 months. Approximately, two thirds (66.7%) of children who were suffering from stunted growth or the double burden were living in rural areas, but 70.6% of OWOB children were from urban areas. This study confirmed the trends of migration of obesity from urban areas into rural increasing the burden of malnutrition and chronic diseases as diabetes mellitus as shown in a study in India [39] and bronchial asthma as shown in a study in Ismailia [40].

Figure (7) shows that child poverty was running closely in parallel with the indicators of malnutrition for wasting and stunting indicating that much of these problems are linked to poverty and its adjuncts (ignorance and vulnerability) that can make mothers be at risk of misinformation and be misled by the fake messages for marketing baby foods and milks. Large family size and short birth intervals characterize communities living in poverty. Studies seemed to show that obesity was associated with large family size but not with birth intervals. The EDHS study in 2014 showed that obesity was high in those with birth intervals of +48 months (15.0%) and 24-47 months (14.7%) compared to <24 months (13.5%). In Gharbia governorate [38] about half of families of children with double burden (55.6%) had more than 3 children in the family and the affected child order came after the third. More than three quarters of families had large

household size (>5) and one third had unsuitable houses. About one quarter of these families had unsanitary water supply, unsanitary sewage disposal, and insufficient food. Electricity was not available for 11.1% of these families. The study in Cairo [29] reported that obesity was linked to families with over 3 children ($P=0.000$) [41].

Regarding Breastfeeding and malnutrition in the preschool children, two studies were conducted by our team that assessed the nutritional status of children 6-59 months who were all EBF in the first 6 months of life. The studies were in Gharbia [42] and in Menoufia [43] for a total of 2000 children. Overweight was detected in 4.8% and 2.2% respectively and obesity in 7.7% and 3.6%. Obesity was highest in 48-59 age groups in Gharbia (9.3%) and 6.5% in the second year of life in Menoufia. Figure (4) compares the prevalence rates of overweight and obesity by age in these two studies with the other studies that included children who were formula fed and with the rates of formula milk feeding by age. Stunting was 1.7% in Gharbia and 0.6% in Menoufia which was much lower than the other studies as shown in figure (5). Wasting was as also lower in the EBF studies with EBF vs. those with formula fed (1.1% in Gharbia and 0.6% in Menoufia) as shown in figure (6). The high obesity rates in the 4-5 year old children in Gharbia was attributed to dietary patterns of feeding milks and diet high in carbohydrate and sugars. The malnutrition rates in the other studies were closely paralleling the rates of milk formula intake.

Early initiation of breastfeeding and colostrum feeding were shown to be protective against obesity in Alexandria [32,33] and in Kafr ElSheikh (LE) [31]. Another study in Gharbia [29] demonstrated that colostrum feeding was significantly associated with decreased prevalence of stunting and underweight. Children not receiving colostrum had 3.45 times risk of underweight relative to those receiving colostrum. The study in Kafr ElShekh [31] showed that early vs late initiation of breastfeeding and longer duration of breastfeeding was protective against obesity. While longer periods of formula feeding and early introduction of foods at 3 months and abrupt weaning off the breast were associated with obesity ($p<0.05$) [31]. Another study showed that all the obese children had received formula milk with or without breastmilk and continued formula milk feeding up to 18 months of age in the obese. While the more recent reviewed study in Sohag [44] showed that obesity was higher in MF fed (23.07%) and that none of non-formula fed were obese $P<0.03$. The study showed that 19.8% of the normal children were exposed to formula whereas 31.6% of the overweight and 28.6% of the obese were exposed to FF. In the Port-Said study [46] obesity was associated with MF and mixed feeding vs. EBF children. This was reported also by other studies [21,45]: While the study in Port Said showed that starting MF before 20 days of age significantly increased the risk of obesity [46].

The Suez Canal university research team [47] highlighted in their research that early age of weaning (before 3 months) and carbohydrates as a main type of weaning food were significantly associated with overweight and obesity in preschool children and that EBF protects against obesity ($P<0.03$). This was substantiated by other studies [46]. A study in Alexandria by the Faculty of Nursing team of research showed that normal non-obese children had higher rates of breastfeeding, i.e. in the normal children 44% were breastfed (BF) while 14.6% were FF, while in the overweight and obese 38.9% were BF vs. 26.2% were FF [34].

The Tanta university team of researchers in Gharbia [38]

reported that less than half of children in the double burden group (44.4%) and more than one third of overweight and obese children were bottle-fed, while about one third (33.3%) of children in the double burden group were BF and started BF within 24 hours. EBF was not practiced by less than half of double burden children, overweight and obese group and one quarter of stunted children were not EBF and about one quarter of double burden children were BF for less than 4 months. More than half of double burden group (55.6%), about two thirds of OWOB group (64.7%) and (61.1%) of stunted children started weaning before the age of 6 months. Hence early termination of BF was linked to the double burden group and overweight and obese children [38].

In the early 1980s malnutrition and diarrheal disease attributed to bottle feeding and early cessation of breastfeeding peaked under the effect of the aggressive marketing for BMS around the world with its devastating effects in developing countries. The Egyptian Ministry of Health officials responded early to this crises by giving full support to the International Code of marketing of breastmilk substitutes (The Code) and released ministerial decrees in 1979 and 1981 to prohibit the marketing of these products in health facilities and public places [49]. However breastfeeding practices remained poor and were linked with malnutrition. Egypt was one of 12 flagship countries to adopt the Ten steps of the Baby-friendly Hospital Initiative in the early 1990s and released a decree through the undersecretary of primary health care to promote Baby friendly practices and prohibit advertising of Breast-Milk Substitutes (BMS) in all health facilities. By the mid nineteen nineties (1995) Egypt declared 126 of its health facilities providing maternity and neonatal care services to mothers around the country as Baby-friendly and represented the lead country with these figures in the Eastern Mediterranean region and around the world [50]. However in the decade that followed Baby-friendly hospitals reversed their practices and the Ten steps were no longer implemented this led to a decrease in the early initiation and increase in the early introduction of MF and decrease in EBF in the first six months of life from 54% to 39% BF for into the second year fell from 40% to 20%. Our study showed that MF took the upper hand in the second year and beyond probably under the effect of Growing Up Milks (GUM) (Figures 4,5,6). Hence much of the obesity is linked to the extended MF feeding for over 2 years that encourages consumption of large amounts of high fat milk. This is supported by the review studies that showed that many of the mothers were bottle feeding after 18 months and well into the third year of life. This could be attributed to the aggressive marketing for the so called GUM. Also a high percentage of children were fed packed potato chips (71.1%) and canned sugary drinks on daily or weekly basis 57.9% [31-33]. These were significantly associated with overweight and obesity. Sedentary life with less physical and outdoor activities was more common in the obese group. The studies also showed that hereditary factors played a role and that overweight and obese parents had overweight and obese children. However this could have been due to the tendency of these families to consume large quantities in their family meals and consequently over feed their children [51].

Obesity was shown by several studies to be associated with micronutrient deficiency states. Anemia was reported to more prevalent in the obese in study carried out in Kafr ElSheikh [31]. The overall prevalence of moderate anemia was 58%, mild 27% and normal 15%. Vitamin A deficiency detected by Xerosis in the eye (17 cases) and Bitôt spots (18 cases) was significantly higher in the obese (50.0%, 52.9% respectively) than normal

weight preschoolers (22.2%, 29.4% respectively) $p=0.02$ [31].

In rural Alexandria the preschool obese children had a mean hemoglobin (Hb) of 11gm/dl with a prevalence of anemia of 75% vs 67.5% in the normal preschoolers under study. VAD was with Xerosis in the eye was reported in 2.7% and Bitôt spots in 23.3% in the whole population under study. VAD as Bitôt spots was detected in 3 (4.3%) of obese and 3(12%) as follicular hyperkeratosis out of a total of 70 (23.3%) and 25 (8.3%). Also 2 and 5 of the obese children showed signs of VDD (broadening of the epiphysis and bowing of the legs) [33]. In urban Alexandria [32] 20.4% of obese children presented with xerosis, 28.6% keratomalacia, 22% Bitôt spots and 11.1% follicular hyperkeratosis. Also among the obese VDD clinical signs were seen as bowing of the leg in 21.4%, bossing of the head in 23.7% and craniotabes in 33.3%. Obese children also showed signs of vitamin B complex deficiencies as angular stomatitis in 21.1% and atrophied glazed tongue in 29.6% [32]. In Gharbia showed that a 8.3% of stunted children had history of rickets and 11.1 % of double burden. Less than half of double burden (44.4%) and about one third of stunted children (33.3%) had history of anemia that is not yet treated. Pallor in the studied children, more than three quarters of double burden group (77.8%), more than half of overweight and obese group (52.9%) and (55.6%) of stunted group vs. one third of normal group (38.7%) who had mild pallor [38]. A number of studies examined the health status of preschool children and showed that there was a positive link between early feeding status and health status and that MF feeding, daily and unlimited access to snacks and canned juices were significantly higher in the obese children [52-54]. Studies showed that poor parental knowledge of optimal dietary practices [55] which had a negative effect in nutritional indices. Sedentary life and inactivity were shown by most of the reviewed studies in all regions in UE and LE [55-57]. Unfortunately, poor attitudes of care takers in nursery day care centers towards optimal nutritional needs of these children, was described in some studies. They recommend training them and incentivizing them to raise nutritional awareness to parents and children [58,59]. In addition care taker in day care nurseries resorted to punishing children by depriving them of sports in many cases hence the need for intervention programs in this respect.

Limitations

Studies on prevalence of obesity in the preschool age group were limited in Egypt. Only after 2014 that research work was intensified in this field. In-depth studies are needed to examine the relationship between preschool obesity and obesity later in life. These require longitudinal cohort studies. The link between early MF and the amounts consumed was not examined and there was poor focus on EBF. Although BF appears to be protective, it is the intensity of feeding formula milk especially the follow-on formula and GUM that need to be examined in more detail in relation to overweight, obesity and the associated nutritional problems of stunting and micronutrient deficiencies states linked with reliance on milks and dairy products rather than on fresh foods. More important is to examine how food snacks and sugary drinks increase their milk intake i.e. whether there is a correlation between high milk intake and high intake of salted snacks and canned sweetened beverages. Also no qualitative studies that could go in-depth with the root causes of obesity in this age were found. Mental health problems associated with obesity were not studied in depth.

Conclusions

The problem of overweight and obese children in early childhood has emerged only recently, over the past decade. This increased the burden of malnutrition and was associated with an increase in stunting and wasting in preschool children. The dietary patterns causing obesity could have also affected the increased stunting. The prominent finding was the increase in the MF beyond two years of age. Children who were EBF in the first six months, and not exposed to MF, showed significantly lower rates of overweight and obesity and negligible rates of stunting and wasting. Obesity was associated with increases in micronutrient deficiency states as iron and vitamin A and D and even B complex deficiency. Obesity seems to be influenced by the suboptimal early infant feeding practices and the superadded poor dietary practices of high fat, fast foods and sugary beverages, confounded by restricted outdoor activities and high milk intake in these years. It will take defiance of the giants ruling the world economy to arrest the commercialized feeding of MF and packed and unhealthy sweetened, salted or fried fast foods to children. Children living in poverty are victims to exploitation by markets that prosper at the expense of the health and survival of poor economies. Also improving our understanding of factors driving fat gain in young children should increase our ability to manage the rising problem of obesity.

Recommendations: The recommendations are consistent with those of the World Health Organization for controlling the aggressive marketing and commercialization of breast-milk substitutes, MF, GUM, baby foods and beverages for young children. Member states should implement policies to control advertisements and marketing tactics targeting the public especially mothers and family members in public areas, shopping outlets, on television and through digital marketing and cross border marketing [6,7]. The control measures should support messages that raise awareness of the public and the care takers in families and day care centers and schools to importance of healthy foods and dietary habits, and dangers of responding to marketing i.e. raise their media literacy, as well as encourage exercise, healthy life styles of activity, exercise, sleep and play. Also health and medical staff need to be advocates and become engaged starting by medical and nursing schools curricula, in their practice and by pressuring policies through advocacy campaigns. Encouraging awareness campaigns that counter the marketing messages and tactics used by industry, whilst encouraging foods, dietary habits and life styles that promote, support and invest in a paradigm shift to return to nature.

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