Curr Pediatr Res 2024; 28 (08): 1-10
ISSN 0971-9032
www.currentpediatrics.com

High blood pressure and obesity: Is not-breastfeeding an added risk for children with benign congenital heart disease

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Received: *24 July, 2024, Manuscript No. AAJCP-24-144987;* **Editor assigned:** *26 July, 2024, Pre QC No. AAJCP-24-144987 (PQ);* **Reviewed:** *12 August, 2024, QC No. AAJCP-24-144987;* **Revised:** *19 August, 2024, Manuscript No. AAJCP-24-144987 (R);* **Published:** *26 August, 2024, DOI:10.35841/0971-9032.28.07.2312-2315.*

Abstract

Background: The rising burden of Cardiovascular Disease (CVD) risk factors of obesity and Elevated Blood Pressure (EBP) from early childhood can aggravate consequences Congenital Heart Defects (CHDs). The aim was to identify associations of early feeding, EBP with CHD and obesity.

Method: A sample of 150 children randomized into 50 breastfed, 50 non-breastfed and 50 mixed fed children aged 3-5 years examined for early feeding practices, EBP and nutritional assessment through anthropometric measurements for estimating Body Mass Index (BMI) and hemoglobin. Doppler studies were carried out to detect CHD.

Findings: Diastolic EBP, but not systolic EBP, was detected in non-breastfed *vs.* fully breastfed. Obesity was positively associated with systolic and diastolic EBP in either sex. Early breastfeeding was protective, while not breastfeeding, bottle feeding with additives, pacifiers, Unhealthy Food Intake (UFI) were associated with EBP. Doppler studies detected 16 cases (10.67%) with CHDs, mostly Mitral Valve Prolapse (MVP) in 7(43.7%) followed by Tricuspid Regurge (TR) in 3(18.75%), Atrial-Septal Defect (ASD) in 1(6.25%) and Ventricular-Septal Defects (VSD) in 1(6.25%). EBP and obesity tended to be common with UFI and non-breastfed but they were not significant ($p<0.05$).

Conclusion: Obesity and EBP start from early childhood; this could affect future cardiac dynamics. Breastfeeding may be physiologically and developmentally beneficial for these children by protection against CVD risk factors as obesity and EBP. Close watch of patients with CHD from an early age is recommended to detect hemodynamic changes affecting the cardiac function especially among children who are obese and hypertensive. Promoting breastfeeding and healthy food intake is important to prevent CVD.

Keywords: Congenital heart defects, Obesity, Hypertension, Breastfeeding, Bottle-feeding, Mitral valve prolapse, Commercial Milk Formula Feeding (CMFF).

Accepted on 20th August, 2024

Introduction

Cardiovascular Diseases (CVD) are recognized to emerge from early childhood. The focus on pediatric cardiology has been on Congenital Heart Disease (CHD) [1]. CHD affects approximately one in every one hundred infants worldwide, making it one of the most prevalent birth abnormalities global. Hypertension or Elevated Blood Pressure (EBP), is a global public health problem, as it is a risk factor for CVD and Chronic Renal Disease (CRD). It affects approximately 1.3 billion people and is responsible for 7.5 million deaths a year. Egypt has the highest prevalence of hypertensive disease (26.3%) which is higher than USA (24%) has increased over the past 2 decades to 29% ranging from 12.1% to 56% [2]. Findings of EBP in preschool children are rarely reported. In school students EBP ranged from 5.1% in Kuwait [3] and 4.30% among preparatory school children in Alexandria [4] to 3.6% among school children in Jordan [5].

Childhood obesity has emerged as a novel global epidemic, becoming a major public health issue. Obesity can have profound effects on cardiac hemodynamics and morphology accentuating the effects of CHD. However the link between the combined effect of the presence of CHD and the dynamic disturbances caused by obesity, EBP which are starting to appear from early childhood need to be verified. Moreover, early suboptimal feeding practices (by not breastfeeding) have been shown to be associated with HBP and obesity. Hence the importance of addressing early feeding practices leading to obesity which can influence cardiovascular health [6]. Obesity-induced alterations in cardiac function and EBP are interlinked and can both have significant implications for cardiovascular health and may contribute to the increased risk of heart-related complications and renal disease especially among individuals with CHD.

Nutritional status is influenced by early feeding practices including breastfeeding, intake of Commercial Milk Formula (CMF) and adequate, diverse healthy complementary food intake. Unhealthy foods high in salt can burden the kidney; interfere with aldosterone-angoitensin-renin maturation predisposing to EBP and renal disease. CMF and high salt in weaning foods can lead to obesity. Although children with CHD tend to be underweight especially younger children under 5 years old with severe CHD 9.8% *vs.* 4.9%, but the difference is normalized in children over 6 years of age. However, obesity rates are increasing even in children with more severe CHD such as Fontan, Tetralogy of Fallot, transposition of the great arteries showing a percentage of overweight children in the excess of 29% [7]. Doppler studies are useful in detecting mild lesions of CHD to prevent later cardiac problems. However, although literature is monitoring the climbing rates of obesity and EBP and their effect on the cardiac function, there is still much to be discovered in this field. The aim of this study is to identify status, determinants and any associations of findings of CHD by Doppler studies with EBP, obesity and in relation to early feeding practices in children under-five years of age. This could impact future management, preventive health strategies and country policies that can minimize the high economic costs in managing these conditions.

Materials and Methods

Study sample included 150 children (males and females) attending in the outpatient department of Damanhur teaching hospital in Behira, Egypt were selected and randomized into fully breastfed from birth 50, fully Commercially Milk Formula fed (CMF) from birth 50 and mixed fed 50. The study was carried out over period from June, 2023 to March, 2024. Inclusion criteria included aged 3-5 years of either sex, apparently healthy or whose mothers were willing to participate. Exclusion criteria included freedom from any severe malnutrition, anemia, acute infectious disease, dehydration or chronic disease or exposure to parents who were heavy smokers. They were interviewed *via* a structured questionnaire about their socio-demographic background, perinatal history, early feeding practices, current feeding practices and family history of cardiovascular disease or diabetes mellitus.

The children were subjected to a thorough clinical examination. Anthropometric measurements were taken for standing height to nearest cm, weight in grams, Mid-Arm Circumference (MAC) and Waist Circumference (WC) to the nearest mm. The Body Mass Index (BMI) was calculated from the weight and height using the WHO methods and BMI tables [8]. These were recorded and plotted on the standard growth charts for children 0-5 years of the World Health Organization [9]. Hemoglobin levels (Hb) were assessed to exclude significant anemia. Blood Pressure (BP) measurements were taken for systolic and diastolic blood pressure using a standard sphygmomanometer and under standard conditions [10]. The BP values are interpreted using the BP nanograms centile curves developed for Egyptian children by El-Shafie et al. [11].

Echocardiographic assessment was carried out using standard methods as M-mode, 2D echocardiogram in different views and Doppler Pulsed Wave (PW) and Continuous Wave (CW) in the parasternal (in short and long axis views), apical and subcostal views which are most suitable for children as described by others [12,13] for detecting valvular lesions as Mitral Valve Prolapse (MVP), Tricuspid Regurgitation (TR) and endocardial cushion defects Atrial or Ventricular Septal Defects (ASD/VSD).

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 26.0. (Armonk, NY: IBM Corp) quantitative data were described using mean and standard deviation analysis was done by Chi square-test (x^2) for comparison of qualitative data of frequency distribution. Student's "T"- test was used for comparison of quantitative data of 2 independent sample with normal distribution variables and one way Analysis of Variance (ANOVA) test for comparison of quantitative data of more than 2 independent samples with normal distribution variables. Correlation between groups were done using Pearson correlation test. The coefficient interval was set to 95%. The level of significance following probability (p) values of $p<0.05$ was used as a cut off for being statistically significant.

Results

The socio-demographic showed no differences with a mean age of around 4-5 years and no sex differences mostly living in slum areas. Two thirds of the parents had some kind of Cardiovascular Disease (CVD) and all children were highly exposed to tobacco from a smoking parent. Wasting with BMI for age <3rd centile was 6.67% ranging from 10% in the fully breastfed to 6% in the Commercial Milk Formula Feeding (CMFF) and 4% in the mixed fed with no significant difference between the groups (P>0.05). BMI for age >97th centile indicative of obesity was 12% ranging from 8% in the breastfed to 18% in the mixed fed with no significant difference between the groups (P>0.05). No differences were noted in WC. MAC was significantly higher in the fully breastfed (16.6 ± 2) compared to Commercial Milk Formula Feeding (CMFF) (15.9 ± 2.1) and mixed fed (15.3 ± 2.8) at (P=0.01). Hemoglobin levels <11 gm/dl was 10% with no significant differences between the groups and no significant clinical pallor requiring further investigation, the results are shown in the tables below.

Clinical data related to BP showed elevated DBP in the girls who were exposed to CMF and not breastfed. In Table 1 overall cases with ESBP in girls were 4 (5.1%) and none in boys (0%) with no ESBP in either sex. Pre-ESBP (>90th-95th centile) was detected in one quarter of the cases (22.2% in boys and 26.9% in girls) and pre-EDBP in one third of the cases (29.2% in boys and 35.9% in girls (Table 1).

	Fully breastfed	Never breastfed	Mixed**	Total	p-value
	N=50	N=50	N=50	(150)	
Age in months					
Sex					
Male	25 (50%)	23 (46%)	24 (48%)	72 (48%)	0.92
Female	25 (50%)	27 (54%)	26 (52%)	78 (52%)	
Residence					
Urban	13 (26%)	19 (38%)	12 (24%)	44 (29.33%)	0.56
Rural	16 (32%)	15 (30%)	18 (36%)	49 (32.67%)	
Slum	21 (42%)	16 (32%)	20 (40%)	57 (38%)	
Family history					
Hypertension	18 (36%)	19 (38%)	19 (38%)	56 (37.33%)	0.99
Heart disease	15 (30%)	16 (32%)	15 (30%)	46 (30.67%)	
Diabetes mellitus	17 (34%)	15 (30%)	16 (32%)	48 (32%)	
Exposure to smoking					
Father	20 (40%)	27 (54%)	24 (48%)	71 (47.3%)	0.16
Mother	0	0	0	0(0%)	
No exposure	30 (60%)	23 (46%)	26 (52%)	79 (52.67%)	
Boys SBP on Egyptian standards by percentile (T=72)					
<50th	0 (0%)	1 (4.35%)	1 (4.2%)	2 (2.7%)	0.29
50th-75th	2 (8%)	8 (34.8%)	7 (29.2%)	17 (23.6%)	
75th-90th	16 (64%)	9 (39.1%)	12 (50%)	35 (48.6%)	
90th-95th	7 (28%)	5 (21.7%)	4 (16.7%)	16 (22.2%)	
>95th	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Boys DBP on Egyptian standards by percentiles					
<50th	2 (8%)	1(4.35%)	1 (4.2%)	4 (5.2%)	0.03*
50th-75th	14 (56%)	6 (26.1%)	4 (16.7%)	24 (33.3%)	
75th-90th	7 (28%)	6 (26.1%)	10 (41.7%)	23 (31.9%)	
90th-95th	2 (8%)	10 (43.5%)	9 (37.5%)	21 (29.2%)	
>95th	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Girls SBP on Egyptian standards by percentile (T=78)					
<50th	0 (0%)	1 (3.7%)	1 (3.8%)	2 (2.6%)	0.29
50th-75th	3 (12%)	8 (29.6%)	7 (26.9%)	18 (23.07%)	
75th-90th	14 (56%)	10 (37%)	13 (50%)	37 (47.4%)	
90th-95th	8 (32%)	8 (29.6%)	5 (19.2%)	21 (26.9%)	
>95th	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Girls DBP on Egyptian standards by percentiles**					
<50th	0 (0%)	1 (3.7%)	2 (7.7%)	3 (3.8%)	0.006
50th-75th	4 (16%)	6 (22.2%)	5 (19.2%)	15 (19.2%)	
75th-90th	15 (60%)	5 (18.5%)	6 (23.1%)	26 (33.3%)	

90^{th}-95^{th}	6 (24%)	12 (44.4%)	10 (38.5%)	28 (35.9%)	
$>95^{th}$	0 (0%)	3 (11.1%)	1 (3.8%)	4 (5.1%)	
BMI-for-age interpreted using WHO percentile for age (0-5 years)					
$<3^{rd}$	5 (10%)	3 (6%)	2 (4%)	10 (6.67%)	0.5
3^{rd} to $<15^{th}$	8 (16%)	7 (14%)	5 (10%)	20 (13.3%)	
15^{th} to $<50^{th}$	9 (18%)	8 (16%)	7 (14%)	24 (16%)	
50^{th} to $<85^{th}$	14 (28%)	15 (30%)	13 (26%)	42 (28%)	
85^{th} to $<97^{th}$	10 (20%)	12 (24%)	14 (28%)	36 (24%)	
$\geq 97^{th}$	4 (8%)	5 (10%)	9 (18%)	18 (12%)	
Echocardiographic Doppler findings of cases with congenital heart defects					
Total cases	5 (10.0%)	6 (12%)	5 (10%)	16 (10.67%)	0.9
Mild mitral valve prolapse	4 (8%)	4 (8%)	3 (6%)	11 (7.3%)	
Mild TR	1 (2%)	1 (2%)	1 (2%)	3 (5.3%)	
Small ASD	0	0	1 (2%)	1 (0.67%)	
Small VSD	0	1 (2%)	0	1 (0.67%)	
Nutritional indices among patients with mitral valve prolapse					
Wasted	2 (50%)	0 (0%)	1 (33.3%)	3 (5.3%)	0.8
Underweight	1 (25%)	1 (25%)	0 (0%)	2 (1.3%)	
Average	1 (25%)	2 (50%)	2 (66.7%)	5 (3.3%)	
Overweight	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Obese	0 (0%)	1 (25%)	0 (0%)	1 (0.67%)	
Mean ± SD of Waist Circumference (WC) and mid arm circumference of groups under study					
WC	54 ± 3.6	55.3 ± 4	54.6 ± 4.2		0.24
MAC	16.6 ± 2	15.9 ± 2.1	15.3 ± 2.8		0.01*
Hemoglobin					
<11 gm/dl	5 (10%)	6 (12%)	4 (8%)		NS
>11 gm/dl	45 (90%)	44 (88%)	46 (92%)		NS
Note=*: Cut off of significance is $p<0.05$; **: Mixed fed means was fed breast-milk but also formula milk in bottle with or without added sugar and starch; MVP: Mild Mitral Valve Prolapse; TR: Tricuspid Regurgitation; ASD: Atrial Septal Defect; VSD: Ventricular Septal Defect; WHO: World Health Organization; DBP: Diastolic Blood Pressure; SBP: Systolic Blood Pressure.					

Table 1. Sociodemographic, anthropometric and clinical data related to blood pressure and echo findings by pattern of feeding in children aged 2-5 years of age.

On echocardiographic examination, Doppler studies showed a preponderance of Mitral Valve Prolapse (MVP) with no differences by pattern of feeding in children aged 2-5 years of age as presented in Table 1. There was no statistically significant association between echocardiographic findings and different parameters among studied children as presented in Table 2. However, the breastfed tended to breastfeed longer and more cases with mild lesions appeared as normal healthy children were detected in the breastfeeding group. Also, none of those who had lesions showed elevated BP compared to the normotensive cases. It raises possibility that the presences of these lesions had a physiological function in preventing the rise in resistance i.e. the diastolic BP.

Variables	**Normal**	**Mild MVP**	**Mild TR**	**ASD/VSD**	**p-value**
	N=136	**N=11**	**N=3**	**N=2**	
SBP					
$>95^{th}$ percentile	21 (15.7%)	0 (0%)	1 (9.1%)	0 (0%)	0.89

90th-95th percentile	28 (20.9%)	1 (33.3%)	1 (9.1%)	0 (0%)	
<90th percentile	85 (63.4%)	2 (66.7%)	9 (81.8%)	2 (100%)	
DBP					
>95th percentile	3 (2.2%)	0 (0%)	0 (0%)	0 (0%)	1
90th-95th percentile	3 (2.2%)	0 (0%)	0 (0%)	0 (0%)	
<90th percentile	128 (95.5%)	3 (100%)	11 (100%)	2 (100%)	
Breastfeeding duration					
1:6 months	51 (38.1%)	2 (66.7%)	4 (36.4%)	1 (50%)	0.94
6:12 months	43 (32.1%)	1 (33.1%)	4 (36.4%)	1 (50%)	
More than one year	40 (29.9%)	0 (0%)	3 (27.3%)	0 (0%)	
Bottle fed duration*					
1:6 months	42 (31.3%)	1 (50%)	3 (42.9%)	1 (50%)	0.97
6:12 months	28 (20.9%)	1 (50%)	3 (42.9%)	1 (50%)	
More than one year	19 (21.3%)	0 (0%)	1 (14.3%)	0 (0%)	
Note=*: Assessed only in group of breastfed and non-breastfed; MVP: Mild Mitral Valve Prolapse; TR: Tricuspid Regurgitation; ASD: Atrial Septal Defect; VSD: Ventricular Septal Defect.					

Table 2. Association between echocardiographic findings and different parameters among children (3-5 years of age).

The patterns of feeding among the groups who were breastfed, non-breastfed and mixed fed during their infancy (Table 3). Early breastfeeding, full breastfeeding and other practices related to optimal breastfeeding were significantly higher in the breastfed, while suboptimal practices were more common among the non-breastfed. Early, breastfeeding, skin to skin, cue feeding, night feeding and full breastfeeding were physiologically adapted to the needs of hemodynamic stabilization and thereby prevention of elevation of BP. The correlation between systolic and diastolic blood pressure in children and among the children of the groups who were breastfed and non-breastfed by feeding practices (Table 4) and shows that optimal breastfeeding practices were associated with optimal BP and suboptimal formula feeding practices were associated with suboptimal BP.

Infant feeding practice	Fully breastfed	Never breastfed	Mixed**	p-value
	N=50	**N=50**	**N=50**	
Early initiation of breastfeeding: <1 hour				
Taken away	12 (24%)	30 (60%)	12 (24%)	0.002*
2-6 hours	14 (28%)	5 (10%)	14 (28%)	
7-24 hours	12 (24%)	7 (14%)	15 (30%)	
>24 hours	12 (24%)	8 (16%)	9 (18%)	
Early initiation by skin to skin contact				
Taken away	7 (14%)	25 (50%)	12 (24%)	0.001*
<1 hour	14 (28%)	10 (20%)	9 (18%)	
2-6hours	6 (12%)	5 (10%)	8 (16%)	
7-24 hours	10 (20%)	3 (6%)	15 (30%)	
>24 hours	13 (26%)	7 (14%)	6 (12%)	
Frequency of feedings per day (breast or formula)				

2 times	0	40 (80%)	22 (44%)	<0.001*
3 times	0	10 (20%)	14 (28%)	
> 3 times	50 (100%)	0	14 (28%)	
Frequency of feeding per night (breast or formula)				
One time	11 (22%)	45 (90%)	17 (34%)	<0.001*
Two times	15 (30%)	5 (10%)	16 (32%)	
>2 times	24 (48%)	0	17 (34%)	
Rooming in				
From birth	34 (68%)	28 (56%)	30 (60%)	0.32
At home	16 (32%)	22 (44%)	20 (40%)	
Pattern of feeding				
Scheduled	23 (46%)	50 (100%)	13 (26%)	<0.001*
On crying	16 (32%)	0	15 (30%)	
Cue led Feeds	11 (22%)	0	22 (44%)	
Age of stopping Breastfeeding				
1-6 months	11 (22%)	31 (62%)	16 (32%)	<0.001*
6-12 month	10 (20%)	19 (38%)	20 (40%)	
>1 year	29 (58%)	0	14 (28%)	
Note=*: Cut off of significance is p<0.05; **: Mixed fed means was fed breast milk but also Commercial Milk Formula (CMF) in bottle with or without added sugar and starch.				

Table 3. Patterns of feeding among the groups who were breastfed, non-breastfed and mixed fed during their infancy.

Blood pressure of children *vs.* variables	**Systolic Blood Pressure**		**Diastolic Blood Pressure**	
	R	**P-value**	**R**	**p-value**
Breastfeeding practices				
Full breastfeeding	-0.16	0.02*	-0.15	0.03*
Early initiation of Breastfeeding <1 hour	-0.18	0.04*	-0.13	0.08
Early initiation of skin to skin contact	0.02	0.81	-0.09	0.2
Prenatal education about infant feeding	-0.15	0.05*	-0.16	0.04*
Frequency of Breastfeeding per day	-0.22	0.01*	-0.13	0.05*
Age of stopping breastfeeding	-0.32	0.03*	-0.12	0.04*
Frequency of night breastfeeds	-0.19	0.02*	-0.17	0.03*
Supplements given	-0.01	0.9	0.12	0.44
Frequency of supplements other than breast-milk	-0.05	0.53	0.18	0.02*
Pacifiers given	0.03	0.66	-0.22	0.005*
Age of start pacifier	0.02	0.72	-0.18	0.02*

Age of stopping pacifier	0.004	0.95	-0.2	0.01*
Non breastfed (formula fed groups)				
Frequency of formula feeding	0.14	0.04*	0.13	0.05*
Addition of sugar to formula	0.13	0.05*	0.15	0.01*
Age of start additives of sugar or starch to formula	-0.18	0.01*	-0.22	0.009*
How cleaned bottle (non-hygienic)	0.18	0.04*	0.21	0.03*
Quality of complementary feeding meals				
Preparation of food 6 m-12 m (salt)	0.27	0.001*	0.24	0.009*
Preparation of food (salt) 12-24	0.16	0.04*	0.18	0.03*
Dietary diversity (high)	-0.07	0.28	-0.05	0.6
High intake of unhealthy diet	0.25	0.008*	0.21	0.01*
Note= *: Cut off of significance p<0.05.				

Table 4. Correlation between systolic and diastolic blood pressure in children and among the children of the groups who were breastfed and non-breastfed by feeding practices.

Discussion

Although EBP in this age group appears to be minimal yet EDBP was detected in girls (5.1%) and not in boys (0%) with any ESBP in either sex. Moreover, it was detected in the girls exposed to Commercial Milk Formula Feeding (CMFF) in their infancy but not in those who were fully breastfed. Prehypertension or pre-ESBP (>90^{th}-95^{th} centile) was detected in one quarter of the cases (22.2% in boys and 26.9% in girls) and pre-EDBP in one third of the cases (29.2% in boys and 35.9% in girls). Such findings coincide with the findings of other studies who reported that the pooled global prevalence of EBP among children was 4.00% [14]. However, studies for EBP in preschoolers have not been reported in Egypt. A cross-sectional study of 1500 adolescents (11-19 years) in Alexandria in Egypt reported that prevalence rates of prehypertension and Hypertension (HTN) were 5.7% and 4.0%[15]. The demographic health survey in 2008 reported that HTN in the 11-19 females (3.8%) and males (4.9%) [16].

Findings from analysis of demographic surveys conducted in 2015 indicate that overall prevalence of HTN in Egypt is 26% and that more than half of Egyptian adults who meet criteria for HTN are unaware of their BP status. Younger, healthier and normal weight people-who are typically at lowest risk for HTN-appear mostly likely to be unaware of their HTN status, less educated people are least likely to know their hypertensive status [17]. Our cases with Doppler findings of Congenital Heart Disease (CHD) did not show any significant elevations in BP. It is ideal to compare our results with standards developed from our own locality. The trend of Egyptian SBP and DBP nanograms, differ from Turkish [18] and American nanograms [19]. The latter task force values were based on nine different populations, including African and Mexican Americans. They used the first BP reading and not the average of two readings as in the Egyptian study. The rise in BP with increasing age is most probably caused by the growth of the child.

It is accepted that the most influential determinants of normal BP are chronological age and body size as determined by height, weight and BMI [20]. This study showed that early breastfeeding and full breastfeeding was associated with lower tendency towards EBP. There were no significant echocardiographic studies. However, a study on which echocardiographic studies were conducted for 76 healthy infants aged 6 to 24 months of life of whom 38 were fed only breast-milk and 38 who were Commercial Milk Formula Feeding (CMFF) in the first six months of life showed some differences in Right Ventricular (RV) studies. Percent fractional shortening (%FAC) for right side was significantly higher in fully breastfed infants compared to the Commercial Milk Formula Feeding (CMFF) (p<0.05).

There was a significant increase in the mean RV Velocity Time Integral (VTI) values in EBF infants (17.2 ± 2.73) than Commercial Milk Formula Feeding (CMFF) infants (15.9 ± 1.94) p<0.01; the Cardiac Output (COP) and the Tricuspid Annular Plane Systolic Excursion (TAPSE) were significantly higher in breastfed infants (5.81 ± 1.01) than Commercial Milk Formula Feeding (CMFF) infants (5.26 ± 1.18), (1.56 ± 0.18) and (1.46 ± 0.20) respectively at p<0.05. Their findings suggested that early feeding patterns in infancy may influence functions and structures of right side of the heart in infancy and that fully breastfeeding supports higher performance and may explain their higher flexibility to cardiac insults later in life [21].

This study revealed that not breastfeeding was associated with increased tendency towards obesity. Breastfeeding reduced the odds of overweight or obesity as indicated by many workers [22-25]. Studies involving autopsies, ultrasounds and cardiac Magnetic Resonance Imaging (MRI) have demonstrated that obesity may influence cardiac morphology [26]. One of the most frequently observed alterations is Left Ventricular (LV) hypertrophy, often eccentric, particularly in the absence of concurrent HTN. Chahal et al., in a study that involved 4127 patients revealed that the right ventricular mass was 15% greater in overweight/obese patients compared to lean patients and right ventricular volumes were 26% larger in overweight/ obese subjects compared to lean patients ($p<0.001$ for the trend) [27]. A cross-sectional study was conducted for 76 healthy infants aged 3 to 12 months of life (38 breastfed and 38 Commercial Milk Formula Feeding (CMFF), BMI percentiles were significantly higher in CMFF infants compared to breasted infants ($p<0.05$). BMI was positively correlated with structural dimensions in CMFF but not breastfed. BMI correlated with RV function in breastfed but not CMF fed infants [28].

This study also indicated that not breastfeeding was associated with EBP. However there is limited evidence that suggests that never *vs.* ever being fed human milk is associated with EBP within a normal range at 6–7 years of age. Moderate evidence suggests there is no association between the duration of any human milk feeding and childhood BP. Limited evidence suggests there is no association between the duration of exclusive human milk feeding and BP or metabolic syndrome in childhood. Additional evidence about intermediate outcomes for the 4 systematic reviews was scant or inconclusive [29]. None the less Metabolic Syndrome (MetS) which is defined by a cluster of several cardio-metabolic risk factors, specifically visceral obesity, hypertension, dyslipidemia and impaired glucose metabolism, were found to increase risks of developing future CVD and Type 2 Diabetes mellitus (T2D) [30].

On the other hand Doppler findings suggested no relationship between the findings of MVP, TR, ASD or VSD and early feeding, BP or obesity. MVP was the commonest lesion detected in 11 cases (7.3%). MVP is s generally considered a benign condition often associated with a leaky valve causing blood to flow back into the atrium; however, at times, it may present with sudden cardiac death, endocarditis, arrhythmias or cerebrovascular accident. It is more associated with leanness rather than obesity. It ranges from 4%-8%. MVP usually occurs as a primary disorder and is commonly, but not invariably, associated with myxomatous proliferation of the mitral valve and chordae tendineae. The absence of any relationship between obesity and even morbid obesity on the progression or complication associated with mitral expel is in agreement with many other workers who studied MR after reconstructive surgery [31].

In addition MVP in association with EBP was not an issue in this study. Low BP is reported by others as a common feature in patients with MVP and association between the two entities was found in population-based studies [32]. MVP individuals demonstrate increased beta-adrenergic receptor responsiveness associated with a hyperkinetic circulation [33]. The latter research team showed that in patients with MVP giving propranolol increased BP and decreased heart rate and depends, namely, on β1 receptors blockade. Increase in BP is an unusual response to adrenergic beta-blockade in normal conditions and this finding supports the preponderance of β2 receptors on the BP control in patients with MVP. Breastfeeding through practices as early initiation, cue feeding, night feeding and tactile stimulation may assist in stabilizing the hyper-responsiveness of adrenergic responses preventing the sudden disturbances in BP and HR shown in individuals with MVP.

However this may need further investigation. A study conducted in Cairo university children's hospital on infants with CHD and Heart Failure (HF) showed that breastfeeding and Skin-to-Skin Contact (SSC) resulted in a sustained improvement in their oxygen saturations and vital signs when compared to the artificially fed infants with CHD and HF [34]. Another study in Sweden showed that immediate SSC *vs.* incubator care had beneficial effects on the cardiorespiratory stabilization of very preterm infants. SSC stimulates oxytocin release in mother and infant which is a hormone and neuropeptide, is associated with calmness, bonding and stress reduction [35]. Inappropriate foods introduced early in life that include adding sugar and starch to bottles and salt to weaning foods are shown to be linked with higher BP.

A study in Egypt showed that high BP prevalence in young school children and youth was associated with adding table salt, regular consumption of certain energy dense foods and certain types of salty foods and foods with high sodium content (or 2.6) [36]. In another study snacking, high intakes of sugary beverages and less physical activity among children had a higher risk for HBP (or 2.5) [37] and especially when children were obese [38,15] In Qalyuibiya, school-aged children with prehypertension or EBP were 4 times less likely to practice sports [39]. EBP was more prevalent in private than in public schools [38]. EBP was more prevalent in obese *vs*. overweight (22% *vs*. 6.4%) and WC was reported to be a good indicator of elevated BP [40]. A study conducted for primary school children in Menoufia in Egypt showed that prehypertension was 2.8% in males and 5.2% in females who were overweight and obese and increase in age in both sexes [41].

The risk of EBP has been associated with disturbed lipid metabolism and other biomarkers of CVD. A study by Ola et al., showed that biomarkers of CVD were higher in non-breastfed children and their mothers who did not breastfeed compared to mothers and children who were exposed to breastfeeding [42]. Obese and hypertensive youth had lipid profiles of atherosclerosis and high-risk patterns of impaired glucose homeostasis (pre-diabetes) and when the research team conducted Doppler studies for these obese youth they found increased risk of diastolic dysfunction [43]. Left Ventricular Diastolic Function (LVDF) is an important marker of early cardiovascular remodeling, which has not been well summarized in young people with overweight/obesity. Increased BMI was associated with worse LVDF in all measures except early mitral inflow deceleration time, with septal early diastolic tissue peak velocity to late diastolic tissue peak velocity ratio having the strongest association (n=13 studies, 1824 individuals; $r=-0.69$; $p<0.001$). Elevated HOMA-

IR was also associated with worse LVDF [44]. Hence obesity and EBP results in a combination of disturbed metabolism of glycemic homeostasis and renal dysfunction apparently emerging from the young age probably triggered by poor early feeding practices of not breastfeeding and exposure to CMFF.

The study has a number of limitations related to its small size and limited representation, although cases were taken from Damanhur Teaching Hospital which is a referral hospital for one of the largest governorates in Egypt, still conclusive findings cannot be made on such a sample. However, it is a definite eye open to the pending holocaust caused by the inappropriate early feeding practices that have invaded the lives and eating behavior of young children. The detection of EBP in this age group and high prevalence of pre-HTN and obesity is a disturbing finding. Moreover CHD, although mild and predominantly encompassing MVP in almost one half of the cases, which is a benign condition, yet could develop into complications if associated with untreated high BMI and EBP on the long run.

Breastfeeding is by far the most suitable and safe feeding practice for children and should be promoted and supported in addition with strict laws to regulate salt intake in marketed foods [45]. Regular monitoring of young children for EBP in nurseries, especially among the obese children is recommended. Future studies that examine these findings through demographic surveys are needed not only in Egypt but in other countries in the region. Preventive actions through early detection and campaigns for increasing awareness of the public about the importance of tracking their child's feeding behavior and checking their BP and physical health status beginning as early as preschool age is recommended.

Declarations

Acknowledgements to pediatric department in Damanhour Teaching Hospital for facilitating collection of data and screening studies by echocardiogram.

Authors contribution

- Sameh Zaki Abdulsamea was involved in the conceptualization, literature review, statistical re-analysis of data, interpretation, presentation and research writing.
- Azza Abul-Fadl was involved in organizing the team, planning of the work, literature review, supervising, collection of data, statistical analysis, interpreting data, writing the discussion and revising paper.
- Maha Mourad, expert in cardiology, reviewer and supervisor.

Ethical approvals

An approval by the local ethical committee was obtained before the study by Benha faculty of medicine (Ethical committee code no: MS 19-10-2022). A verbal informed consent was obtained from all participants (parents) before participation in the study, since most of them were illiterate or limited education. The objectives of the study, the expected benefits and types of information to be obtained were explained to them.

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