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*COMPARATIVE STUDY OF ARTERIAL BLOOD  
PRESSURE MEASUREMENTS IN HEALTHY  
EXCLUSIVELY BREASTFED AND EXCLUSIVELY  
FORMULA FED INFANTS*

**By**

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**ABSTRACT**

**Background:** *It is believed that breastfeeding in infancy compared with formula feeding associated with lower mean blood pressure at different ages.*

**Objective:** *To compare arterial blood pressure measurements in healthy exclusively breastfed and exclusively formula fed infants.*

**Participators and methods:** *This study was cross-sectional study including 1000 infants. They were classified into two equal groups; Group (A): 500 healthy infants receiving exclusive breastfeeding for 6 months and Group (B): 500 healthy infants receiving only formula feeding for 6 months. This study was conducted on infants who had received their obligatory vaccination in Kafr El Batiekh hospital (Dumyat), from July 2018 to July 2020.*

**Results:** *In the present study, there were 215 (43.0%) child male in group (A) versus 233 (46.6%) in group (B) with non-statistical significant differences. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were nearly comparable between them at 2 months of age (SBP;  $82.78 \pm 3.1$  mmHg Vs  $83.53 \pm 3.32$  mmHg and DBP;  $43.13 \pm 4.3$  mmHg Vs  $43.5 \pm 4.3$  mmHg). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were nearly comparable between them at 4 months of age (SBP;  $85.45 \pm 3.15$  mmHg Vs  $85.01 \pm 3.38$  mmHg and DBP;  $44.63 \pm 3.23$  mmHg Vs  $44.97 \pm 3.19$  mmHg). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were nearly comparable between them at 6 months of age (SBP;  $86.81 \pm 3.01$  mmHg Vs  $87.41 \pm 3.01$  mmHg and DBP;  $45.73 \pm 3.07$  mmHg Vs  $47.29 \pm 3.28$  mmHg) with insignificant difference.*

**Conclusion:** *The results of this study indicate that type of feeding has no significant effect on arterial blood pressure in infants up to age of 6 months.*

**Recommendations:** *Further studies are required to compare arterial blood pressure in different socioeconomic status including a big number of participants.*

**Keywords:** *Child; Breastfeeding; Formula feeding; Blood pressure.*

## INTRODUCTION

Breastfeeding has extensive physical and psychological benefits for the mother and the newborn. For the infant, breastfeeding offers passive immunization against infectious diseases, translating to a reduction of diarrheal episodes, bacteremia, pneumonia, and meningitis during the first year of life. Breastfeeding has also been linked to a reduced risk of sudden infant death syndrome, allergies, asthma, and childhood leukemia and to a further effect on the incidence of adult obesity and diabetes (**Britton et al., 2009**).

Similarly, maternal benefits include an improved bond with the newborn, weight stabilization, and reduced risk of depression during the postpartum period, as well as a lower lifetime incidence of breast and ovarian cancer. Breastfeeding provides short and long term health, economic, and environmental advantages to children, women, and society (**Rollins et al., 2016**).

The feeding in infancy affects arterial blood pressure which is the force of the blood against the wall of blood vessel. It has been postulated that factors operating in early life (in utero, infancy and childhood), influence the development of blood pressure in

adulthood, and that nutrition early in life may programme subsequent blood pressure (**Barker, 1998**).

Blood pressure (BP) measurement may be oscillometric (on calibrated machine that has been validated for use in pediatric population) or auscultatory (by using a mercury or aneroid sphygmomanometer) (**Ostchega et al., 2011**).

BP should be measured in the right arm by using standard measurement practices (unless the child has atypical aortic arch anatomy, such as right aortic arch) (**Podoll et al., 2007**).

An appropriately sized cuff should be used for accurate BP measurement. Normative values for neonates and infants BP have generally been determined in the right upper arm with the infant supine. The influence of breastfeeding on blood pressure is of interest because of the differing composition of breast milk and formula milk, particularly the sodium and fatty acid content. BP can also vary across visits (**Daley et al., 2013**).

Previously, the sodium content of breast milk was much lower than that of formula milk, low sodium intake in infancy has been related to lower levels of BP both in short and long term. Long chain polyunsaturated fatty acids are

present in breast milk but not in formula milk, these play an important part in the vascular endothelium and, when given as nutritional supplements, seem to reduce BP in children and adults (Forsyth et al., 2003).

This work was designed to compare arterial blood pressure measurements in healthy exclusively breastfed and exclusively formula fed infants.

#### **Ethical considerations:**

- Approval of ethical committee in the department and university was obtained before the study.
- Approval of Central Agency for Public Mobilization and Statistics was obtained before the study.
- An informed consent had been taken from parents before involving their infants in the study.
- The steps of the study, the aim the potential benefits and hazards all had been discussed with the parents.
- The parents of the participants had the right to withdraw from the study at any time.
- Confidentiality of all data had been ensured.

- There is no conflict of interest regarding the study and publication.
- The author declared that there is no financial support regarding the study and publication.

#### **PARTICIPANTS AND METHODS**

##### **Participants:**

This study was cross-sectional study including 1000 infants. They were classified into two equal groups; **Group (A):** 500 healthy infants receiving exclusive breastfeeding for 6 months and **Group (B):** 500 healthy infants receiving only formula feeding for 6 months. This study was conducted on infants who had received their obligatory vaccination in Kafr El Batiekh hospital (Dumyat), from July 2018 to July 2020.

##### **Inclusion criteria:**

- Apparently healthy term infants, males and females, has been examined at 2, 4 and 6 months.
- Weight, length between 3rd and 97th percentile.
- Normal vital signs, systemic examination.
- Normal development.

- Types of feeding:
  - a. exclusive breastfeeding for 6 months. (Group A).
  - b. exclusive formula feeding for 6 months. (Group B).

**Exclusion criteria:**

- Mixed feeding.
- Early weaning infants before 6 months of life.
- Infants on special formulas.
- Preterm infants.
- NICU admission (other than jaundice requires phototherapy).
- Abnormal growth (>97% or <3% weight and length).
- Developmental delay.
- History or examination suggesting systemic disease.
- Acute illness.
- Smoking mothers.
- Hypertensive parents.

**Methods:**

**Our study participants were subjected to:**

- Prenatal, natal and postnatal history.

- Measurement of weight, length and then plotting on percentiles (WHO).
- General and systemic examination.
- Blood pressure measurement of right upper arm.
- Blood pressure: was obtained when the infant was calm, in supine position, the upper extremity is exposed and the infant cuff is rolled around the right upper arm snugly. The blood pressure will be measured by using CMS500 monitor, China 2015.

**Statistical analysis:**

IBM's SPSS statistics (Statistical Package for the Social Sciences) for windows (version 25, 2017) was used for statistical analysis of the collected data. Shapiro-Wilk test was used to check the normality of the data distribution. All tests were conducted with 95% confidence interval. P (probability) value < 0.05 was considered statistically significant. Charts were generated using SPSS' chart builder and Microsoft Excel for windows 2019.

## RESULTS

Our results will be demonstrated in the following tables.

**Table (1): Comparison between studied cases regarding sex**

	Group A (500)	Group B (500)	Z score	P value
Male	215 (43.0%)	233 (46.6%)	1.15	0.25
Female	285 (57.0%)	267 (53.4%)		

This table shows insignificant difference regarding sex in both groups.

**Table (2): Comparison between the groups regarding blood pressure at different ages**

	Group A	Group B	T test	P value
<b>At 2<sup>nd</sup> month:</b>				
SBP (mmHg)	82.78±3.1	83.53±3.32	1.930	.051
DBP (mmHg)	43.13±4.3	43.5±4.3	0.916	.360
<b>At 4<sup>th</sup> month:</b>				
SBP (mmHg)	85.45±3.15	85.01±3.38	1.21	0.225
DBP (mmHg)	44.63±3.23	44.97±3.19	0.94	0.348
<b>At 6<sup>th</sup> month :</b>				
SBP (mmHg)	86.81±3.018	87.41±3.01	1.79	0.07
DBP (mmHg)	45.73±3.07	47.29±3.28	4.41	0.09

This table shows insignificant difference regarding systolic and diastolic blood pressure at different ages between both groups.

**Table (3): Global correlation between studied cases of group (A) at 2 months of age**

	weight		Length		SBP		DBP	
	r	p	r	p	r	p	r	p
weight	--	--	0.239	0.001	0.08	0.292	0.007	0.932
Length	0.239	0.001	--	--	0.01	0.89	-0.095	0.209
SBP	0.08	0.292	0.01	0.89	--	--	0.26	0.209
DBP	0.007	0.932	-0.095	0.209	0.26	0.209	--	--

This table shows that there was positive correlation between length and weight, weight and SBP and between weight and DBP. In addition to positive correlation between length and SBP and between SBP and DBP and also, negative correlation between length and DBP.

**Table (4): Global correlation between studied cases of group (B) at 2 months of age**

	weight		Length		SBP		DBP	
	r	p	r	p	r	P	r	p
weight	--	--	0.147	0.02	-0.022	0.388	0.021	0.395
Length	0.147	0.02	--	--	-0.022	0.04	-0.15	0.02
SBP	-0.022	0.388	-0.022	0.04	--	--	0.389	0.001
DBP	0.021	0.395	-0.15	0.02	0.389	0.001	--	--

This table shows that there was positive correlation between length and weight and between weight and DBP associated with negative correlation between

weight and SBP. In addition to negative correlation between length and SBP and between length and DBP also between SBP and DBP.

**Table (5): Global correlation between studied cases of group (A) at 4 months of age**

	weight		Length		SBP		DBP	
	r	p	r	p	r	p	r	p
weight	--	--	0.273	0.001	0.002	0.975	0.067	0.41
Length	0.273	0.001	--	--	0.073	0.359	-0.102	0.202
SBP	0.002	0.975	0.073	0.359	--	--	0.271	0.001
DBP	-0.067	0.41	-0.102	0.202	0.271	0.001	--	--

This table shows that there was positive correlation between length and weight, weight and SBP and between weight and DBP. Also, positive correlation

between length and SBP and also between SBP and DBP. In addition to negative correlation between length and DBP.

**Table (6): Global correlation between studied cases of group (B) at 4 months of age**

	weight		Length		SBP		DBP	
	r	p	r	p	r	p	r	p
weight	--	--	0.265	0.001	-0.066	0.396	-0.054	0.482
Length	0.265	0.001	--	--	-0.008	0.914	0.033	0.665
SBP	-0.066	0.396	-0.008	0.914	--	--	0.498	0.001
DBP	-0.054	0.482	0.033	0.665	0.498	0.001	--	--

This table shows that there was positive correlation between length and weight associated with negative correlation between weight and SBP or

DBP. Also, positive correlation between SBP and DBP. In addition to negative correlation between length and SBP.

**Table (7): Global correlation between studied cases of group (A) at 6 months of age**

	weight		Length		SBP		DBP	
	r	p	r	p	r	p	r	p
weight	--	--	0.608	0.001	-0.014	0.858	-0.096	0.221
Length	0.608	0.001	--	--	0.044	0.577	0.101	0.194
SBP	-0.014	0.858	0.044	0.577	--	--	0.386	0.001
DBP	-0.096	0.221	0.101	0.194	0.386	0.001	--	--

This table shows that there was positive correlation between length and weight associated with negative correlation

between weight and SBP or DBP. Also, positive correlation between SBP and DBP and between length and SBP or DBP.

**Table (8): Global correlation between studied cases of group (B) at 6 months of age**

	weight		Length		SBP		DBP	
	r	P	r	p	r	p	r	p
weight	--	--	0.604	0.001	-0.036	0.652	-0.077	0.326
Length	0.604	0.001	--	--	-0.063	0.421	0.001	0.993
SBP	-0.036	0.652	-0.063	0.421	--	--	0.368	0.001
DBP	-0.077	0.326	0.001	0.993	0.368	0.001	--	--

This table shows that there was positive correlation between length and weight associated with negative correlation

between weight and SBP or DBP. Also, positive correlation between SBP and DBP and between length and DBP.

## DISCUSSION

Breastfeeding has established short term advantages for the infants such as fewer infections (**Victora et al., 2016**), but may benefit longer term health as well, especially on cardiovascular health. Indeed, **Horta et al. (2015)** reported associations of breastfeeding as compared with infant formula with lower blood pressure (BP) in childhood and adulthood. The composition of breast milk strongly differs from infant formula, among others as breast-milk contains n-3 long-chain polyunsaturated fatty acids (n-3 LCPUFAs), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which traditionally were not present in infant formula (**Andreas et al., 2015**).

Although the content of formula milk has become increasingly similar to that of breast milk in recent years, it is undeniable that the accumulated sodium intake in formula-fed infants is greater than in breastfed infants. In addition to sodium intake, it has been reported that breastfeeding could influence BP via a variety of mechanisms such as altering glucose and lipid metabolism (**Martin et al., 2016**).

The aim of this study was to compare systolic and diastolic

arterial blood pressure measurements in healthy exclusively breastfed and exclusively formula fed infants.

Our study included 1000 participants, they were divided into two groups, the group (A) included 500 healthy infants with exclusive breastfeeding for 6 months, while the group (B) included 500 healthy infants with formula feeding only. After complete physical examination; systolic and diastolic blood pressure were checked by CMS500 monitor for each participant at the age of 2 months, 4 months and 6 months.

The benefits of breastfeeding in early childhood are well established. Breastfeeding is the recommended form of nutrition for the first 6 months of infant life. Current data on the impact of breastfeeding on overweight in childhood provide equivocal findings. Some studies have shown a significant protective effect (**Rito et al., 2019**).

Measurement of BP is not performed during routine consultations in the pediatric group (**Silva et al., 2016**). Additionally no national statistics on the prevalence of high BP in the pediatric population, which hinders the knowledge of the real problem faced by children.



Furthermore, it is believed that high BP is rare in childhood and, thus, its incidence ends up being underestimated due to the difficulty of diagnosis, which requires adequate technique, material, and an appropriate environment for BP measurement (Nobre & Lessa, 2016).

The results of our study demonstrated that the arterial systolic and diastolic blood pressure were statistically insignificant in the two groups of study.

Owen et al; (2003) reported that Selective publication of small studies with positive findings may have exaggerated claims that breast feeding in infancy reduces systolic blood pressure in later life. The results of larger studies suggest that feeding in infancy has at most a modest effect on blood pressure, which is of limited clinical or public health importance.

Horta et al; (2015) reported that breastfeeding is not associated with change in arterial blood pressure.

### **CONCLUSION**

**From the results of our study we conclude that:**

- There are no statistical significant differences in SBP and DBP between exclusive

breastfed and exclusive formula fed infants at 2 months, 4 months and 6 months.

### **RECOMMENDATION**

- Further studies are required to compare arterial blood pressure in different socioeconomic status including a big number of participants.
- Also it is important to study the arterial blood pressure after the age of 6 months in exclusive breastfeeding and exclusive formula feeding infants in later life.

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# دراسة مقارنة قياس ضغط الدم الشرياني بين الرضع الأصحاء المقتصرين على الرضاعة الطبيعية و المقتصرين على الألبان الصناعية

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التغذية المناسبة أثناء الرضاعة و الطفولة المبكرة  
ضرورية للنمو و الصحة و تطور الأطفال إلى أقصى  
إمكاناتهم. سوء التغذية يزيد خطورة المرض وهو المسؤول  
مباشرة و غير مباشرة عن ثلث الوفيات تقريبا في عمر  
الأطفال تحت 5 سنوات.

تأثير الرضاعة الطبيعية علي ضغط الدم مثار اهتمام  
للاختلاف في تركيب اللبن الطبيعي عن اللبن الصناعي،  
خاصة الصوديوم والأحماض الدهنية.

انخفاض تناول الصوديوم في فترة الرضاعة تم ربطه  
بانخفاض مستويات ضغط الدم علي المدى القريب والبعيد.  
السلاسل الطويلة من الأحماض الدهنية غير المشبعة المتعددة  
موجودة في اللبن الطبيعي وغير موجودة في اللبن الصناعي.  
هذه السلاسل تلعب دورا هاما في بطانة الأوعية الدموية، يبدو  
أنها تقلل ضغط الدم في الأطفال والبالغين.

تشير الدراسات القائمة على الملاحظة أن الرضاعة الطبيعية لها علاقه بتقليل ضغط الدم في مرحلة الطفولة. ومع ذلك لم توضح كل الدراسات المنشورة اي ارتباط و بالإضافة إلى اختلاف نسبة الصوديوم في بعض الألبان الصناعية عن لبن الأم ربما يكون له تأثير على الارتفاع المبكر لضغط الدم الشرياني لدى الأطفال.

لذلك كان الهدف من الدراسة هو مقارنة قياسات ضغط الدم بين الرضع المقتصرين على الرضاعة الطبيعية المطلقة والرضع المقتصرين على الرضاعة الصناعية المطلقة.

هذه الدراسة أجريت على 1000 من الرضع الأصحاء خلال الستة أشهر الأولى من العمر وتم تقسيمهم إلى مجموعتين:

1. **مجموعة (أ):** 500 من الأطفال الناضجين الأصحاء المقتصرين على اللبن الطبيعي.

2. **مجموعة (ب):** 500 من الأطفال الناضجين الأصحاء المقتصرين على اللبن الصناعي.

تم الحصول على التاريخ الكامل و الفحص الطبي الظاهري لجميع الرضع محل الدراسة مع قياس ضغط الدم لهم.

مجموعة (أ) تشمل 500 رضيع: 215 ذكر (43%) و 285 أنثى (57%).

مجموعة (ب) تشمل 500 رضيع: 233 ذكر (46.6%) و 267 أنثى (53.4%).

**في مجموعة (أ):** كان ضغط الدم (الانقباضي؛  $3.1 \pm 82.78$  مم زئبق و الانبساطي؛  $4.3 \pm 43.13$  مم زئبق) عند شهرين، (الانقباضي؛  $3.15 \pm 85.45$  مم زئبق و الانبساطي؛  $44.63 \pm 3.23$  مم زئبق) عند 4 شهور و (الانقباضي؛  $3.018 \pm 86.81$  مم زئبق و الانبساطي؛  $3.07 \pm 45.73$  مم زئبق) عند 6 شهور.

**في مجموعة (ب):** كان ضغط الدم (الانقباضي؛  $3.32 \pm 83.53$  مم زئبق و الانبساطي؛  $4.3 \pm 43.5$  مم زئبق) عند شهرين، (الانقباضي؛  $3.38 \pm 85.01$  مم زئبق و الانبساطي؛  $3.19 \pm 44.97$  مم زئبق) عند 4 شهور و (الانقباضي؛  $3.01 \pm 87.41$  مم زئبق و الانبساطي؛  $47.29 \pm 3.28$  مم زئبق) عند 6 شهور.

### نتائج دراستنا كالتالي:

- لا يوجد اختلاف واضح في قراءات ضغط الدم بين الأطفال المقتصرين على الرضاعة الطبيعية المطلقة والأطفال المقتصرين على الرضاعة الصناعية المطلقة عند عمر شهرين.
- لا يوجد اختلاف واضح في قراءات ضغط الدم بين الأطفال المقتصرين على الرضاعة الطبيعية المطلقة

والأطفال المقتصرين على الرضاعة الصناعية المطلقة  
عند عمر 4 شهور.

- لا يوجد اختلاف واضح في قراءات ضغط الدم بين  
الأطفال المقتصرين على الرضاعة الطبيعية المطلقة  
والأطفال المقتصرين على الرضاعة الصناعية المطلقة  
عند عمر 6 شهور.

من كل ما سبق، نستنتج أن نوع اللبن في رضاعة  
الأطفال المشاركين في البحث ليس له دلالة إحصائية واضحة  
على ضغط الدم خلال السنة أشهر الأولى من العمر.