

## Does Infant's Feeding Contribute to Childhood Obesity?

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### Abstract

**Objective:** to establish an association between breastfeeding and its duration versus artificial feeding in relation to later on childhood obesity in Jeddah, Saudi Arabia.

**Methods:** A cross-sectional retrospective study was conducted in Jeddah, Saudi Arabia in 2014-2015 among children aged 2-12 years old. The participants were directed to an ambulatory clinic in King Abdulaziz Hospital where they had their anthropometric measurements taken. A total of 521 children (283 male and 238 female) provided complete data for the analysis.

**Results:** There was no significant association found between breastfeeding and a higher BMI or weight, however, there was a significant association between artificial feeding and a higher waist to hip ratio (P value= .030). Also, appetite had a P-value=0.0001, which signifies a relation between BF and appetite, 117 children (36.4%) were breastfed and they have decreased appetite, while 93 (29.0%) were breastfed and had an increased appetite. As for the duration, males who have been breastfed for a complete two years were 30 and who have been breastfed for 18 months were 15, breastfed for one year were 33, but 72 males were breastfed for less than a year.

**Conclusion:** While there was no significant association found between breastfeeding and a higher BMI or weight, however, there was a significant association between artificial feeding and a higher waist to hip ratio; Which entails a higher risk for cardiopulmonary disease. Also, appetite control in breastfed infants had a significant effect, which indicates that there is an inverse relation between breastfeeding and appetite. As for the duration, prolonged duration of breastfeeding had a more protective effect on obesity.

**Keywords:** Breastfeeding; Artificial; Feeding; Childhood; Obesity; Appetite

### Introduction

Childhood obesity is a major public health problem. It is now being rightly referred to as a global epidemic [1]. The world health organization has estimated that by year 2015, approximately 2.3 billion adults will be overweight and more than 700 million children and adolescents will be obese. Children who have obesity after 6 years are 1.5 times more likely to develop adult obesity, irrespective of their parents' obesity status [2]. Due to the related sequelae of childhood obesity, their prevention has become a priority. Many studies have addressed that obesity's worldwide epidemics might be lessened by advertising "breastfeeding" as a public health priority, and by uniting forces across disciplines to support a strong and effective public health campaign to increase breastfeeding rates exponentially [3,4]. Obesity is a multifactorial disease arising from interactions between genes and the environment. Early infant nutrition is one of the most powerful factors that determine early growth and development, it has been hypothesized that breastfeeding may be protective against obesity. As obesity rates in children are rising, breast milk may become recognized as a key intervention to keep both mother and baby healthy. Breastfeeding has many benefits as The American Pediatric Association (APA) recommends breast milk as the sole source of nutrition for infants aged 6 months and younger [5]. The nutrient composition of breast-milk and artificial milk differ, which might be one of the factors that affect obesity in children. Therefore, studies are aiming to investigate the relationship between breastfeeding, artificial feeding, duration of feeding with overweight and obesity

### Methodology

#### Study design and population

A cross-sectional retrospective study was conducted in Jeddah in 2014-2015 among children aged 2-12 years old. Girls and Boys were

selected randomly to represent different economic status, level of education and family structure of Jeddah population in the sample. Subject were included in the study if they were 2 to 12 years of age and obese or overweight. A total of 521 children (283 male and 238 female) provided complete data for the analysis.

#### Ethical approval

The Research and Ethics committee at the King Abdulaziz University Hospital in Jeddah approved the study. A parent's informed consent and the agreement of the child for physical examination and blood sample drawing were collected with the questionnaires.

#### Data collection

A cross-sectional study design was used. The study population concerned n=521 children and adolescent whom were randomly selected. The young females and males were chosen from this age group (4-12) to represent the pre-pubertal age to avoid the hormonal factors that may affect the validity of the results. The participants were directed to ambulatory clinic in King AbdulAziz Hospital in Jeddah, Saudi Arabia. Data was collected by medical students who volunteered (n=60). The exclusion criteria were child on dietary intervention, exposure to hormonal therapy, development of secondary obesity

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due to endocrinopathies, chronic diseases and data insufficiency. For the research we used the following items Personal data, type of feeding in infancy of the participants was determined as either breast fed, artificially fed, Duration of exclusive breastfeeding was determined as these time intervals (less than one year, a year, 18 months, 2 years), appetite (increased, decreased, average).

Trained health personnel at ambulatory clinic collected anthropometric data. Height was measured using a wall-mounted stadiometer, with the children not wearing shoes and their shoulders in a relaxed position and their arms hanging freely. Weight was measured with a beam-balance scale, which was re-calibrated for every new subject. Subjects were weighed barefoot and wearing minimal clothing.

### BMI measurements

BMI was calculated as  $\text{weight} \div \text{height}^2$ . After BMI is calculated for children and teens, it is expressed as a percentile, which can be obtained from either a graph, and these percentiles express a child's BMI relative to other children who participated in national surveys. Because weight and height change during growth and development, as does their relation to body fatness, a child's BMI must be interpreted relative to other children of the same sex and age. BMI percentile was determined for each subject according to the Centers for Disease Control and Prevention (CDC) BMI charts. Normal weight is BMI between 5<sup>th</sup> – 85<sup>th</sup> percentiles. Overweight is BMI between 85<sup>th</sup> – 95<sup>th</sup> percentiles. Obesity is BMI > 95<sup>th</sup> percentile. Severe obesity is BMI > 99<sup>th</sup> percentiles.

### Waist to hip ratio

Each child's measurements were taken using a measuring tape to measure the circumference of the hips the widest part of the buttock and the waist at the smallest circumference of the waist then divided the waist measurement by the hip measurement for the ratio. By using the university of Maryland [6] waist-hip ratio calculator. The risk of heart disease rises sharply for women with waist-hip ratios above 0.8 and for men with ratios above 1.0 and they are defined as the "high waist hip ratio"

### Statistical analysis

A one-way analysis of variance (ANOVA) was conducted to test the difference between the mean ratios of waist-hip circumferences of each feeding category as defined in the methodology. Chi-square was used to test the relation between children's appetite and types of feeding.

### Definition

Appetite was defined as average, Increased or decreased by asking the participants about frequency, amount, enjoyment and speed of meals that the child has in a day compared to peers or siblings at the same age.

For the duration of breast-feeding, Infants that were breastfed less than one year were considered as combination feeding as they were both breast-fed and artificially fed for they continued on artificial milk after the cessation of breast-milk.

### Limitations

Data on complementary feeding and family dietary style is missing.

## Results

### Descriptive data of the participants

Mean of height cm =  $132.7 \pm 14.34$  cm

Range: (45,167)

Mean of weight kg =  $46.5 \pm 15.1$  kg

Range: (20, 98)

Mean of BMI  $\text{kg/m}^2$  =  $25.4 \pm 4.24$   $\text{kg/m}^2$

Range: (15.98, 39.4)

Mean of BMI sds =  $2.8 \pm 1.002$  sds

Range: (0.1, 5.22)

Mean of ratio of center circumference to hip=  $0.9 \pm 0.07$

Range: (0.73, 1.10)

Mean of age =  $8.5 \pm 2.2$  year

Range: (4,12)

### Breastfeeding and waist to hip ratio

By using ANOVA Method, we compared the mean ratio of waist-hip circumferences of both Breastfed children and artificially fed or mixed feeding. We found a significant difference with artificial and/or mix feeding. (P-value .030) which signifies that artificial feeding is associated with a higher risk for an increased waist to hip ratio; higher risk of cardiopulmonary disease. We found that the number of High-risk group of waist-hip ratio in breast-fed infants = 32, while the High-risk group of waist-hip ratio in artificially fed or combination fed infants = 86. Entailing that obesity and an increased long-term risk for cardiopulmonary disease is more in artificially fed or combination fed infants (Tables 1 and 2, Chart 1 and 2).

### Appetite and type of feeding

P-value=0.0001, there is a significant inverse relation between breastfeeding and appetite, 117 children (36.4%) were breastfed and they had a decreased appetite, while 93 (29.0%) were artificially fed or combination feeding and had an increased appetite (Table 3).

### Duration of breastfeeding and BMI

Males who have been breastfed for a complete two years were 30 and who have been breastfed for 18 months were 15, breastfed for one year were 33, but 72 males were breastfed for less than a year which signifies that a lesser duration of breastfeeding is associated with a higher risk of obesity (Table 4).

## Discussion

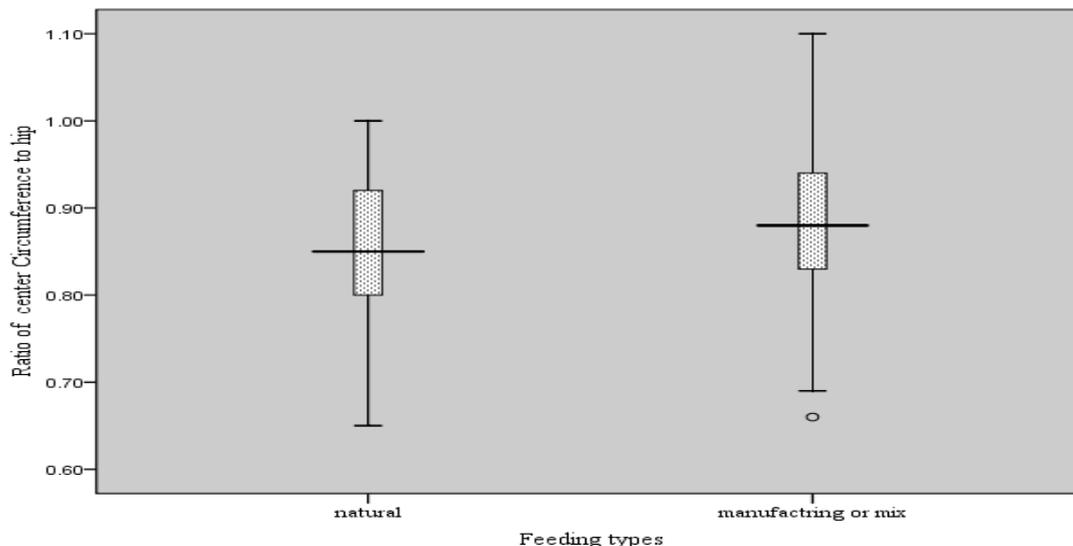
The relationships between childhood obesity with some of the contributing factors in children are of much concern. In regard to breastfeeding as a contributing factor to childhood obesity earlier systematic reviews and meta-analyses demonstrated that breastfeeding

| Type of feeding                       | Number of children | Mean ratio of waist-hip circumferences | P-value |
|---------------------------------------|--------------------|--|---------|
| Breastfeeding                         | 73                 | .8857                                  | .030    |
| Artificial feeding and mixed feeding. | 180                | .8787                                  |         |

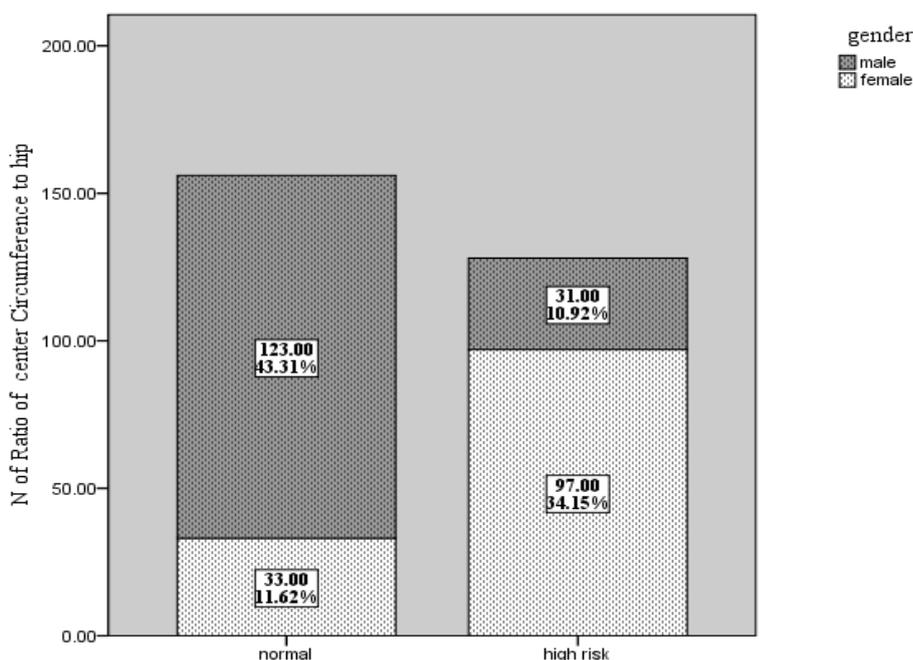
Table 1: Showing mean ratio of waist to hip circumferences of each type of feeding.

| Gender  | Number of children with normal ratio | Number of children with high risk ratio | Obese       |
|---------|--------------------------------------|---|-------------|
| Males   | 123 (43.3%)                          | 31 (10.9%)                              | 186 (51%)   |
| Females | 33 (11.6%)                           | 97 (34.2%)                              | 166 (45.5%) |

Table 2: Showing percentage of males and females who had normal or high-risk ratio, and those who were obese.



**Chart 1:** Signifies increased risk of waist- hip ratio with manufactured (artificial) or mixed feeding, in comparison with the risk associated with breast-feeding. More so, the results showed a difference between normal and high-risk ratio in both sexes.



**Chart 2:** Stacked bar chart signifying that while the number of obese children was more in males is more, an increased waist- hip ratio was more in females.

has a role in childhood obesity [7-9]. More specifically, a study stressed on the long-term effects of breast-feeding [10]. On the other hand, there are systematic reviews and meta-analyses that questioned the significance of the relation between breastfeeding and childhood obesity and their unlikely effect to reduce the global epidemic of childhood obesity [11-13]. Breastfeeding continues to be strongly recommended, as it can't be too strongly emphasized that it is the preferred choice for all infants. However, it may not be as effective as moderating familial factors, such as dietary habits and physical activity in preventing children from becoming overweight [11]. Another study added that if the association is causal, the effect of breastfeeding is probably small

compared to other factors that influence child obesity [13]. While obesity is slightly more common in males than females according to their BMI, females are at more risk to develop heart disease and metabolic syndrome according to their age and body measurements (Chart 1).

In regard to the debate about artificial feeding versus breast-feeding and their effect on childhood obesity, it has been established that artificial milk contains significantly higher levels of protein and fat than breast milk. The high fat and protein levels found in artificial formula lead to an increased secretion of insulin like growth factor, which in turn stimulates the over-production of adipocytes, which has been

| Feeding Type * Appetite Cross Tabulation |                   |                |                                 |             |           |       |
|--|-------------------|----------------|---------------------------------|-------------|-----------|-------|
|  |                   |                | Nutritional habits: 1- Appetite |             |           | Total |
|  |                   |                | Decreased                       | Normal rate | Increased |       |
| Feeding Type                             | Natural           | Count          | 117                             | 74          | 93        | 284   |
|  |                   | Expected Count | 105.3                           | 75.2        | 103.5     | 284.0 |
|  |                   | % of Total     | 36.4%                           | 23.1%       | 29.0%     | 88.5% |
|  | Manufactured milk | Count          | 2                               | 11          | 24        | 37    |
|  |                   | Expected Count | 13.7                            | 9.8         | 13.5      | 37.0  |
|  |                   | % of Total     | .6%                             | 3.4%        | 7.5%      | 11.5% |
| Total                                    | Count             | 119            | 85                              | 117         | 321       |       |
|  | Expected Count    | 119.0          | 85.0                            | 117.0       | 321.0     |       |
|  | % of Total        | 37.1%          | 26.5%                           | 36.4%       | 100.0%    |       |

Table 3: Showing the type of appetite according to the type of feeding.

| Duration of breastfeeding | > 1 year | One year | 18 months | 2 years |
|---------------------------|----------|----------|-----------|---------|
| Overweight                | 12       | 6        | 4         | 8       |
| Obese                     | 44       | 39       | 12        | 23      |
| Severe obesity            | 54       | 26       | 17        | 33      |

Table 4: Shows number of children who were overweight, obese, severely obese and the duration of breast-feeding.

associated with overweight and obesity in human populations [14]. Moreover, Human milk is quantitatively and qualitatively different from formula [15]. Numerous bioactive factors are exclusive to human milk, which impact differentiation, growth, and functional maturation of the human organism [16,17]. Additionally, a longitudinal study showed a significant association between early protein intake and later BMI, suggesting that a higher protein intake early in life might increase the risk of later obesity [18]. Despite the many similarities in the major constituents of breast and artificial milk, there are many subtle differences in the composition, which might account for the metabolic differences. Moreover, there are additional differences in the biological nature between them as the pattern of sucking, gut motility, and the spectrum of organisms that colonize the gut, which could affect the metabolic and hormonal response to feeding [19]. There is data that indicates that formula feeding increases the risks of later cardiovascular disease. They examined over 87,000 individuals observing differences in feeding methods and later cardiovascular malfunction they found that breastfed populations had significantly lower rates of cardiovascular disease [20]. A study suggests that breastfeeding plays a major role in the prevention of cardiovascular disease. According to this study, breastfeeding is associated with lower LDL cholesterol and blood pressure, and has long-term benefits for cardiovascular functioning [21]. Our study supported the previous studies; that breastfeeding has a protective effect against obesity. As our results showed that breastfeeding correlated with a lower waist hip ratio and artificial feeding was correlated with a higher waist hip ratio. (P-value = .030). This does not only support the protective effect of breastfeeding against obesity, but it also signifies the long-term protective effect on the risk of cardiopulmonary diseases.

It has been suggested that one of the reasons that formula-fed infants are more likely to develop overweight and obesity later in life is that there are predetermined recommended dosages which often times leads to overeating and the inability to determine satiety [22]. A research on infant bottle emptying (used as an indicator of low infant self-regulation) supports this assertion, revealing that infants who were directly breastfed from 0-6 months empty bottles less often in

later infancy (27% of the time) compared to infants bottle-fed either human milk (54%) or formula (68%) [22]. Thus, establishing a precise and dependable point of satiety is guided by internal physiologic rather than by external social cues [23]. Direct breastfeeding was not found to differentially affect growth trajectories from infancy to childhood compared to bottle-feeding; results suggest direct breastfeeding during early infancy is associated with greater appetite regulation later in childhood [24]. Breastfed infants also exhibited greater variability in the volume of feeds, taking larger volume feedings following longer periods without milk [25]. Children who were fed human milk in a bottle during the first three months of life were 67% less likely to have high satiety responsiveness at the age of 3-6 years when compared to children who were directly breastfed after considering child age, child weight status, maternal race, and maternal education level [26]. The study also added that the chronic pattern of continuing to feed an infant after satiety cues are exhibited might increase children's subsequent responsiveness to external food cues and risk of overeating. Our study supported that appetite is better controlled in breastfed infants (P-value= .0001), as the results showed an inverse pattern as the breastfed infants had a decreased appetite, while the artificially fed infants had an increased appetite.

Many studies focused on the effect of exclusive breastfeeding and its effect on obesity, while little light was shed on the effect of combination of both breast milk and formula feeding and how they affect obesity in children. There was a study that found that the most statistically powerful results were detected in exclusively breastfed populations; those subjects who were formula fed in infancy were significantly more likely to develop overweight and obesity during later childhood. These results are critical as they demonstrate the protective effects of exclusive breastfeeding as opposed to formula feeding or breastfeeding using formula supplementation [27]. An additional study tested whether exclusive breastfeeding was correlated with BMI at six years of age. They looked at newborns with almost identical BMI's, and revisited these infants at later stages of their lives. At every interval, the formula fed children had significantly higher BMI's than the breastfed cohort. At the ages of four through six, the prevalence of obesity tripled in the formula fed population [28]. Our study supported that combination feeding is associated with a higher risk of an increased waist to hip ratio. High-risk group of waist-hip ratio in breast-fed infants = 32, while the High risk group of waist-hip ratio in artificially fed or combination fed infants = 86.

As for the duration of breastfeeding, a study found that the effects of breastfeeding are dose-response specific, as their data indicates that the longer a child is breastfed, the less likely the child is to become overweight or obese in later life [29]. Additional research have confirmed by clearly demonstrating the dose-response specificity of breastfeeding as data confirms that the longer a child is breastfed, the stronger the protective effect of breastfeeding against overweight and obesity throughout life. One study showed statistically not significant favorable effects on BMI of previously breast-fed infants at the ages of 3 and 4 years, but larger and significant ones at the ages of 5 and 6 years denoting long-term effect of duration [28]. The risk of overweight was reduced by 4 percent for each month of breastfeeding, this decline resulted in more than a 30% decrease in the odds of overweight for a child breastfed for 9 months when the comparison was with a child never breastfed. The most significant protective effects of breastfeeding were observed in participants who were breastfed for nine months or longer [20]. Our study supported that a lesser duration of breastfeeding is indeed associated with a higher risk of obesity and an increased relation had a more protective effect (Table 1).

## Conclusions

While there was no significant association found between breastfeeding and a higher BMI or weight, a significant association between artificial feeding and a higher waist to hip ratio; which entails a higher risk for cardiopulmonary disease. Also, appetite was more controlled in breastfed children rather than the increased appetite found in artificially fed children. More so, a lesser duration of breastfeeding was associated with a higher risk for obesity.

## Recommendations

We strongly encourage and recommend breastfeeding to all the mothers, as it is an ideal nutrient for the healthy growth and development of infants. The World Health Organization currently recommends as a global public health recommendation that infants should be exclusively breastfed for the first 6 months of life to achieve optimal growth, development, and health. As our study stressed about the importance of breastfeeding and its relation with a lower waist-hip ratio, signifying both a lower risk of obesity and a long-term lower risk of developing cardiopulmonary diseases.

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