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Childhood obesity: Is it related to feeding type of the infant?

Çocukluk çağı obezitesi: Bebeklik döneminde beslenme şekli ile ilişkili mi?

Emel Kabakoğlu Ünsür [1], Narin Akıcı [2], Didem Kızmaz İşançlı [2]

[1] Department of Pediatrics, Acıbadem University, Acıbadem Kayseri Hospital, Seyitgazi, Melikgazi, Kayseri, Turkey
[2] Department of Pediatrics, Haydarpasa Numune Training and Research Hospital, Istanbul, Turkey

ORCID ID of the author(s)
EÜ: 0000-0002-5816-7554
NA: 0000-0002-0600-8631
DKİ: 0000-0002-0791-5903

Corresponding author / Sorumlu yazar:
Emel Kabakoğlu Ünsür
Address / Adres: Acıbadem Üniversitesi-Acıbadem Kayseri Hastanesi Çocuk Sağlığı ve Hastalıkları Kliniği Seyitgazi Mustafa Kemal Paşa Blv. No: 1, 38030 Melikgazi, Kayseri, Türkiye
E-mail: emelunsur@yahoo.com.tr

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Etik Kurul Onayı: Bu çalışma için Haydarpaşa Numune Eğitim ve Araştırma Hastanesi Klinik Araştırmalar Etik Kurulu'ndan onay alındı (sayı no: HNEAH-kaek 2019/KK/163, tarih: 16.12.2019). İnsan katılımcıların katıldığı çalışmalardaki tüm prosedürler, 1964 Helsinki Deklarasyonu ve daha sonra yapılan değişiklikler uyarınca gerçekleştirilmiştir.

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Abstract

Aim: The prevalence of childhood obesity has risen currently, and the relationship between feeding types in the infancy period and childhood obesity remains controversial. It is aimed to investigate the impact of feeding practices in the first six months of life on early childhood obesity in exclusively breast-fed, exclusively formula-fed, and mixed (breast milk and formula) fed Turkish infants.

Methods: This study was conducted in the Department of Pediatrics at Haydarpasa Numune Training and Research Hospital with 545 children aged between 2-5 years. We asked the parents various questions to determine the feeding patterns during infancy. Three groups were formed: Exclusively breastfeed, exclusively formula-fed and the mixed (breast milk and formula) fed group. Obesity rates were determined according to body mass index (BMI) and compared.

Results: Among a total of 545 children, with a mean age of 3.4 years, there were 285 (52,3%) females. Evaluation based on BMI revealed that the obesity (≥95th percentile) rate was 8.8% and the percentage of overweight children was significantly higher in the only formula-fed group (28.2%) compared to those who were only breast-fed (16.8%) (P=0.009).

Conclusions: Our findings showed that feeding the child exclusively with formula during the first six months of life may increase body weight during early childhood more than feeding solely breast milk. Therefore, it is necessary to promote breastfeeding to prevent childhood obesity.

Keywords: Obesity, Breast milk, Formula, Infant

Öz

Amaç: Çocukluk çağında obezite prevalansı günümüzde artmıştır, bebeklik dönemindeki beslenme şekli ile çocukluk çağı obezitesi arasındaki ilişki hala tartışmalıdır. Çalışmamızda ilk 6 ayda sadece anne sütüyle beslenen, sadece mama ile beslenen ve karma (anne sütü + mama) beslenen Türk bebeklerde beslenme uygulamalarının erken çocukluk çağı obezitesi üzerindeki etkisinin araştırılması amaçlanmıştır.

Yöntemler: Bu çalışma Haydarpaşa Numune Eğitim ve Araştırma Hastanesi pediatri bölümünde 2-5 yaş arası 545 çocuk ile yapıldı. Anne babalara ilk 6 aydaki bebeklik döneminde beslenme tiplerini belirlemek için anket yapıldı. Sadece anne sütüyle beslenen, sadece mama ile beslenen ve karma (anne sütü + mama) beslenen bebekler olarak beslenme şekillerine göre 3 grup oluşturuldu; 2-5 yaş çocukların vücut kitle indeksi hesaplandı ve bu gruplara göre obezite görülme oranı belirlendi ve birbirleri ile karşılaştırma yapıldı.

Bulgular: 285'i (%52, 3) kız olmak üzere toplam 545 çocuğun yaş ortalaması 3,4 idi. Vücut kitle indeksine göre yapılan değerlendirmede obezite (≥95 persantil) oranı genel olarak %8,8 olarak tespit edildi. Fazla kilolu çocukların yüzdesi ise sadece formül mama ile beslenen grupta (%28,2) hiç formül mama ile beslenmeyenlere (%16,8) göre anlamlı olarak yüksek bulundu (P=0,009).

Sonuçlar: Bulgularımız, mamayla beslenmenin vücut ağırlığını anne sütünden daha fazla artırabileceğini gösterdi; bu nedenle özellikle erken çocukluk çağındaki obeziteyi önlemek için ilk 6 ayda sadece anne sütü ile beslenmeyi teşvik etmek gereklidir.

Anahtar kelimeler: Obezite, Anne sütü, Formül mama, İnfant

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Introduction

Obesity is defined as the storage of fat in the body due to energy intake exceeding expenditure. Overweight or obese children include those who are over normal weight for their age and height [1]. The prevalence and severity of childhood obesity has increased significantly throughout the world [2] and in Turkey [3]. Childhood obesity also increases the likelihood of adult obesity and leads to obesity-related complications such as hypertension, type 2 diabetes, and cardiovascular morbidities [4].

The etiology of obesity is multifactorial and complex, involving the interaction between genetic, biological, and environmental factors and ecological influences. Many factors present in the first 1000 days of life (from conception up to the age of 2 years) are strongly associated with weight in later life. It has been suggested that the early life period is particularly sensitive to environmental "programming" [5]. In particular, rapid weight gain in early life due to feeding practices has been shown to be a risk factor for later obesity [6]. However, the data are controversial. According to the accelerated postpartum weight gain hypothesis, formula feeding alone increases the fat mass of infants and may cause obesity in later life [7].

While formula feeding was associated with obesity risk in some studies [8,9], others did not report a significant difference in body mass index (BMI) between formula-fed and breast-fed infants [10,11]. In the various meta-analyses published in Western countries, breastfeeding was reported to reduce the risk of childhood obesity, but this relationship is controversial in studies which are performed across many other countries. These differences may be due to ethnicity, sample size, varying definitions of overweight and obesity, socioeconomic status, parental obesity, and birth weight [8].

In the present study, we aimed to investigate the impact of feeding practices (etc. exclusively breast-fed, only formula-fed and breast milk combined with formula) in the first six months of life on early childhood obesity among the Turkish population, because of the differing reports in the literature.

Materials and methods

This cross- sectional study was conducted in the Department of Pediatrics at Haydarpasa Numune Training and Research Hospital between January-February 2020. We determined the feeding patterns during the infancy of 545 children (aged 2-5 years) by asking the parents when they visited our pediatric clinic for routine controls. The study group included children with normal birth weights (2500-4000g) without any malformations, chronic diseases or physical disabilities that could affect growth and nutritional status. A questionnaire was prepared to determine the socio-demographic data, physical examination findings and growth parameters of the children. The same healthcare providers asked the questions to all parents (mostly mothers) after obtaining their consent. The age of the children when they visited the clinic, gender, gestational age, birth weight, birth dates of the children and pregnancy history were inquired. The age of the mothers at the birth, education level and socioeconomic status were also noted.

The mothers were asked about the beginning of feeding, for how long the child received breast milk or formula, introduction of complementary food and total duration of breast milk or formula consumption with complementary food. According to the feeding patterns of the infants during the first six months of life, three study groups were formed. The first group was exclusively breastfed, the second group was exclusively formula-fed, and the third group was mixed fed, including a combination of formula and breastfeeding.

The growth parameters of children, such as the weight, relative weight, height, and body mass index (BMI), were evaluated during routine controls. All children were weighed naked with the same, delicate scales and their heights were measured with the Herpenden Statiometry. The relative weight was calculated by the ratio of the child's weight to the weight of the normal child of the same age. Obesity was determined by calculating body mass index (BMI), as weight in kilograms divided by height in meters squared. We defined overweight as BMI between the 85th to <95th percentiles and obesity as BMI at or above the 95th percentile based on Turkish Child Growing Charts.

Statistical analysis

Statistical analyses were performed with the SPSS 25.0 software. Data were expressed as mean (standard deviation), numbers and/or percentages, where appropriate. Categorical and continuous variables between the groups were compared with the chi-square test and t-test, respectively. An overall type I error of 5% was used to infer statistical significance.

Results

Among 545 children with a mean age of 3.4 years (range: 2-5 years), 285 (52.3%) were female. The mean birthweight and gestational age of the children were 3200 gr (range: 2500-4000 g) and 38+3 (range: 38+1-39+6 weeks) weeks, respectively.

No children had a history of a chronic disease and all had normal physical examination findings in routine controls. The parents of the children had middle socio-economic status and education levels (most had graduated from the high school). No mothers had gestational diabetes mellitus or any other chronic diseases and feeding patterns of the mothers during the pregnancy were almost similar.

According to body mass index (BMI), 15.6% (n=85) of children were underweight (<5 percentile), 18.6% (n=101) were overweight (≥85th percentile), and obesity (≥95th percentile) rate was 8.8%. Based on body weight evaluation, the percentage of low weight (≤ -2 SD) females (3.9%) were significantly higher than males (0.8%) (P=0.045) (Table 1).

Table 1: Growth parameters of the children

	Total	Boys (n=260)	Girls (n=285)
Patients (%)	100.0	47.7	52.3
Mean age (years)	3.4	2.7	3.3
Mean gestational age (week)	38+3	38+2	38+3
Mean birthweight (gr)	3200	3275	3185
Mean height (cm)	89	90.5	98
Mean weight (kg)	12.6	13	15.4
Mean BMI (kg/cm^2)	16.12	16.03	15.6

BMI: body mass index

The percentages of children who were exclusively breast-fed, exclusively formula-fed and mixed-fed during the first six months of life were 91.9% (n=501), 15.8% (n=86), and 31.6% (n=172), respectively. The mean feeding time with breast milk and formula were 15.6 (8.9) months (0.1-48 months) and

10.8 (7.6) months (0.5-42 months), respectively. The mean time until introduction of complementary food was 6.4 (1.9) months (range: 1.5-24 months).

Based on BMI, the percentage of overweight children was significantly higher in the exclusively formula-fed group (28.2%) compared to the exclusively breast-fed group (16.8%) (P=0.009). No statistically significant difference was found regarding the growth parameters of the children who were mixed fed.

There was no statistically significant difference between the three groups in terms of feeding types (only breast milk, only formula or mixed fed group) with regards to gender (Table 2). The percentage of overweight children was lower (18.3% vs 36.8 %) and underweight children was higher (17.1% vs 0%) (P=0.043) among exclusively breast-fed males. The percentage of overweight children was significantly higher among formula fed males compared to those who did receive formula at all (11.1 vs. 3.6%, P=0.042). Among females, the percentage of overweight was significantly higher in the mixed fed group (breast milk + formula) compared to the exclusively breast-fed group (8.2% vs. 4.8%, P=0.03) (Table 3).

Table 2: Comparison of feeding type by gender

	Total	Boys (n=260)	Girls (n=285)	*P*-value
Breastmilk alone				
Yes	501 (91.9)	241 (48.1)	260 (51.9)	0.637
No	44 (8.1)	19 (43.2)	25 (56.8)	
Formula alone				
Yes	86 (15.7)	36 (41.9)	50 (58.1)	0.242
No	359 (84.3)	224 (48.8)	235 (51.2)	
Breastmilk + Formula				
Yes	172 (31.5)	75 (43.6)	97 (56.4)	0.198
No	273 (68.5)	185 (49.6)	188 (50.4)	

Table 3: Growth status in boys and girls by feeding type

		SD-based BW category			Percentile-based BMI category		
		Underweight (≤-2 SD)	Normal weight (>-2 to +2 SD)	Overweight (>2 SD)	Underweight (<5th percentile)	Normal weight (5th to 85th percentile)	Overweight (≤85th percentile)
Boys	Breastmilk alone						
	Yes	0.0%	94.7%	5.3%	0.0%	63.2%	36.8%
	No	0.8%	94.6%	4.6%	17.1%	64.6%	18.3%
	P-value	0.916			0.043		
	Formula alone						
	Yes	0.4%	96.%	3.6%	15.6%	67.0%	17.4%
	No	2.8%	86.1%	11.1%	17.1%	48.6%	34.3%
	P-value	0.042			0.05		
	Breastmilk + Formula						
	Yes	0.5%	95.7%	3.8%	16.3%	67.4%	16.3%
	No	1.3%	92.%	6.7%	14.7%	57.3%	28.0%
	P-value	0.479			0.099		
Girls	Breastmilk alone						
	Yes	0.%	84.%	16.0%	16.0%	60.0%	24.0%
	No	4.2%	90.8%	5.0%	15.4%	67.7%	16.9%
	P-value	0.055			0.651		
	Formula alone						
	Yes	4.3%	89.8%	6.0%	14.0%	69.8%	16.2%
	No	2.%	92.%	6.0%	22.0%	54.0%	24.0%
	P-value	0.754			0.097		
	Breastmilk + Formula						
	Yes	5.9%	89.4%	4.8%	12.8%	70.2%	17.0%
	No	0.%	91.8%	8.2%	20.6%	60.8%	18.6%
	P-value	0.03			0.175		

BMI: body mass index, BW: body weight, SD: standard deviation

Discussion

The Centers for Disease Control and Prevention (CDC) [12] report that childhood obesity is more prevalent in developing countries. The overall prevalence of obesity in children is 18.5%, affecting 13.7 million children and adolescents, and obesity prevalence among children aged 2-5 years is 13.9% [12]. In our study, we found that 18.6% of children under 5 years of age were overweight and 8.8% were obese based on BMI. According to Childhood Obesity Survey of Turkey (COSI-TUR) 2016 data [13], the rate of overweight children was 14.6% and the obesity rate was 9.9% in Turkey. The Turkish Demographic and Health Survey (TDHS, 2018) [14] reported the rate of overweight children rates under 5 years of age as 8 %. Our findings are similar to these national surveys.

Today, although the importance of breastfeeding is accepted by the countries all over the world, breastfeeding rates are still low. According to the UNICEF 2018 report, analysis of data from 123 countries shows that 4%, or 1 in 25 babies, are never breastfed in low- and middle-income countries. In high-income countries, 21% of babies or more than 1 in 5 babies are never breastfed [15]. In our country, based on the data from TDHS, exclusively breast-feeding rate is 41% in the first five months of life, and continuation of breastfeeding is 66% for the first year and 34% for the second year. The average breastfeeding period is 16.7 months, and time until introduction of complementary food is 6-8 months in 85% of children [14]. According to TDHS, low-middle-income and educated mothers continue to breastfeed longer than others. In our study, the breastfeeding rate in the first six months was 91.9%, the rate of only formula-fed and mixed (breast milk + formula) fed infants were 15.8%, and 31.6%, respectively. These promising findings may be due to the mothers' education and income levels (high school-middle income).

Breastfeeding has many well-known benefits on maternal and child health [16-18]. The relationship between breastfeeding and childhood obesity is controversial and less conclusive in the literature [10,19-24]. It may be due to adjusted confounding factors such as ethnicity, sample size, maternal obesity, obesity / overweight definitions, socioeconomic status of children, and birth weights [8]. It is still unclear which breastfeeding mechanism could protect against overweight and obesity. One of the physiological mechanisms proposed as long-term breastfeeding is that longer exposure to maternal hormones in breast milk could theoretically alter the baby's lipid metabolism and increase the risk of obesity in later life [25]. Similarly, in a recent Chinese cohort study, they reported that exclusively breastfeeding for a shorter period of time (3-6 months) improved children's growth status [26]. Conversely, short breastfeeding time may exacerbate early growth, which is linked to higher obesity later in life [27,28].

It is currently known that rapid weight gain in infancy is associated with later obesity. Breast milk provides adequate energy and nutrients and is considered the ideal food for infants younger than 6 months. Several potential mechanisms may explain how breastfeeding can protect against rapid infant weight gain, including better appetite control and lower protein intake than formula-fed infants. Infant formula has a higher protein / nitrogen content than breast milk and may cause metabolic responses such as increased insulin and insulin-like growth factor-1 (IGF-1) secretion, leading to excessive and rapid weight gain [7-9]. In addition, breast milk contains hormones such as leptin, adiponectin, and ghrelin, which can affect long-term appetite, and the presence of these hormones, growth factors, and

bioactive factors in breast milk can inhibit adipocyte differentiation [29]. We found that the rate of obesity (28.2%) in the exclusively formula-fed group was more prevalent than that in the breastfed group (16.8%) in children aged ≤ 5 years, regardless of gender. This finding was compatible with most of the studies in the literature [30-32], and it is encouraging that the rate of exclusively formula feeding is not exceedingly high in our study. Also, rapid weight gain of the infant can be associated not only with the type of milk consumed, but also with the way of feeding. Regardless of the type of milk, feeding with a bottle is different from breastfeeding, and its effect on infant weight gain has been reported in numerous studies [9,32-34].

In a study from Turkey, Kondolot et al. [33] investigated the risk factors for overweight and obesity in preschool children and reported that there were no associations between the gender and breastfeeding, or formula-feeding. In the other studies, akin to ours, associations were reported between obesity and gender [32]. Especially in the exclusively formula-fed group, the percentage of overweight males were significantly higher (3.6%). Among females, the percentage of overweight was significantly higher in the mixed fed group (breast milk + formula) compared to the exclusively breastfed group (8.2% vs. 4.8%).

Early beginning time of complementary food, especially in formula-fed infants, leads to higher food intake and higher rates of rapid infant weight gain compared to breast-fed infants [28]. In our study, the mean time until introduction of complementary food was (6.4) (1.9) months (range: 1.5-24 months), which was in accordance with recommendations, thus, it should not have influenced the results.

Limitations

First, we did not determine the bottle-feeding rates regardless of milk type, for it may also influence the weight gain of the infants. Second, breastfeeding data were based on self-report of mothers. Although it is thought that maternal recall was valid and reliable, self-reporting may lead to inaccurate disclosure of information. The other limitation was that the feeding style of the mothers when they were pregnant and weight gain were not recorded, but we excluded the children who were small and large for gestational age according to birthweight to standardize the birth weight of the children.

Conclusion

The overweight/obesity prevalence among pre-school children increase in many developing and developed countries, just as in Turkey. It is accepted that effective interventions of obesity should begin as early as infancy. Despite our limitations, our findings show that formula feeding may increase body weight more than breast milk; therefore, it is necessary to encourage the mothers to breastfeed and promote healthcare programs about breastfeeding practices in infancy period to prevent childhood obesity in developing countries.

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