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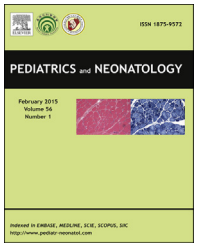

ORIGINAL ARTICLE

Association of Breast Feeding and Birth Weight with Anthropometric Measures and Blood Pressure in Children and Adolescents: The CASPIAN-IV Study

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Key Words
adolescents;
anthropometric measurements;
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blood pressure;
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Background: Noncommunicable diseases (NCDs) and their risk factors are major health threats especially for developing countries. The aim of this study was to assess the association between breast feeding (BF) and birth weight (BW) with anthropometric measures and blood pressure (BP) in a nationally–representative sample of Iranian children and adolescents.
Methods: In this national survey, 14,880 children and adolescents, aged 6–18 years, were selected using a multistage, cluster sampling method from rural and urban areas of 30 provinces of Iran. BF duration and BW were assessed by validated questionnaires completed by parents.

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Results: The study participants were 13,486 students (participation rate of 90.6%). They consisted of 49.24% girls, 75.6% urban residents, with a mean age of 12.5 years (95% confidence interval: 12.3–12.6). The family history of obesity had a significant association with BW ($p < 0.001$). A substantial association was found between BF duration and the order of children in the family, both in boys ($p < 0.001$) and girls ($p < 0.001$). The mean values for height, weight, body mass index, as well as waist, wrist, and hip circumferences were higher in those with higher BW categories (p for trend < 0.001). As BW increased, there was a linear decrease in underweight (p for trend < 0.001) and a linear increase in the prevalence of generalized obesity (p for trend < 0.001) was documented.

Conclusion: BW was associated with a higher prevalence in general obesity and a lower prevalence of being underweight. Duration of BF had no significant association with anthropometric measures and BP. Future longitudinal studies are necessary to determine the clinical implications of these findings.

1. Introduction

Noncommunicable diseases (NCDs) and their risk factors are major health threats, especially for developing countries.[1] Being under- or overweight is associated with an increased risk of adverse health outcomes such as type 2 diabetes and cardiovascular diseases (CVDs).[2]

Obesity and its increasing prevalence are now considered to be a common health problem both in developed and developing countries.[3] Most obese children and adolescents are already at high risk of wide health problems.[4,5] Moreover, some evidence exists on long-term adverse health outcomes in adulthood.[4,6] Obesity is a multi-factorial disorder; genetic, socio-economic status (SES), life style, physical activity, and food behaviors are important predisposing factors.[7]

Over the past decade, blood pressure (BP) has increased among children and adolescents. This increase is partially attributable to an increased prevalence of being overweight.[8] The effect of BW and BF on adolescents' BP remains a controversial debate.[9–11]

The evaluation of adolescents' cardiometabolic risk factors is well documented.[1] Therefore; more attention needs to be directed to designing and conducting metabolic risk factor studies.[1] The present study aimed to estimate the association between BF and BW with anthropometric measures and BP in Iranian children and adolescents.

2. Methods

The study participants consisted of a nationally representative sample of children and adolescents studied in the fourth national survey of a school-based surveillance system entitled "Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease" (CASPIAN-IV) study. It was conducted in 2011–2012 in 30 provinces in Iran. 14,880 students, aged 6–18 years, were selected from elementary, middle, and high schools using multistage cluster sampling method from rural and urban areas (48 clusters of 10 students in each province). The details of the aim and protocol of this study were published previously.[12]

All processes of measurement with calibrated instruments and the recording of information in validated checklists were followed by trained health care professionals. The aim was to achieve the highest quality of data through the present multi-center data. Gathering different levels of quality assurance were also supervised by the Data and Safety Monitoring Board (DSMB) of the project.[12]

2.1. Definition of terms

2.1.1. Anthropometric measures and BP

The modified criteria for definition of risk factors in the pediatric age group were as follows: abdominal obesity as waist circumference (WC) $\geq 90^{th}$ percentile for age and sex; and elevated BP as either systolic or diastolic (SBP, DBP) $\geq 90^{th}$ percentile for age, sex, and height.[13,14]

Overweight and general obesity were defined based on the criteria of the Centers of Disease Control and Prevention (CDC), which have been confirmed to be appropriate for Iranian children and adolescents.[15,16] The age- and sex-specific percentiles of body mass index (BMI) $> 95^{th}$ percentile were considered as obesity, BMI of $> 85^{th}$ and $\leq 95^{th}$ percentile as overweight, BMI of $> 5^{th}$ and $\leq 85^{th}$ percentile as normal weight, and $< 5^{th}$ percentile as underweight.[15]

2.2. Breast feeding

In this study, breast feeding (BF) refers to BF that includes the whole month that participants were breast fed. For example, when Table 1 presents the duration of BF, not "exclusive breastfeeding" means the participant consumed other foods, in addition to having been breast fed.

For comparative analyses, BF duration (month) was categorized into five groups of 0 months, $<$ 6 months, $>$ 6–12 months, $>$ 12–18 months, and $>$ 18–24 months.

Table 1 presents the duration of "ever breastfeeding", but not "exclusive breastfeeding", so in some periods while the infant was breastfed, he/she also consumed other foods.

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Table 1 General characteristics of participants according to breast feeding duration and birth weight categories: The CASPIAN-IV study.

	BF duration (mo)						BW (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p*	< 2500	2500–4000	> 4000	*p*
Age (y), Mean (95%CI)[a]	12.42 (11.93, 12.91)	12.44 (12.17, 12.71)	12.86 (12.58, 13.14)	12.53 (12.26, 12.80)	12.40 (12.19, 12.61)	0.200	12.34 (12.06, 12.61)	12.30 (12.12, 12.48)	12.48 (12.18, 12.78)	0.932
Living place										
Urban	2.41 (2.1, 2.77)	29.27 (27.62, 30.98)	10.92 (10.09, 30.98)	12.26 (11.46, 13.1)	45.14 (43.49, 46.79)	0.0294	8.65(8.03, 9.3)	83.13 (82.23, 83.99)	8.22 (7.58, 8.92)	0.001**
Rural	1.49 (1.09, 2.05)	25.83 (22.63, 29.3)	10.32 (8.94, 11.88)	12.85 (11.27 14.61)	49.51 (46.26, 52.77)		9.66 (8.44, 11.02)	84.57 (82.87, 86.13)	5.77 (4.87, 6,84)	
Sex										
Boy	2.07 (1.71, 2.51)	28.76 (26.71, 30.90)	10.58 (9.58, 11.67)	11.45 (10.5, 12.46)	47.14 (43.03, 49.27)	0.202	8.58 (7.82, 9.42)	82.7 (81.58, 83.78)	8.71 (7.92, 9.58)	0.001**
Girls	2.31 (1.94, 2.75)	28.12 (25.98, 30.36)	10.97 (9.98, 12.05)	13.38 (12.32, 14.52)	45.22 (43.15, 47.3)		9.2 (8.42, 10.05)	84.27 (83.16, 85.31)	6.53 (5.82, 7.33)	
Family history of Diabetes										
Yes	2.23 (1.83, 2.71)	30.55 (28.75, 32.40)	10.97 (9.92, 12.13)	12.38 (11.34, 13.5)	43.88 (42.03, 45.74)	0.001**	8.98 (8.14, 9.90)	82.59 (81.39–83.74)	8.42 (7.6, 9.33)	0.0412
No	2.11 (1.79, 2.48)	27.14 (25.59, 28.76)	10.77 (9.92, 11.68)	12.42 (11.56, 13.33)	47.56 (45.91,49.23)		8.71 (8.01, 9.46)	84.13 (83.14–85.08)	7.16 (6.52, 7.85)	
Obesity										
Yes	2.32 (1.95, 2.75)	30.06 (28.35, 31.83)	11.14 (10.21, 12.13)	12.18 (11.24, 13.17)	44.31 (42.56, 46.08)	0.001**	9.12 (8.32, 9.98)	82.21 (81.1, 83.27)	8.67 (7.91, 9.49)	0.001**
No	2.07 (1.73, 2.48)	27.18 (25.55, 28.88)	10.50 (9.61,11.46)	12.63 (11.72, 13.59)	47.62 (45.93, 49.31)		8.66 (7.95,9.42)	84.6 (83.60, 85.56)	6.74 (6.08, 7.46)	
Dyslipidemia										
Yes	2.34 (1.96, 2.80)	29.41 (27.73, 31.15)	11.2 (10.2, 12.29)	12.26 (11.32, 13.26)	44.78 (43.03, 46.55)	0.01*	8.98 (8.22, 9.80)	82.39 (81.29, 83.44)	8.63 (7.86, 9.47)	0.001
No	2.06 (1.74, 2.44)	27.64 (26.04, 29.30)	10.42 (9.60, 11.31)	12.59 (11.7, 13.55)	47.28 (45.62, 48.95)		8.73 (8.01, 9.52)	84.45 (83.44, 85.41)	6.82 (6.19, 7.50)	
Hypertension										
Yes	2.20 (1.86, 2.59)	30.04 (28.42, 31.72)	10.70 (9.83, 11.64)	12.06 (11.2, 12.98)	44.99 (43.34, 46.66)	0.001**	9.18 (8.47, 9.95)	82.84 (81.82, 83.82)	7.97 (7.27, 8.74)	0.0923
No	2.15 (1.80, 2.58)	26.5 9 (24.93, 28.32)	10.86 (9.95, 11.85)	12.8 (11.84, 13.82)	47.59 (45.82, 49.37)		8.46 (7.69, 9.30)	84.35 (83.24, 85.40)	7.19 (6.49, 7.96)	
Birth order										
1st	2.51 (2.11, 2.98)	30.18 (28.45, 31.97)	10.4 (9.5, 11.38)	13.03 (12.05, 14.07)	43.88 (42.12, 45.66)	0.001**	8.28 (7.53, 9.09)	84.98 (83.91, 85.99)	6.74 (6.02, 7.54)	0.01*
2nd	1.9 (1.48, 2.44)	30.05 (28.08, 32.1)	10.48 (9.39, 11.69)	12.55 (11.39, 13.81)	45.01 (42.97, 47.07)		9.06 (8.11, 10.11)	82.75 (81.38, 84.04)	8.18 (7.28, 9.19)	
3rd	1.86 (1.33, 2.59)	25.11 (22.84, 27.53)	11.15 (9.7, 12.79)	11.37 (9.94, 12.99)	50.51 (47.96, 53.05)		9.2 (7.89, 10.7)	81.72 (79.7, 83.57)	9.08 (7.77, 10.58)	
≥ 4th	2.17 (1.62, 2.91)	24.73 (22.45, 27,17)	11.97 (910.46, 13.68)	11.51 (10.07, 13.13)	49.61 (46.97, 52.24)		9.98 (8.61, 11.54)	82.03 (80.04, 83,86)	7.99 (6.8, 9.37)	
Family size										
≤ 4 person	2.49 (2.13, 2.92)	30.32 (28.62, 32.06)	9.94 (9.1, 10.85)	12.37 (11.46, 13.34)	44.89 (43.17, 46.61)	0.001**	7.94 (7.25, 8.68)	84.55 (83.59, 85.48)	7.51 (6.84, 8.24)	0.001**
> 4 person	1.91 (1.57, 2.32)	26.74 (25.08, 28.47)	11.52 (10.55, 12.57)	12.37 (11.42, 13.38)	47.46 (45.69, 49.23)		9.88 (9.07, 10.75)	82.26 (81.08, 83.37)	7.87 (7.1, 8.71)	
Watching TV										
≤ 2 h/d	2.39 (2.01, 2.82)	27.37 (25.7, 29.11)	10.29 (9.4, 11.26)	12.25 (11.33, 13.22)	47.4 (45.95, 49.46)	0.001**	9.14 (8.37, 9.98)	83.43 (82.32, 84.48)	7.43 (6.71, 8.22)	0.519
> 2 h/d	2.02 (1.67, 2.44)	29.47 (27.83, 31.16)	11.18 (10.26, 12.15)	12.5 (11.58, 13.48)	44.84 (43.15, 46.54)		8.65 (7.93, 9.43)	83.55 (82.52, 84.52)	7.8 (7.11, 8.56)	
Working computer										
≤ 2 h/d	2.2 (1.92, 2.51)	28.67 (27.21, 30.18)	10.53 (9.79, 11.32)	12.52 (11.76, 13.31)	46.08 (44.61, 47.56)	0.203	9.01 (8.41, 9.65)	83.62 (82.78, 84.43)	7.37 (6.81, 7.98)	0.001**
> 2 h/d	1.99 (1.31, 3.03)	28.07 (25.2, 31.14)	12.71 (10.83, 14.85)	11.13 (9.34, 13.21)	46.1 (42.87, 49.35)		7.16 (5.82, 8.77)	83.48 (81.17, 85.56)	9.36 (7.73, 11.31)	
Screen time										
≤ 2 h/d	2.23 (1.94, 2.56)	28.26 (26.78, 29.8)	10.5 (9.74, 11.31)	12.52 (11.75, 13.33)	46.49 (44.98, 48.01)	0.286	9.08 (8.45, 9.74)	83.54 (82.68, 84.37)	7.38 (6.81, 8.73)	0.069
> 2 h/d	2.02 (1.49, 2.73)	29.33 (27.03, 31.74)	11.8 (10.45, 13.29)	11.67 (10.3, 13.2)	45.17 (42.75, 47.62)		8.1 (7.06, 9.29)	83.3 (81.63, 84.85)	8.59 (7.46, 9.87)	
Physical activity										

(*continued on next page*)

Table 1 (*continued*)

	BF duration (mo)						BW (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p*	< 2500	2500–4000	> 4000	*p*
Mild	2.6 (2.16, 3.13)	28.25 (26.18, 30.42)	11.32 (10.29, 12.42)	12.64 (11.51, 13.86)	45.19 (43.05, 47.35)	0.01*	9.1 (8.18, 10.12)	82.37 (81.02, 83.64)	8.53 (7.6, 9.55)	0.001**
Moderate	1.9 (1.53, 2.36)	27.14 (25.34, 29.01)	10.89 (9.88, 11.98)	12.92 (11.83, 14.09)	47.16 (45.24, 49.08)		8.31 (7.5, 9.2)	83.93 (82.71, 85.09)	7.75 (6.91, 8.69)	
Severe	2.11 (1.67, 2.66)	30.55 (28.33, 32.87)	9.91 (8.7, 11.26)	11.34 (10.21, 12.58)	46.09 (43.82, 48.37)		9.34 (8.35, 10.43)	84.24 (8.29, 85.49)	6.43 (5.64, 7.32)	
Sleeping h/wk										
< 5h	0	33.33 (23.89, 44.33)	12.35 (6.86, 21.23)	13.58 (7.79, 22.63)	40.74 (30.46, 51.9)	0.678	7.58 (3.23, 16.77)	86.36 (75.82, 92.75)	6.06 (2.28, 15.16)	0.175
5–8	2.43 (1.92, 3.07)	28.99 (26.75, 31.33)	10.95 (9.7, 12.33)	11.64 (10.46, 12.94)	45.99 (43.64, 48.35)		9.09 (8, 10.32)	82.22 (80.65, 83.69)	8.69 (7.61, 9.9)	
> 8	2.15 (1.86, 2.49)	28.21 (26.71, 29.76)	10.68 (9.9, 11.51)	12.53 (11.73, 13.38)	46.43 (44.9, 47.96)		8.84 (8.21, 9.51)	83.88 (83, 84,72)	7.28 (6.69, 7.92)	
Socio–economic status										
Low	2.51 (2.02, 3.1)	25.18 (23.01, 27.47)	10.53 (9.43, 11.74)	12.24 (11.08, 13.52)	49.54 (47.25, 51.83)	0.001**	11.25 (10.11, 12.51)	83.15 (81.67, 84.53)	5.6 (4.82, 6.5)	0.001**
Intermediate	2.07 (1.64, 2.6)	28.86 (26.92, 30.88)	10.31 (9.25, 11.48)	13.63 (12.44, 14.91)	45.14 (43.12, 47.17)		8.34 (7.46, 9.31)	83.43 (82.13, 84.66)	8.23 (7.36, 9.19)	
High	2.19 (1.76, 2.72)	30.99 (28.91, 33.14)	11.32 (10.1, 12.66)	11.59 (10.53, 12.75)	43.91 (41.79, 46.06)		6.98 (6.17, 7.89)	84.46 (83.14, 85.69)	8.56 (7.6, 9.63)	
Type of complementary feeding										
[a]Always homemade foods	2 (1.71, 2.33)	26.14 (24.62, 27.72)	10.01 (9.26, 10.82)	12.29 (11.47, 13.16)	49.56(47.97, 51.15)	0.001**	8.78 (8.15, 9.45)	84.04 (83.12, 84.92)	7.18 (6.56, 7.86)	0.001**
[b]Always formula	2.95 (1.76, 4.93)	40.23 (934.95, 45.74)	16.14 (12.77, 20.19)	10.23 (7.7, 13.46)	30.45 (25.88, 35.45)		13.91 (10.64, 17.99)	74.02 (69.05, 78.43)	12.07 (9.08, 15.89)	
Usually homemade foods	2.6 (2.02, 3.33)	33.13 (30.7, 35.65)	12.18 (10.79, 13.71)	13.44 (12.08, 14.92)	38.66 (36.28, 41.1)		7.84 (6.78, 9.04)	83.72 (82.18, 85.15)	8.44 (7.4, 9.61)	
Usually formula	3.51 (2, 6.09)	37.13 (31.85, 42.75)	14.62 (10.23, 20.47)	11.11 (8.04, 15.16)	33.63 (28.01, 39.74)		11.11 (7.91, 15.38)	80.07 (74.93, 84.37)	8.82 (6.02, 12.76)	
Type of milk consumed										
Breast feeding	0	22.71 (21.18, 24.32)	9.71 (8.97, 10.51)	13.6 (12.78, 14.46)	53.98 (52.37, 55.58)	0.001**	7.32 (6.78, 7.9)	85.02 (84.19, 85.82)	7.66 (7.06, 8.3)	0.001**
Formula	40.69 (36.17, 45.37)	45.34 (40.89, 49.87)	4.25 (2.8, 6.41)	2.63 (1.54, 4.47)	7.09 (4.97, 10.01)		19.1 (15.85, 22.85)	73.29 (69.24, 76.99)	7.6 (5.58, 10.27)	
Cow's milk	3.44 (2.53, 4.66)	58.17 (55.04, 61.23)	18.1 (15.82, 20.62)	8.57 (7.05, 10.39)	11.72 (9.88, 13.96)		15.5 (13.47, 17.77)	78.59 976.12, 80.86)	5.91 (4.77, 7.3)	
Mixed	4.03 (2.45, 6.57)	57.26 (51.88, 62.47)	23.66 (19.51, 28.37)	6.45 (4.38, 9.41)	8.6 (6.1, 12)		11.92 (8.78, 15.98)	73.84 (68.73, 78.37)	14.24 (10.66, 18.77)	

* Significantly different from > 18–24 month, $p = 0.003$.
** Significantly different from > 18–24 month, $p = 0.02$.
CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease.
[a] Use of homemade foods but sometimes formula.
[b] Use of formula but sometimes homemade foods.

Table 2 Mean (95% CI) of anthropometric indices and blood pressure (BP) level in breast feeding (BF) duration and birth weight (BW) categories: the CASPIAN-IV study.

	BF duration (mo)						BW categories (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p* trend	< 2500	2500–4000	> 4000	*p* trend
Weight (kg)	40.93 (38.62, 43.23)	42.62 (41.15, 43.78)	44.15 (42.77, 45.53)	42.29 (41.06, 43.52)	42.10 (41.19, 43.02)	0.362	39.96 (38.73, 41.18)	41.95 (41.17, 42.74)	45.46 (43.89, 47.02)	0.001*
Height (cm)	146.07 (143.80, 148.34)	147.13 (145.72, 148.53)	148.87 (147.38, 150.37)	147.07 (145.70, 148.45)	146.67 (145.60, 147.74)	0.424	144.79 (143.40, 146.19)	146.40 (145.48, 147.32)	149.13 (147.54, 150.72)	0.001*
BMI (kg/m2)	18.39 (17.80, 18.98)	18.91 (18.68, 19.14)	19.20 (18.90, 19.51)	18.8 (18.54, 19.08)	18.79 (18.61, 18.97)	0.402	18.29 (18, 18.58)	18.80 (18.64, 18.95)	19.64 (19.29, 19.99)	0.001*
WC (cm)	66.11 (64.59, 67.62)	66.87 (66.15, 67.60)	68.16 (67.33, 69.0)	66.67 (65.84, 67.50)	67.07 (66.53, 67.62)	0.809	65.83 (65.02, 66.65)	66.87 (66.39, 67.34)	69.28 (68.27, 70.29)	0.001*
WHtR	42.28 (44.53, 46.04)	45.54 (45.25, 45.84)	45.83 (45.46, 46.20)	45.14 (45, 45.82)	45.81 (45.54, 46.03)	0.130	45.54 (45.15, 45.94)	45.75 (45.56, 45.93)	46.51 (46.03, 46.98)	0.609
Wrist (cm)	14.48 (14.23, 14.72)	14.75 (14.63, 14.88)	14.94 (14.77, 15.11)	14.76 (14.63, 14.89)	14.76 (14.67, 14.85)	0.884	14.46 (14.32, 14.60)	14.72 (14.64, 14.80)	15.11 (14.96, 15.78)	0.001*
Hip (cm)	80.16 (78.33, 81.98)	80.68 (79.72, 81.63)	82.04 (80.56, 83.52)	80.47 (79.42, 81.52)	80.85 (80.10, 81.60)	0.946	79.41 (78.38, 80.44)	80.42 (79.78, 81.06)	83.13 (81.88, 84.38)	0.001*
WhtR	18.22 (17.99, 18.46)	18.61 (18.36, 18.85)	18.61 (18.38, 18.83)	18.73 (18.42, 19.05)	18.57 (18.45, 18.68)	0.978	18.51 (18.32, 18.71)	18.64 (18.51, 18.780	18.56 (18.26, 18.860	0.683
SBP (mmHg)	99.42 (97.86, 100.99)	101.59 (100.81, 102.37)	102.74 (101.80, 103,69)	101.36 (100.47, 102.24)	101.35 (100.71, 101.99)	0.663	100.52 (99.61, 101.42)	101.28 (100.76, 101.80)	102.49 (101.36, 103.62)	0.003
DBP (mm Hg)	63.73 (62.33, 65.13)	64.92 (64.25, 65.58)	65.75 (64.92, 66.58)	64.52 (63.74, 65.30)	64.74 (64.21, 65,27)	0.609	64.35 (63.53, 65.18)	64.73 (64.28, 65.17)	65.32 (64.43, 66.21)	0.083

BMI = body mass index; DBP = diastolic blood pressure; SBP = systolic blood pressure; WC = waist circumference; WHtR = waist to height ratio; WhtR = waist to hip ratio.
* Significantly different from > 18–24 month, $p = 0.02$.
CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease.

Table 3 Prevalence (95% CI) of obesity, overweight, abdominal obesity and blood pressure (BP) categories in breast feeding (BF) duration and birth weight (BW) categories: the CASPIAN-IV study.

	BF duration (mo)						BW categories (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p* trend	< 2500	2500–4000	>4000	*p* trend
Underweight	14.75 (11.15, 19.250	11.88 (10.69, 13.18)	11.04 (9.36, 12.98)	12.97 (11.35, 14.78)	12 (11.06, 13.02)	0.994	15.85 (13.67, 18.31)	12 (11.25, 12.8)	7.97 (6.39, 9.9)	0.001*
Overweight	6.47 (4.04, 10.21)	9.46 (8.57, 10.43)	10.08 (8.55, 11.85)	9.6 (8.22, 11.19)	9.92 (9.14, 10.75)	0.243	8.35 (6.87, 10.11)	9.77 (9.17, 10.41)	12.23 (10.26, 14.5	0.004
General obesity	10.07 (6.82, 14.63)	12.99 (11.79, 14.31)	12.14 (10.46, 14.05)	11.32 (9.75, 13.1)	11.39 (10.48, 12.36)	0.071	9.38 (7.73, 11.34)	12.12 (11.35, 12.93)	16.92 (14.65, 19.46)	0.001*
Abdominal obesity	16.13 (12.10,21.17)	18.99 (17.51,20.57)	20(17.94,22.23)	17.77 (15.84, 19.87)	19.49(18.22,20.83)	0.519	19.03(16.7, 21.6)	19.26(18.25,20.30)	24.27(21.56,27.20)	0.007
High SBP	0.72 (0.18, 2.83)	0.78 (0.45, 1.34),	1.17 (0. 7, 1.96)	0.76 (0.42, 1.39)	0. 97 (0. 73, 1.3)	0.561	1.31 (1, 2.350	0.81 (0.63, 1.05)	1 (0, 2)	0.460
High DBP	2.15 (0.97, 4.68)	3.36 (2.41, 4.67)	3.59 (2.55, 5.03)	2.86 (1.93, 4.22)	2.87 (2.33, 3.52)	0.429	3 (2.0, 4.45)	2.94 (2.43, 3.55)	3.15 (2.16, 4.58)	0.863
HTN	2.51 (1.21, 5.13)	3.89 (2.88, 5.24)	4.32 (3.18, 5.84)	3.81 (2.76, 5.24)	3.53 (2.94, 4.23)	0.638	3.56 (2.47, 5.11)	3.57 (3.02, 4.22)	3.8 (2.67, 5.4)	0.797

DBP = diastolic blood pressure; HTN = hypertension; SBP = systolic blood pressure.
* Significantly different from > 18–24 month, $p = 0.02$.
CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease.

2.2.1. Birth weight
Participants' birth weight (BW; g) was categorized into three groups; $<$ 2500 g, 2500–4000 g, and $>$ 4000 g for statistical analysis.

2.3. Measurements

2.3.1. Anthropometric measures
Height (Ht) and weight (Wt) were measured by trained research assistants, according to standardized protocols, without shoes and with light clothing to the nearest 0.1 unit of measure (cm for Ht and kg for Wt). As a measure of obesity, BMI was calculated as Wt (kg) divided by Ht squared (m^2).[14,17] WC was measured over the skin, midway between the lower border of the rib margin and the iliac crest at the end of normal expiration, to the nearest 0.1 cm. Both WC and Ht were measured using nonelastic tapes.[11,15]

2.3.2. Blood pressure
SBP and DBP were measured, using standardized mercury sphygmomanometers, on the right arm after a 15 minute rest in a sitting position. The first and fifth Korotkoff sounds were recorded as SBP and DBP, respectively. After 5 minute intervals, BP was measured for a second time and the average of two measurements was considered as the actual value.[12,18]

2.4. Demographic information

Two sets of standardized questionnaires were completed by students and their parents. Demographic information regarding family history of chronic diseases (hypertension, dyslipidemia, diabetes, and obesity), parental level of education (the highest total years of schooling), ownership of a family private car and type of home, dietary habits, lifestyle habits, physical activity pattern, and sedentary lifestyle), was collected by trained interviewers for all participants through interview with parents or children in a calm atmosphere inside the schools.

2.5. Statistical analyses

Categorical variables are presented as a percentage with 95% confidence interval (CI). Mean of continuous variables are summarized with 95% CI.

Comparisons of continuous and categorical variables across BF and BW categories were assessed by using analysis of variance (ANOVA) and Pearson Chi-square tests. Logistic regression analyses were used to evaluate the association between BF duration and BW categories with anthropometric measurements and BP in different models, adjusting for possible confounders. Model I is a crude model (without adjustment). In Model II, the association was adjusted for age, sex, and living place, and in Model III, family history of chronic diseases, screen time, physical activity, SES, birth order, family size, type of complementary feeding, type of milk consumed in infancy, sleeping hours, BMI, and elevated BP were additionally adjusted. In Model IV, additional adjustment was considered for BF duration and BW categories.

Statistical measures were estimated using survey data analysis methods. Data were analyzed by using STATA package Corp. 2011 (Stata Statistical Software, Release 12. Stata Corp LP, College Station, TX, USA). A p value < 0.05 was considered as statistically significant.

2.6. Ethical consideration

The study was reviewed and approved by ethical committees and other relevant regulatory organizations at national and provincial levels. The process of sampling and examination began after explaining the project to the students and their parents. Participation in the study was voluntary. Written informed consent and verbal consent were obtained from parents and students, respectively.

3. Results

Overall, 13,486 students completed the study (participation rate of 90.6%). They consisted of 49.24% girls, 75.6% urban residents, with a mean age of 12.5 years (95% CI: 12.3–12.6). The general characteristics of study participants according to BF duration and BW categories are presented in Table 1.

Compared to boys, the number of girls was higher in the first ($<$ 2500 g) and second (2500–4000 g) categories of BW ($p < 0.001$). Family history of obesity had a significant association with BW ($p < 0.001$). Overall, 82.21% (95% CI: 81.1–83.27) of participants with BW of 2500–4000 g had a positive family history of obesity, which was significantly higher than the two BW categories.

We found a significant association between BW categories and living place ($p < 0.001$). Low BW was more prevalent in rural areas [9.66 (8.44–11.02) vs. 8.65 (8.03–9.3)]. Regarding the family history of chronic diseases; family history of obesity had a significant association with BW ($p < 0.001$). There was no significant association between BF duration and family history of chronic disease. SBP and DBP had no significant association with BF duration and BW.

As presented in Table 1, a significant association was found between BF duration and the order of children in the family, both in boys ($p < 0.001$) and girls ($p < 0.001$). Likewise, the family size had a significant association with both BF duration ($p < 0.001$) and BW ($p < 0.001$).

The distribution of the participants in different categories of BF duration and BW groups had a significant association with SES categories ($p < 0.001$), the type of complementary feeding ($p < 0.001$), and the type of milk consumed during infancy ($p < 0.001$).

All participants had a history of breast feeding, which was categorized in to five time duration groups. Analysis of data from 10,502 participants, shows that 53.98% ($n = 5669$) had 18–24 months duration of BF. Respectively, 13.6% ($n = 1428$) were breast fed for 12–18 months and 9.7% ($n = 1020$) for 6–12 months. Whereas for 22.7% ($n = 2385$) of participants, time duration of BF was up to 6 months.

Mean (95% CI) anthropometric indices and BP in categories of BF duration and BW are presented in Table 2. The mean values for Ht, Wt, BMI, WC, wrist, and hip

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Table 4 Odds ratios (95% CIs) for underweight, obesity, overweight, abdominal obesity, and blood pressure categories in breast feeding duration and birth weight categories: The CASPIAN-IV study.

	BF duration (mo)						BW categories (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p* trend[a]	< 2500	2500–4000	> 4000	*p* trend[a]
Underweight										
Model I[b]	1	0.78 (0.56, 1.09)	0.71 (0.50, 1.04)	0.86 (0.60, 1.23)	0.79 (0.56, 1.10)	0.994	1	0.72 (0.60, 0.87)*	0.46 (0.34, 0.61)*	0.001**
Model II[c]	1	0.76 (0.54, 1.07)	0.71 (0.49, 1.02)	0.84 (0.59, 1.20)	0.76 (0.54, 1.06)	0.799	1	0.73 (0.61, 0.87)*	0.47 (0.35, 0.63)*	0.001**
Model III[d]	1	0.66 (0.47, 0.94)	0.60 (0.41, 0.88)	0.71 (0.49, 1.03)	0.67 (0.47, 0.95)	0.762	1	0.78 (0.64, 0.95)	0.51 (0.37, 0.71)*	0.001**
Model IV[e]	1	0.71 (0.49, 1.05)	0.69 (0.45, 1.06)	0.79 (0.52, 1.19)	0.75 (0.52, 1.10)	0.729	1	0.78 (0.64, 0.95)	0.53 (0.38, 0.73)*	0.001**
Overweight										
Model I[b]	1	1.51 (0.90, 2.52)	1.62 (0.96, 2.73)	1.53 (0.91, 2.58)	1.59 (0.96, 2.63)	0.243	1	1.19 (0.95, 1.48)	1.53 (1.15, 2.03)	0.004
Model II[c]	1	1.55 (0.93, 2.60)	1.65 (0.97, 2.79)	1.59(0.94, 2.68)	1.67 (1.00, 2.77)	0.128	1	1.18 (0.94, 1.48)	1.48 (1.11, 1.97)	0.008
Model III[d]	1	1.69 (0.93, 3.07)	1.82 (0.99, 3.35)	1.86 (1.02, 3.40)	1.82 (1.01, 3.26)	0.130	1	1.20 (0.94, 1.54)	1.43 (1.04, 1.97)	0.028
Model IV[e]	1	0.49 (−0.13, 1.11)	0.53 (−0.11, 1.17)	0.55 (−0.07, 1.18)	0.56 (−0.05, 1.17)	0.177	1	1.20 (0.93, 1.55)	1.42 (1.02, 1.99)	0.039
General obesity										
Model I[b]	1	1.33 (0.86, 2.07)	1.23 (0.79, 1.93)	1.14 (0.72, 1.79)	1.15 (0.74, 1.77)	0.171	1	1.33 (1.07,1.65)	1.97 (1.50, 2.59)*	0.001**
Model II[c]	1	1.37 (0.88, 2.12)	1.29 (0.83, 2.02)	1.21 (0.77, 1.90)	1.20 (0.78, 1.84)	0.129	1	1.32 (1.06, 1.64)	1.86 (1.41, 2.44)*	0.001**
Model III[d]	1	1.70 (1.03, 2.82)	1.58 (0.94, 2.66)	1.41 (0.83, 2.38)	1.45 (0.88, 2.39)	0.116	1	1.34 (1.05, 1.71)	1.72 (1.26, 2.34)*	0.001**
Model IV[e]	1	1.53 (0.91, 2.56)	1.37 (0.81, 2.33)	1.25 (0.73, 2.14)	1.33 (0.80, 2.22)	0.206	1	1.30 (1.01, 1.66)	1.67 (1.22, 2.29)*	0.001**
Abdominal adiposity										
Model I[b]	1	1.22 (0.86, 1.73)	1.3 (0.91, 1.85)	1.12 90.78, 1.61)	1.26 (0.89, 1.77)	0.526	1	1.01 (0.86, 1.19)	1.36 (1.10, 1.69)	0.007
Model II[c]	1	1.25 (0.88, 1.78)	1.35 (0.94, 1.92)	1.18 (0.82, 1.70)	1.32 (0.94, 1.86)	0.287	1	1.0 (0.85, 1.18)	1.29 (1.04, 1.60)	0.025
Model III[d]	1	1.34 (0.92, 1.97)	1.42 (0.96, 2.11)	1.23 (0.82, 1.81)	1.41 (0.97, 2.06)	0.323	1	0.96 (0.80, 1.14)	1.20 (0.94, 1.52)	0.164
Model IV[e]		1.33 (0.88, 2.00)	1.37 (0.90, 2.08)	1.18 (0.77, 1.80)	1.42 (0.95, 2.12)	0.251	1	0.93 (0.77, 1.11)	1.13 (0.89, 1.44)	0.366
High SBP										
Model I[b]	1	1.08 (0.26, 4.44)	1.64 (0.40, 6.73)	1.06 (0.23, 4.86)	1.36 (0.33, 5.68)	0.561	1	0.62 (0.34, 1.13)	0.75 (0.30, 1.84)	0.460
Model II[c]	1	1.06 (0.26, 4.39)	1.55 (0.37, 6.46)	1.13 (0.25, 5.13)	1.40 (0.34, 5.81)	0.441	1	0.59 (0.33, 1.08)	0.64 (0.26, 1.59)	0.320
Model III[d]	1	1.06 (0.28, 4.07)	1.35 (0.33, 5.44)	0.88 (0.20, 3.96)	1.09 (0.28, 4.31)	0.978	1	0.54 (0.28, 1.02)	0.43 (0.14, 1.32)	0.126
Model IV[e]	1	0.87 (0.23, 3.23)	1.09 (0.28, 4.25)	0.90 (0.20, 3.98)	1.01 (0.26, 3.90)	0.752	1	0.55 (0.28, 1.08)	0.47 (0.15, 1.46)	0.185
High DBP										
Model I[b]	1	1.58 (0.68, 3.68)	1.69 (0.71, 4.03)	1.34 (0.54, 3.30)	1.34 (0.60, 2.98)	0.429	1	0.98 (0.67, 1.43)	1.05 (0.62, 1.79)	0.863
Model II[c]	1	1.55 (0.67, 3.58)	1.59 (0.67, 3.77)	1.33 (0.54, 3.24)	1.32 (0.60, 2.91)	0.471	1	0.98 (0.67, 1.43)	1.02 (0.60, 1.74)	0.942
Model III[d]	1	1.34 (0.58, 3.09)	1.26 (0.53, 3.01)	1.05 (0.41, 2.66)	1.04 (0.46, 2.35)	0.235	1	1.08 (0.70, 1.67)	1.13 (0.63, 2.03)	0.682
Model IV[e]	1	1.73 (0.65, 4.62)	1.73 (0.62, 4.83)	1.31 (0.43, 3.92)	1.39 (0.52, 3.76)	0.366	1	1.11 (0.72, 1.71)	1.10 (0.60, 2.01)	0.743
HTN										
Model I[b]	1	1.57 (0.73, 3.40)	1.75 (0.81, 3.81)	1.54 (0.68, 3.49)	1.42 (0.68, 2.99)	0.638	1	1.0 (0.70, 1.43)	1.07 (0.65, 1.77)	0.797
Model II[c]	1	1.54 (0.71, 3.31)	1.65 (0.76, 3.57)	1.54 (0.69, 3.46)	1.41 (068, 2.93)	0.715	1	1.00 (0.70, 1.43)	1.02 (0.62, 1.69)	0.938
Model III[d]	1	1.35 (0.63, 2.90)	1.38 (0.63, 2.99)	1.21 (0.53, 2.79)	1.12 (0.53, 2.37)	0.336	1	1.06 (0.71, 1.59)	1.03 (0.59, 1.81)	0.001**
Model IV[e]	1	1.61 (0.68, 3.81)	1.70 (0.71, 4.07)	1.41 (0.54, 3.68)	1.42 (0.59, 3.41)	0.592	1	1.06 (0.71, 1.59)	1.03 (0.59, 1.81)	0.911

Note. overweight = BMI 85th– 95th; obesity = BMI > 95th; abdominal obesity = waist to height ratio > 0.5; HTN = > 95th adjusted by age, sex, height.

* Significantly different from > 18–24 month, $p = 0.04$.

** Significantly different from > 18–24 month, $p = 0.02$.

CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease.

[a] *p* for trend are resulted from logistic regression.

[b] Without adjustment (crude model).

[c] Adjusted for age, sex, and living place.

[d] Additionally adjusted for other characteristics including family history of chronic diseases, screen time, physical activity, socioeconomic status, birth order, family size, type of complementary feeding, type of milk, sleeping hours, and BMI (only for HTN).

[e] Additionally for breast feeding duration birth weight is adjusted and for birth weight categories breast feeding duration is adjusted.

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Table 5 β-coefficients (95% CIs) for anthropometric indices and blood pressure (BP) by categories of breast feeding and birth weight: the CASPIAN-IV study.

	BF duration (mo)						BW categories (g)			
	0	≤ 6	> 6–12	> 12–18	> 18–24	*p* trend[a]	< 2500	2500–4000	> 4000	*p* trend[a]
BMI (kg/m^2)										
Model I[b]	1	0.52 (−0.10, 1.13)	0.81 (0.17, 1.46)	0.42 (−0.21, 1.06)	0.40 (−0.20, 1)	0.406	1	0.51 (.022, 0.79)*	1.35 (0.92, 1.78)*	0.001***
Model II[c]	1	0.55 (0.05, 1.06)	0.60 (0.08, 1.12)	0.43 (−0.09–0.95)	0.51 (0.02, 1.00)	0.994	1	0.50 (0.27, 0.73)*	1.18 (0.83, 1.53)*	0.001***
Model III[d]	1	0.80 (0.29, 1.31)	0.85 (0.31, 1.39)	0.66 (0.14, 1.19)	0.76 (0.27, 1.26)	0.720	1	0.45 (0.21, 0.69)*	0.95 (0.58, 1.32)*	0.001***
Model IV[e]	1	0.69 (0.12, 1.26)	0.71 (0.12, 1.30)	0.53 (−0.05, 1.11)	0.66 (0.11, 1.22)	0.750	1	0.42 (0.18, 0.67)*	0.89 (0.50, 1.27)*	0.001***
WC (cm)										
Model I[b]	1	0.77 (−0.82, 2.35)	2.06 (0.40, 3.71)	0.56 (−1.10, 2.23)	0.96 (−0.57, 2.50)	0.810	1	1.03 (0.25, 1.81)	3.44 (2.26, 4.63)*	0.001**
Model II[c]	1	0.83 (−0.41, 2.07)	1.39 (0.11, 2.67)	0.67 (−0.66, 1.9)	1.25 (0.05, 2.44)	0.101	1	1.00 (0.39, 1.62)*	2.77 (1.85, 3.68)*	0.001**
Model III[d]	1	0.92 (−0.37, 2.22)	1.58 (0.25, 2.91)	0.88 (−0.49, 2.26)	1.47 (0.23, 2.70)	0.037	1	0.82 (0.18, 1.46)	2.22 (1.22, 3.22)*	0.001**
Model IV[e]	1	0.62 (−0.84, 2.08)	1.30 (−0.20, 2.79)	0.42 (−1.11, 1.96)	1.23 (−0.17, 2.63)	0.039	1	0.73 (0.06, 1.39)	2.06 (1.02, 3.10)*	0.001**
WHtR										
Model I[b]	1	0.003 (−0.005, 0.010)	0.005 (−0.003, 0.01)	0.001 (−0.007, 0.010)	0.01 (−0.002, 0.012)	0.135	1	0.002 (−0.001, 0.006)	0.01 (0.003, 0.02)*	0.002
Model II[c]	1	0.003 (−0.005, 0.01)	0.007 (−0.001, 0.015)	0.002 (−0.006, 0.010)	0.006 (−0.001, 0.013)	0.073	1	0.002 (−0.002, 0.006)	0.009 (0.003, 0.01)	0.005
Model III[d]	1	0.005 (−0.004, 0.013)	0.008 (−0.0003, 0.017)	0.004 (−0.005, 0.012)	0.008 (−0.0002, 0.16)	0.056	1	0.0004 (−0.0004, 0.005)	0.006 (−0.004, 0.012)	0.082
Model IV[e]		0.004 (−0.006, 0.013)	0.007 (−0.002, 0.017)	0.002 (−0.008, 0.012)	0.007 (−0.002, 0.016)	0.064	1	0.0004 (−0.005, 0.004)	0.004 (0.002, 0.01)	0.240
Wrist										
Model I[b]	1	0.28 (0.03, 0.53)	0.46 (0.18, 0.74)*	0.28 (0.02, 0.54)	0.28 (0.04, 0.53)	0.885	1	0.27 (0.14, 0.39)*	0.66 (0.47, 0.84)*	0.001**
Model II[c]	1	0.26 (0.09, 0.43)	0.31 (0.011, 0.50)	0.28 (0.10, 0.46)	0.29 (0.13, 0.46)*	0.176	1	0.27 (0.18, 0.35)*	0.54 (0.41, 0.67)*	0.001**
Model III[d]	1	0.29 (0.12, 0.46)*	0.35 (0.15, 0.55)*	0.28 (0.09, 0.46)	0.32 (0.15, 0.49)*	0.190	1	0.28 (0.19, 0.38)*	0.51 (0.37, 0.66)*	0.001**
Model IV[e]		00.24 (0.05, 0.42)	0.29 (0.08, 0.51)	0.20 (0.00. 0.40)	0.26 (0.08, 0.44)	0.336	1	0.28 (0.18, 0.38)*	0.50 (0.35, 0.65)*	0.001**
Hip (cm)										
Model I[b]	1	0.52 (−1.38, 2.42)	1.88 (−0.37, 4.13)	0.31 (−1.70, 2.32)	0.69 (−1.16, 2.54)	0.946	1	1.01 (0.05, 1.97)	3.72 (2.30, 5.15)*	0.001**
Model II[c]	1	0.67 (−0.53, 1.87)	0.87 (−0.79, 2.53)	0.34 (−1.00, 1.68)	1.13 (−0.05, 2.31)	0.107	1	1.02 (0.37, 1.67)	3.12 (2.20, 4.03)*	0.001**
Model III[d]	1	0.79 (−0.44, 2.02)	1.45 (−0.32, 3.21)	0.61 (−0.78, 2.00)	1.42 (0.19, 2.64)	0.059	1	0.73 (0.002, 1.14)	2.53 (1.49, 3.57)*	0.001**
Model IV[e]	1	0.61 (−0.76, 1.98)	0.54 (−0.94, 2.02)	0.28 (−1.23, 1.78)	1.28 (−0.08, 2.63)	0.030	1	0.64 (−0.10, 1.39)	2.47 (1.40, 3.55)*	0.001**
WhtR										
Model I[b]	1	0.004 (0.001, 0.007)	0.004 (0.001, 0.006)	0.005 (0.001, 0.009)	0.003 (0.001, 0.006)	0.978	1	0.001 (−0.001, 0.003)	0.0004 (−0.002, 0.003)	0.682
Model II[c]	1	0.003 (0.0002, 0.006)	0.004 (0.001, 0.007)	0.005 (0.001, 0.008)	0.002 (0.0002, 0.005)	0.639	1	0.001 (−0.001, 0.003)	0.001 (−0.002, 0.003)	0.593
Model III[d]	1	0.004 (0.0003, 0.007)	0.003 (0.0003, 0.006)	0.004 (0.0005, 0.008)	0.002 (−0.0002, 0.004)	0.377	1	0.002 (0.0002, 0.004)	0.002 (−0.002, 0.005)	0.247
Model IV[e]	1	0.004 (−0.00004, 0.007)	0.003 (0.0002, 0.007)	0.004 (0.0002, 0.008)	0.002 (−0.0007, 0.004)	0.329	1	0.002 (0.0002, 0.005)	0.002 (−0.002, 0.005)	0.335
SBP (mmHg)										
Model I[a]	1	2.17 (0.51, 3.82)	3.32 (1.56, 5.08)*	1.93 (0.22, 3.65)	1.92 (0.35, 3.50)	0.664	1	0.76 (−0.11, 1.63)	1.97 (0.66, 3.29)	0.003
Model II[c]	1	2.16 (0.62, 3.70)	2.80 (1.17, 4.42)*	2.03 (0.43, 3.63)	2.09 (0.60, 3.57)	0.889	1	0.73 (−0.07, 1.53)	1.34 (0.14, 2.55)	0.026
Model III[d]	1	1.42 (−0.20, 3.05)	2.18 (0.48, 3.88)	1.46 (−0.22, 3.14)	1.62 (0.03, 3.21)	0.540	1	0.15 (−0.71, 1.00)	0.29 (−1.04, 1.62)	0.663
Model IV[e]	1	1.25 (−0.49, 2.99)	1.92 (0.10, 3.74)	1.35 (−0.45, 3.16)	1.50 (−0.22, 3.21)	0.490	1	0.10 (−0.77, 0.97)	0.25 (−1.11, 1.60)	0.719
DBP (mmHg)										
Model I[b]	1	1.18 (−0.30, 2.67)	2.02 (0.46, 3.58)	0.79 (−0.71, 2.29)	1.01 (−0.40, 2.41)	0.628	1	0.37 (−0.41, 1.16)	0.97 (−0.11, 2.05)	0.082
Model II[c]	1	1.19 (−0.23, 2.60)	1.73 (0.24, 3.21)	0.84 (−0.59, 2.27)	1.10 (−0.25, 2.45)	0.883	1	0.36 (−0.41, 1.13)	0.62 (−0.41, 1.66)	0.232
Model III[d]	1	0.76 (−0.73, 2.26)	1.09 (−0.48, 2.67)	0.35 (−1.18, 1.88)	0.63 (−0.81, 2.06)	0.752	1	0.10 (−0.73, 0.92)	0.28 (−0.84, 1.40)	0.628
Model IV[e]	1	1.11 (−0.45, 2.67)	1.56 (−1.00, 3.22)	0.70 (−0.89, 2.28)	1.09 (−0.42, 2.60)	0.980	1	−0.02 (−0.88, 0.83)	0.2 (−1.11, 1.16)	0.973

* Significantly different from > 18–24 month, $p = 0.04$.

** Significantly different from > 18–24 month, $p = 0.02$.

BMI = body mass index; CASPIAN = Childhood and Adolescence Surveillance and Prevention of Adult Noncommunicable Disease; DBP = diastolic blood pressure; SBP = systolic blood pressure; WC = waist circumference; WHtR = waist to height ratio; WhtR = waist to hip ratio.

[a] *p* for trend are resulted from logistic regression.

[b] Without adjustment (crude model).

[c] Adjusted for age, sex and living place.

[d] Additionally adjusted for other characteristics including family history of chronic diseases, screen time, physical activity, socioeconomic status birth order, family size, type of complementary feeding, sleeping hours, BMI (only for SBP and DBP).

[e] Additionally for breast feeding duration birth weight is adjusted and for birth weight categories breast feeding duration is adjusted.

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circumferences increased linearly by higher BW categories (p for trend < 0.001).

The prevalence (95% CI) of obesity, overweight, abdominal obesity, and BP in categories of BF duration and BW are shown in Table 3. The prevalence of general obesity increased linearly by increasing BW categories (p for trend < 0.001), while the prevalence of being underweight had a linear negative association with BW categories (p for trend < 0.001). Elevated SBP and DBP had no significant association with BF and BW categories.

The association of anthropometric and BP measures with BF duration and BW are presented in Table 4. It shows that being underweight decreased linearly by increasing BW (p for trend < 0.001), whereas general obesity had a significant association with BW categories, affirming the same trend based on the crude model and adjusted model for sex and living place (Model II).

Table 5 shows β-coefficients (95% CIs) for anthropometric indices and BP by categories of BF and BW. BMI and WC had a significant trend (p for trend < 0.001) of increasing values with higher BW categories.

4. Discussion

The present study presents the association of BF duration and BW with anthropometric and BP measures in Iranian children and adolescents. The results showed that BW had significant associations with increased risk of higher general obesity and a lower prevalence of being underweight.

We found an inverse association between BW and being underweight and a positive association of BW with general obesity in adolescents. We did not document any significant association between BF duration and BW with anthropometric measures. It should be considered that some controversial evidence exists on the association of BW with adulthood body size.[19,20]

A similar study found a significant association of BW with adolescents' body size, weight, and BMI. They reported that multiple linear regression analyses adjusted for age, pubertal stage, and gestational age did not show any significant effect of BW with adolescents' weight or BMI.[21] Some studies on younger children reported a positive relationship between BW and childhood BMI.[21,22] In a cohort study, BW was associated with higher insulin levels during adolescence, and this effect was independent of the current weight of adolescents.[19] The tracking of BW with anthropometric indicators of adolescence was investigated in a large study of twins. It identified a significant positive relationship of adolescent body size with BW, which was also influenced by their parents' body size.[23,24]

Most related studies emphasized that both genetic predisposition and factors associated with BW were associated with adult obesity. However, the underlying mechanisms of association between BW and obesity remain to be determined.[22,24,26]

We did not document a significant association of BF and BW with BP. Our findings are consistent with a previous study on the effect of neonatal parameters on adolescents' BP, which did not find a significant relationship of BW with adolescents' BP.[21,25] However, our findings are not in line with another study that found a significant negative relationship of BW with later BP in 11–12-year-olds in Jamaica.[10] A study on Danish young adult men also detected a significant inverse relationship of BW with SBP, which was significant only after adjustment for current BMI of participants.[9]

The controversies regarding the relationship between BF and BW with adolescent anthropometric measures and BP may be related to a number of factors including age, ethnicity, maternal glucose tolerance during pregnancy, changing body composition in adolescence, diet and physical activity, as well as hormonal changes.[19]

One of the strengths of this current study was that we benefited from using a large national representative sample of Iranian children and adolescents. Moreover measuring the anthropometric measures and BP as the inputs prior to our models led to a reduction in confounder effects as far as possible. The main limitation of this study was its cross-sectional design, which led to some limitations and recall bias of parents in gathering information. Although we adjusted for all potential confounders, residual confounding may still have occurred due to lack of access to birth status variables.

5. Conclusion

BW was associated with a higher risk of general obesity and a lower risk of being underweight. However, we did not detect any significant association for BF with anthropometric measures and BP.

Our findings emphasize paying more attention to the association between parental consideration on BW and its subsequent health outcomes. The promotion of screening strategies in target groups to receive specific preventive and therapeutic services can help improve present and future health status. The role of early life factors should be underscored in early prevention of NCDs, and longitudinal studies are necessary to assess the possible clinical impacts of our findings.

Conflict of interests

The authors declared no conflict of interests.

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