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Nutritional status and related factors of schoolchildren in Çorum, Turkey

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Abstract

Objective: We aimed to determine nutritional status and related factors among schoolchildren in Çorum, Central Anatolia, Turkey.
Design: Schoolchildren's height and weight were measured to calculate BMI and BMI *Z*-scores. Height, weight and BMI *Z*-scores were analysed and nutritional status classified according to the WHO.
Setting: Central Anatolia, Turkey.
Participants: Schoolchildren aged 5–17 years (*n* 1684) participated in study.
Results: Of children, 4·2 % were stunted, 6·9 % thin, 13·8 % overweight and 6·6 % were obese. Proportions of stunting, thinness and overweight/obesity were significantly higher in children aged >10 years (78·6, 75·0 and 64·9 %, respectively) than in those aged ≤10 years (21·4, 25·0 and 35·1 %, respectively; all $P<0·001$). Median (range) birth weight and breast-feeding duration in children with stunting (2750 (1400–3600) g; 10 (0–36) months) were significantly lower and shorter, respectively, than those of normal height (3200 (750–5500) g; 15 (0–72) months) and tall children (3500 (2500–4900) g; 18 (0–36) months; $P<0·001$, <0·001, 0·011 and 0·016, respectively). The same relationship was observed in thin children (3000 (1000–4500) g; 12 (0–36) months) compared with normal-weight (3200 (750–5500) g; 15 (0–72) months) and overweight/obese children (3300 (1200–5500) g; 16 (0–48) months; $P=0·026$, <0·001, 0·045 and 0·011, respectively).
Conclusions: Overweight and obesity are health problems that must be addressed in schoolchildren. Adolescents also have a risk of double malnutrition. Promoting normal birth weight and encouraging long duration of breast-feeding are important to support normal growth in children.

Keywords
Adolescent
Breast-feeding
Child
Malnutrition
Obesity

Paediatric malnutrition is defined as an imbalance between nutritional requirements and intakes, resulting in cumulative energy, protein or micronutrient deficits that may negatively affect growth, development and other relevant outcomes(1). The term 'malnutrition' covers three broad groups of conditions: undernutrition; micronutrient-related malnutrition; and overweight, obesity and diet-related non-communicable diseases(2).

In children and adolescents, measuring height, weight and BMI are simple ways of assessing nutritional status(3). To assess malnutrition, BMI can be used for children aged 61 months to 17 years, whereas weight, height and weight-for-height *Z*-scores are used for those aged 0–60 months(4). The WHO defines thinness as BMI *Z*-score <-2(4). Thinness has recently been adopted as a more appropriate indicator of malnutrition than underweight in older children(5). In addition, thinness can be an indicator of acute and/or chronic malnutrition and can serve as a basis for morbidities associated with malnutrition(3). Overweight and obesity (OW/OB) among children and adolescents has emerged as one of the most serious public health concerns of the 21st century. The worldwide prevalence of childhood obesity has increased strikingly over the past three decades(6). The increasing prevalence of childhood obesity has led to the emergence of multiple serious obesity-related co-morbidities(7).

To achieve healthy body structure and development, not only a timely diet and physical activity but also dietary characteristics, composition and quality during the first 1000 d of life (from conception until 2 years of age) are critically important(8–10). During the prenatal period, the environment in which the mother lives as well as her activities and diet can cause 'metabolic programming' that permanently influences fetal physiology and

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metabolism[11]. The mother's diet has the most important influence on metabolic programming[12]. Similarly, the dietary process following birth is also effective in shaping metabolic programming. Diet, especially during infancy and early childhood, affects health status in adulthood, in addition to supporting the child's growth and development[13,14].

The present study aimed to determine the frequency of childhood and adolescent malnutrition (stunting, thinness and OW/OB) and assess their related factors in the province of Çorum, a city in Central Anatolia, Turkey.

Methods

The present study was conducted among children aged between 5 and 17 years who were enrolled in schools in Çorum city centre and surrounding towns. Schoolchildren who were not in this age group were excluded from the study. Considering the different socio-economic characteristics of the city centre and nearby towns, a stratified random sampling method was used for sample selection. In addition, we determined the number of all primary-, secondary- and high-school students, and careful assessment was done to determine the towns based on the weight of strata. Then, the number of samples was determined based on a simple random sampling method. A survey was administered querying children's delivery mode, birth weight, duration of predominant breast-feeding, complementary feeding time, duration of breast-feeding, mothers' age and maternal education level. Children with birth weight <2500 g were classified as low birth weight (LBW), those between 2500 and 4000 g were classified as normal birth weight (NBW) and those ≥4000 g were classified as high birth weight (HBW). Children diagnosed with chronic diseases were excluded from the study. The study was approved by the Hitit University Clinical Research Ethical Board (approval number 2017–83). Signed voluntary consent forms were obtained from the parents of study participants.

Children's height and weight were measured to calculate their BMI and BMI *Z*-scores. Weight was measured using a portable electronic scale with 0·1 g precision, with heavy clothing, such as coats and shoes, removed. Height was measured using a portable stadiometer with 0·1 cm precision, with shoes removed and participants standing with feet adjacent and in an upright position. Height, weight and BMI *Z*-scores were calculated using WHO AnthroPlus software version 1.0.4[15]. Nutritional conditions were classified according to the WHO[4].

Statistical analysis

The statistical software package IBM SPSS Statistics version 22.0 was used for all data analyses. Descriptive statistics are presented as number and percentage for qualitative variables, and as mean and standard deviation or as median and range for quantitative variables. The normal distribution of data was evaluated using Kolmogorov–Smirnov and Shapiro–Wilk tests to guide choice of statistical test. Homogeneity of variances was investigated using Levene's test. Relationships between continuous variables were examined using Spearman's correlation coefficient. When interpreting the association based on Spearman's correlation coefficients, reference ranges were adopted as follows: $0·00 < r < 0·25$, very weak; $0·26 < r < 0·49$, weak; $0·50 < r < 0·69$, moderate; $0·70 < r < 0·89$, high; and $0·90 < r < 1·00$, very high. When comparing the mean values between two independent groups, the Student *t* test was used for data with normal distribution and the non-parametric Mann–Whitney *U* test was used for data with a non-normal distribution. When comparing more than two groups, the non-parametric Kruskal–Wallis test was used because of the unavailability of hypotheses. Following the variance analysis, a *post hoc* pairwise comparison test was used to determine differences among the groups.

The association between height and BMI *Z*-scores and birth weight and breast-feeding duration was analysed using multiple linear regression. Risk factors influencing height and BMI category were determined using binary logistic regression analysis. To determine the ability of birth weight and breast-feeding duration to predict height (maximum sensitivity and specificity), the receiver-operating characteristic curve analysis method was used. Receiver-operating characteristic curves were drawn and the area under the curve and 95 % confidence interval of this area were calculated. During the analyses, the significance of variables in determining at-risk groups was area under the curve >0·500 (0·9–1·0, perfect; 0·8–0·9, good; 0·7–0·8, moderate; 0·6–0·7, weak; 0·5–0·6, ineffective). To classify the success, sensitivity and specificity of data, positive predictive value, negative predictive value and positive likelihood values were calculated. The Youden index was used to determine the best cut-off point in the receiver-operating characteristic curve analysis. A total of fourteen students who had missing data for height, weight or date of birth were excluded in the statistical analyses. A *P* value <0·05 was considered statistically significant.

Results

A total of 1684 children were included in the study, consisting of 882 (52·4 %) girls, with mean age of 11·7 (SD 3·3) years (range 5–17 years). Among the participants, 547 (32·5 %) were students in primary school, 583 (34·6 %) in secondary school and 554 (32·9 %) in high school. A total of 1057 (63·0 %) children were born via normal vaginal delivery. The median breast-feeding duration was 15 months (range 0–72 months; Table 1). Girls and boys did not differ significantly with respect to height and BMI

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Z-scores ($P = 0{\cdot}436$ and $P = 0{\cdot}517$, respectively). Girls' median height and BMI *Z*-scores were 0·01 (range −5·0 to 4·5) and −0·23 (range −5·5 to 3·9), respectively. Boys' median height and BMI *Z*-scores were 0·12 (range −5·0 to 3·5) and −0·22 (range −4·5 to 3·5), respectively.

After evaluating the children's nutritional status, we found that 4·2 % of them were stunted, 6·9 % were thin, 13·8 % were overweight and 6·6 % were obese; 65·7 % had normal height and weight, and 3·2 % were tall with normal weight (Table 2).

The median height *Z*-score of 0·23 (range −3·4 to 3·5) in children aged ≤10 years was significantly higher than in those aged >10 years: −0·09 (range −5·0 to 4·5; $P < 0{\cdot}001$).

Table 1 Sociodemographic characteristics of the school children aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

Characteristic	*n*	%
Gender		
Girls	882	52·4
Boys	802	47·6
Mode of delivery		
Normal vaginal delivery	1057	63
Caesarean section	620	37
Birth weight (g)		
< 2500	218	14·5
2500–3999	1182	78·4
≥ 4000	107	7·1
Duration of predominant breast-feeding		
None	112	6·7
0–3 months	324	19·8
4–6 months	1204	73·5
Complementary feeding time		
0–3 months	125	7·6
4–5 months	362	21·9
6 months	1161	70·5
Duration of breast-feeding		
0–12 months	1032	64·7
≥ 13 months	563	35·3
Mother's age at child's birth		
< 20 years	159	10·2
20–35 years	1311	84·5
> 35 years	82	5·3
Maternal education status		
≤ Secondary school	989	59·9
> Secondary school	661	40·1

After evaluating the distribution of stunting among children by age, a statistically significant difference was observed: 78·6 % of participants were aged >10 years and 21·4 % were aged ≤10 years ($P < 0{\cdot}001$; Table 3). Children's height *Z*-score and age were weakly negatively correlated ($r = -0{\cdot}160$, $P < 0{\cdot}001$; Fig. 1).

The frequency of thinness in children aged >10 years (8·6 %) was higher than that in children aged ≤10 years (4·4 %; $P < 0{\cdot}001$). After examining the distribution of thinness among children by age, 75·0 % were aged >10 years and 25·0 % were aged ≤10 years ($P < 0{\cdot}001$; Tables 2 and 3). The OW/OB frequency in children aged >10 years (22·0 %) was higher than that in children aged ≤10 years (17·9 %; $P < 0{\cdot}001$). When examining the distribution of OW/OB among children by age, 64·9 % were aged >10 years and 35·1 % were aged ≤10 years ($P < 0{\cdot}001$; Table 3).

When factors associated with children's height and BMI *Z*-score were analysed, birth weight and breast-feeding duration were weakly correlated with height and BMI *Z*-scores ($r = 0{\cdot}236$, $P < 0{\cdot}001$ and $r = 0{\cdot}168$, $P < 0{\cdot}001$ for birth weight; and $r = 0{\cdot}122$, $P < 0{\cdot}001$ and $r = 0{\cdot}83$, $P = 0{\cdot}001$ for breast-feeding duration, respectively). When assessing the linear regression analysis, children's height and BMI *Z*-scores were found to increase by +0·0421 and +0·032, respectively, for each 100-g increase in birth weight. Height and BMI *Z*-scores were also found to increase by +0·0129 and +0·012, respectively, for each 1-month increase in breast-feeding duration (Figs 2 and 3).

Birth weight in children with stunting, median 2750 (range 1400–3600) g, was found to be significantly lower than in normal-height and tall children: 3200 (750–5500) g ($P < 0{\cdot}001$) and 3500 (2500–4900) g ($P < 0{\cdot}001$), respectively. Birth weight of thin children, median 3000 (range 1000–4500) g, was significantly lower than those of normal-weight and OW/OB children: 3200 (750–5500) g ($P = 0{\cdot}026$) and 3300 (1200–5500) g ($P < 0{\cdot}001$), respectively (Table 4).

Breast-feeding duration in children with stunting, median 10 (range 0–36) months, was significantly shorter than in normal-height and tall children: 15 (0–72) months

Table 2 Comparison of height and weight status according to nutritional status and age among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

	Height												
	Stunting				Normal				Tall				
	Age ≤ 10 years		Age > 10 years		Age ≤10 years		Age > 10 years		Age ≤10 years		Age > 10 years		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	Total
Weight													
Thinness	1	0·8	11	9·5	28	24·1	70	60·4	0	0	6	5·2	116
Normal	14	1·2	39	3·1	469	38·6	638	52·6	33	2·7	21	1·8	1214
OW/OB	0	0·0	5	1·5	100	29·4	198	58·2	18	5·3	19	5·6	340
Total	15		55		597		906		51		46		1670*
	n 70, 4·2 %				*n* 1503, 90·0 %				*n* 97, 5·8 %				

OW/OB, overweight and obesity.
*A total of fourteen students who had missing height, weight or date of birth data were excluded from the statistical analyses.

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Table 3 Comparison of nutritional status according gender and age among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

Gender/age (years)	*n*	Stunting *n*	Stunting %	Thinness *n*	Thinness %	Overweight *n*	Overweight %	Obesity *n*	Obesity %	OW/OB *n*	OW/OB %
Girls											
5–10	348	7	2·0	15	4·3	41	11·8	19	5·5	60	17·2
11–17	525	30	5·7	53	10·1	71	13·5	45	8·6	116	22·1
Boys											
5–10	316	8	2·5	14	4·4	38	12·0	21	6·6	59	18·7
11–17	479	25	5·2	34	7·1	79	16·5	25	5·2	104	21·7

OW/OB, overweight and obesity.

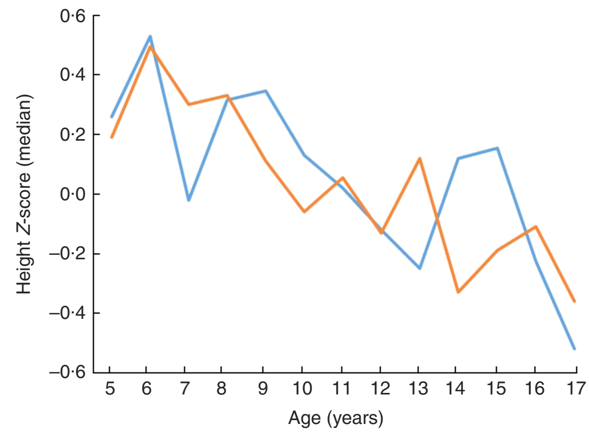

Fig. 1 (colour online) Height *Z*-score according to age and gender (——, girls; ——, boys) among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

(*P* = 0·011) and 18 (0–36) months (*P* = 0·016), respectively. In thin children, median breast-feeding duration of 12 (range 0–36) months was found to be significantly shorter than in children with normal weight and OW/OB: 15 (0–72) months (*P* = 0·045) and 16 (0–48) months (*P* = 0·011), respectively (Table 4).

LBW children had significantly higher risk of stunting than NBW children (OR = 3·855; 95 %CI 2·236, 6·646). Children who were breast-fed for ≤12 months had significantly higher risk of stunting than those breast-fed for >12 months (OR = 2·343; 95 % CI 1·332, 4·120). HBW children were at significantly higher risk of being OW/OB than NBW children (OR = 1·730; 95 % CI 1·123, 2·667). The risk of being thin was found to be significantly higher in children who were breast-fed for ≤12 months than in those breast-fed for >12 months (OR = 1·583; 95 % CI 1·042, 2·405; Table 5).

Receiver-operating characteristic curve analysis showed that the cut-off value between stunting and normal height and tallness was 2915 g (area under the curve = 0·759 (95 % CI 0·706, 0·813), *P* <0·001) for birth weight and 14·5 months (area under the curve = 0·611 (95 % CI 0·532, 0·690), *P* <0·003) for breast-feeding duration (Fig. 4).

Discussion

Growth parameters of height and weight are primarily determined by genetic characteristics. However, these parameters are also largely affected by environmental factors, especially nutrition[13,16]. Nutritional disorders are also known as malnutrition, which covers undernutrition, overnutrition and micronutrient deficiencies in children[2]. Weight is primarily affected during periods of acute undernutrition, which is shorter than 3 months, whereas chronic undernutrition, which lasts longer than 3 months, typically manifests as stunting because of

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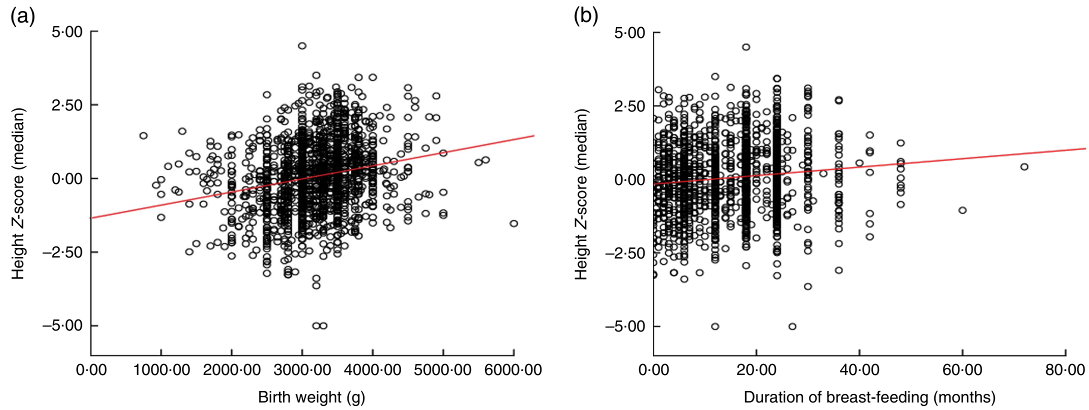
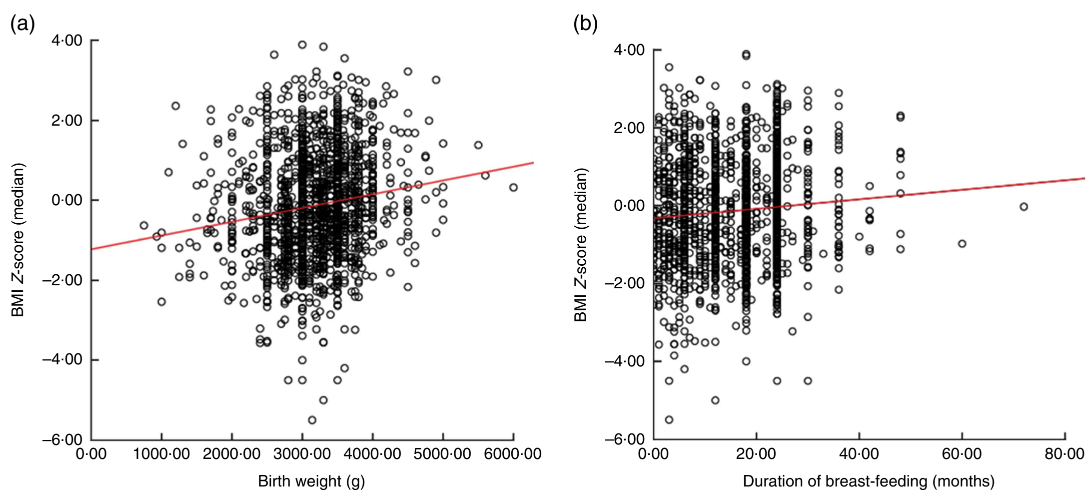


Model	*B*	SE	*β*	*t*	*P*
Birth weight	0·000421	0·000	0·207	8·095	<0·001
Duration of breast-feeding	0·0129	0·003	0·101	3·946	<0·001
Adjusted R^2 = 0·06					

Fig. 2 (colour online) Correlation scatter graph (○, observation; ——, linear regression line) between (a) height *Z*-score and birth weight and (b) height *Z*-score and duration of breast-feeding among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017



Model	*B*	SE	*β*	*t*	*P*
Birth weight	0·00032	0·000	0·144	5·546	<0·001
Duration of breast-feeding	0·01231	0·004	0·087	3·335	0·001
Adjusted R^2 = 0·03					

Fig. 3 (colour online) Correlation scatter graph (○, observation; ——, linear regression line) between (a) BMI *Z*-score and birth weight and (b) BMI *Z*-score and duration of breast-feeding among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

especially reduced height velocity[1]. Undernutrition in schoolchildren seriously impacts their health, cognition and subsequent educational achievement. Poor health and inadequate nutrition among schoolchildren likely prevent adequate cognitive development, either through physiological changes or by reducing their ability to participate in learning experiences, or both[5,17]. There is growing evidence that improving the nutrition of schoolchildren can have a measurable positive impact on cognition, linear growth and other health outcomes[18].

In Turkey, both over- and undernutrition of school-aged children are public health problems[19]. Undernutrition has decreased over the past two decades; however, the frequency of OW/OB has increased by 11·6-fold in the past two decades[20–22]. A national study conducted among children aged 6–18 years in the country found that the stunting frequency was 7·7 %. This percentage varied

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Table 4 Factors associated with nutritional status of the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

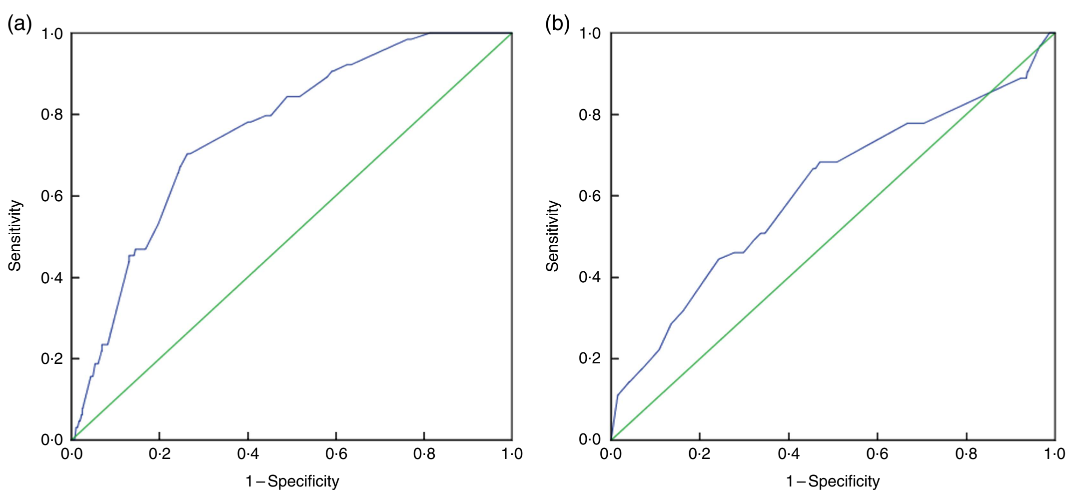
	Stunting		Normal		Tall			Thinness		Normal		OW/OB		
	Median or Mean	Range or SD	Median or Mean	Range or SD	Median or Mean	Range or SD	*P*	Median or Mean	Range or SD	Median or Mean	Range or SD	Median or Mean	Range or SD	*P*
Birth weight (g), median and range	2750	1400–3600	3200	750–5500	3500	2500–4900	0·001	3000	1000–4500	3200	750–5500	3300	1200–5000	<0·001
Predominant breast-feeding time (months), mean and SD	4·2	2·2	4·6	2·0	4·5	2·0	0·371	4·7	1·9	4·6	2·0	4·5	2·0	0·957
Complementary feeding time (months), mean and SD	5·5	1·4	5·6	1·3	5·5	1·3	0·801	5·6	1·2	5·5	1·3	5·7	1·3	0·131
Duration of breast-feeding (months), median and range	10	0–36	15	0–72	18	0–36	0·002	12	0–36	15	0–72	16	0–48	0·016
Mother's age at child's birth (%)														
< 20 years	5·6		87·9		6·5		0·229	5·2		76·2		18·6		0·433
20–35 years	4·0		89·7		6·3			7·2		71·9		20·9		
> 35 years	3·7		95·1		1·2			7·3		78·0		14·7		
Maternal education (%)														
≤ Secondary school	5·1		89·3		5·6		0·091	7·7		72·3		20·0		0·482
> Secondary school	2·9		91·0		6·1			6·1		73·2		20·7		

OW/OB, overweight and obesity.

Table 5 Binary logistic regression analysis results to predict stunting, overweight/obesity and thinness, respectively, according to control group with birth weight and breast-feeding time as independent variables, among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017

				95 % CI for OR	
	B	*P*	OR	Lower	Upper
Stunting					
Birth weight (LBW *v.* NBW)	1·349	< 0·001	3·855	2·236	6·646
Duration of breast-feeding (≤12 *v.* >12 months)	0·851	0·003	2·343	1·332	4·120
OW/OB					
Birth weight (HBW *v.* NBW)	0·548	0·013	1·730	1·123	2·667
Thinness					
Duration of breast-feeding (≤12 *v.* >12 months)	0·459	0·031	1·583	1·042	2·405

LBW, low birth weight; NBW, normal birth weight; HBW, high birth weight; OW/OB, overweight and obesity.



Birth weight	
Sensitivity (95 % CI)	70·3 (57·4, 80·7)
Specificity (95 % CI)	73·7 (71·3, 75·9)
PPV (95 % CI)	10·6 (7·9, 14·1)
NPV (95 % CI)	98·2 (97·2, 98·9)
LR+ (95 % CI)	2·6 (2·2, 3·2)
LR+W (95 % CI)	0·11 (0·09, 0·15)

Duration of breast-feeding	
Sensitivity (95 % CI)	68·2 (55·1, 79·0)
Specificity (95 % CI)	52·9 (50·4, 55·5)
PPV (95 % CI)	5·66 (4·17, 7·6)
NPV (95 % CI)	97·5 (96·2, 98·4)
LR+ (95 % CI)	1·45 (1·21, 1·73)
LR+W (95 % CI)	0·06 (0·04, 0·08)

Fig. 4 (colour online) Receiver-operating characteristic curve analysis (——, data; ——, line of no discrimination) for estimation of height *Z*-score group according to (a) birth weight and (b) duration of breast-feeding among the schoolchildren aged 5–17 years (*n* 1684) from Çorum, Central Anatolia, Turkey, January–May 2017. (a) AUC = 0·759 (95% CI 0·706, 0·813), *P* < 0·001; (b) AUC = 0·611 (95% CI 0·532, 0·690), *P* <0·003 (AUC, area under the curve; PPV, positive predictive value; NPV, negative predictive value; LR +, likelihood ratio; LR + W, likelihood ratio weighted)

between 2·2 and 13·0 % in different regions. In addition, the thinness frequency was found to be 3·8 %, varying between 1·3 and 6·2 % across regions(23). Similar to these studies, we also found a frequency of stunting of 4·2 % and frequency of thinness of 6·9 %.

Rapid changes in technology have greatly affected the way of life in many countries. Electronic devices and digital games have replaced outdoor games. Use of motorized devices and cell phones has reduced walking distances and increased sedentary lifestyles. Nutritional habits have shifted from the consumption of traditional foods to more fast foods, which are characterized by high fat, high cholesterol, high Na and low fibre contents. All these factors have played major roles in increasing the prevalence of obesity(24,25). As in any transitional society, rapid changes have occurred in the social, economic, nutritional and lifestyle aspects of Turkish society over the past three decades. As a result, the prevalence of OW/OB

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has increased dramatically among the Turkish population[26]. In a meta-analysis conducted by Alper *et al.*[22] in Turkey in 2015, the prevalence of obesity increased from 0·6 % in 1990–1995 to as high as 7·3 % in 2010–2015, an 11·6-fold increase. Regional studies conducted in the past decade have found the incidence of overweight and obesity is 10·3–13·6 % and 6·1 %–9·9 %, respectively[27,28]. A multicentre study performed across Turkey reported incidences of 14·3 and 8·2 % for overweight and obesity, respectively[23]. Our results were consistent with these percentages, namely 13·8 % for overweight and 6·6 % for obesity.

In our study, the frequencies of stunting (5·5 %), thinness (8·7 %) and OW/OB (21·9 %) among adolescents were significantly higher than those among primary-school children (2·3, 4·4 and 17·9 %, respectively). After the first year and early years of life, adolescence is the second most critical period in which physical growth continues. In this period, various physiological, psychological and behavioural changes occur, and the risk of malnutrition is extremely high because of increased food and energy requirements[29,30]. Adolescents' nutritional and health status affects their overall health in terms of stunting but is also closely associated with adult health and chronic diseases and fetal complications during pregnancy, because undernutrition and obesity are largely maintained during adulthood, which carries associated complications[30,31].

In transitional countries, a significant disparity among children's nutritional outcomes exists between urban and rural societies[32]. In the rural societies, most individuals consume traditional foods whereas urban residents with moderate to high socio-economic status consume foods that are energy-dense but have poor nutritional content[32,33]. Undernutrition exists alongside increasing obesity due to the coexistence of traditional and convenience foods. Coexistence of under- and overnutrition, a phenomenon known as the 'double burden', poses a novel public health challenge[34] and causes health-care problems associated with malnutrition and obesity, which are more commonly observed in adolescents[35].

A great number of studies have shown that in addition to future health problems and chronic diseases, diet in the first 1000 d has significant effects on body size/shaping and being OW/OB among children, adolescents and adults[8,9,36,37].

In a cohort study, Eide *et al.*[38] reported that both birth weight and height were predictors of adult height and weight and that each had independent contributions. In a study conducted in Brazil in 2012, birth weight was shown to be positively correlated with height in adolescents[39]. In a meta-analysis that included five cohort studies conducted in five low- and middle-income countries, Kuzawa *et al.*[40] concluded that birth weight is a strong predictor of adult fat-free mass, independent of sex and geographic location.

In a meta-analysis by Adair *et al.*[41] including five prospective studies and 8362 adults, HBW was found to be associated with increased BMI and substantial gain in height. In a study conducted among 5141 children between the ages of 9 and 11 years in twelve countries, Qiao *et al.*[36] found a positive association between children's birth weight and BMI *Z*-score. In another meta-analysis, Yu *et al.*[42] showed that HBW was a risk factor for obesity. Concurrently, children's birth weight was found to be positively and linearly associated with height and BMI *Z*-scores. In our study, significant differences were found in birth weight for stunted, normal-height and tall children. LBW children's risk of stunting was found to be 3·855 (95 % CI 2·236, 6·646) times higher than that of NBW children.

In studies conducted among both children and adolescents, LBW and undernutrition were positively associated[43,44]. Similarly, thin children's birth weights were found to be significantly low in our study.

Epidemiological studies suggest that individuals who were breast-fed are taller in childhood and adulthood[45]. In previous studies, results regarding the effects of breast-feeding duration on adult height have differed: some findings have shown a positive effect but others have suggested no effect at all[43,45–47]. In our study, children's breast-feeding duration and height *Z*-score were significantly and positively associated. Breast-feeding for longer than 12 months protected the children from stunting.

While some meta-analyses have reported that breast milk has a significant protective effect against obesity, others have indicated a small protective effect and still others have reported no clear findings[48–50]. In a systematic review by the WHO in 2013, a long period of breast-feeding decreased the frequency of being OW/OB at a rate of 10 %; however, it was also concluded that influencing factors, such as the mother's educational and income levels, cannot be reset[51]. In the current study, duration of breast-feeding was not found to have a protective effect against obesity but did show a significant protective effect against thinness.

The present study has several limitations. The current heights of children, and not final heights, were assessed and other malnutrition indicators, such as mid-upper arm circumference, subcutaneous fat tissue thickness and fat-free mass, were not assessed. Information about children's birth weight and early feeding practices was obtained from the mothers. However, difficulty in recalling or inability to recall this information may have existed. Influencing factors, such as the family's socio-economic status or paternal factors, may have also affected the statistical results.

Conclusion

In conclusion, OW/OB was found in one of every five and undernutrition was found in one of every ten children in the current study. In addition, double malnutrition was found among adolescents. Normal birth weight and prolonged breast-feeding duration were found to significantly positively affect the growth of schoolchildren aged 5–17 years in Turkey.

Our study revealed evidence to support that OW/OB is a primary health problem and must be addressed in schoolchildren. Preventing LBW, promoting NBW and encouraging prolonged breast-feeding are important factors that foster normal growth in children. In addition, education and training on nutrition, especially among adolescents, should be conducted to help maintain a healthy body structure among adults.

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