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Review

Trend in the prevalence of obesity and overweight among Iranian children and adolescents: A systematic review and meta-analysis

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ABSTRACT

Objective: Childhood obesity is an important predisposing factor for most non-communicable diseases. The aim of this review was to provide evidence on the prevalence and trends of childhood obesity and overweight in Iran.

Methods: Multiple international and Iranian scientific databases were searched for relevant literatures. Two independent reviewers identified relevant papers in several steps. Separate meta-analyses (using fixed- or random-effect models) were performed to estimate the overall, age, sex, and age–sex specific prevalence of obesity and overweight. Stratified analysis based on Centers for Disease Control and Prevention, International Obesity Task Force, and World Health Organization definition criteria and study year also were performed.

Results: We included 107 studies in the meta-analysis (49 English and 58 Persian). Based on Centers for Disease Control and Prevention definition criteria, the overall prevalence of obesity and overweight remained relatively constant in the 2000s and are estimated to be about 5.1% (95% confidence interval [CI], 4.4–5.8) and 10.8% (95% CI, 10.2–11.4), respectively. The meta-regression analysis showed that the prevalence of obesity and overweight did not vary significantly with respect to sex and age of study participants. Girls had a lower prevalence of obesity and higher prevalence of overweight than boys.

Conclusion: This review, which is the first of its kind in the Middle East and North Africa, suggests that although the trend in the prevalence of childhood obesity in Iranian children is not considerably high, but the escalating trend of excess weight among young children is alarming and should be considered by providers of interventional preventive programs at national and regional levels.

Introduction

The epidemic of non-communicable diseases (NCD) is a global problem that is expected to rise considerably in low- and middle-income countries [1,2]. Excess weight is one of the most common risk factors for most NCDs. A growing body of evidence exists about the worldwide increase in mean body mass index (BMI) [3], as well as the prevalence of obesity and overweight [4], with substantial variation in levels and trends in different countries. Excess weight is not limited to adults, and it has become an emerging health problem in the pediatric age group, even in developing countries [5,6].

Of special concern in this regard is the situation in the Middle East and North Africa (MENA), which is facing a double burden of nutritional disorders. The epidemiologic transition, lifestyle changes, and considerably high prevalence of obesity has led the Middle Eastern population to face the greatest global burden of NCDs, notably diabetes [7] and cardiovascular diseases [8]. As a country in this region, Iran has a high prevalence of obesity and

The literature search, data extraction and analysis were done by RK and BS. All authors contributed equally to development of search strategy, interpreting the results, and development of paper. The authors report no conflict of interest.

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related disorders, such as metabolic syndrome and diabetes in different age groups [9–11]. Such disorders pose high costs to the health care system. For instance, the total national cost of diagnosed diabetes mellitus in 2009 in Iran was estimated as high as U.S.$3.78 billion [12]. Therefore, prevention and early control of the risk factors associated with NCDs is a public health priority in Iran.

Childhood obesity is considered one of the major predisposing factors of most NCDs [13,14]. Therefore, having an insight on the prevalence and trend of childhood overweight and obesity can provide evidence-based information for health policymakers at national and international levels in order to implement programs for primordial and primary prevention of NCDs.

In recent years, various prevalence rates for childhood overweight and obesity have been reported; however, as Iran is the 18th-largest country in the world, with an area of 1 648 195 km^2, and a population of around 75 million, it is necessary to condense the existing information to gain a general perception on this situation among Iranian children and adolescents. As the first report of its kind in MENA, the aim of this review was to assess the trend in the prevalence of childhood obesity and overweight in Iran, using systematic review and meta-analysis.

Material and methods

Search strategy

We searched multiple international (MEDLINE through PubMed and Scopus) and Iranian scientific databases (Scientific Information Database [SID] and IranMedex) for English and Persian language studies published between October 2007 and August 2012 that contained data on the prevalence of obesity and/or overweight among Iranian children and adolescents. The literature was searched combining keywords from the following concepts: the population (children, students, and adolescents and their related MeSH terms); the outcome (overweight, obesity, weight status, BMI, and anthropometric measures); the study design (prevalence, proportion, survey, descriptive, and epidemiology); and the study location (an English transcription of Iran and the name of Iranian medical universities) [15]. The search strategy used for PubMed and Scopus is shown in the supporting information (Table S1). For Iranian databases, Persian equivalents of the English keywords were applied, and the search strategy was constructed accordingly. Additionally, to maximize the sensitivity of the Persian literature search, we did not consider any time limitation. For studies published before October 2007, we entered all relevant articles from the previous meta-analysis on the prevalence of obesity in Iran [16]. Additionally, the reference list of all reviews and included papers was screened for any additional studies.

Study selection and eligibility criteria

Having removed duplicates, the relevant papers were selected in three phases. In the first and second phases, titles and abstracts of papers were screened, and irrelevant papers were excluded. In the last phase, the full text of identified papers was explored deeply to select only relevant papers. All three screening phases were done by two independent reviewers (RK and BS). Discrepancies were resolved by consultation and consensus.

In the next step, the eligibility of relevant papers was checked. We included studies if they were conducted among randomly selected healthy children/adolescents ages 2 to18 y and provided data on the prevalence of obesity and/or overweight (including sample size) according to age–sex specific BMI cutoffs provided by the following organizations: U.S. Centers for Disease Control and Prevention in 2000 (CDC 2000) (i.e., 85th percentile BMI $\leq$ 94th percentile was regarded as overweight and BMI $\geq$ 95th percentile as obese) [17]; World Health Organization (WHO) (i.e., BMI $\geq$ 2 *z* score was regarded as overweight and BMI $\geq$ 3 *z* score as obese) [18]; or International Obesity Task Force (IOTF) (i.e., percentile curves that correspond to cutoff points of 25 kg/m^2 and 30 kg/m^2 for adult overweight and obesity, respectively) [19].

Papers were excluded if they reported a mixed prevalence of overweight and obesity, did not report the prevalence of obesity or overweight separately for children and adults, did not provide any prevalence data on obesity or overweight, or contained duplicate data. Duplicate data was identified by examining similarities in the province in which the study was performed and by evaluating studies in terms of the author's names, the city name and rural/urban area, age and sex of participants, as well as the study year. Thus, when authors presented the results of the same study in more than one paper, the most recent one with the most comprehensive results and maximum sample size were included. However, for three studies, we extracted the most detailed information (on age-sex–specific prevalence) from five excluded articles. Moreover, we excluded the Persian version of a paper if it repeated results of the same English paper included in this review. We found one cohort study, Tehran Lipid and Glucose Study; for this cohort, we included one article, which presented the results of the two consecutive cross-sectional samples of this cohort [20].

The selection process of our systematic review is depicted in Figure 1.

Quality assessment

The methodological quality of each eligible paper was assessed using a checklist based on guidelines provided in an earlier study [21], in which papers were assigned up to a total score of 8 for fulfilling the main issues in prevalence studies, including sampling, measurements, and analysis.

Data extraction and abstraction

The required information that was extracted from all eligible papers was as follow: general characteristics of the study (first author's name, publication year, study year, study design, sampling method, and study location [i.e., province and city/town's name]), characteristics of the study population (age and sex of studied participants and the sample size), definition of obesity or overweight, and the prevalence of obesity or overweight by different definitions. Based on the information provided in each paper, we extracted the total prevalence and categorized it by age, sex, and age–sex combined. We analyzed the data in three age groups (2–6, 7–11, and 12–18 y).

One reviewer (RK) extracted the data, while another (BS) randomly selected 10% of the papers and checked their extracted data.

Statistical analysis

All eligible papers were entered into meta-analysis. The binomial distribution formula was used to compute the variance of point prevalence. Heterogeneity among studies was assessed using the Q statistic with a significance level of 0.1; I^2 was used to assess the degree of heterogeneity among studies. The random effects model was used to estimate the prevalence after heterogeneity was tested; if no heterogeneity was observed, the fixed model was used.

Separate meta-analyses were performed to estimate the prevalence of obesity and overweight overall, as well as age-, sex-, and age–sex specific. Moreover, to assess the prevalence trends, all meta-analyses were stratified by three categories of the study year. For the sake of space, forest plots were provided for the total and sex-specific prevalence.

We used meta-regression to assess the association of participant's age and sex and year of data collection with the prevalence of obesity and overweight. As the CDC criteria were the most frequent definition, our meta-regression was restricted to papers that used this definition. Statistical analyses were performed using Stata version 11.0, Texas, US.

Results

Study selection and characteristics

Our electronic search yielded 2 330 papers, of which 916 duplicate papers retrieved from more than one database were excluded. In the first (title evaluation) and second phase (abstract evaluation), 864 and 337 papers were excluded, respectively. Checking references and screening relevant studies from previous meta-analysis [16] resulted in 28 more papers being discovered. Finally, 241 papers were further assessed in full text; of these, 107 articles (49 English and 58 Persian) were included in this systematic review and meta-analysis. Figure 1 presents the flowchart of our study selection and the frequency of reasons for exclusion.

All studies were conducted among children or adolescents, except two, which were conducted among both children and adults, and two among participants younger than age 20 y. Five papers reported the prevalence in more than 1 y, and five were

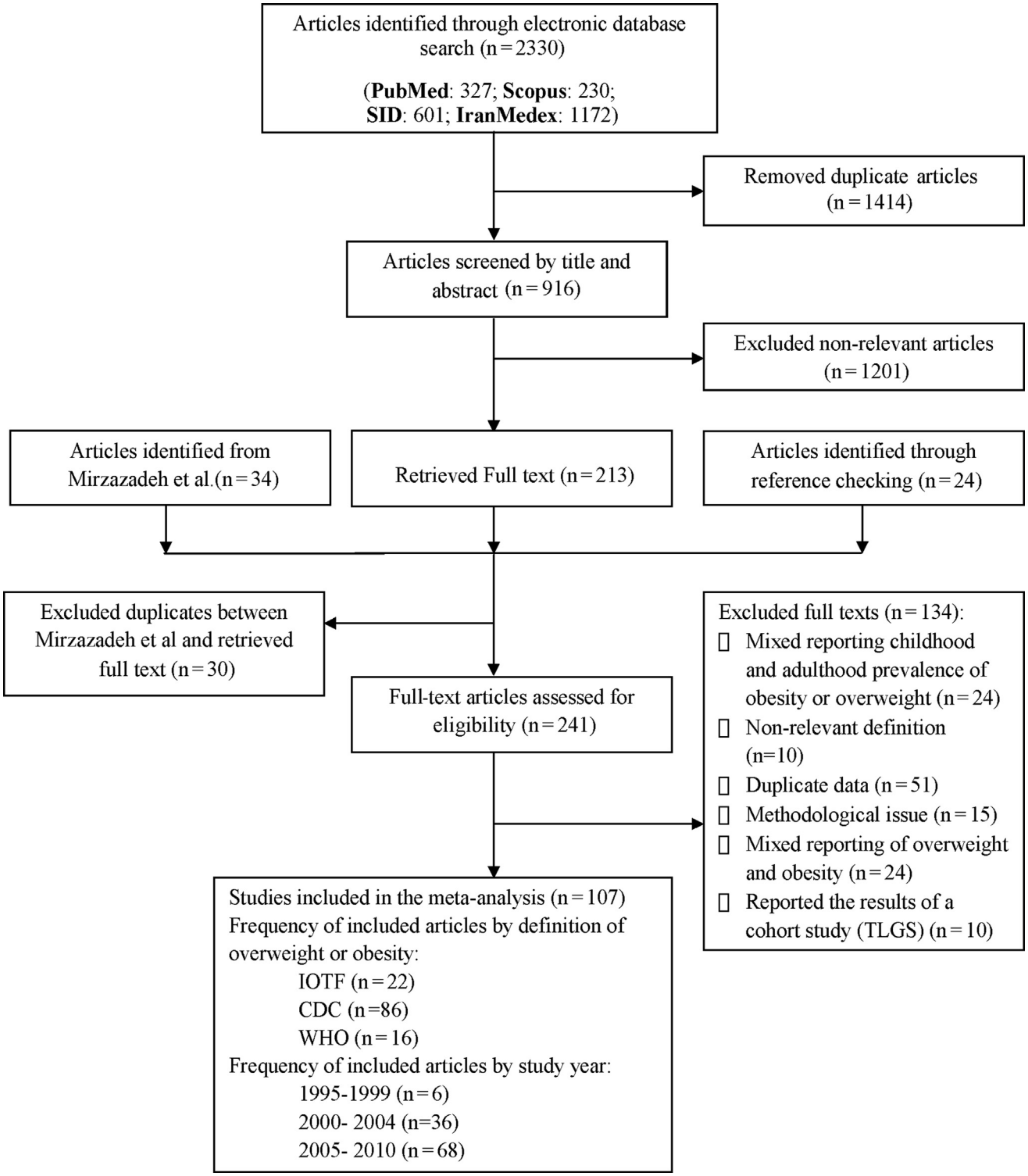

Fig. 1. Flowchart of study selection. CDC, Centers for Disease Control and Prevention; IOTF, International Obesity Task Force; SID, Scientific Information Database; WHO, World Health Organization.

national surveys. Included studies were conducted between 1995 and 2010, the majority being conducted from 2005 to 2010. Thirteen studies used more than one definition to assess childhood overweight or obesity, with the CDC 2000 as the most frequently used definition. Age-, sex-, and age-sex–specific prevalence of overweight or obesity was found in 103, 97, and 90 papers, respectively. A total of 3 746 869 children and adolescents ages 2 to 18 y were included, with the interquartile range of sample sizes of 415 to 2076. The minimum and maximum quality scores of included studies were 3 and 8, respectively; about 57% had a score of more than 6 (Table S2 shows the characteristics of included papers [20,22–127]).

Table 1
Point estimate and 95% confidence interval for the prevalence of childhood obesity among Iranian children and adolescents using CDC definition criteria

	1995–1999		2000–2004		2005–2010	
	Number of studies (I^2)	Pooled estimate (95% CI)	Number of studies (I^2)	Pooled estimate (95% CI)	Number of studies (I^2)	Pooled estimate (95% CI)
All (y)	4 (99.3)	7.4 (0–14.9)	34 (95.4)	5.1 (4.4–5.8)	57 (97.5)	5.1 (4.9–5.4)
2–6	1	23.2 (21.1–25.2)	6 (84.5)	6.9 (4.8–9.1)	9 (97.0)	3.7 (3.4–3.9)
7–11	NA	NA	18 (95.8)	5.0 (4.0–5.9)	27 (97.7)	7.0 (5.5–8.5)
12–18	3 (82.3)	1.9 (0.2–3.5)	25 (96.0)	6.0 (4.9–7.1)	24 (95.8)	5.3 (4.2–6.4)
Girls (y)	4 (98.6)	6.9 (1.4–12.5)	29 (93.9)	4.8 (4.0–5.5)	40 (95.9)	5.7 (4.7–6.6)
2–6	1	21.9 (19.0–24.8)	5 (36.5)	5.3 (4.4–6.3)*	3 (96.5)	6.0 (0.1–11.9)
7–11	NA	NA	15 (93.7)	5.2 (4.0–6.3)	19 (96.4)	5.9 (4.2–7.6)
12–18	3 (82.3)	1.9 (0.3–3.5)	19 (95.9)	6.1 (4.7–7.6)	21 (92.5)	4.8 (3.8–5.8)
Boys (y)	1	24.4 (21.4–27.4)	22 (96.1)	5.8 (4.7–6.8)	28 (97.4)	7.5 (5.9–8.9)
2–6	1	24.4 (21.4–27.4)	5 (84.4)	5.4 (2.9–7.9)	3 (96.7)	8.6 (1.1–16.2)
7–11	NA	NA	12 (92.9)	4.7 (3.5–5.9)	14 (97.9)	8.2 (5.4–10.9)
12–18	NA	NA	14 (97.4)	6.8 (4.7–9.0)	14 (95.8)	5.9 (4.0–7.8)

CI, confidence interval; I^2, I square; NA, no published article was found which have examined the prevalence of childhood obesity in the selected years based on the determined definition

* Using fixed method.

Prevalence of childhood obesity and overweight

According to the CDC criteria, the overall prevalence of obesity remained constant during 2000 to 2004 and 2005 to 2010 and is estimated to be 5.1%. However, the sex-specific prevalence has increased during these periods of time. For girls, the prevalence of obesity increased from 4.8% between 2000 and 2004 to 5.7% between 2005 and 2010. The corresponding values for boys were 5.8% and 7.5%, respectively (Fig. S1). Comparison of the estimates of prevalence in different age groups showed that the overall prevalence of obesity has increased in children ages 2 to 6 and 7 to 11 y during the 2000s, but it has decreased among those ages 12 to 18 y. These findings were consistently observed in girls and boys (Table 1).

The overall prevalence of overweight has increased from 10.4% during 2000 to 2004 to 10.8% during 2005 to 2010, based on the CDC criteria, but the sex-specific prevalence showed a different pattern. In girls, the prevalence of overweight increased from 10.4% during 2000 to 2004 to 11.6% during 2005 to 2010. The corresponding values for boys were 10.2% and 9.4%, respectively (Fig. S2). Comparison of the prevalence estimates in different age groups showed that the overall prevalence of overweight has increased for children ages 7 to 11 y during the 2000s, but it has decreased among those ages 2 to 6 and 12 to 18 y. These findings were consistently observed for girls and boys (Table 2).

Compared with the CDC criteria, we found that the IOTF and WHO criteria tend to underestimate the prevalence of obesity and overestimate the prevalence of overweight (Tables S3 and S4). Additionally, due to the small number of studies performed before 2000, these results are only presented in figures (Figs. S1 and S2) and tables, and are not deeply discussed in this review.

Predicted prevalence of childhood obesity and overweight

The meta-regression analysis showed that the prevalence of overweight and obesity did not vary significantly with respect to year of data collection, sex, and age of study participants. Our findings showed that girls had a lower prevalence of obesity (difference, −1.2%, 95% confidence interval [CI], −2.7 to 0.3; $P = 0.123$) and higher prevalence of overweight (difference, 1.4%; 95% CI, −0.3 to 3.0; $P = 0.110$) compared with boys. Compared with participants ages 2 to 6 y, those ages 7 to 11 and 12 to18 y had a lower prevalence of obesity (for 7–11 y, difference, −1.5%; 95% CI, −3.9 to 1.1; $P = 0.248$, and for 12–18 y, difference, −1.9%; 95% CI, −4.4to 0.5; $P = 0.115$) and a higher prevalence of overweight (for 7–11 y, difference, 0.2%; 95% CI, −2.5 to 2.9; $P = 0.882$, and for 12–18 y, difference, 2.3%; 95% CI, −0.3 to 4.9; $P = 0.088$). Studies conducted from 1995 to1999 revealed a higher prevalence of obesity (difference, 3.8%; 95% CI, −0.4 to 8.1; $P = 0.078$) and overweight (difference, 1.2%; 95% CI, −3.9 to 6.4; $P = 0.63$), and those during 2000 and 2005 showed a lower prevalence of obesity (difference, −0.4%; 95% CI, −1.9 to 1.1; $P = 0.588$) and overweight (difference, −0.1%; 95% CI, −1.7 to 1.6; $P = 0.911$), compared with studies that were conducted during 2005 and 2010. The trend in the predicted prevalence of obesity and overweight among different age–sex populations is presented in Table 3.

Discussion

This systematic review and meta-analysis has provided a precise estimate for the trend of obesity and overweight by age group and sex in Iranian children and adolescents. We documented various trends for overweight and obesity among different age groups of the Iranian pediatric population; in general, our findings revealed a higher increase in the trend of excess weight in children ages 2 to 6 and 7 to 11 y than in older age groups. This finding may suggest that younger children are getting fatter more rapidly than their older counterparts. This finding may reflect an epidemiologic transition along with a notable nutrition transition, in the Iranian population. The recent changes in lifestyle of children from a traditional style toward a Westernized pattern that includes consuming calorie-dense foods and engaging in sedentary activities might explain the higher prevalence of excess weight in younger than in older children. This finding is consistent with the situation reported in some other developing countries [6,128] and deserves attention at individual and public health levels.

Globally, a rapid rise has been reported for the prevalence of obesity and overweight among children ages < 5 y (i.e., 60% increase from 1990 to 2010, with an estimated rise of 9% from 2010 to 2020). It is noteworthy that the highest increase has been observed in low- and middle-income countries, with the Middle East being one of the regions with the highest prevalence of excess weight in preschoolers [129]. It should be noted that although part of the escalating trend of childhood obesity in poorer than in wealthier populations might be due to globalization and epidemiologic transition; however it could also be

Table 2
Point estimate and 95% confidence interval for the prevalence of childhood overweight among Iranian children and adolescents using CDC definition criteria

	1995–1999		2000–2004		2005–2010	
	Number of studies (I^2)	Pooled estimate (95% CI)	Number of studies (I^2)	Pooled estimate (95% CI)	Number of studies (I^2)	Pooled estimate (95% CI)
All (y)	3 (95.0)	10.9 (4.6–17.1)	33 (98.1)	10.4 (8.9–11.8)	50 (99.1)	10.8 (10.2–11.4)
<7	1	15.5 (13.7–17.3)	6 (95.0)	9.4 (5.1–13.7)	8 (99.8)	9.0 (7.9–10.1)
7–11	NA	NA	16 (98.1)	8.3 (6.3–10.3)	21 (97.3)	11.4 (9.4–13.3)
12–18	2	8.4 (3.4–13.3)	24 (94.8)	12.7 (11.1–14.3)	24 (93.4)	11.7 (10.3–13.2)
Girls (y)	3 (95.2)	11.5 (4.3–18.8)	28 (97.8)	10.4 (8.7–12.1)	39 (93.2)	11.6 (10.4–12.7)
<7	1	17.6 (14.9–20.2)	5 (91.1)	8.3 (4.3–12.3)	3 (84.4)	7.2 (3.8–10.5)
7–11	NA	NA	15 (97.7)	8.8 (6.5–11.1)	18 (95.2)	10.9 (8.8–12.9)
12–18	2	8.4 (3.4–13.3)	19 (97.5)	13.3 (10.4–16.1)	21 (89.6)	10.3 (10.7–13.8)
Boys (y)	1	13.3 (10.9–15.7)	21 (97.6)	10.2 (8.3–12.1)	27 (92.5)	9.4 (8.2–10.6)
<7	1	13.3 (10.9–15.7)	5 (97.2)	10.6 (3.4–17.8)	3 (59.2)	7.3 (5.1–9.5)
7–11	NA	NA	12 (94.8)	8.3 (6.4–10.1)	13 (96.1)	9.3 (6.9–11.7)
12–18	NA	NA	14 (97.2)	10.8 (7.9–13.6)	14 (92.2)	9.7 (7.7–11.8)

CI, confidence interval; I^2, I square; NA, no published article was found which have examined the prevalence of childhood obesity in the selected years based on the determined definition

due to the problem of stunting in children of developing countries. Therefore, the double burden of nutritional disorders and the persisting problem of micronutrient deficiency should be considered reasons for elevated BMI in children of developing countries.

Our meta-regression analysis showed that the prevalence of obesity and overweight did not vary significantly in girls and boys. We found that girls had a lower prevalence for obesity and a higher prevalence for overweight compared with boys. This may be because girls pay higher attention to their body image than boys [130]. Our findings show that, in general, the prevalence for obesity and overweight in Iranian children is not very high and the trend in its increase is not very sharp, but given that until a few years ago underweight was the main nutritional problem of Iranian children, the obtained trend in childhood obesity and overweight is alarming. We documented differences in the trend of obesity and overweight among Iranian children and adolescents, but any kind of excess weight may have harmful health consequences. A remarkable point is that Asians have an ethnic predisposition to adverse health effects of obesity and overweight at lower BMI levels than Western populations [131]. Therefore, an increase in the BMI of children, even less than normal limits, may have long-term health consequences.

Another point that should be considered for children of developing countries is the problem of low birth weight, which by itself [132] or accompanied with a rapid growth spurt during childhood [133] makes one prone to NCDs. As low birth weight is not uncommon in such populations, including Iran [134], the escalating trends in excess weight of Iranian children may be an accumulating risk for those who were under weight at birth. Therefore, the true public health burden of childhood obesity in Iran may be higher than expected by the trend reported in our study.

Different definitions of childhood obesity make it hard to compare data between studies. We found that compared with the CDC criteria, the IOTF and WHO definitions tend to underestimate the prevalence of obesity and overestimate the prevalence of overweight among Iranian children. This finding is consistent with our previous nationwide study in showing close agreement of BMI cutoff points for Iranian children when using CDC criteria rather than other criteria [66].

Table 3
Trend in the predicted prevalence of obesity and overweight among Iranian children and adolescents 2 to 18 y based on CDC definition criteria

Gender	Age group (y)	Predicted prevalence (%)		
		1995–1999	2000–2004	2005–2010
Childhood obesity				
All	All	5.13	6.14	7.25
Girls	All	4.52	5.73	9.69
Boys	All	6.30	7.51	11.47
All	2–6	6.82	6.82	8.27
	7–11	6.33	6.33	7.78
	12–18	5.55	5.55	7.00
Boys	2–6	12.32	8.07	8.49
	7–11	10.85	6.6	7.02
	12–18	10.37	6.12	6.54
Girls	2–6	11.13	6.88	7.30
	7–11	9.66	5.41	5.83
	12–18	9.18	4.93	5.35
Childhood overweight				
All	All	10.43	11.25	10.88
Girls	All	10.81	11.29	12.18
Boys	All	9.63	10.11	11.10
All	2–6	9.07	9.67	9.07
	7–11	9.71	10.31	9.71
	12–18	11.83	12.43	11.83
Boys	2–6	9.83	8.50	8.59
	7–11	10.04	8.71	8.80
	12–18	12.13	10.80	10.89
Girls	2–6	11.18	9.85	9.94
	7–11	11.38	10.06	10.15
	12–18	13.48	12.15	12.24

Conclusion

This review, which is likely the first of its kind in the MENA region, appraised and synthesized a large number of studies. By calculating a pooled average result across studies, this study provides research evidence on the trend of obesity and overweight among Iranian children. The escalating trend of excess weight among young children is alarming and provides information for policymakers and health care providers at national and regional levels for preventive programs and interventions.

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Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.nut.2013.08.011.

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