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Prevalence of Obesity in Iranian Children: A Systematic Review and Meta-Analysis

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ABSTRACT

Context: The prevalence of childhood obesity and overweight and its rising trend in recent decades have taken a worrying sign. Since obesity at this age lays the foundation for obesity in adulthood and entails consequences, and also in view of the extensive studies conducted that have yielded different results, the present meta-analysis was done to evaluate the prevalence of obesity in Iranian children.

Evidence Acquisition: All cross-sectional studies on the prevalence of obesity in Ian were extracted from national and international databases such as Scopus, Iranmedex, SID, Magiran, and PubMed in January 2000 to May 2022. Moreover, random effect model with 95% confidence level was used to analyze the data and obtain summary effect.

Findings: This study included 42 articles that met the inclusion criteria. According to the studies, the prevalence of obesity and overweight in Iranian children was 10.32% and 12.48%, respectively.

Conclusion: The present meta-analysis indicated that the prevalence of obesity in this country is increasing and the rate is higher in the girls than the boys. Changing lifestyles and amendment of bad eating habits in modern society have necessitated the planning and implementation of intervention programs for this age group at the family, school, and societies.

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Context

Overweight, obesity, and health-related problems are so prevalent in today's world that they are gradually displacing problems such as nutritional poverty and infectious diseases that were once considered common worldwide [1]. Overweight is the second leading cause of death in the world, with 300,000 people losing their lives each year; moreover, obesity is considered an underlying cause of many recognized illnesses [2]. In fact, obesity is now considered a global risk causing somatic and mental diseases, including stress and depression [3]. According to World Health Organization (WHO) standards, a body mass index (BMI) between 25 kg/m^2 and 30 kg/m^2 indicates overweight, while an index greater than 30 kg/m^2 represents obesity [4]. About 69% of people in America are overweight and 38% are obese [5]. In Iran, a developing country, the prevalence of this disease in children in recent years has increased with age in recent years. With a prevalence of 17% overweight and obesity at school entry, Iran is among the Western countries [6]. Research has demonstrated that cardiovascular diseases due to obesity and overweight cause 46% of deaths in Iran. These diseases also affect healthier people and cause significant costs to the healthcare system [7]. Rising BMI is also associated with the incidence of many chronic diseases [8] and body image dissatisfaction [9]. In addition, the number of deaths in obese people is three times higher than in other people [10].

As body fat percentage increases, total body fat enhances in both men and women. Therefore, body weight is generally used as an indicator for diagnosing obesity [11]. According to reports, 77% of obese children become obese adults, which increase the risk of developing various chronic diseases, including diabetes II, hypertension, elevated cholesterol, cardiovascular disease, atherosclerosis, orthopedic disease, and some cancers, leading to early death of people [6].

Many dietary habits and patterns are formed in childhood and persist until the end of life. Proper nutrition during this period helps to promote the child's growth and development. The prevalence of obesity in 6–10-year-old children is estimated at 10-30% and is considered one of the major problems in this age group. Obesity reduces the child's work performance and leads to hypertension, cardiovascular disease and diabetes [12].

Today, the industrialization of societies has led to greater use of vehicles, elevators, computers, and TV, reducing children's physical activity; meanwhile, access to high-calorie and low-fat foods has led to changes in consumption habits between the meals and main meals, increasing caloric intake from 1990, which may be a cause of childhood overweight and obesity. The prevalence of obesity in the total population of children can be used by experts and planners as a determinant of health. Overweight and obesity are one of the most important risk factors for numerous diseases. There is no officially accepted national estimate of the prevalence of obesity in the 6-14-year-old age group, with the numerous documents available indicating differences. To get a clear picture of the results and to validate them, it is essential to conduct a meta-analysis to provide planners and policymakers with a credible rate. It should be noted that most research on obesity has not conducted screening; the aim of the present study was to determine the prevalence of obesity in Iranian children.

Evidence Acquisition

In this study, all printed studies on the prevalence of obesity in children without restraints were examined according to the time, place, and year of their publication. The target population consisted of elementary school children aged 6-14 years. The method for determining the prevalence of obesity in Iranian children was based on the extraction of files from the IranMedex, Magiran, SID, Scopus, and PubMed. The keywords obesity, prevalence of obesity, children, and students were used to search relevant studies in the above databases in January 2000 to May 2022. A combination of the intended keywords was used to explain the search strategy. An inferential statistical method was used to analyze the data, and CMA2 software was applied to investigate and answer the research questions.

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In the present study, fixed-effects and random-effects meta-analysis models were used to analyze the data; Hedges' g-effect size to obtain a separate effect size; funnel plots and trim and fill by Duval and Tweedie to examine publication bias; the fail-safe N test to investigate missing studies and the Q and I2 tests to examine heterogeneity of studies. The CMA2 meta-analysis software analyzed all of these procedures.

Inclusion criteria

These criteria included studies that investigated the prevalence of obesity in college students currently; in fact, to determine obesity in the studies, one of the three standards, including the Iranian sources, which considered obesity as a person with a BMI above the 95th percentile of the Iranian reference [13], as well as the 2000 Centers for Disease Control and Prevention, which used the National Health Statistics and National Health and Nutrition Survey, which used new BMI percentile curves by age and gender for 2-18-year-old children [14]. In addition, the 2000 International Obesity Task (IOTF) standard was applied used, which uses the National Growth Survey for 2-18-year-old children by age and gender [15].

Exclusion criteria

These criteria included a lack of access to the full text of the articles and irrelevant studies in this regard. However, the articles whose abstracts contained the full data were not excluded. Data were extracted based on the inclusion and exclusion criteria. A summary of the articles was studied by the researcher (Seyed Mohsen Nemati); then, irrelevant studies were rejected, and relevant studies were specified to extract their texts and data. After the accepted articles were included, the required data were entered in a summarized and collected form into an electronic spreadsheet that already contained certain data, including variables of the author, year of the study, population studied, place where the study was conducted and overall prevalence of obesity by age and gender. These data were compiled by Seyed Mohsen Nemati and A'zam Hadi (Figure 1).

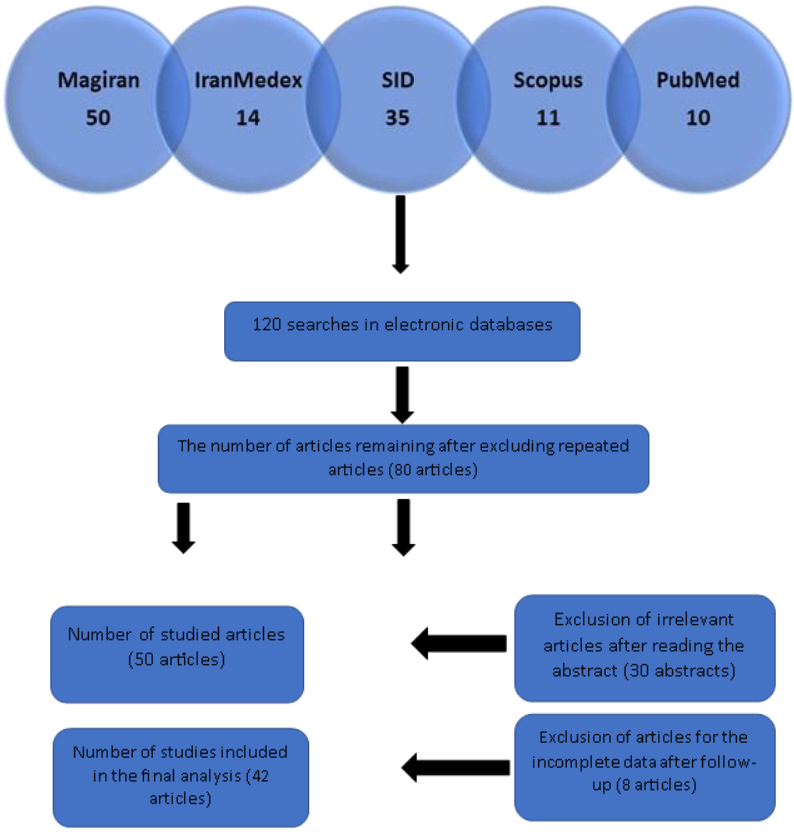

Fig 1. Search strategy to find studies related to the prevalence of obesity among children

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Findings

A review of studies on the prevalence of obesity revealed 14 factors in 42 studies, 9 of which confirmed the lack of a relationship, while the rest confirmed the presence of a relationship (table 1). In fact, the H0 of 33 studies was rejected (χ 2 was 0.317), whereas the rest were confirmed. According to the studies, the prevalence of obesity and overweight in Iranian children was 10.32% and 12.48%, respectively.

Are research hypotheses stated significant?

Comparison of table 2 with the chi-square distribution table (Delavar, 2012) revealed that the $^{2}\chi$ of the rejected hypotheses with a value of 0.025 was smaller than that of the chi-square distribution table; thus, H_0 was rejected, and H_1 is confirmed at 0.05. Next, the adjusted and unadjusted funnel plots were first constructed based on the standard error and accuracy indicators in each of the studies; then, the calculated effect size results were reported for each of the studies. Finally, the homogeneity of the studies was tested, and the incomplete safe numbers of each study were obtained.

Figures 2 and 3 show that the studies used in this study are not symmetrically distributed around the mean effect size, with the scatter of studies around one side of the mean indicating the presence of bias in the studies. The larger studies are shown at the top of the figure, the smaller ones at the bottom. To examine and subsequently eliminate the biases, the trim- and-fill method of Duval and Tweedie was used. This method calculates the missing studies on the left side of the figure, which, when created, can eliminate the bias. The table 3 represents the results of using this method.

As illustrated in Table 3, 8 studies are considered missing, and the fixed-effects model estimate changes from 0.29658 to 0.14362 using the trim- and-fill procedure of Duval and Tweedie. Moreover, the estimate of the random effects model changed from 0.19084 to 0.13768. In other words, the addition of 8 studies on the right side of the human effect size, created a state of symmetry in this figure. Figures 4 and 5 illustrate that with the addition of 8 studies on the right side of the figure, the mean biases are removed, changing the distribution of studies from the asymmetric condition to the symmetric condition. The added studies are displayed as filled circles.

Examination of homogeneity of the studies

The Q test was used to test the homogeneity of the studies. The homogeneity of the test results of the studies shows these things: Model: fixed, Q-value: 129, df: 40, p-value: 0.000, I^2: 0.18428.

As indicated in Figure 6 the Q value is 129, which is significant at a probability level of less than 0.05. Thus, the null hypothesis of homogeneity of studies is rejected, indicating that the considered group of studies is heterogeneous. The I^2 indicator demonstrated that 0.18428% of the change in effect size across studies was due to heterogeneity of studies; the following diagram and numerical results suggest that the study results were highly heterogeneous, ranging from 0.03 to 0.099.

Computing effect size values of each of the studies

For each of the studies, the effect size values were calculated based on Hedges' g indicator (from smallest to largest), lower bound, upper bound, z values, and p values at the 95% confidence level, while their significance was evaluated by the Fischer z test. Table 4 contains the calculation results.

In Table 4, the name of the researcher is given in the first column, and the subvariables of the study are given in the second column. The Hedges' g index given in the next column is considered the effect size of each study as calculated by the CMA-2 software. The next columns include lower and upper limits at the 95% confidence level, the z value, and the probability levels of each study. As can be seen from the table, the remaining studies have significant effects with the exception of Majid Aminzadeh, Nasrin Akbari, Parvin Sajjadi, Fariba Asadi Noghabi, Amir Tayouri, Akbar Fotubhi, and Seyed Abolhasan Naghibi's studies, which found non-significant effects. To test the overall significance of the effect size after combining the

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studies, two fixed and random models were examined, the results of which are illustrated in Table 5.

As exhibited in table 6, the total effect size of the studies in the fixed-effect model using Hedges' g index was 0.149 with a 95% confidence level at distance range of 0.086 to 0.214, but for the random-effect model, the total effect size of the studies using Hedges' g index was 0.289 with a 95% confidence level at distance range of 0.218 to 0.286.

Examining the bias of study publication

To investigate and determine publication bias of combined studies, the incomplete safe number index was used. Table 6 contains the results of publication bias. Table 6 shows that the number of 1068 missing studies with an effect size of 0 is required to transform the above significant results into non-significant results and bring the p-value to the alpha level. Investigating the χ^2 index of research: Is the prevalence of obesity and overweight higher in girls than boys?

As for research on the prevalence of obesity in obese children, 42 samples were studied, 7 of which showed no significance, while the rest remained in the study. In these studies, the null hypothesis regarding the hypotheses about the prevalence of obesity in girls was confirmed in four cases, while the research hypotheses were confirmed in 17 cases and the null hypotheses were rejected. In addition, in these studies, the null hypothesis regarding the prevalence of obesity in boys was confirmed in 3 cases; in 11 cases, the research hypotheses were confirmed, and the null hypothesis was rejected. When analyzing the data in relation to the confirmation or rejection of the H_0 hypothesis, a chi-square value of 0.025 was calculated, which, given that this value is smaller than the critical chi-square, is significant at the 0.05 level. Thus, the prevalence of obesity is higher in girls than boys.

Table 1: Studies of the statistical sample (The characteristics of the reviewed articles, regarding the prevalence of obesity in Iranian children)

N.	Author	Year of publication	City	Total samples	Gender		Percentage of obesity		Percentage of overweight		Age interval
					Girls	Boys	Girls	Boys	Girls	Boys	
1	Ayatollahi	2006	Shiraz	2397	1129	1268	6.1	3.3	3.8	6.8	11-56.5
2	F. Kompni	2013	Ahvaz	5811	2907	2904	19.3	.05	19.3	23.6	7-11
3	M. Zarati	2014	Tehran	1184	625	559	5.28		21.92		10-13
4	M. Aminzadeh	2010	Ahvaz	1594	835	759	17.7		18.8		6-10
5	Sh. Ghaibi	2004	Orumieh	584	584		4		4.10		10-12
6	J. Sohaili	2000	Hamedan	2000	1000	1000	7.2	4			6-11
7	L. Salehi	2012	Shahriar	325	160	165	26.1	73.9	60.5	39.5	6-12
8	AR. Dorosti	2012	Islamshahr	480	256	224			17		7-9
9	N. Akbari	2005	Esfahan	300			62.7	37.3			6-12
10	K. Heydari	2014	Esfahan	12946	10531	2415	29.9	33.7	29.9	26.9	12-14
11	Sh. Assar	2005	Ahvaz	4793	2500	2293	2.48	2	6.44	5.71	7-14
12	M. Aminzadeh	2012	Ahvaz	1594	759	835	21.08	14.65	21.74	16.17	6-10
13	M. Tabatabai	2013	Ahvaz	3482	1639	1843	10.9				6-12
14	R. Kelishadi	2011	Iran	2600065			3.3-4.3-5.4 2007-2008-2009		10.13-2.12-5.8 2007-2008-2009		6
15	K. Hajian	2008	Babol	1000			3.8	8.8	12.2	12.5	7-12
16	P. Sajjadi	2012	Babol	3647	1867	1780	13.7	15.07	13.37	18	7-11
17	F. Asadi	2001	Babol	1350	689	661	6.2	10.9	12.8	10	7-11
18	A. Tayuri	2015	Birjand	270		270		5.6		10	10-14
19	T. Kazemi	2013	Birjand	1541	851	960	7.9	10.9	8.3	11	6-11
20	B. Moghimi	2014	Pakdasht	95			9.1		15.1		
21	S. Pirouzpanah	2016	Tabriz	857	366	491	0.9	3.1	9.7	5.5	6-11
22	A. Movahadi	2015	E. Azarbaijan	7278			5.5		13.9		
23	MR. Sohrabi	2010	Tehran	1040	1040		8.65		16.54		6-11
24	ST. Heydari	2013	Jahrom	984	477	506	8.5	11.1	12.4	15.9	6

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25	AH. Parno	2015	Javanrud	335	335		4.77		7.76		7-12
26	H. Mozaffari	2019	Farsan	1189	674	515	3.4	8.5	8.6	9.9	6-12
27	HR. Dorosti	2010	Khoy	4400	2333	2067			15.4		6-12
28	T. Shahraki	2010	Zahedan	1079	579	500			10.3	8.9	7-11
29	N. Mokhtari	2013	Rasht	426	83	83	15.3	19	14	8.6	6-7
30	A. Fatuhi	2007	Dezful	4508	2079	2429	5.3		2.6		6-17
31	M. Rezaian	2019	Rafsanjan	1292	648	644	7.4		48.4		5
32	SM. Safavi	2016	Zabul	3443	1695	1748	4.56		10.98		7-11
33	M. Karaji	2004	Zahedan	2067	2067		1.4				7-11
34	B. Falak Alaflaki	2016	Zanjan	1366	780	586	4.5	3.1	3.9	12.2	12-14
35	SAH. Qoibi	2018	Sari	211	112	99	16.1		22.3		6-11
36	B. Karimi	2010	Semnan	400			10.4	17.9	21.8	15.9	7-12
37	S. Ahmadi	2010	Sanandaj	694	354	340	1.1.	5.3	9.6	12.9	12-14
38	SM. Fatemi	2018	Qom	385	192	192	10.4	16.2	18.2	19.8	6-12
39	A. Tizvier	2013	Karaj	450	219	231	5	19	21	19	6
40	H. Pouraram	2016	Bijar	255	122	133	1.14		16.46		6-12
41	H. Safizadeh	2019	Kerman	731	355	376	8.1		9.2		5
42	H. Kazemini	2016	Iran	514963	261633	253330	2.6		8.4		5

Table 2. Descriptive statistics and chi-square estimate of research hypotheses

H_0	Fo	Fe	Fo- Fe	$\chi 2$
Rejected H_0	0.463			11
Confirmed H_0	0.025	1.52	1.48	3
Total (14 factors)	14 factors were entered into the analysis			

Table 3. Duval and Tweedie's trim and fill

Values	Added studies	Fixed effects			Random effects			Value Q
		Point of estimation	Lower bound	Upper bound	Point of estimation	Lower bound	Upper bound	
Observed values	-	0.29558	0.18325	0.27750	0.19084	0.20902	0.26058	365.68469
Modified values	8	0.14362	0.9635	0.21394	0.15732	0.13768	0.18932	689.59543

Table 4. Calculation of effect sizes and significance test for each of the studies (ranking based on effect size values) (N=42)

N.	Researcher	Variables	Statistical indicators				
			Hedges' g	Lower bound	Upper bound	Z value	P Value
1.	Ayatollahi	Girl	0.339	0.203	0.462	4.696	0.000
2.	Farshid Kompani	Girl	0.340	0.354	0.503	3.487	0.033
3.	Mitra Zarati	Girl	0.350	0.184	0.497	3.987	0.001
4.	Majid Aminzadeh	Girl	0.350	0.197	0.486	4.324	0.056
5.	Shah Sanam Ghaibi	Boy	0.357	0.236	0.467	5.488	0.001
6.	Jafar Sohaili Far	Boy	0.358	0.219	0.483	4.841	0.000
7.	Leily Salehi	Boy	0.360	0.195	0.505	4.111	0.004
8.	Ahmadreza Dorosti Motlagh	Girl	0.360	0.219	0.486	4.782	0.001
9.	Nasreen Akbari	Boy	0.370	0.206	0.514	4.237	0.933
10.	Kamal Heydari	Boy	0.370	0.091	0.209	0.776	0.000
11.	Shideh Assar	Boy	0.370	0.085	0.273	1.043	0.000
12.	Majid Aminzadeh	Boy	0.400	0.079	0.279	1.108	0.000
13.	Mina Tabatabai	Girl	0.410	0.066	0.298	1.265	0.000
14.	Roya Kelishadi	Boy	0.430	0.113	0.348	1.009	0.000
15.	Karimullah Hajian	Girl	0.481	0.035	0.211	2.739	0.006
16.	Parveen Sajjadi	Girl	0.497	0.058	0.298	1.337	0.181

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17.	Fariba Asadi Noughabi	Girl	0.502	0.001	0.260	1.951	0.051
18.	Amir Tayuri	Boy	0.170	0.206	0.514	4.237	0.072
19.	Tuba Kazemi	Girl	0.191	0.206	0.514	4.237	0.038
20.	Bijan Moghimi Dehkordi	Boy	0.193	0.239	0.539	4.621	0.000
21.	Saeed Pirouzpanah	Girl	0.201	0.250	0.548	4.752	0.003
22.	Ario Movahadi	Boy	0.210	0.299	0.545	5.943	0.036
23.	Mohammad Reza Sohrabi	Girl	0.243	0.329	0.609	5.622	0.000
24.	Seyyed Taghi Heydari	Girl	0.279	0.385	0.595	7.654	0.012
25.	Abdul Hossein Parno	Boy	0.365	0.056	0.426	2.516	0.012
26.	Hassan Mozaffari Khosravi	Girl	0.250	0.103	0.386	3.301	0.001
27.	Ahmadreza Dorossti Motlagh	Girl	0.256	0131	0.373	3.945	0.000
28.	Turan Shahraki	Girl	0.260	0.086	0.418	2.903	0.004
29.	Nasrin Mokhtari Lakeh	Boy	0.270	0.111	0.416	3.276	0.001
30.	Akbar Fatuhi	Girl	0.280	0.088	0.452	2.833	0.653
31.	Mohsen Rezaian	Boy	0.284	0.139	0.417	3.774	0.000
32.	Syed Morteza Safavi	Girl	0.502	0.353	0.626	5.919	0.002
33.	Mansour Karaji Bani	Boy	0.589	0.490	0.673	9.490	0.000
34.	Behnaz Falak Al-aflaki	Boy	0.58	0.513	0.656	12.095	0.000
35.	Seyed Aboulhasan Naghibi	Boy	0.591	0.493	0.674	9.533	256/0
36.	Batul Karimi	Girl	0.760	0.642	0.843	8.335	0.000
37.	Salahuddin Ahmadi	Girl	0.295	0.212	0.374	6.682	0.000
38.	Sayeda Marzieh Fatemi Abhari	Boy	0.310	0.121	0.477	3.157	0.002
39.	Afsoun Tizvir	Boy	0.314	0.176	0.440	4.324	0.000
40.	Hamed Pouraram	Boy	0.324	0.200	0.438	4.940	0.000
41.	Hossein Safizadeh	Girl	0.330	0.186	0.460	4.350	0.000
42.	Hossein Kazemi	Boy	0.330	0.162	0.480	3.740	0.000

Table 5. Results of combining effect sizes of studies and their significance

Model	Statistical indicators					Calculating mean effects	
	Hedges' g	Lower bound	Upper bound	Z value	P value	Positive	Negative
Fixed	0.149	0.086	0.214	42.208	0.000	0.229	0.184
Random	0.289	0.218	0.286	28.485	0.000		

Table 6. Publication bias results

Z of observed studies	P value	Alpha value	Z alpha	Number of observed studies	Number of missing studies
29.54983	0.000	0.04000	1.59463	42	1068

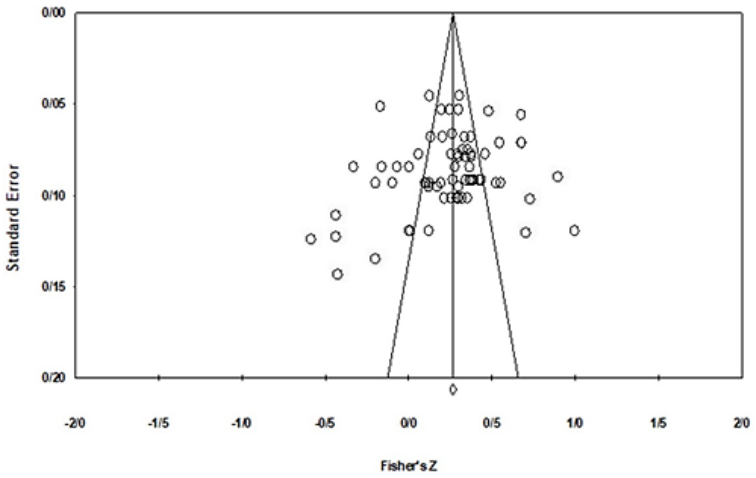

Fig 2. Funnel plot using standard error indicators in studies pertaining to the research question

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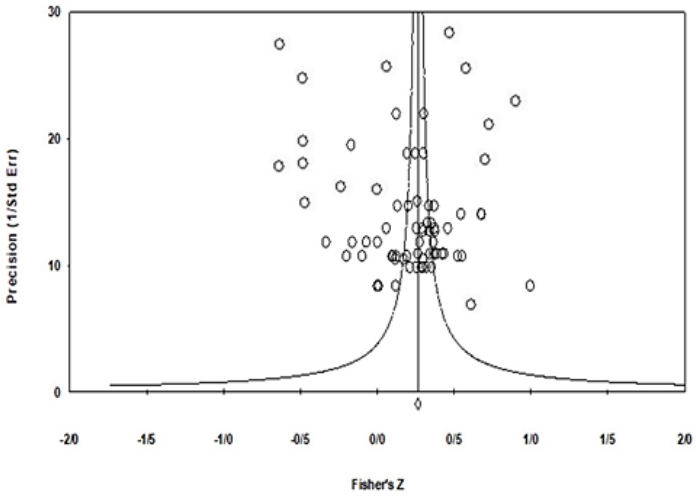

Fig 3. Funnel plot using indicators of accuracy

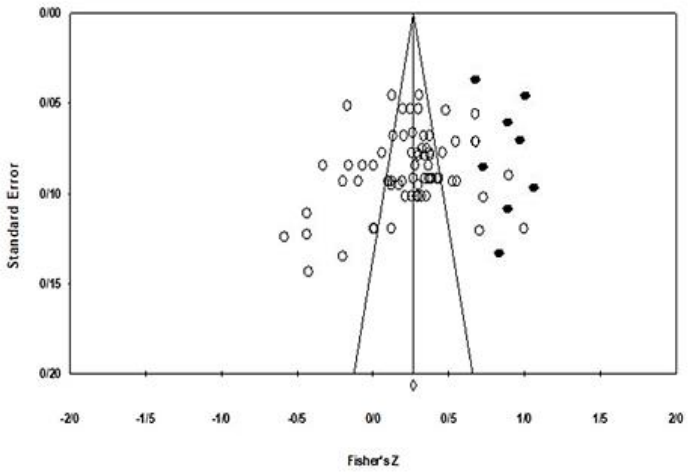

Fig 4. Adjusted funnel plot using standard error indicators related to the research question

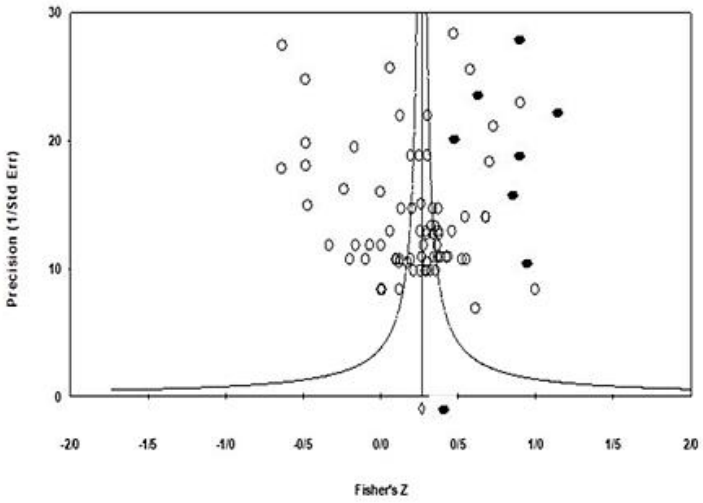

Fig 5. Adjusted funnel diagram using accuracy indicators

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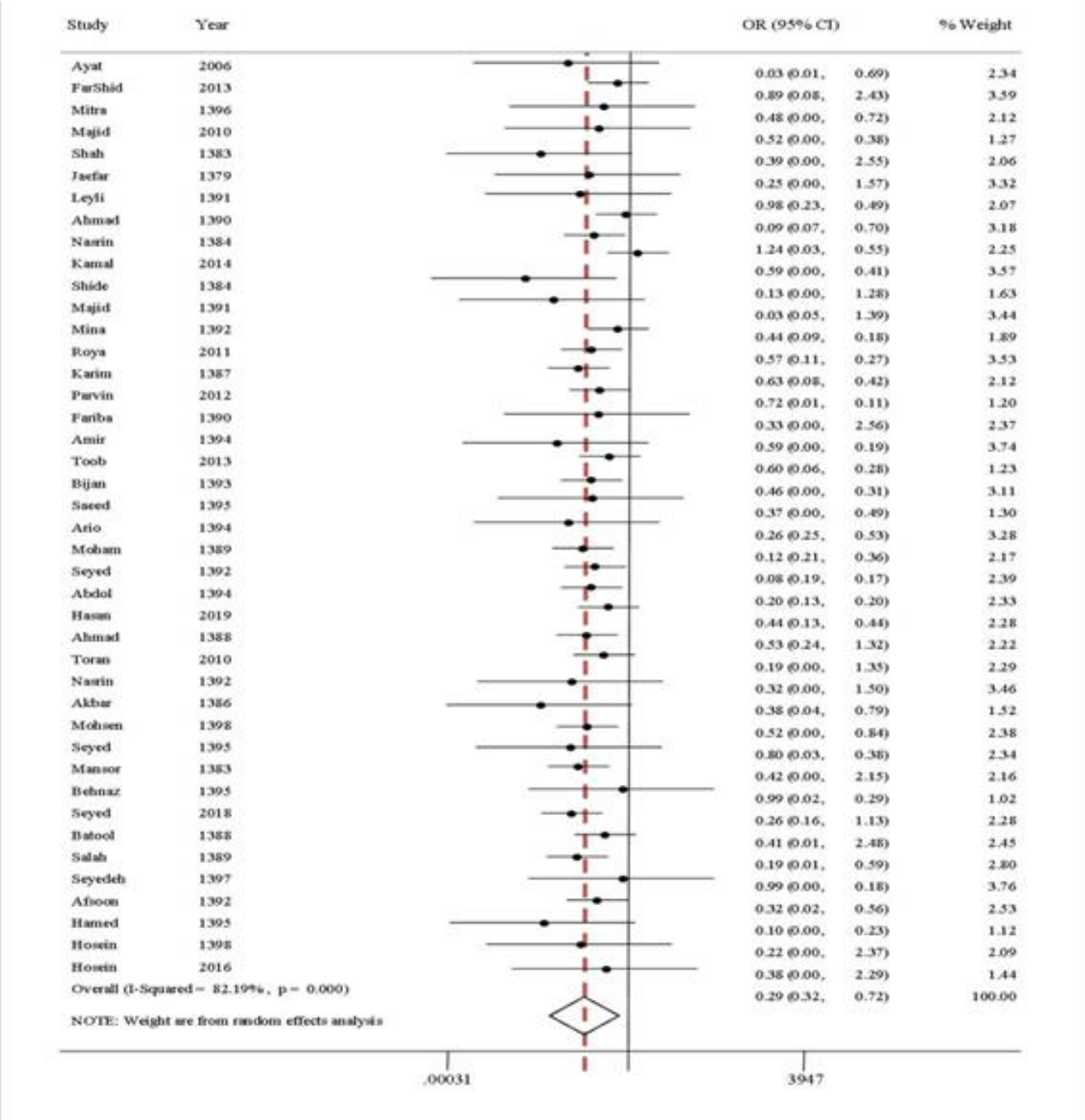

Fig 6. Examining homogeneity of the studie

Discussion

The present study was the first systematic and meta-analytic review study on childhood overweight and obesity in Iran. The results of this study on the prevalence of obesity are consistent with the values obtained in other regional studies in Asia [1-8]. However, the prevalence values are generally higher than those expected for developing and global countries. The combined prevalence of obesity and overweight in developing countries was 6.1% in 20120 and is projected to increase to 8.6% by 2022 [9]. This rate in Iran requires public health interventions. The findings of the present study indicated that the prevalence of childhood overweight was increasing, and the rate was higher in girls than boys. Furthermore, the overall

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prevalence of obesity and overweight in Iranian children was 10.32% and 12.48%, respectively.

The results of the present study which refer to the prevalence of obesity and overweight in the entire population studied, are consistent with studies conducted in Brazil (2014), China (2018), the United States (2020), Ukraine (2006), Sweden (2006), and eight European countries in 2019, all of which state that the prevalence of overweight is higher than that of obesity [16-21]. However, the findings of the ongoing study were inconsistent with those of the 2020 Spanish study [22]. This can be attributed to cultural differences, the measurement of obesity and overweight, and deprivation or non-deprivation in the areas studied.

Other findings suggested a gender difference between obesity and overweight, as the prevalence of obesity was higher in girls than boys. A 2017 study conducted in Cameroon also found that obesity was higher in girls than boys, which is consistent with the present study [23]. Another study conducted in Australia in 2005 revealed that the prevalence of obesity was higher in girls than boys [24]. Another cross-sectional study conducted in 2018 in Ukrainian children found that the prevalence of obesity was higher in girls than boys, suggesting that the results are in line with those of the present study [19].

However, the results of the present study on obesity and overweight in girls and boys were different from those of a study conducted in Kuwait and Egypt in 2017. This present study reports a greater percentage of obesity in girls than boys [25]. In addition, in another study done in Taiwan, the prevalence of obesity and overweight in boys was higher than that in girls [26], as the findings conflict with those of the present study. These differences can be due to social-economic and cultural differences, country and residence, parental literacy, the difference in mental impressions about bodily images, and familial issues. In the traditional families of our country, to be thin means to be weak or sick; moreover, due to the outbreak of the corona virus and the immobility of children and computer games, girls have become too obese and outnumber boys. Regarding the different prevalence of obesity and overweight in various parts of the world, we can refer to genetic, economic, and social differences, dietary habits, country development, and lifestyle. In general, obesity is increasing in developed countries, and Iran is following this trend.

Limitations of the study

There are insufficient domestic studies on different age groups of children, studies that do not focus on indicators such as body mass, diet, and psychological factors, and lack of access to case samples consistent with the demographics of the present study.

Conclusion

The present meta-analysis study revealed that the prevalence of obesity is increasing in the country and that it is more common in girls than boys. Consistent with the findings of the present study and those of other studies, it is concluded that the prevalence of obesity has risen in all countries during the last two decades, with a 50% increase in most countries and a 100% increase in some others. The results also have suggested that obesity has increased in Iran compared to the last two decades and the rate will double in the next five years if prevention measures are not taken. Considering the technological progress and its impact on people's lives, as well as coronavirus followed by immobility and increasing obesity, it is necessary to consider plans to change wrong eating habits, improve lifestyle and nutrition, and increase mobility and physical activity at family and social levels.

Research and practical recommendations

Use the findings of the current research in organizations and executive agencies and share with parents, use the results of the present research to inform the media and social networks, and use mixed methods such as brainstorming, Delphi, and fuzzy Delphi methods to use expert opinion in the present research, prioritize the factors affecting the prevalence of childhood obesity using multi-criteria decision-making methods, weigh the factors and parameters affecting each study, and re-examine the results of the present study

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