Trend of Stunting, Overweight and Obesity among Children Under Five Years in a Rural Area in Northern Iran, 1998–2013: Results of Three Cross-Sectional Studies

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Abstract

Background: Obesity is a common health problem in the world and the purpose of this study was to identify the trend of overweight, obesity and stunting among children under five from 1998 to 2013 that was carried out in three stages in the villages of Golestan province in the northern Iran (south east of the Caspian Sea).

Methods: Three cross-sectional studies with sample sizes of 7575, including 2339, 2749 and 2487 cases were carried out in 1998, 2004 and 2013, respectively. Among 118 villages, 20 were chosen by random sampling and all of the under-five-children in these villages were assessed. For all subjects, a questionnaire was completed and anthropometric indices were measured. Z-score was used for body index classification with following categories: Z≤ 2SD=Normal or under-nutrition; >2SD Z ≤3SD = Overweight and Z>3SD = Obesity. *P*-value under 0.05 indicated significance.

Results: In 1998, 2004 and 2013, the prevalence of overweight was 8.5% (95% CI; 7.3–9.6), 3.3% (95% CI; 2.7–4.0) and 5.2% (95% CI; 4.2–6.1), that of obesity was 4.6%(95% CI; 3.8–3.5), 1.2% (95% CI; 0.8–1.6) and 3.5% (95% CI; 2.8–4.3), and that of stunting was 32.8% (95% CI; 31.0–34.6), 13.4% (95% CI; 12.2–14.6) and 15.7% (95% CI;14.3–17.2), respectively. In boys, the mean of height was significantly different in all age groups while the mean of weight was significant only at ages 13–24, 37–48 and 49–60 months ($P < 0.005$ for all). In girls, the mean of height significantly different from 36 months age ($P < 0.01$) whereas weight difference was significant only at age of 37–48 months ($P = 0.002$).

Conclusion: A heterogenic trend was seen in stunting, overweight and obesity. Although short stature was the main cause of obesity in 1998, extra weight was its major cause in 2013. Renewed increase of obesity among children under-five is considerable in the northern Iran.

Keywords: Children, Iran, obesity, stunting, trend

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Introduction

Worldwide economic growth has been accompanied by an increase in animal fat intake, food availability, low physical activity and urbanization.[1] In many developing countries, the acceleration of nutrition transition has led to decrease in stunting and increase in overweight and obesity.[2,3]

Cross-sectional and secular trends studies indicate a global increase in childhood obesity.[4,5] The stunting and underweight have reduced from 34% to 27% and from 27% to 22%, respectively in a 10-year period (1990–2000) in children worldwide.[2]

It is predicted that obesity will decrease to 22% over the next decade. The global target is to reduce 3.9% of stunting rate per year and to reduce the number of stunted children from 171 million in 2010 to 100 million in 2025.[6]

It is estimated that 43 million children worldwide (35 million in developing countries) are obese or overweight and 92 million are at risk of overweight. Obesity plus overweight has increased from 4.2% in 1990 to 6.7% in 2010.[2] However, worldwide estimates cannot be used to monitor the regional level.[3]

Obesity, metabolic syndrome, hypertension and hypertriglyceridemia have been recognized as the main cardio-metabolic risk factors in Iranian children.[7,8] Underweight, short stature and obesity (including overweight) were seen in 20%, 6.6% and 14.3% of 6 year-old children in Iran, respectively[9] Among children under-five in the West Azerbaijan province in Iran, the prevalence of stunting, overweight and obesity was reported to be 7.3%, 1.3% and 5.1%, respectively.[10] In Tehrani preschool-children, the prevalence of underweight, overweight and obesity was 4.77%, 9.81% and 4.77% in boys and 4.77%, 10.31% and 4.49% in girls, respectively.[11]

Among several techniques, anthropometry is an easy method for assessing nutritional status in both individual and communities. Childhood malnutrition is multifaceted and its etiologies include biological, cultural and socioeconomic factors.[12] Using free fat mass (FFM) as a proper index for estimating body composition instead of body mass index (BMI) has been suggested in field studies.[13] In addition, preparing a national growth chart has been suggested by researcher.[14]

The Golestan Province with 1.7 million people is located in northern Iran (south east of the Caspian Sea), and 43.9% of its population live in rural areas. Agriculture is the main job in vil-

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lages where Persians, Turkmens and Sistanis are the three large ethnic groups.[15]

Body composition may have been altered by life style and food behavior in recent years. Due to little information about the trend of secular growth in northern Iran, this paper aimed to describe the trend of stunting, overweight and obesity among children under-five in rural areas in a 15-year period. Data on the trend of overweight and obesity besides stunting will assist the health policy makers to establish a suitable prevention program for control of cardio-metabolic risk factors.

Materials and Methods

This paper is the result of three cross-sectional studies that were carried out on 7575 subjects in three stages including 2339, 2749, 2487 cases in 1998[16] 2004[17] and 2013, respectively. Among 118 villages, 20 were chosen by random sampling and all of the children under-five- were considered. The children were selected within health care files and were called to health house to measure anthropometric indices and complete the questionnaire. The villages were constant in three stages of the studies. With assumption of 40% rate,[16] a confidence level of 95% and a maximum marginal error about 0.02, the sample size was calculated at least 2304 subjects.

Twenty healthcare staffs were trained as interviewers before starting the studies. The interviewers in three stages were the same. For all cases, a questionnaire was completed by interview. Birth date was recorded from the health care file available from primary health care system.

Body-weight was measured to the nearest 0.1 kg in light dress, using a balanced-beam scale, and height was measured to the nearest 0.5 cm without shoes, while standing up with head, back, and buttock on the vertical land of the height-gauge. The height of children under 18 months was measured in a lying posture.

The Center for Disease Control and Prevention (CDC) reference, approved by the world health organization (WHO), was used to compare anthropometric data. The parameter used for overweight and obesity was Weight-for-Height (WFH) as indicator of present and past nutrition. Z-score was used for body index classification with the following categories: Z≤ 2SD=Normal or undernutrition; >2SD Z-score <3SD= overweight and Z≥3SD=obesity. Overweight (Weight-for-Age) (WFA) and stunting (Height-for-Age) (HFA) were defined as Z>2SD and Z<-2SD, respectively.[18,19]

SPSS software (version 19, Chicago II, USA) was used for statistical analysis. ANOVA and post-hoc Tukey test were used for more than two quantities groups and Chi-square test was used for qualities groups. *P*-value under 0.05 indicated significance. The mothers who did not consent to the inclusion of their children in our study were excluded from this study. We used the ENA (Emergency Nutrition Assessment) software for anthropometric data analysis.

These studies were approved by the Ethical Research Committee of Golestan University of Medical Sciences (G-P-35-1112). Verbal informed consent was received from all cases.

Results

In 2013, the prevalence of obesity, overweight (WFH) and stunting (HFA) was 3.5% (95% CI; 2.5–4.6), 5.3% (95% CI; 4.2–6.7) and 16.0% (95% CI; 14.0–18.0) in boys and 3.6% (95% CI; 2.5–4.6), 5.0% (95% CI; 3.7–6.2) and 15.3% (95% CI; 13.3–17.4) in girls, respectively.

The mean of weight, height and Weight-for-Height based on age and sex in three studies are presented in Table 1. Compared to weight, the variation in height was considerable in both boys and girls. In boys, ANOVA revealed significant differences in weight only at ages of 13–24, 37–48 and 49–60 months; however, change of height was significant in all age groups. Increasing trend of height was greater in 1998–2004 than 2004–2013. In girls, ANOVA revealed significant difference for weight only at age of 37–48 months ($P = 0.002$); however, height differences were significant from age of 36 months ($P < 0.01$). Height increased more in 1998–2004 than 2004–2013. Tukey's Post Hoc test was significant between stages 1 and 2 and between stages 1 and 3 based on height among all of the age groups ($P<0.05$ for all) while weight difference was significant only at age 37–48 months between stages 2 and 3.

The prevalence of overweight and obesity based on sex and age is presented in table 2. In 1998, 2004 and 2013, overweight was prevalent in 8.5% (95% CI; 7.3–9.6), 3.3% (95% CI; 2.7–4.0) and 5.2% (95% CI; 4.2–6.1) and obesity was prevalent in 4.6% (95% CI; 3.8–3.5), 1.2% (95% CI; 0.8–1.6) and 3.5% (95% CI; 2.8–4.3), respectively. In 2013, the variations of overweight and obesity were not significant between genders. Overweight (including obesity) declined by 2% from 1998 to 2004 while it increased 0.5% from 2004 to 2013, annually. Totally, the prevalence of overweight and obesity in boys decreased by 9.9% from 1998–2004 ($P = 0.001$) and increased by 4.8% from 2004–2013 ($P = 0.001$). In girls, it decreased 10.6% from 1998–2004 ($P = 0.001$) and increased 3.5% from 2004-2013 ($P = 0.007$).

Generally, an inverse association was seen between extra weight and age. Pearson's correlation analysis showed that the inverse correlation between age and overweight or obesity is significant ($r = -0.155$, $P = 0.001$).

The prevalence of overweight (WFA) and stunting (HFA) based on sex is presented in Tables 3 and 4. The trend of overweight is significantly different in the three studies ($P < 0.001$). The prevalence of overweight remained unaltered from 1998 to 2004 while it increased significantly from 2004 to 2013 ($P < 0.002$). The prevalence of stunting changed from 32.8% (95% CI; 31.0–34.6) in 2004 to 15.7% (95% CI; 14.3–17.2) ($P = 0.001$) in 2013.The variation of stunting was heterogeneous during the 15-year studies and this figure was recognized in both genders. Statistical differences were significant among the three studies ($P < 0.001$).

The trends of overweight (WFA), obesity (WFH) and stunting (HFA) in three-stage studies are compared in Figure 1. However, a descending trend was seen for stunting and obesity in early years of study but it turned upward over the next years. A steady rising slope was seen in the overweight trend in the 15-year period. The interval point of overweight in comparison with obesity and stunting is notable at the first study in 1998.

Discussion

In the present study, obesity, overweight and stunting were prevalent in 3.5%, 5.2% and 15.7% of subjects in 2013 and the difference was not statistically significant between genders. A heterogeneous trend of overweight, obesity and stunting was seen in a 15-year period among children in northern Iran.

Our results were compatible with prevalence of stunting in

Table 1. The comparison of mean (standard deviation) of weight (WT), Height (HT) and Weight-for-Height (WFH) among three stages of study.

Gender	Age (Month)	Mean (SD)														
		1998 (n = 2339)				2004 (n = 2749)				2013 (n = 2487)				ANOVA P-Value		
		N	WT(kg)	HT(cm)	WHZ-score	N	WT(kg)	HT(cm)	WHZ-score	N	WT(kg)	HT(cm)	WHZ-score	WT	HT	WHZ
Boy	1–12	212	8.16(1.94)	66.18(7.02)	0.98(1.59)	325	7.97(1.90)	67.61(7.76)	0.26(1.62)	364	8.17(2.38)	66.96(8.77)	0.73(1.45)	0.641	0.627	0.928
	13–24	237	10.99(1.49)	77.40(6.01) a	0.81(1.77)	307	11.15(1.40)	80.63(5.31) b	0.11(1.30)	321	11.29(1.90)	80.05(7.45) c	0.46(1.72)	0.043	0.001	0.218
	25–36	236	13.18(1.92)	86.41(6.33) j	0.46(1.37)	282	13.38(1.62)	90.05(5.62) h	-0.01(0.85)	220	13.48(2.04)	89.53(7.23) k	0.14(1.36)	0.105	0.001	0.029
	37–48	230	14.74(1.79)	93.06(6.17)	0.45(1.24)	289	14.92(1.64)	96.93(5.88)	-0.10(0.91)	214	15.09(1.97)	96.68(7.58)	0.05 (1.35)	0.045	0.001	0.005
	49–60	246	16.09(1.82) g	99.42(7.03)	0.26(1.19)	226	16.38(1.79) y	103.48(5.63)	-0.29(0.87)	161	16.92(2.24) t	103.76(6.12)	0.01(1.33)	0.001	0.001	0.062
Girl	1–12	227	7.59(1.66)	65.43(6.21)	0.75(1.53)	302	7.36(1.81)	65.91(7.26)	0.27(1.39)	348	7.42(2.19)	64.64(8.42)	0.86(1.50)	0.495	0.018	0.015
	13–24	220	10.57(1.35)	76.84(5.84) d	0.81(1.55)	264	10.41(1.47)	79.09(5.78) e	0.02(1.25)	262	10.45(1.95)	77.89(7.22) f	0.43(1.63)	0.572	0.363	0.137
	25–36	221	12.65(2.03)	85.01(.86) z	0.53(1.45)	258	12.49(1.47)	88.15(5.76) p	-0.11(1.13)	238	12.71(1.61)	88.18(7.12) q	0.05(1.27)	0.470	0.001	0.002
	37–48	234	14.11(1.98) r	91.84(6.57)	0.45(1.27)	264	14.33(1.81) u	95.38(6.43)	-0.02(1.06)	193	14.69(1.94) v	96.23(6.28)	0.09(1.33)	0.002	0.001	0.011
	49–60	276	15.66(2.03)	98.26(7.41)	0.39(1.24)	232	15.97(2.28)	102.42(6.47)	-0.16(1.00)	166	16.05(2.11)	103.02(7.07)	-0.17(1.63)	0.072	0.001	0.001

Tukey's *Post Hoc* test is significant between a and b ($P < 0.001$), d and e ($P < 0.001$), a and f ($P < 0.001$), z and q ($P < 0.001$), g and t ($P < 0.0007$), y and t ($P < 0.008$), r and v ($P < 0.05$), u and v ($P < 0.05$).

Table 2. The comparison of overweight and obesity among three stages of study according to Weight-for-Height (WFH) index.

Gender	Weight-for-Height N(%)												P-Value#
	1998(n = 2339)				2004(n = 2749)				2013(n = 2487)				
	N	Normal or under nourished N % (CI 95%)	Overweight N % (CI 95%)	Obese N % (CI 95%)	N	Normal or under nourished N % (CI 95%)	Overweight N % (CI 95%)	Obese N % (CI 95%)	N	Normal or under nourished N % (CI 95%)	Overweight N % (CI 95%)	Obese N % (CI 95%)	
Boy	1161	1000 86.1(83.9–88.0)	104 9.0(7.3–10.7)	57 4.9(3.6–6.1)	1429	1372 96.0(95.0-96.9)	46 3.2(2.3–4.2)	11 0.8(0.4–1.3)	1280	1167 91.2(89.5–92.6)	68 5.3(4.2–6.7)	45 3.5(2.5–4.6)	0.0001
Girl	1178	1033 87.7(85.7–89.5)	94 8.0(6.5–9.5)	51 4.3(3.2–5.6)	1320	1253 94.9(93.8-96.1)	45 3.4(2.5–4.4)	22 1.7(1.0–2.4)	1207	1104 91.5(89.9–93.0)	60 5.0(3.7–6.2)	43 3.6(2.5–4.6)	.0011
Total	2339	2033 86.9(85.6–88.4)	198 8.5(7.3–9.6)	108 4.6(3.8–5.5)	2749	2625 95.5(94.7-96.3)	91 3.3(2.7–4.0)	33 1.2(0.8–1.6)	2487	2271 91.3(90.1–92.4)	128 5.2(4.2–6.1)	88 3.5(2.8–4.3)	0.0001

Z- score≤ 2SD: Normal or undernourished; >2SD Z-score <3SD: Overweight; Z-score ≥3: Obesity

Chi-squared test for trend was used to compare "Overweight+ obesity" with "normal or undernourished" children among three- stage of studies. Significant differences were seen between 1998 and 2004 and between 2004 and 2013 both based on boys and based on girls ($P < 0.001$ for all).

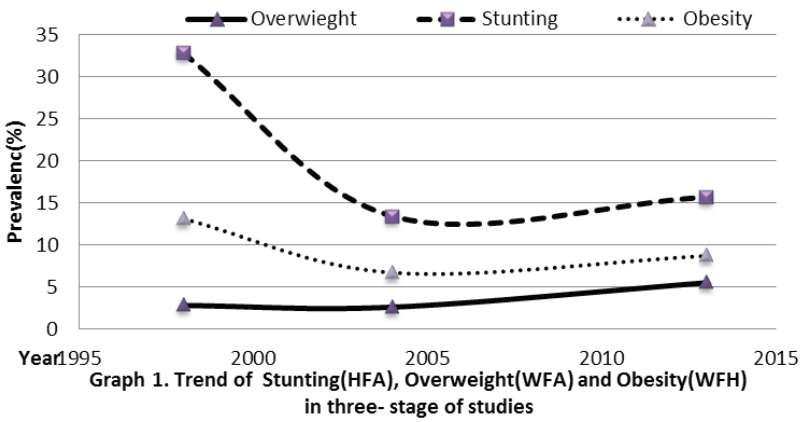

Figure 1. Trend of stunting (HFA), overweight (WFA) and obesity (WFH) in three-stage of studies.

South Khorasan in Iran,[20] Pakistan[21] and Malaysia,[22] while it was greater than Iran as a whole,[9] as well as some parts of Iran e.g., in children under six in Fars province,[23] in 2–5 year-old childrenin Birjand,[24] in rural children in West Azarbijan[10] and in preschool children in Rasht [25] and Tehran.[11]

The prevalence estimates of the present study are not comparable to all of the other studies due to the lack of a single definition for childhood overweight and obesity.

Some national studies in Iran have reported the obesity as a cardiovascular risk factor.[26,8] The prevalence of obesity and overweight in our area were compatible with West Azarbaijan[10] and other countries such as Malaysia [22] Bangladesh[27] and Pakistan,[21] while it was less than Iran as a whole,[9,28] and other parts of Iran, for example, Babol[29] and Tehran.[11] Compared with other studies in the world, it was less than Saint Lucia[30] and South Africa.[31]

Some ethnic groups including Turkmens, Persians (native) and Sistanis live in northern Iran and disparity in overweight and obesity was perhaps associated with disparity in various food behaviors in these groups. According to the previous study,[32] secular growth variation has been seen in children of the Golestan Province compared with other regions of Iran. Generalizing a longitudinal study in view of socio-demographic factors will help to recognize the reasons of these inequalities in our area of study.

In our study, the trend of obesity among children under five was heterogeneous in a 15-year period. In Saint Lucian children under five, obesity tripled in 2006 compared to 1976 (15.2% vs. 4.3%).[30] In a study among children in Peru, overweight significantly reduced from 1996 to 2011; however, this reduction stopped in urban settings since 2005.[33] A dropping trend of malnutrition[34] and underweight[35] was seen in children of other developing countries. A salient decreasing of stunting from 49% to 28% was seen in Asian children from 1990 to 2010, which is expected to reduce by 19% in 2020.[3] Stunting reduced from 22.5% to 11.4% whereas overweight (including obesity) rose from 6.7% to 9.3% in a six-year period (1999–2005) in Brazilian under-five children.[19] Overweight(including obesity), among children under five, increased from 2% in 1985 to 8.1% in 2010 in China,[36] and it declined from 17.1% in 1999 to 14.0% in 2005 in South Africa.[37] Underweight dropped from 10.1% to 8.2% in the past 15 years (1996–2011) in Peru.[33]

Contrary to previous studies, we found heterogeneity in the trend of obesity; however, the underlying causes are different in three studies. The heterogeneous trend of obesity was mostly related to height failure in 1998 and extra weight in 2013. In our final study, short stature had gradually improved but weight gain was the main cause of obesity.

The decrease in the prevalence of stunting, wasting and underweight may be related to socio-demographic factors, food security, health education and water purification that have improved in the last decades in developing countries.[38] It seems northern children as like as other children in Iran[39,40] and in the world[30,41,42] are in a transition phase from protein and trace element deficiency to high calorie intake.

We did not evaluate all factors related to nutrition; e.g. food intake, physical activities, ethnicity and socio-demographic factors and a proper statistical test was not used for considering the design effect caused by cluster sampling. On the other hand, the time interval during three stages was not equal; therefore, the impact of socioeconomic factors on the secular trend would be evaluated on the comparison of findings in three stages. In addition, we did not estimate the participation rate. These are our limiting study factors.

In conclusion, although obesity is low in children under five in rural areas in northern Iran, its causes are not similar during the 15 years of study. A heterogeneous trend was seen in stunting, overweight and obesity. Although short stature was the main cause of obesity in 1998, extra weight was the main origin in 2013. Renewed increase of obesity is remarkable in under-five children. According to these findings, children under five are in a nutrition transition phase and upward trend of obesity should be expected in northern Iran in future.

Conflict of interest statement

There is no conflict of interest.

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Table 3. The prevalence of stunting (Z<-2SD) in three stages of studies.

Gender	Height-for-Age N(%)									P-Value#
	1998(n = 2339)			2004(n = 2749)			2013(n = 2487)			
	N	Stunting N %(CI 95%)	Other N %(CI 95%)	N	Stunting N %(CI 95%)	Other N %(CI 95%)	N	Stunting N %(CI 95%)	Other N %(CI 95%)	
Boy	1161	383 33.0(30.4–35.6)	778 67.0 (64.4–69.6)	1429	180 12.6 (10.8–14.4)	1249 87.4 (85.6–89.2)	1280	205 16.0 (14.0–18.0)	1075 84.0 (82.0–86.0)	<0.001
Girl	1178	385 32.7 (30.1–35.4)	793 67.3 (64.6–69.9)	1320	189 14.3 (12.4–16.3)	1131 85.7 (83.7–87.6)	1207	185 15.3 (13.3–17.4)	1022 84.7 (82.6–86.7)	<0.001
Total	2339	768 32.8 (31.0–34.6)	1571 67.2 (65.4–69.0)	2749	369 13.4 (12.2–14.6)	2380 86.6 (85.4–87.8)	2487	390 15.7 (14.3–17.2)	2097 84.3 (82.8–85.7)	<0.001

Chi-squared test for trend among three- stage of studies. Significant differences were seen among three-stage of studies based on boys (P<0.001) and based on girls (P<0.001).

Table 4. The prevalence of Overweight based on Weight-for- Age (WFA) in three stages of studies.

Gender	Weight-for-Age N(%)									P-Value#
	1998(n = 2339)			2004(n = 2749)			2013(n = 2487)			
	N	Overweight N % (CI 95%)	Other N % (CI 95%)	N	Overweight N % (CI 95%)	Other N % (CI 95%)	N	Overweight N % (CI 95%)	Other N % (CI 95%)	
Boy	1161	33 2.8(2.0–3.9)	1128 97.2(96.1–98.0)	1429	37 2.6(1.8–3.4)	1392 97.4 (96.6–98.2)	1280	72 5.6(4.4–6.9)	1208 94.4(93.4–95.9)	<0.001
Girl	1178	32 2.7(1.8–3.7)	1146 97.3(96.3–98.2)	1320	35 2.7(1.9–3.6)	1285 97.3(96.4–98.1)	1207	64 5.3(4.1–6.6)	1143 94.7(93.4–95.9)	<0.001
Total	2339	65 2.8(2.2–3.4)	2274 97.2(96.6–97.8)	2749	72 2.6(2.0–3.3)	2677 97.4(96.7–98.0)	2487	136 5.5(4.6–6.4)	2351 94.5(93.6–95.4)	<0.001

Chi-squared test for trend. Except between 1998 and 2004 stages, chi-square is significant between other, based on sex and on total ($P < 0.002$ for all).

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