

Original Article

Second National Integrated Micronutrient Survey in Iran: Study Design and Preliminary Findings

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Abstract

Background: The main objective of the Second National Integrated Micronutrient Survey (NIMS-II) was to assess the nutritional status of four micronutrients, namely iron, zinc, and vitamins A and D, and also to conduct an anthropometric assessment of selected groups of children, adolescents, pregnant women, and adults, disaggregated by sex and residential area in nationally representative samples. This paper reports the design of the study along with preliminary findings.

Methods: In this study, 32 770 individuals were selected by using single-stage cluster sampling. Venous blood samples were collected on site for laboratory analysis; interviews were conducted, and anthropometric measurements were performed.

Results: The prevalence of anemia was highest (17.1%) among 15- to 23-month-old children; vitamin A deficiency was 18.3% in this age group. As regards iron deficiency anemia, the prevalence in all age/sex groups was less than 5%, ranging from 0.5% in 6-year-old children to 4.2% in 15- to 23-month-old children. Zinc and vitamin D deficiencies were highest among pregnant women (8% and 85.3%, respectively). Finally, the prevalence of overweight and obesity among adults was 40.3% and 29.2%, respectively.

Conclusion: Results of this study can help in designing nutritional intervention programs for nationwide implementation. Of all micronutrient deficiencies, vitamin D deficiency was the most prevalent in all study groups. Thus, appropriate actions should be taken in our community.

Keywords: Iran, Micronutrients, NIMS, National survey, Study design

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Introduction

The first attempt to assess the national nutritional situation in Iran was made by Browe et al in 1956 on soldiers.¹ It was followed by other surveys by the National Nutrition and Food Technology Research Institute (NNFTRI) to assess energy and nutrient intakes.²

Having adequate and updated information is the most important requirement for proper planning to overcome malnutrition and micronutrient deficiencies. Countries design and implement studies to evaluate previous interventions and plan new ones. For example, researchers in the United States have designed and implemented the National Health and Nutrition Examination Survey (NHANES) regularly since 1971.³ In addition, researchers in Japan and South Korea have conducted some studies for assessing the health and nutritional status of children

and adults.^{4,5} Other countries have similar projects.

The first national survey to assess the micronutrient and anthropometric situation, the National Integrated Micronutrient Survey I (NIMS-I), was conducted by NNFTRI and published in 2006.⁶ It provided useful information on the nutritional status of four key micronutrients (iron, zinc, and vitamins A and D) in various age/sex and physiological groups, and also their relationship with anthropometric indices and some other factors. As an example, NIMS-I showed that iron deficiency anemia (IDA) was prevalent in all age/sex groups studied, which prompted authorities to launch the national flour fortification program as a major strategy to control iron and folic acid deficiencies.⁷⁻⁹

Owing to the rapid socioeconomic, lifestyle, and food consumption changes, Iran is undergoing a nutritional

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transition. Changes in consumption patterns over the recent decades have influenced the micronutrient status.¹⁰ Therefore, assessment of the micronutrients status and updating the information after 11 years, were deemed essential to determine prevalence trends, and make recommendations for planning and implementing suitable intervention strategies. Thus, the aim of the NIMS study in our country was to determine the status of iron, zinc, and vitamins A and D based on blood levels and anthropometric indexes in selected age/sex and physiological groups, in urban and rural areas. In this paper we introduce the NIMS project (design and implementation) and also we present some of the preliminary findings, as well as making relevant suggestions/recommendations.

Materials and Methods

NIMS-II was conducted upon the request of the Nutrition Department, Ministry of Health and Medical Education (MOHME), by the School of Nutritional Sciences and Dietetics (SNSD), Tehran University of Medical Sciences (TUMS), Tehran, Iran, with close collaboration of the School of Public Health, TUMS; Reference Health Laboratory, MOHME; Universities of Medical Sciences throughout the country; and UNICEF Office, Iran. The process of designing and implementing the survey has been documented independently by the Iranian National Health Research Institute.¹¹ The survey was conducted between 2011 and 2015. The statistical population included Iranian households with apparently healthy individuals living in urban and rural regions. The study groups included 15- to 23-month-old children,

6-year-old children, pregnant women past their fifth month of gestation, adolescents (14- to 20-year-old girls and 15- to 20-year-old boys), and adults (50- to 60-year-old women and 45- to 60-year-old men).

The country was divided into 11 study zones based on similarities in socioeconomic and geographic characteristics. Each zone included one or more provinces or parts of provinces, and at least one university of medical sciences (Figure 1). The sampling method was one-stage cluster sampling, with equal-sized samples. The reason for choosing this sampling method was the wide scattering of the statistical units and the difficulty of accessing these statistical units.

The final sample size, considering the design effect (1.3), the need to have disaggregated information for each zone by MOHME, and the likelihood of missing some units, was determined to be 397 (for practical purposes, $n = 400$) for each statistical group in each study zone. The cluster size chosen was 5, so each cluster included 5 children aged 15–23 months, 5 children aged 6 years, 5 girls aged 14–20 years, 5 boys aged 15–20 years, 5 pregnant women past their fifth month of gestation, 5 women aged 50–60 years, and 5 men aged 45–60 years. Consequently, 80 five-subject clusters of each of the 7 statistical groups in each of the 11 study zones were included in the study; that is, $n = 2800$ in each of the 11 zones. Thus, a total of 30 800 individuals were included in the study. In order to ensure that a sufficient number (5) of subjects was selected in each age/sex group, 7 rather than 5 subjects were identified and invited for the interview, considering that some identified subjects may not be present at the right time. So, the total number of

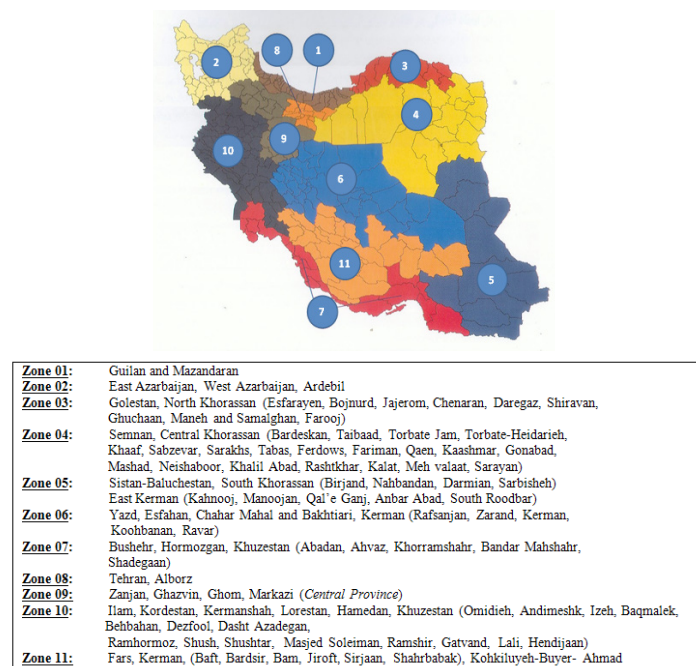


Figure 1. The Study Zones.

study participants (32770) outnumbered the estimated minimum sample size (30800).

In each zone, the cluster starting points were determined proportionately in each rural and urban area,¹² and based on the sampling frame, each 5-subject cluster was then chosen in each age/sex group. Anthropometric parameters (weight and height or length) were determined in all study groups, except for pregnant women, based on standard techniques:

A. Height or Length:

(1) For 15- to 23-month-old children: in a supine position, using the UNICEF height-board (provided by UNICEF).

(2) For other age groups: in a standing position, using an inelastic measuring tape.

B. Weight:

(1) For 15-to 23-month-old children: using a calibrated baby scale (used routinely in health units), checked daily.

(2) For other age groups: with minimum clothing, using a portable digital scale (provided by UNICEF).

The precisions of height and weight measurements in all cases were 0.1 cm and 100 g, respectively. Venous blood samples were collected on site for laboratory analysis (for micronutrient-related measurements) and at the same time and place, interviews were conducted; and anthropometric measurements made by using standard protocols.¹³ Complete blood count was performed by using an automated hematology analyzer (Sysmex K1000; Sysmex, Tokyo, Japan). Ferritin and vitamin D levels were simultaneously measured by using chemiluminescence (Elecsys 2010 machine), and serum vitamin A and zinc levels by using high-performance liquid chromatography (HPLC YL 9100 machine) and atomic absorption (Younglin AAS 8020 machine), respectively.

The survey was conducted in six phases as follows:

Phase 1. Formation of multidisciplinary scientific committees (both from academia and executive bodies), including steering, scientific, and implementation committees. Each member (or group of members) of each scientific committee was assigned a specific function

(e.g., literature review, writing objectives, laboratory arrangements and analysis, etc.).

Phase 2. Regular, weekly meetings of the scientific committee to prepare the research proposal, plan activities according to a Gantt chart, and so on.

Phase 3. Conducting a pilot study to modify and rearrange the timing of different parts and procedures of the study.

Phase 4. Preparing detailed procedures for data collection according to scientific standards to ensure good performance, supervision of the fieldwork, and data quality control.

Phase 5. Implementation (data collection phase). The processes of planning and data collection (fieldwork) took about 9 months.

Phase 6. Data analysis and report writing.

The Cut-offs Used in This Survey

For anthropometric parameters, assessing nutrition status and determining the prevalence of child malnutrition, the latest World Health Organization criteria were used.^{14,15} In addition, to determine blood levels of micronutrients, internationally accepted valid criteria were used as shown in Table 1.^{14,16-20} It should be noted that serum zinc was measured in all groups except adults, and vitamin A was determined only in 15- to 23-month-old children and pregnant women.

Data Analysis

For data analysis, SPSS version 19 was used. All data were presented as percentages. To assess the normal distribution of the variables, we applied the Kolmogorov-Smirnov test and histograms. For non-normally distributed variables, we conducted log transformation. To examine the differences in the distribution of the participants in terms of categorical variables across sex and urban and rural areas, we used the chi-square test. However, whenever the number of participants in each category was low, we used the Fisher exact test. We considered 95% confidence intervals in estimating population

Table 1. Summary of Cut-off Points for Micronutrient Deficiencies

Variable	Cut-off						
	15-23 Months	6 y	Adolescent		Pregnant Women (after the 5th month of pregnancy)	Adults	
			Boys (15-20 y)	Girls (14-20 y)		Men (45-60 y)	Women (50-60 y)
Anemia (low hemoglobin), g/dL	<11	<11.5	<13	<12	<11	<13	<12
Low ferritin, µg/L	<12	<15	<15	<15	<15	<15	<15
Low MCV, fL	<73	<76	<80	<80	<80	<80	<80
Zinc deficiency (low serum zinc), µg/dL	<70	<70	<70	<70	<65	-	—
VAD ² (low serum retinol), µg/dL	<20	-	-	-	<20	-	-
Vitamin D insufficiency (low serum 25 hydroxy cholecalciferol), ng/mL	<20	<20	<20	<20	<20	<20	<20

MCV, Mean corpuscular volume; VAD, Vitamin A deficiency, determined only in pregnant women and 15–23-month-old children.

means. It should be noted that because the sampling was conducted based on the one-stage cluster method, with equal-size samples in each zone, the percentages and confidence estimates shown in the tables have been calculated based on survey and weighted analysis. Since equal number of samples was selected in each zone, we used a sampling weight to adjust the weight of each observation proportional to the region's population size. The weights for each zone were published in a paper previously.²¹

Results

Table 2 shows the nutritional status of different age/sex groups based on anthropometric measurements. The findings showed that the prevalence of stunting in the 15- to 23-month-old children was significantly higher in rural areas than in urban areas (8.8% vs. 6.8%), and also it was higher in boys than in girls (9.8% vs. 6%). No significant differences were observed in regard to overweight and obesity in this group. On the other hand, the prevalence of overweight and obesity in the 6-year-old children group was significantly higher in urban areas than in rural areas

Table 2. Nutritional Status of Different Age/Gender Groups Based on Anthropometric Measurements ^a

Age Groups	Variable	Total No. % (95% CI)	Urban Areas		P Value	Rural Areas		P Value	
			Male No. % (95% CI)	Female No. % (95% CI)		Male No. % (95% CI)	Female No. % (95% CI)		
Malnutrition	15-23 months	Wasting ^b (moderate & severe) -5≤WHZ<-2	N = 4578 4.9 (4.3–5.5)	N = 1964 5.7 (4.7–6.7)	N = 1012 4.7 (3.4–6.0)	0.271	N = 833 4.0 (2.7–5.3)	N = 769 2.0 (1.0–3.0)	0.018
		Stunting ^b (moderate & severe) -6≤HAZ<-2	N = 4578 8.0 (7.2–8.8)	N = 1964 8.5 (7.3–9.7)	N = 1012 5.2 (3.8–6.6)	0.001	N = 833 10.7 (8.6–12.8)	N = 769 6.7 (4.9–8.5)	0.006
		Underweight ^b (moderate & severe) -6≤WAZ<-2	N = 4578 3.3 (2.8–3.8)	N = 1964 3.8 (3.0–4.7)	N = 1012 2.3 (1.4–3.2)	0.025	N = 833 4.0 (2.7–5.3)	N = 769 2.0 (1.0–3.0)	0.018
		At risk of Overweight 1≤BMIZ<2	N = 4578 13.6 (12.6–14.6)	N = 1964 13.4 (11.9–14.9)	N = 1012 13.4 (11.3–15.5)	0.971	N = 833 13.4 (11.1–15.7)	N = 769 15.6 (13.0–18.2)	0.219
		Overweight & Severe overweight 2≤BMIZ<5	N = 4578 5.2 (4.6–5.8)	N = 1964 5.2 (4.2–6.2)	N = 1012 4.4 (3.1–5.7)	0.373	N = 833 6.6 (4.9–8.3)	N = 769 5.2 (3.6–6.8)	0.235
	6 years	Wasting (BMI Z-score) (moderate & severe) -5≤BMIZ<-2	N = 4729 7.9 (7.1–8.7)	N = 1515 7.9 (6.5–9.3)	N = 1512 7.8 (6.5–9.2)	0.905	N = 834 6.8 (5.1–8.5)	N = 868 7.7 (5.9–9.5)	0.482
		Stunting (moderate & severe) -6≤HAZ<-2	N = 4729 4.9 (4.3–5.5)	N = 1515 4.5 (3.5–5.5)	N = 1512 4.0 (3.0–5.0)	0.477	N = 834 5.3 (3.8–6.8)	N = 868 5.3 (3.8–6.8)	0.982
		Underweight (moderate & severe) -6≤WAZ<-2	N = 4729 6.5 (5.8–7.2)	N = 1515 6.7 (5.4–8.0)	N = 1512 4.9 (3.8–6.0)	0.030	N = 834 7.8 (6.0–9.6)	N = 868 7.8 (6.0–9.6)	0.975
		At risk of Overweight 1≤BMIZ<2	N = 4729 7.9 (7.1–8.7)	N = 1515 9.5 (8.0–11.0)	N = 1512 9.1 (7.7–10.6)	0.720	N = 834 3.0 (1.8–4.2)	N = 868 6.0 (4.4–7.6)	0.003
		Overweight & Severe overweight 2≤BMIZ<5	N = 4729 5.6 (4.9–6.3)	N = 1515 8.0 (6.6–9.4)	N = 1512 5.9 (4.7–7.1)	0.023	N = 834 2.5 (1.4–3.6)	N = 868 1.6 (0.8–2.4)	0.188
Over nutrition	Adolescents ^c	Overweight 1≤BMIZ<2	N = 9387 15.9 (15.2–16.6)	N = 2943 15.3 (14.0–16.6)	N = 3065 19.0 (17.6–20.4)	0.022	N = 1655 9.0 (7.6–10.4)	N = 1724 15.5 (13.8–17.2)	0.000
		Obesity (moderate & severe) 2≤BMIZ<5	N = 9387 6.9 (6.4–7.4)	N = 2943 8.6 (7.6–9.6)	N = 3065 7.0 (6.1–7.9)	0.022	N = 1655 5.9 (4.8–7.0)	N = 1724 5.0 (4.0–6.0)	0.232
	Adults ^c	Overweight 25≤BMI<30	N = 9551 40.3 (38.2–42.4)	N = 2994 47.1 (45.3–48.9)	N = 3118 39.3 (37.6–41.0)	0.000	N = 1685 37.1 (34.8–39.4)	N = 1754 33.6 (31.4–35.8)	0.031
		Obesity BMI ≥30	N = 9551 29.2 (28.2–30.1)	N = 2994 20.4 (19.0–21.8)	N = 3118 43.2 (41.5–45.0)	0.000	N = 1685 13.3 (11.7–15.0)	N = 1754 36.3 (34.1–38.6)	0.000

^a Since the sampling method was one-stage cluster sampling, with equal-size samples in each zone, the percentages in the table have been weighted. ^b Based on the WHO 2007 classification; ^c Girls 14 to 20 years old and boys 15 to 20 years old; 5 Women 50 to 60 years old and men 45 to 60 years old. WHZ, Weight for Height Z-score; HAZ, Height for Age Z-score; WAZ, Weight for Age Z-score; BMIZ, Body Mass Index Z-score.

Table 3. Micronutrient Status of Different Age/Sex Groups ^a

Variable	Age Group	Total No. % (95% CI)	Urban Areas		P Value	Rural Areas		P Value
			Male	Female		Male	Female	
			No. % (95% CI)	No. % (95% CI)		No. % (95% CI)	No. % (95% CI)	
Anemia (low Hb)	15-23 months	N = 4563 17.1 (15.8-18.4)	N = 1572 16.2 (14.2-18.3)	N = 1370 13.0 (11.0-15.1)	0.015	N = 855 23.4 (20.3-26.5)	N = 766 21.2 (18.3-24.1)	0.253
	6 years	N = 4726 9.9 (8.9-10.9)	N = 1510 9.8 (8.0-11.6)	N = 1509 8.0 (6.5-9.5)	0.125	N = 842 12.9 (10.4-15.5)	N = 865 11.0 (8.8-13.3)	0.249
	Adolescents	N = 9377 9.0 (8.3-9.7)	N = 2924 4.7 (3.9-5.6)	N = 3031 11.4 (10.1-12.7)	0.000	N = 1676 8.1 (6.7-9.5)	N = 1746 13.7 (11.9-15.4)	0.000
	Pregnant	N = 4475 14.3 (13.1-15.5)	-	N = 2870 14.4 (12.9-15.9)	-	-	N = 1605 14.1 (12.0-16.2)	—
	Adults	N = 9543 10.3 (9.6-11.0)	N = 2979 6.4 (5.5-7.4)	N = 3121 12.3 (11.0-13.6)	0.000	N = 1673 10.3 (8.6-12.0)	N = 1770 14.0 (12.1-15.9)	0.002
IDA ³ (Low Hb, ferritin and MCV)	15-23 months	N = 416 4.2 (2.8-6.5)	N = 151 2.1 (0.7-5.9)	N = 121 2.4 (0.9-6.3)	0.870	N = 78 8.0 (3.8-16.1)	N = 66 9.8 (4.5-20.0)	0.707
	6 years	N = 425 0.5 (0.2-1.5)	N = 132 0.5 (0.1-3.7)	N = 142 0.5 (0.1-3.8)	0.985	N = 68 0.0 (0.0-5.3)	N = 83 1.2 (0.0-6.5)	1.000
	Adolescents	N = 844 2.2 (1.4-3.4)	N = 268 0.8 (0.3-2.5)	N = 269 3.2 (1.6-6.4)	0.044	N = 155 1.9 (0.6-6.1)	N = 152 3.0 (1.3-6.9)	0.510
	Pregnant	N = 400 0.6 (0.2-1.5)	-	N = 268 0.0 (0.0-1.4)	-	-	N = 149 1.7 (0.6-4.3)	—
	Adults	N = 846 3.0 (2.0-4.7)	N = 270 0.6 (0.1-2.3)	N = 266 6.0 (3.3-10.4)	0.002	N = 155 0 (0-2.4)	N = 155 5.3 (2.3-11.6)	0.007
Zinc deficiency	15-23 months	N = 4372 19.1 (17.5-20.7)	N = 1507 18.0 (15.6-20.3)	N = 1313 17.4 (15.1-19.7)	0.682	N = 819 23.4 (19.7-27.1)	N = 733 20.9 (17.2-24.7)	0.291
	6 years	N = 4577 13.6 (12.2-15.0)	N = 1453 14.9 (12.5-17.4)	N = 1470 10.8 (8.8-12.8)	0.005	N = 815 16.5 (13.4-19.6)	N = 839 14.1 (11.3-16.8)	0.182
	Adolescents	N = 9193 11.4 (10.3-12.5)	N = 2866 9.6 (8.2-11.0)	N = 2968 13.2 (11.5-15.0)	0.000	N = 1642 9.4 (7.5-11.3)	N = 1717 13.4 (11.0-15.8)	0.001
	Pregnant	N = 4395 28.0 (26.0-30.1)	-	N = 2815 28.3 (25.9-30.8)	-	-	N = 1580 27.4 (24.1-30.7))	—
Vitamin A deficiency	15-23 months	N = 4261 18.3 (16.7-19.9)	N = 1479 17.7 (15.3-20.2)	N = 1260 15.6 (13.1-18.2)	0.193	N = 805 24.3 (20.3-28.2)	N = 717 19.0 (15.7-22.2)	0.019
	Pregnant	N = 4269 14.1 (12.7-15.5)	-	N = 2739 13.6 (12.0-15.2)	-	-	N = 1530 15.1 (12.6-17.6)	-
Vitamin D deficiency	15-23 months	N = 4393 23.3 (21.7-24.9)	N = 1522 22.6 (20.2-25.1)	N = 1313 28.7 (25.7-31.6)	0.001	N = 820 15.0 (12.1-17.9)	N = 738 22.7 (18.8-26.6)	0.001
	6 years	N = 425 ^b 61.8 (56.7-66.9)	N = 131 60.2 (50.7-69.7)	N = 142 71.5 (63.3-79.8)	0.080	N = 69 40.2 (28.1-52.3)	N = 83 62.1 (50.3-73.9)	0.016
	Adolescents	N = 842 ^b 76.0 (73.0-79.0)	N = 266 60.5 (54.0-67.0)	N = 269 92.8 (89.4-96.3)	0.000	N = 154 53.7 (45.4-62.0)	N = 153 95.6 (91.4-99.7)	0.000
	Pregnant	N = 4,378 85.3 (83.9-86.8)	-	N = 2802 86.7 (85.1-88.3)	-	-	N = 1576 82.4 (79.6-85.2)	—
	Adults	N = 837 ^b 59.1 (55.3-62.9)	N = 269 59.3 (52.6-65.9)	N = 259 60.4 (53.7-67.1)	0.815	N = 156 55.1 (46.9-63.3)	N = 153 60.2 (51.6-68.7)	0.371

^a Since the sampling method was one-stage cluster sampling, with equal-size samples in each zone, the percentages in the table have been weighted.^b In a sub-sample.

(7.0% vs. 2.1%). Further analysis of the data showed that urban adolescents were significantly at a higher risk of overweight than rural adolescents (17.7% vs. 12.3%), and girls were at a higher risk than boys (18.4% vs. 13.4%). As regards adults, the prevalence of overweight and obesity was higher in urban areas, and prevalence of obesity in women was twice that in men (39.6% vs. 18.4%), with statistically significant differences.

The micronutrient status of the study groups is presented in Table 3. The lowest prevalence of anemia was found in adolescent boys (5.8%), in comparison with girls (12.1%), with a statistically significant difference. The findings also showed that the highest prevalence of IDA was found in 15- to 23-month-old children (8.8%) in rural areas, four times higher than that in urban areas (2.2%). Urban pregnant women showed the highest prevalence of zinc deficiency (28.3%) among the study groups; but no statistically significant difference was found between pregnant women in urban and rural areas. On the other hand, vitamin A deficiency in the 15- to 23-month-old children in rural areas (21.8%) was significantly higher than that in urban areas (16.8%).

Finally, the lowest prevalence of vitamin D deficiency was in 15- to 23-month-old children in rural areas (18.7%), which was significantly less than that in urban areas (25.4%). Remarkably, the prevalence of vitamin D deficiency in other study groups was more than 50%, and the highest prevalence was in pregnant women (85.3%).

Discussion

The global rates of child stunting (low height for age), underweight (low weight for age), and wasting (low weight for height) are 26.3%, 16.1%, and 8.1%, respectively, whereas the corresponding rates in Asia are 27.7%, 20%, and 10.2%.¹⁴ In our study, the prevalence rates of stunting, underweight, and wasting in 15- to 23-month-old children were 8%, 3.3%, and 4.9%, whereas in 6-year-old children they were 4.9%, 6.5%, and 7.9%, respectively. Comparison of these rates with those in the world and Asia shows that as regards the nutritional status of children, Iran is in a better condition.¹⁴ Reasons for this relatively better situation in Iran include the following: special attention to child nutrition, nutritional education of households, implementation of nutrition supportive programs throughout the country, and wide coverage of needy families. In addition, comparison of the findings of this survey with previous findings (NIMS-I),⁶ shows improvements in children's nutritional status, including reductions in the prevalence of wasting, stunting, and underweight.

As regards overweight and obesity among children, the prevalence rates in Iran (5.2% in 15- to 23-month-old children and 5.6% in 6-year-old children) are lower

than those in developing and developed countries (more than 10% in both groups).¹⁵ It is to be noted that in the Kelishadi et al study, the prevalence of overweight and obesity in children based on the CDC criteria was reported to be 3.3% and 4.1%, respectively (total rate = 7.4%).²² Despite this, it is recommended to take action to improve the situation with proper planning and management. On the other hand, the findings of this study confirm the high prevalence of overweight and obesity in both men (61.6%) and women (77.3%). Therefore, planning and implementing policies and programs for controlling overweight and obesity are essential.

The situation of iron and zinc in all age/sex groups is relatively worse, compared to Europe and the United States; and better than many other countries, including the WHO Eastern Mediterranean Region member countries.²³⁻²⁵ Available data show that the lowest prevalence of anemia in pregnant women among all WHO regions is seen in the western pacific region (24.3%), significantly higher than that in Iranian pregnant women (14.3%).²³

Finally, The prevalence rates of vitamin A deficiency (based on a retinol level of <20 µg/dL) in this survey were 18.3% and 14% for 15- to 23-month-old children and pregnant women, respectively. Based on WHO classification,¹⁴ vitamin A deficiency in these 2 study groups is moderate (≥10% to ≤20%). The prevalence of vitamin A deficiency in the region (WHO Eastern Mediterranean Region) in 2 age groups varies between 1% among school children in Oman and 32% among pregnant women in Saudi Arabia.²⁶

Comparison of the results of the current study with those of the previous one (NIMS-1)⁶ shows that prevalence of vitamin D deficiency has increased significantly not only in 15-23-month-old children (0.5% in NIMS-1 compared to 18.3% in NIMS-2), but also in all age groups. Vitamin D deficiency is highly prevalent in most regions of the world (36% in the United States, 61% in Canada, 57-64% in Europe, and 90% in Middle East countries).²⁷

The limitations of this study are explained in detail in the document prepared by the National Health Research Institute entitled, "Lessons Learnt from the Second Survey on the Micronutrient Situation in Iran".¹¹ Some limitations include the large sample size, which means that the data gathering process took a very long time; impracticality of covering all age/sex groups; length of time to transfer the blood samples to the laboratory; and finally, financial restrictions.

In conclusion, this national study, designed to investigate the micronutrient situation in Iran, was planned and implemented reasonably successfully. It owes its success to several factors including a strong, multidisciplinary

scientific committee; continuous supervision at all levels during planning and implementation phases; detailed and clear division of functions and responsibilities; optimization of financial and other resources; and strong support by the MOHME and the universities of medical sciences throughout the country.

Our findings reveal the micronutrient situation in Iran, and will help policy makers in designing and implementing effective intervention programs. We would like to make the following recommendations:

- To pay more attention to the widespread malnutrition among children, and continue the ongoing supportive and intervention programs;
- To continue and expand targeted nutrient supplementation and food fortification programs. In addition, it is essential to fortify different foods with micronutrients other than iron and folic acid, particularly vitamins A and D²⁸;
- To make the zinc supplement distribution program for children a national priority;
- To design and implement comprehensive programs and mass campaigns aiming at reducing overweight and obesity in all age groups.

Finally, based on our experience, the following recommendations are made in connection with the design and methodology in national studies:

- Detailed protocols/procedures should be prepared by the scientific committee and become available to the teams;
- In each zone, a supervisory team should be formed which performs its functions based on a uniform procedure;
- During the course of the study, especially in the fieldwork, the personnel (data collectors, etc.) should have easy access to selected persons (field supervisors, etc.) to solve their potential problems;
- Use the services of local people as much as possible; and
- Integrate and implement all national health- and nutrition-related projects in a systematic way.

We hope that this project will serve as a model for similar national large-scale studies in other countries.

Authors' Contribution

FS and KM designed the study; searches were carried out by HP, ARD, ZA, GS, AY and KKH; HP and AD wrote the first draft of the paper; KM, RH, AD, FS and MJ revised the paper. HP and AD prepared the final draft. Final approval was given to the final manuscript by all authors.

Conflict of Interest Disclosures

The authors have no conflicts of interest.

Ethical Statement

Informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, plagiarism, etc.

have been observed by the authors.

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