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Distribution of Dietary Risk Factors in Iran: National and Sub-National Burden of Disease

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Abstract

Background: Non-communicable diseases (NCDs) are one of the greatest threats to public health, and have been related to poor quality dietary patterns. This study was conducted to determine the distribution of dietary risk factors in Iran.

Methods: Cross-sectional data was gathered between April and November 2016 from 30,541 eligible adults (out of 31 050 individuals who were selected through systematic proportional to size cluster random sampling) living in urban and rural areas, using the WHO-based STEPs risk factor questionnaire. Low intakes of fruits, vegetables, dairy products, and fish, and high intakes of salty processed food (SPF), as well as daily intake of hydrogenated fat (HF) were considered as nutritional risk factors.

Results: At the national level, 82.8% (95% CI: 82.4-83.2), 57.8% (95% CI: 57.2-58.4), 80.6% (95% CI: 80.1-81) and 90.3% (95% CI: 90-90.6) of participants of all age groups had sub-optimal intakes of fruits, vegetables, dairy products and fish, respectively. Furthermore, 12.8% (95% CI: 12.4-13.1), and 29.4% (95% CI: 28.9-29.9) of respondents had high SPF intakes and HF use, respectively. At the sub-national level, the highest distribution of suboptimal intake of fruits (97.2%; 95% CI:96-98.3), vegetables (79.2%; 95% CI: 76.3-82.1) and dairy products (92.9%; 95% CI: 91-94.7) was observed in Sistan and Baluchistan. Except for Boushehr and Hormozgan, the majority of the population of other provinces consumed fish less than twice a week. Similarly, the high intake of SPF was found mostly in the population of Yazd (23.7; 95% CI: 20.2-27.2). HF consumption was the highest in North Khorasan (64.2%; 95% CI: 60.3-68.1).

Conclusion: These findings highlight the widespread distribution of dietary risk factors in Iran, which should be a priority for the people and the politicians in order to prevent NCDs.

Keywords: Chronic disease, Non-communicable disease, Nutritional status

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Introduction

Following an appropriate dietary pattern offers an effective way to reduce the burden of chronic ailments.[1,2] However, people globally have become adapted to food consumption systems which have harmful effects on their health.[3] There is strong evidence that poor diet quality (sub-optimal daily intake of fruits, vegetables, low-fat milk or dairy, and high intake of hydrogenated fat (HF) and salt, as well as low-frequency consumption of certain foods such as fish) is associated with non-communicable diseases (NCDs), namely type 2 diabetes and cardiovascular disease.[4-9] Antioxidant compounds, vitamins, minerals and fiber in fruits and vegetables,[10] in addition to calcium, vitamin D and leucine derived from dairy products[11] could explain the related beneficial relationship observed between the intake of such food items and lower risk of several

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disorders. Additionally, protein, omega 3 fatty acids, vitamin D, iodine and selenium in fish all have protective effects on metabolic profiles.[12] On the other hand, it has been well established that trans fatty acids consumed from hydrogenated oil, as well as high salt intake, are associated with cardiovascular diseases.[13,14] Interestingly, previous studies have published reports regarding the sub-optimal dietary intake figures in Iranian adults,[6] although no sub-national level data are available. Iran is also facing relatively high rates of diabetes and cardiovascular diseases,[15-18] which impose direct and indirect health costs on the society.[19,20] Considering SDGs 3.4 (Sustainable Development Goals) "to reduce the unconditional NCDs probability of death by 30% by 2030",[21] scientists, policymakers and managers at national and sub-national levels need data on risk factor distribution. Identifying various food consumption patterns as modifiable risk factors may be imperative in reducing the risk of multiple chronic illnesses and their future costs. For this reason, in the present study, the aim was to investigate the national and sub-national distribution of certain dietary risk factors by age, sex, socio-demographic, socio-economic variables and medical risk factors in Iran.

Materials and Methods

This study was a community population-based, cross-sectional survey, and was conducted by the Non-Communicable Diseases Research Center group between April and November 2016, using the modified version of WHO-based STEPS (STEPwise approach to Surveillance) risk factor questionnaire.[22] The target population included adults (male and female) aged 18 and above who lived in urban and rural areas of Iran. It was designed to collect data on 31 050 individuals who were selected through systematic proportional to size cluster random sampling; however, a final total of 30 541 eligible adults were selected to participate in the study (Figure 1). A signed informed consent form was obtained prior to initiation of the study. The study protocol has been previously published[22] and included detailed information on setting, data collection, sampling protocol, and the precise controls used for possible errors such as questioner error, non–response

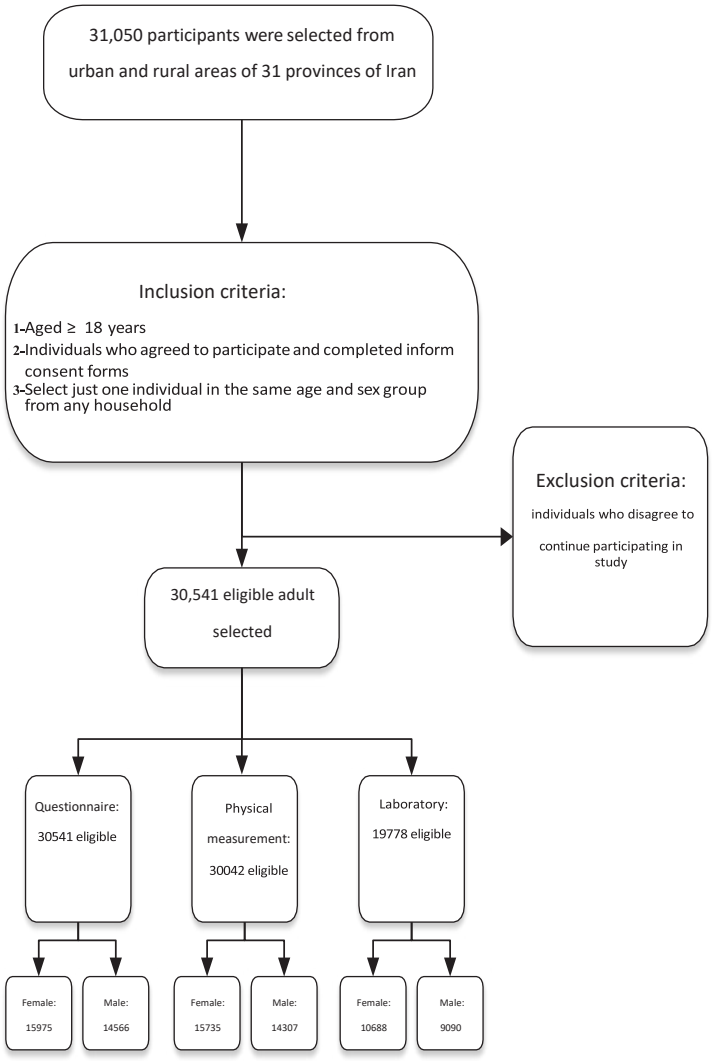

Figure 1. Study Protocol Diagram of Data Collection Process.

error and error in data entry.[22] The above-mentioned questionnaire measured the daily consumption of fruits, vegetables, milk or dairy products, type of cooking oil, and the frequency of fish and salty processed foods (SPFs) consumed per week. Current tobacco smoking status, household information, and anthropometric and biological measurements were also recorded. The validity and reliability of the questionnaire have been previously evaluated.[22]

Selection of Dietary Risk Factors

Six dietary risk factors were selected, all of which have demonstrated associations with chronic diseases. Low intake of fruits (<2 servings/day), low intake of vegetables (<3 servings/day),[23,24] low intake of dairy products (<2 servings/day),[25] low intake of fish (<twice/week),[26] high intake of SPF (>0 time/week),[27] and daily intake of HF[28] were considered as nutritional risk factors.

Physical Activity Assessment

The Global Physical Activity Questionnaire (GPAQ) was used to assess physical activity levels.[29] The intensity of physical activity was expressed using metabolic equivalents (METs)-minutes per week.

Data Analysis

The distribution of nutritional risk factors in Iran was examined generally by province, sex, age, education level, marital status, wealth index, lipid profiles, and specific NCDs such as diabetes, cardiovascular disease, and hypertension, and was reported as percentage and frequency. Additionally, missing data was controlled for by applying weightings to participants in the responding sample. Data were analyzed using the STATA statistical software version 14.0 (StataCorp. 2015. STATA Statistical Software: Release 14. College Station, TX: StataCorp LP). Survey data analysis was used to analyze the data.

Results

Distribution of Dietary Risk Factors at National Level

Of those surveyed, 15975 participants (52.3%) were women and 14566 (47.7%) were men, of whom 21,493 (70.37%) lived in urban and 9048 (29.63%) lived in rural areas. The distribution of dietary risk factors was stratified into socio-demographic characteristics, physical activity and body mass index lipid profiles, and NCDs at the national level (provided in Table 1 and Table 2).

At the national level, 82.8% (95% CI: 82.4–83.2), 57.8 % (95% CI: 57.2–58.4), 80.6% (95% CI: 80.1–81), and 90.3% (95% CI: 90–90.6) of the participants of all age groups had sub-optimal intake of fruits, vegetables, dairy products, and fish, respectively. Furthermore, 12.8% (95% CI: 12.4–13.1), and 29.4% (95% CI: 28.9–29.9) of respondents ate SPFs during the week and used hydrogenated vegetable oil and margarine to cook daily, respectively. Additionally, 83.9% (95% CI: 83.3–84.5), 57.1% (95% CI: 56.3–57.9), 82.4% (95% CI: 81.8–83) and 90.3% (95% CI:89.9–90.8) of all female and 81.6% (95% CI: 80.9–82.2), 58.7% (95% CI: 57.9–59.5), 78.7% (95% CI:78.0–79.4) and 90.2 (95% CI: 89.7–90.7) of all male participants ate less than the recommended portions of fruit, vegetables, dairy products and fish. Likewise, 11.1% (95% CI: 10.5–11.6) and 30% (95% CI: 29.3–30.7) of all females and 14.6% (95% CI: 14–15.2) and 28.7% (95% CI: 27.9–29.4) of all males consumed SPFs during the week and used hydrogenated vegetable oil and margarine to cook daily.

Furthermore, the consumption of hydrogenated vegetable oil and margarine was higher in rural populations and among people with lower education levels, lower wealth indices, as well as lower body mass index (BMI<18.5 kg/m^2 versus ≥ 25 kg/m^2). Sub-optimal intake of vegetables (<3 servings/day) was seen in two out of three underweight people. Furthermore, the similarities in the distribution of most of the nutritional risk factors were found in the patient (having diabetes and/or cardiovascular disease and/or hypertension and/or lipid disorders) and non-patient subgroups. However, the consumption of SPFs was lower in people with cardiovascular diseases and hypertension than in non-patient subgroups.

It is also worth noting that the frequency and percentage of the missing values of each nutritional risk factor was as follows: 602 (1.97) for fruits, 548 (1.79) for vegetables, 663 (2.17) for dairy products, 549 (1.80) for fish, 551 (1.81) for SPFs and 589 (1.93) for oil and fat.

Distribution of Dietary Risk Factors at Sub-National Levels

The highest distribution of dietary risk factors was observed in provinces representing 97.2% (95% CI: 96–98.3) of the population for the sub-optimal intake of fruits, 79.2% (95% CI: 76.3–82.1) for vegetables, 92.9% (95% CI: 91–94.7) for dairy products, 98.3% (95% CI: 97.3–99.3) for fish, 23.7% (95% CI: 20.2–27.2) for excess SPFs and 64.2% (95% CI: 60.3–68.1) for hydrogenated vegetable oil and margarine. While the lowest distribution of dietary risk factors was in the provinces representing 54.1% (95% CI: 49.4–58.7) of the population for sub-optimal intake of fruits, 39.3% (95% CI: 35–43.7) for vegetables, 59.8% (95% CI: 55.9–63.7) for dairy products, 43.4% (95% CI: 38.3–48.4) for fish, 5.3% (95% CI: 3.8–6.9) for excess SPFs and 9.4% (95% CI: 7.3–11.4) for hydrogenated vegetable oil and margarine (Table 3, Figures 2A-E, Figure 3).

Discussion

The distribution of six dietary risk factors was investigated at the national and sub-national level in Iran. The results at the national level demonstrated that the majority of people in age, sex and BMI specific subgroups had sub-

Table 1. Distribution of Dietary Risk Factors by Physical Activity, Body Mass Index and Sociodemographic Background of the Study Population at the National Level

		Low intake of Fruits (< 2 Servings/day)	Low intake of Vegetables (< 3 Servings/day)	Low intake of Dairy products (< 2 Servings/day)	Low intake of Fish (< Twice/week)	High intake of Salty Processed Food (> 0 time/week)	Daily intake of Oil and Fat			
							Hydrogenated Vegetable Oil and Margarine	Liquid Vegetables Oil	Animal Fat and Butter	Others
Variables		N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Age (y)	All age	24754 (82.8)	17269 (57.8)	23940 (80.6)	27163 (90.3)	3799 (12.8)	9018 (29.4)	19260 (65.3)	1059 (3.3)	615 (2)
	18–24	2253 (82.3)	1707 (62.4)	2241 (81.9)	2474 (89.7)	683 (24.5)	925 (33.3)	1731 (63.3)	60 (2.2)	33 (1.2)
	25–34	5783 (81.3)	4128 (58.4)	5649 (79.9)	6460 (90)	1200 (17.1)	2287 (31.2)	4565 (64.9)	174 (2.4)	115 (1.6)
	35–44	5230 (82.4)	3504 (55.3)	5012 (79.7)	5785 (90.5)	846 (13.2)	1879 (28.8)	4187 (66.6)	187 (2.8)	115 (1.8)
	45–54	4459 (81.5)	2987 (54.7)	4363 (80.4)	4944 (90)	626 (11.5)	1619 (28.9)	3567 (66.2)	179 (3)	107 (1.9)
	55–64	3588 (83.7)	2382 (55.6)	3449 (80.6)	3874 (89.8)	283 (6.6)	1233 (27.8)	2760 (65.4)	182 (4.1)	121 (2.8)
	65–69	1211 (85.8)	858 (60.2)	1159 (82.8)	1289 (90.9)	69 (5)	350 (24.2)	932 (67.6)	87 (5.7)	40 (2.6)
	70+	2230 (88.3)	1703 (67.3)	2067 (82.5)	2337 (92)	92 (3.7)	725 (27.9)	1518 (61.9)	190 (6.9)	84 (3.3)
Sex	Female	13146 (83.9)	8922 (57.1)	12828 (82.4)	14236 (90.3)	1714 (11.1)	4840 (30)	9990 (64.7)	549 (3.3)	321 (2)
	Male	11608 (81.6)	8347 (58.7)	11112 (78.7)	12927 (90.2)	2085 (14.6)	4178 (28.7)	9270 (65.9)	510 (3.4)	294 (2)
Place of residence	Rural area	7564 (85.3)	5476 (62.2)	6837 (78.1)	7963 (89.2)	800 (9)	3936 (43)	4417 (51.5)	408 (4.4)	99 (1.1)
	Urban area	17190 (81.8)	11793 (56.1)	17103 (81.6)	19200 (90.7)	2999 (14.3)	5082 (23.8)	14843 (70.9)	651 (2.9)	516 (2.4)
Marital status	Single	3589 (82)	2600 (59.8)	3496 (80.2)	3963 (89.9)	971 (22.1)	1266 (28.4)	2928 (67.6)	102 (2.3)	79 (1.8)
	Married	18904 (82.3)	12974 (56.5)	18265 (80.1)	20836 (90.2)	2630 (11.4)	6966 (29.6)	14724 (64.9)	857 (3.5)	469 (2)
	Divorced	456 (86.8)	327 (62.9)	451 (86.3)	484 (91.4)	64 (12.7)	167 (30)	334 (65.5)	16 (2.8)	9 (1.7)
	Widow	1674 (89.1)	1280 (68.3)	1601 (86.1)	1743 (92.2)	117 (6.4)	590 (30.4)	1153 (62.8)	82 (4.1)	53 (2.6)
Education	Illiterate	4111 (90.1)	3116 (68.5)	3721 (82.3)	4180 (91)	288 (6.5)	1974 (42.4)	2297 (51.4)	231 (4.8)	64 (1.4)
	1–6 years of education	6343 (84.9)	4428 (59.5)	6101 (82.5)	6827 (90.6)	709 (9.5)	2822 (36.8)	4210 (57.5)	321 (3.9)	139 (1.8)
	7–12 years of education	9679 (81.6)	6640 (56.1)	9455 (80.2)	10771 (90.2)	1803 (15.2)	3191 (26.4)	8197 (69.5)	283 (2.3)	225 (1.8)
	12+ years of education	4621 (77.2)	3085 (51.7)	4663 (78)	5385 (89.4)	999 (16.6)	1031 (16.6)	4556 (76.7)	224 (3.7)	187 (3)
Wealth Index	Lowest	5215 (89.9)	3921 (67.4)	4722 (82.5)	4944 (83.6)	556 (9.8)	2606 (43.7)	2888 (51.1)	248 (3.9)	81 (1.4)
	Second	5127 (88.5)	3713 (64.1)	4866 (84.5)	5355 (91.5)	689 (11.8)	2237 (37.3)	3331 (58.5)	194 (3.2)	66 (1.1)
	Middle	4807 (82.8)	3359 (58)	4721 (81.7)	5451 (93.2)	733 (12.7)	1826 (31)	3759 (65.1)	168 (2.7)	76 (1.3)
	Fourth	4696 (80.7)	3076 (53.1)	4681 (80.6)	5406 (92.7)	772 (13.3)	1421 (24.3)	4081 (70.3)	182 (3)	146 (2.4)
	Highest	4223 (72.1)	2830 (49)	4246 (72.9)	5269 (90)	945 (16.1)	825 (13.8)	4526 (78.1)	254 (4.1)	237 (4)
Current tobacco smoking	No	21206 (82.6)	14619 (57.1)	20551 (80.6)	23360 (90.4)	3037 (11.9)	7507 (28.5)	16721 (66)	952 (3.5)	536 (2)
	Yes	3518 (84.2)	2635 (62.9)	3354 (80.7)	3769 (89.4)	756 (18.1)	1507 (35.1)	2508 (60.5)	107 (2.4)	79 (1.9)
Low physical activity	No	9510 (80.9)	6391 (54.5)	9024 (77.2)	10687 (90.3)	1559 (13.4)	3553 (29.2)	7482 (64.7)	460 (3.7)	284 (2.4)
	Yes	12730 (84.5)	9111 (60.4)	12671 (84.5)	13702 (90.2)	1804 (11.9)	4205 (27.3)	10134 (67.8)	481 (3)	299 (1.9)
BMI (kg/m^2)	Underweight (BMI < 18.5)	1028 (88)	829 (71)	967 (83.9)	1046 (88.3)	198(16.9)	512 (43.8)	605 (52.4)	38 (2.7)	14 (1.1)
	Normal weight (18.5 ≤BMI< 25)	8933 (84.2)	6429 (60.7)	8568 (81.3)	9694 (90.5)	1457 (13.8)	3443 (31.4)	6642 (63.7)	362 (3.2)	188 (1.8)
	Overweight (25 ≤ BMI < 30)	8675 (81.8)	5890 (55.8)	8439 (80)	9658 (90.7)	1279 (12.1)	2913 (26.9)	7094 (67.6)	380 (3.4)	234 (2.1)
	Obesity (BMI≥30)	5373 (81.7)	3566 (54)	5231 (80.1)	5939 (89.6)	761 (11.7)	1847 (27.4)	4349 (66.9)	239 (3.4)	161 (2.3)

BMI, body mass index.
Current tobacco smoking: Those who smoked tobacco daily in the past 30 days.
Low physical activity: <600 Metabolic Equivalent (MET)-minutes/week
Wealth index: An index of the living condition such as materials used for housing construction; and types of water access and household›s ownership of car, television, electricity, gas, telephone, cell phone, internet access, heating & cooling system, kitchen, kitchen equipment, and bathroom.

Table 2. Distribution of Dietary Risk Factors by Lipid Profile and Non-communicable Diseases at the National Level

		Low intake of Fruits (< 2 Servings/day)	Low intake of Vegetables (< 3 Servings/day)	Low intake of Dairy Products (< 2 Servings/day)	Low intake of Fish (< Twice/week)	High intake of Salty Processed Food (>0 time/ week)	Daily intake of Oil and Fat			
							Hydrogenated vegetable oil and margarine	Liquid Vegetables Oil	Animal Fat and Butter	Others
Variables		**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Self-reported CVD	No	24188 (82.8)	16857 (57.8)	23392 (80.5)	26567 (90.3)	3744 (12.9)	8850 (29.5)	18819 (65.2)	1023 (3.3)	595 (2)
	Yes	498 (86.3)	374 (64.9)	490 (85.1)	529 (90.6)	41 (7.1)	155 (25.8)	375 (65.9)	30 (5.1)	20 (3.3)
Hypertension (BP ≥140/90 mm Hg) and/ or medication for hypertension	No	18045 (82.2)	12621 (57.6)	17524 (80.3)	19982 (90.4)	3078 (14.1)	6637 (29.5)	14243 (65.6)	704 (3)	422 (1.9)
	Yes	6627 (84.6)	4595 (58.8)	6329 (81.5)	7091 (89.7)	704 (9.1)	2354 (29.4)	4942 (64.3)	350 (4.1)	190 (2.3)
Diabetes (FBS ≥126 mg/ dL and/or medication for diabetes)	No	14570 (82.4)	10144 (56.9)	14038 (80.6)	16150 (90.5)	2015 (11.3)	5863 (30.6)	10785 (63.6)	730 (3.7)	374 (2.1)
	Yes	1643 (81.7)	1095 (56.1)	1584 (80.7)	1754 (88.7)	160 (8.9)	516 (24.7)	1313 (68.1)	95 (4.4)	54 (2.9)
LDL-c ≥130	No	12858 (82.1)	8946 (56.9)	12407 (80.3)	14325 (90.6)	1815 (11.4)	5209 (30.9)	9566 (63.6)	616 (3.5)	318 (2)
	Yes	3880 (83.7)	2653 (56.5)	3739 (82.4)	4151 (90.3)	432 (10.2)	1276 (25)	3017 (67.7)	220 (3.8)	130 (3.5)
Hypertriglyceridemia (TG≥ 150 mg/dL)	No	11986 (82.9)	8343 (57.6)	11481 (80.7)	13156 (90.2)	1591 (11)	4955 (31.7)	8658 (62.8)	590 (3.6)	295 (1.9)
	Yes	4330 (80.7)	2973 (54.9)	4248 (80.3)	4874 (90.6)	600 (11.1)	1452 (25.3)	3536 (67.7)	240 (4)	133 (3)
Total cholesterol (TC ≥ 170 mg/dL)	No	8999 (82.7)	6266 (57.2)	8638 (80.6)	10005 (90.9)	1280 (11.4)	3710 (31.7)	6646 (63.2)	387 (3.3)	200 (1.8)
	Yes	7309 (82)	5045 (56.5)	7081 (80.6)	8015 (89.7)	911 (10.6)	2696 (27.9)	5538 (65.2)	443 (4.3)	228 (2.6)
Total cholesterol (TC ≥ 200 mg/dL)	No	12714 (82.4)	8834 (56.9)	12238 (80.4)	14122 (90.6)	1790 (11.4)	5197 (31.2)	9381 (63.3)	606 (3.6)	307 (1.9)
	Yes	3594 (82.3)	2477 (56.7)	3481 (81.3)	3898 (89.2)	401 (9.8)	1209 (25.7)	2803 (67)	224 (4.2)	121 (3.1)

CVD, Cardiovascular Diseases; BP, Blood Pressure; FBS, Fasting Blood Sugar; LDL, Low Density Lipoprotein; TG, Triglycerides; TC, Total Cholesterol

Table 3. Distribution of Nutritional Risk Factors in 31 Provinces of Iran, Separately

Risk Factors	Low intake of Fruits (< 2 servings/day)	Low intake of Vegetables (< 3 servings/day)	Low intake of Dairy Products (< 2 servings/day)	Low intake of Fish (<Twice/Week)	High intake of Salty Processed Food (> 0 time/Week)	Daily intake of Oil and Fat			
						Hydrogenated-Vegetable Oil and Margarine	Liquid Vegetables Oil	Animal fat and Butter	Others
Provinces	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**	**Percent (95%CI)**
Markazi	77.4 (73.5-81.3)	52.1 (47.5-56.7)	74.3 (70.4-78.2)	98.1 (96.8-99.4)	15.2 (11.8-18.7)	27.8 (23.7-31.9)	61.2 (56.7-65.7)	4.4 (2.6-6.2)	6.6 (4.3-8.9)
Gilan	84.6 (82.1-87.2)	51.2 (47.8-54.7)	77.7 (74.8-80.6)	75.2 (72.2-78.2)	8.1 (6.1-10.1)	9.4 (7.3-11.4)	89.3 (87.2-91.5)	1.3 (0.5-2)	0.1 (0-0.2)
Mazandaran	70.8 (67.9-73.7)	49 (45.8-52.2)	78 (75.4-80.7)	92 (90.3-93.7)	13.5 (11.2-15.9)	19.4 (17-21.9)	75.9 (73.3-78.6)	3.7 (2.5-4.9)	1 (0.4-1.6)
East Azerbaijan	83.7 (81.6-85.8)	52.3 (49.5-55.2)	81.8 (79.5-84)	97.9 (96.4-99.4)	12.5 (10.6-14.4)	50.7 (47.8-53.6)	43.8 (40.9-46.7)	4.5 (3.4-5.7)	0.9 (0.4-1.4)
West Azerbaijan	83.9 (81.6-86.1)	51.8 (48.8-54.8)	86.4 (84.4-88.5)	97.9 (97-98.7)	9.6 (7.7-11.4)	50 (47-53.1)	41.7 (38.7-44.7)	8 (6.5-9.6)	0.2 (0-0.5)
Kermanshah	86 (83.4-88.6)	67.3 (63.8-70.7)	82.1 (79.3-85)	95.8 (94.4-97.2)	6.8 (4.9-8.8)	25.9 (22.6-29.2)	73.4 (70.1-76.7)	0.7 (0.1-1.3)	
Khuzestan	88.8 (87.2-90.4)	49.7 (47.2-52.3)	76.9 (74.8-79)	70.6 (68.3-72.9)	19.4 (17.4-21.4)	15.9 (14-17.7)	82.3 (80.4-84.3)	0.8 (0.4-1.3)	1 (0.5-1.5)
Fars	82.3 (80.4-84.2)	49.7 (47.3-52.1)	81.4 (79.6-83.3)	88.6 (87.1-90.1)	19.9 (17.9-21.9)	29 (26.8-31.3)	68.6 (66.3-70.9)	1.1 (0.5-1.6)	1.3 (0.8-1.8)
Kerman	84.6 (82.4-86.9)	75.5 (72.8-78.2)	79.4 (76.9-81.9)	94.1 (92.6-95.5)	16.2 (13.9-18.6)	36.6 (33.6-39.6)	59.5 (56.4-62.5)	1.5 (0.8-2.2)	2.4 (1.4-3.4)
Khorasan_razavi	86.3 (84.7-87.8)	61.2 (59-63.3)	80.1 (78.3-81.8)	96.5 (95.7-97.3)	13.6 (12-15.2)	41.6 (39.4-43.7)	44.7 (42.5-46.9)	10.7 (9.4-12)	3 (2.3-3.7)
Isfahan	78 (76.1-80)	61.5 (59.2-63.9)	71.6 (69.4-73.8)	94.1 (92.9-95.3)	16 (14.1-17.8)	16.8 (15-18.6)	78.9 (76.9-80.9)	2.1 (1.4-2.8)	2.1 (1.5-2.8)
Sistan & Baluchistan	97.2 (96-98.3)	79.2 (76.3-82.1)	92.9 (91-94.7)	77.9 (75-80.9)	5.3 (3.8-6.9)	57.3 (53.8-60.8)	40.4 (37-43.9)	2.1 (1.1-3.2)	0.1 (0-0.4)
Kordestan	87.3 (84.4-90.2)	73.5 (69.6-77.3)	80.2 (76.7-83.6)	98.3 (97.3-99.3)	7.4 (5.1-9.7)	38.3 (34.1-42.5)	58.8 (54.6-63.1)	1.1 (0.2-1.9)	1.8 (0.6-3)
hamedan	77.3 (73.9-80.7)	60.5 (56.6-64.4)	85.7 (82.9-88.6)	95.7 (94-97.4)	12.2 (9.5-14.9)	33.1 (29.3-36.8)	62.4 (58.6-66.2)	2 (0.8-3.2)	2.5 (1.3-3.8)
Chahar mahaal & Bakhtiari	73.9 (70.4-77.4)	52.7 (48.7-56.7)	59.8 (55.9-63.7)	93.1 (91-95.1)	9.6 (7.2-12)	34.3 (30.5-38.1)	62.7 (58.9-66.6)	2.4 (1.3-3.5)	0.6 (0-1.1)
Lorestan	82.4 (79.3-85.5)	60.5 (56.5-64.6)	73.9 (70.2-77.5)	93.6 (91.6-95.5)	11.3 (8.7-14)	41.2 (37.2-45.3)	57.2 (53.1-61.3)	0.8 (0.2-1.4)	0.8 (0.1-1.6)
Ilam	91.6 (88.8-94.4)	62.6 (57.9-67.2)	89.6 (86.7-92.6)	90.9 (88.2-93.6)	6.5 (4.1-9)	42.9 (38.2-47.7)	54.4 (49.6-59.2)	1.5 (0.3-2.7)	1.1 (0.2-2)
Kohgiluye &Boyer-Ahmad	69.5 (65.5-73.6)	39.3 (35-43.7)	67 (62.8-71.2)	86.3 (83.3-89.4)	16.1 (12.9-19.3)	37.2 (32.9-41.5)	60.7 (56.4-65.1)	2 (0.8-3.3)	
Boushehr	76.4 (72.1-80.6)	34 (29.1-38.8)	84.3 (80.6-88)	43.4 (38.3-48.4)	12.3 (8.8-15.8)	4.2 (2.2-6.2)	86.4 (82.9-89.8)		9.5 (6.5-12.4)
Zanjan	80.6 (77.7-83.5)	45.8 (42.3-49.4)	71.7 (68.5-75)	95.9 (94.5-97.2)	12.6 (10.1-15)	40.9 (37.3-44.4)	53.3 (49.7-56.9)	2.5 (1.4-3.6)	3.3 (2.1-4.6)
Semnan	75.4 (71.1-79.8)	45 (40.2-49.8)	79.8 (75.7-83.8)	96 (94.1-97.9)	17.6 (13.6-21.6)	35.1 (30.6-39.7)	49.7 (45-54.4)	12.3 (9.4-15.2)	2.9 (1.3-4.4)
Yazd	87.9 (85.4-90.5)	71.5 (68-75.1)	85.1 (82.3-87.9)	95.7 (94.1-97.4)	23.7 (20.2-27.2)	17.8 (14.7-20.9)	72 (68.5-75.5)	4.6 (3.1-6.1)	5.6 (4-7.2)
Hormozgan	91 (88.6-93.5)	72.1 (68.4-75.8)	89.4 (86.8-92.1)	44.2 (40.1-48.3)	18.3 (15.1-21.6)	19.3 (15.9-22.6)	79.7 (76.3-83.1)		1 (0.2-1.7)
Tehran	80 (78.8-81.2)	55.8 (54.3-57.3)	82 (80.8-83.2)	94.3 (93.6-95)	15.8 (14.7-17)	17.5 (16.4-18.6)	78.6 (77.4-79.8)	1.5 (1.1-1.8)	2.4 (1.9-2.8)
Ardebil	91.7 (88.8-94.6)	70.1 (65.6-74.6)	92.6 (89.9-95.4)	88.5 (85.5-91.5)	18.3 (14.4-22.3)	47.1 (42.1-52.1)	43.7 (38.8-48.6)	7.3 (4.8-9.7)	1.9 (0.5-3.3)
Qazvin	54.1 (49.4-58.7)	61.6 (57.1-66.1)	75.1 (71-79.2)	97.3 (95.9-98.7)	21.4 (17.5-25.3)	40 (35.5-44.6)	55.5 (50.9-60.1)	0.4 (0-0.9)	4.1 (2.3-5.9)
Golestan	77.9 (74.3-81.5)	54.5 (50.3-58.7)	79.1 (75.6-82.6)	93.3 (91.1-95.4)	15.7 (12.5-19)	49.4 (45.2-53.7)	48.9 (44.6-53.1)	0.8 (0.2-1.4)	0.9 (0.2-1.6)
North Khorasan	77.7 (74.2-81.2)	51.6 (47.5-55.7)	77.1 (73.6-80.6)	97.4 (96-98.9)	11.7 (8.9-14.5)	64.2 (60.3-68.1)	28.7 (25-32.4)	6 (4.2-7.8)	1.1 (0.3-1.9)
South Khorasan	82.4 (79-85.8)	56.6 (52.3-60.9)	69.2 (65.1-73.3)	95.8 (94-97.7)	14.8 (11.5-18)	36.4 (32.2-40.7)	46.7 (42.3-51.1)	12.9 (10.1-15.8)	3.9 (2.3-5.5)
Alborz	93.3 (91.5-95.1)	71.6 (68.6-74.7)	92.1 (90.3-94)	97 (95.9-98)	14.3 (11.7-16.8)	21.3 (18.5-24.1)	77 (74.1-79.8)	1 (0.4-1.6)	0.8 (0.2-1.4)

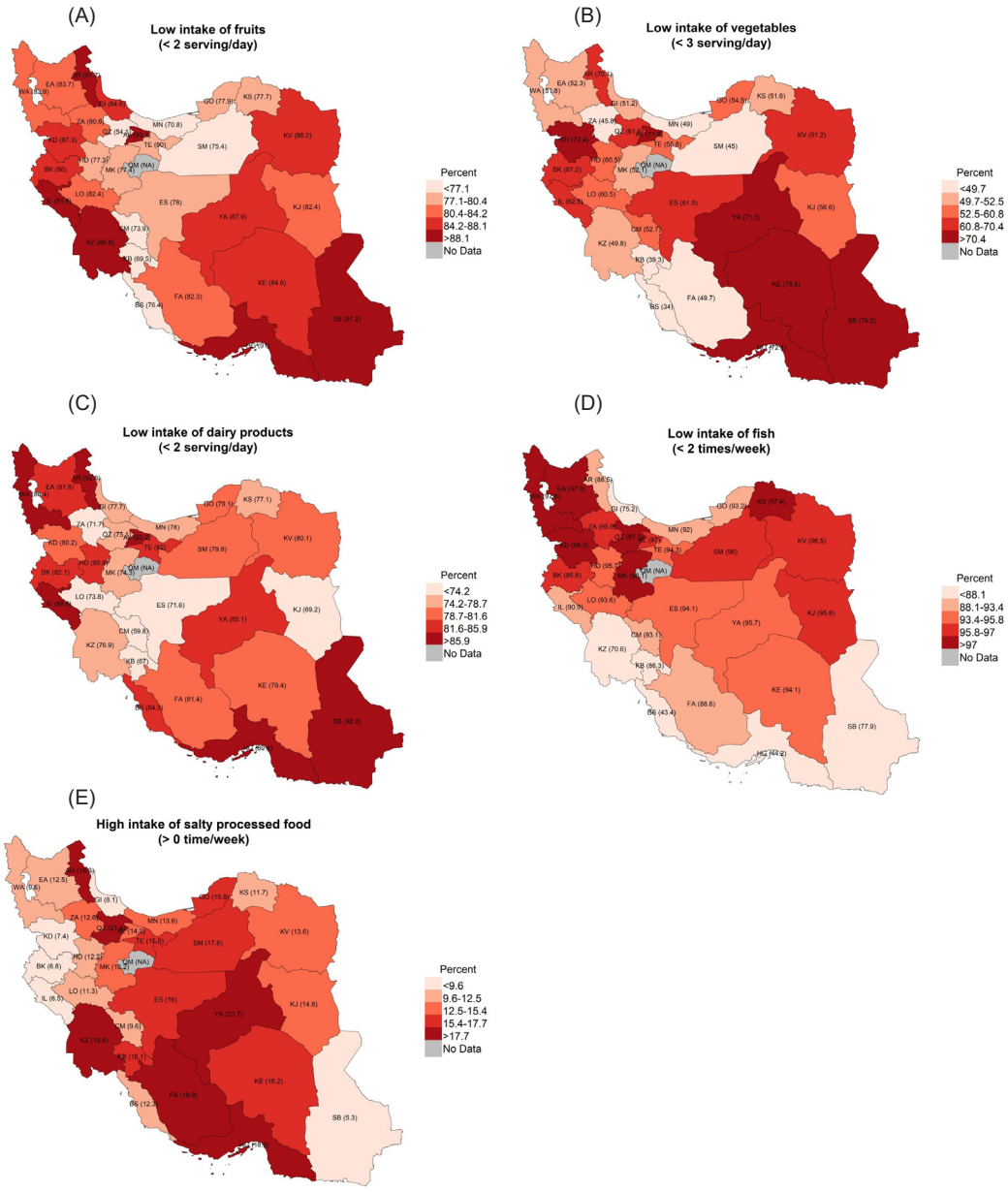

Figure 2. (A) Distribution of low fruit consumption by province, Iran. **(B)** Distribution of low vegetable consumption by province, Iran. **(C)** Distribution of low dairy product consumption by province, Iran. **(D)** Distribution of low fish consumption by province, Iran. **(E)** Distribution of high salty processed food consumption by province, Iran.

optimal intakes of fruits, vegetables, dairy products, and fish. Overall, 12.8% of all age groups ate SPFs during the week. Additionally, about one in three respondents in the age and sex subgroups used hydrogenated vegetable oil and margarine to cook. Furthermore, in the BMI subgroups, a higher percentage of underweight people (BMI <18.5 kg/m^2) had sub-optimal consumption of fruits, vegetables, and dairy products and also used SPFs and HF compared to other BMI subgroups. This may be a reflection of malnutrition in this group of people. Sub-optimal dietary intakes in Iranian adults has been previously reported in recent years.[6,30] Poor dietary quality is driven by a number of factors affecting inadequate food supply (e.g. food and agricultural policies, food marketing), as well as inadequate food utilization (e.g. education, income, nutritional knowledge, access to the supermarket, and food availability in local stores).[31] Previous studies in Iran have highlighted the impact of these factors on inappropriate food intakes.[32,33] As an example, one qualitative study conducted on Iranian men showed that lack of nutritional knowledge, taste preferences for fatty foods and fast food, the influence of friends and peers on youth eating, media advertisements, nutritional transition, women's societal roles, and lack of access to healthy food due to high prices, time limitation, lack of confidence to select healthy foods, and easy access to unhealthy foods were the main obstacles to healthy eating.[32] In turn, factors such as lack of access to healthy food (due to inadequate knowledge, the high cost

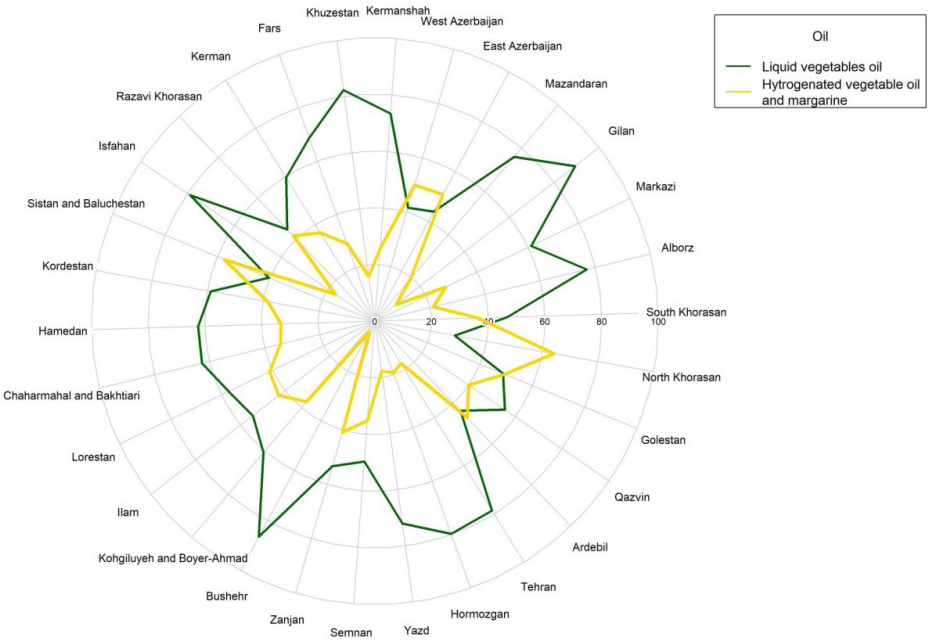

Figure 3. Distribution of oil (Liquid and Hydrogenated) and Margarine Consumption by Province, Iran.

of healthy foods, time limits for preparing healthy foods, poor restaurant hygiene, and the limited variety of healthy foods), interpersonal and cultural effects (e.g. unhealthy behavioral modeling and inappropriate prioritization), and food preferences (personal taste and the limited variety of healthy foods) have been suggested as the major barriers to healthy nutrition among Iranian females.[33]

In spite of the nutritional obstacles mentioned in Iran, there is growing policy attention on increasing fruit and vegetable consumption, limiting salt intake (through mass media education, salt reduction in food industries and restaurants), and reducing fat intake (through public education with an emphasis on reducing fat and oil consumption, as well as encouraging people to use liquid oils in cooking and governmental educational provision about the harmfulness of saturated and trans fatty acids on human health).[34] Despite these efforts, an alarming distribution of nutritional risk factors for NCDs was also shown across the provinces of Iran (based on Table 3). It seems that inequalities arising from the social, political, cultural, economic and geographical conditions in Iran[35,36] could be the main cause of the widespread distribution of nutritional risk factors in certain provinces. Multiple lines of evidence converge to support the potential role of socioeconomic status (SES) in making appropriate food choices.[37, 38] Sub-optimal intakes of fruits, vegetables and fish and also consumption of unhealthy fat have been reported among Iranian Kurdish groups with low SES.[39] Similarly, in a study conducted on Kurdish and Azeri ethnic groups in Urmia, Rezazadeh et al showed that household SES was associated with dietary patterns.[40] In addition to SES, belonging to racial and ethnic minority groups has also been considered as a factor affecting diet-related inequalities.[41] As an example, Mexican-American men living in Texas consumed poorer diets (less fruits and vegetables) compared to Latino men in California.[42] Additionally, food insecurity has been reported to be more prevalent in the Iranian Baluch population compared to Fars ethnic households.[43] It is worth noting that food insecurity also affects dietary choices.[44-46] Based on a meta-analysis conducted on the prevalence of food insecurity in Iran, 49% of households suffer from food insecurity.[47] Besides these factors, inadequate geographical access to healthy foods is another challenging issue that has been mentioned in previous studies.[48,49] Greater distances to higher quality food stores are also a major obstacle to accessing healthy foods, especially in low-income areas.[50,51] On the whole, the current study was a step toward understanding the distribution of some dietary risk factors in order to provide a basis for future studies into the deeper causes of these distributions.

The strength of this study was that the distribution of major nutritional risk factors was investigated at both national and sub-national levels. However, the current study had some limitations, as follows. Firstly, the study was designed to provide general information about nutritional risk factors at national and sub-national levels in Iran, without measuring total energy or fat intake. Secondly, the contribution of nutritional risk factors to the national burden of disease has not been investigated. Thirdly, some important dietary risk factors, such as low intake of whole grains, seafood omega-3 fatty acids, nuts, and seeds, and high intake of processed meat and sugar-sweetened beverages, were not included in this study.

In conclusion, there is a large gap between the recommendation and consumption of fruits, vegetables,

dairy products, fish, SPFs, and sources rich in trans-fatty acids (hydrogenated vegetable oil and margarine) among the adult population of Iran. Several individual-, community- and national-level factors can explain this gap, which should be considered as a priority for politicians to prevent NCDs.

Authors' Contribution

General designing of the paper: FF, NZ; Designing methods: FF, NZ, MY, FP, SSM; Analysis: MY, SSM, SHD; Writing primary draft: NZ, MS, NSH, FP; Manuscript revision: FF, RH, MM, HZ, MJH; Administrative process: ADM, AK, NH, AP. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interest.

Ethical Statement

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures were approved by the Ethical Committee of National Institute for Medical Research Development (NIMAD) (ID:IR.NIMAD.REC.1394.032). Additionally, ethical issues including plagiarism, authorship, privacy, conflicts of interest, informed consent, data fabrication, double submission etc have been completely observed by the researchers and authors.

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