Mortality Attributable to Excess Body Mass Index in Iran: Implementation of the Comparative Risk Assessment Methodology

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ABSTRACT

Background: The prevalence of obesity continues to rise worldwide with alarming rates in most of the world countries. Our aim was to compare the mortality of fatal disease attributable to excess body mass index (BMI) in Iran in 2005 and 2011.

Methods: Using standards implementation comparative risk assessment methodology, we estimated mortality attributable to excess BMI in Iranian adults of 25–65 years old, at the national and sub-national levels for 9 attributable outcomes including; ischemic heart diseases (IHDs), stroke, hypertensive heart diseases, diabetes mellitus (DM), colon cancer, cancer of the body of the uterus, breast cancer, kidney cancer, and pancreatic cancer.

Results: In 2011, in adults of 25–65 years old, at the national level, excess BMI was responsible for 39.5% of total deaths that were attributed to 9 BMI paired outcomes. From them, 55.0% were males. The highest mortality was attributed to IHD (55.7%) which was followed by stroke (19.3%), and DM (12.0%). Based on the population attributed fractions estimations of 2011, except for colon cancer, the remaining 6 common outcomes were higher for women than men.

Conclusions: Despite the priority of the problem, there is currently no comprehensive program to prevention or control obesity in Iran. The present results show a growing need to comprehensive implications for national and sub-national health policies and interventional programs in Iran.

Keywords: Body mass index, burden, mortality, obesity, population attributed fraction

INTRODUCTION

The prevalence of obesity continues to rise worldwide with alarming rates in most of the world countries.[1,2] Evidence shows that obesity is a major cause of death in both developed and developing countries.[3,4] These increases over the last several decades as well as growing

reports of co-morbidities and mortality, has led to considerable interest in estimating and evaluating obesity possible health effects'.[5,6]

Most of recent global, national, and sub-national studies approved the body-mass index (BMI), as a reasonably good measure of general adiposity.[7-9] The increasing trends of BMI are widely associated with adverse effects on health trends.[9-12]

Raised BMI is an established risk factor for several causes of death, including ischemic heart disease (IHD), stroke, hypertensive diseases (hypertension [HTN]), diabetes mellitus (DM), and cancers.[4,5,10] It has been suggested that obesity is second only to smoking as a preventable cause of death accounting for as many as 300,000 globally deaths per year as a public health threat.[5,13,14]

In Iran, studies emphasized on noticeable increase in overweight and obesity prevalence for all ages and both sexes.[3,9,15] Considering the higher population of young people, ignoring the priority of the problem and lack of effective policies, burden of obesity in the near future, become the irreparable concern of health.[3,14]

To designing the controlling programs and allocating resources, a determinant question is the role of risk factors on mortality.[16] Population attributed fraction (PAF) is one of the important parameters of measuring health effect of risk factors and evaluating their potential impact of preventive programs in community level.[17] Evidence reveal that for obesity, PAFs may be best-considered indicators of attributed outcomes effects.[18] It also provide some information on the consequences of interventions.[19]

There are few evidence that estimated the mortality effects of BMI in Iran. Although some of them are conducted based on exact methodological approaches, there are limited to some national and socioeconomic-geographical regions estimations.[10,20] The previous related study was based on data that were not nationally representative. Moreover, it estimated the effects of BMI defined clinical thresholds, even though epidemiologic studies reveal that the association between BMI and its attributed outcomes continues below such thresholds.[9,10,18] In this estimations, incompleteness of the vital registration system and misclassification of cause of death, and uncertainty of the estimated number of deaths were other problems.[21]

Considering above, using the representative national and provincial data, benefiting from the most comprehensive of mortality data, and following the global burden of diseases (GBD) studies approach, the aim of this study was to estimate and compare the mortality attributable to excess BMI in Iranian population.

METHODS

Using the PAF, we estimated mortality attributable to excess BMI in Iranian adults of 25–65 years old, at the national and sub-national levels. PAF provides the fraction by which the occurrence of an interesting disease/risk factor would be reduced under a sustained alternative, more favorable, exposure distribution.[11,16,22]

To assess the full effects of BMI distribution as an "exposure," following the comparative risk assessment (CRA) project, we used the counterfactual of BMI distribution with a mean of 21 kg/m^2 and a standard deviation (SD) of 1 kg/m^2.[1,20,23] In summary, to calculate deaths attributable to excess BMI, the total number of deaths is multiplied by the PAF which may be interpreted as the proportion of deaths attributable to excess BMI:

$$PAF = \frac{\text{Attributable population risk}}{\text{Total population risk}}$$

$$= \frac{\text{Factual population risk} - \text{Counterfactual population risk}}{\text{Factual population risk}}$$

These aggregates of population risk can be thought of as proportional to "areas under the curve," made up, in a discrete approximation, of small strata of proportions exposed at a given level times the risk at that level, so that:

$$PAF = \frac{\sum P_1 RR_i - \sum P_2 RR_i - 1}{\sum P_1 RR_i}$$

where P_1 refers to the factual (or predicted) and P_2 to the counterfactual BMI distribution. In the CRA method, the relative risks (RRs) for all positions on the counterfactual exposure distribution are set to 1 and given that the sum of the probability distribution is 1, the formula simplifies to:

$$PAF = \frac{\sum P_1 RR_i - 1}{\sum P_1 RR_i}$$

Data sources
- For BMI values, we used data from the Noncommunicable Disease Surveillance Survey (NCDSS) which followed STEP wise approach of WHO guidelines. Surveys' data are available for 6 years (2005–2009, 2011). This is the only complete data source that contains the information of BMI, separately by age and sex at provincial and district levels for adults of 25–65 years old.[10] After refine processing, we had 3182 point of data that was representative of 169,347 population

- The effect size of excess BMI for outcomes' specific mortality was included by RR. Aim to that we used recent relevant meta-analyses of international cohorts evidence[20]
- Mortality data are from Death Registration System (DRS) that is currently collected by Ministry of Health and Medical Education (MOHME) and National Organization for Civil Registration (NOCR). Because of delayed registration and inaccurate recording of cause of deaths in NOCR data, only MOHME data were employed in this study. The MOHME DRSs collected by Deputy of Research and Technology from 1996 to 2001 and by Deputy of Public Health from 2001 to 2010. This system registers the death by age, sex, cause of death, date of death, place of residence, place of death, and other information[24,25]
- Population data are from the censuses which are systematically iterated every 10 years, except periods. Accordingly, seven censuses have been conducted so far (1986–2011, Province, District).[24]

$$(x + a)^n = \frac{dy}{dx} P_1 RR_{BMI} - P_2 RR_{BMI} - 1$$

Estimation of attributable mortality

We considered 9 attributable outcomes of excess BMI for loss of life, based on deaths assigned codes of ICD-10. These include: IHDs, stroke, hypertensive heart disease HTN, DM, colon cancer, cancer of the body of the uterus (only in females), breast cancer (only in ≥45-year-old females), kidney cancer, and pancreatic cancer. These losses are expressed in the metrics of deaths.

Using simulation methods, combining the uncertainties of BMI distributions, RRs, and outcome-specific mortality, we estimated the corresponding uncertainty intervals of deaths estimations. By assuming an SD of 20% of the estimated completeness, the uncertainty of incompleteness of death registration considered as the variance of the estimated level of completeness.[20] Computation were based on 1000 draws for each mentioned parameter in repeated calculations and reported 95% uncertainty intervals based on the distributions of 1000 estimated attributable deaths. The uncertainty of the basic assumptions of the extrapolation of age patterns and RRs across population is not considered in this analysis.[26] These analyses were performed by Stata software (version 11) and R software (version 3.0.2).

RESULTS

In 2011, in adults of 25–65 years old, at the national level, excess BMI was responsible for 39.5% (10,210 deaths) of total 25,860 deaths that were attributed to 9 BMI paired outcomes. Of them, 5619 (55.0%) were males. Considering BMI outcomes, the highest mortality was attributed to IHD (55.7%) which was followed by stroke (19.3%), and DM (12.0%). Except for IHD and colon cancer, attributed death to all of other common outcomes, considerably, were higher in females. Figure 1 shows the national attributed deaths (and uncertainty intervals) trends of excess BMI, by outcomes, sex, and age groups.

In Figure 2, the provincial patterns of excess BMI attributed death have been presented by outcomes and sex, in 2005 and 2011. Based on the provincial patterns, the most incremental changes happened in Central and Western provinces. These increases are more impressive in females than males and in IHD, HTN, and cancers than other outcomes.

Figure 3 shows the provincial excess BMI attributed deaths by outcomes, sex, and age groups, in 2011. For all of the outcomes, the highest death was, mostly, happened in 55–59 and 60–64 age groups. Isfahan, Mazandaran, and Khuzestan were the first leading province for IHD attributed death in males. For females, these orders changed to Khuzestan, Mazandaran, and Isfahan. The highest deaths for stroke were aligned, respectively, to Tehran, Isfahan, and Khuzestan in males and Tehran, Khuzestan, and East Azerbaijan in females. Khorasan Razavi and Isfahan were the first two provinces with the highest HTN death, for both sexes, which were followed by Tehran in males and East Azerbaijan in females. At the same way, Khuseatan and Isfahan were two top ranked of highest DM death that were followed by Razavi Khorasan in males and Mazandaran in females. For cancers mortality: Tehran, Isfahan, and Khuzestan, unanimously, were three first leading provinces in both sexes. It is mentionable that in females, West Azerbaijan was together with Khuzestan stand at the third ranks.

Given the comparative results at national levels, between 2005 and 2011, obtained PAFs, were increased for all 9 excess BMI attributed outcomes'. Considering the age-specific changes, these increasing detected in most of adult age groups. Except for colon cancer, the remaining 6 common outcomes of IHD, stroke, HTN, DM, kidney cancer, and pancreatic cancer, were higher for women than men. It is noteworthy that colon cancer showed higher attributed risk in all of age groups of males, compared with females. Figure 4 compares the national PAFs of all 9 excess BMI attributed outcomes, by sex, by age groups, between 2005 and 2011. Based on the categorical references, for breast cancer, data were estimated only for over 45 age groups.

In Tables 1 and 2, respectively, for males and females, the PAFs of three leading cause of excess BMI attributed
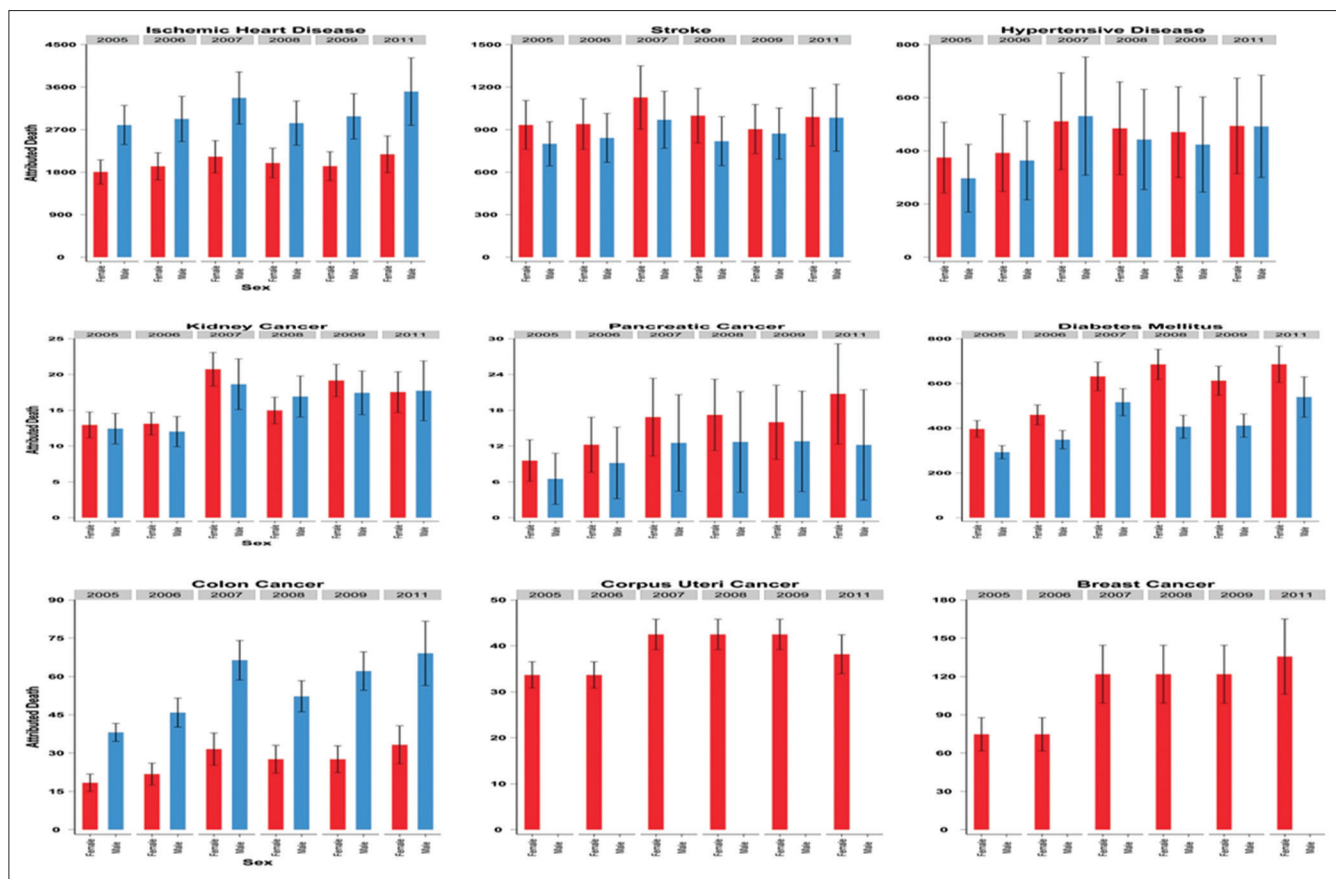
Figure 1: The national attributed deaths (and uncertainty intervals) trends of excess body mass index, by outcomes, sex, and age groups (2005–2011)

death, IHD, stroke, HTN, and DM compared between different age groups at national and provincial levels. In each province, the lowest and highest levels have been showed, respectively, in green and red.

Overlay at national level, in males, the highest PAF for IHD, stroke, HTN, and DM were, respectively, detected in 35–39, 35–39, and 40–44, and 45–49 age groups. At the same way, for all three outcomes, the lowest values were related to 60–64 age groups.

At provincial levels, the highest PAFs for IHD were in Kohgiluyeh and Boyer-Ahmad and Mazandaran (0.74), for stroke, in Ardabil and Kohgiluyeh and Boyer-Ahmad (0.69), for HTN, in Ardabil and Kohgiluyeh and Boyer-Ahmad (0.65), and for DM, in Mazandaran (0.87) provinces.

In females, the highest national PAF for IHD (0.58), stroke (0.54), and HTN (0.60) was, respectively, detected in 40–44 age groups. Two age groups of 35–39 and 50–54 also had the highest value for PAF of stroke (0.54). The highest national PAF for DM (0.54) was detected in 50–54 age groups. Except for all other three outcomes, with lowest PAFs of 25–29 age groups, for DM the lowest

value was found in 60–64 age groups. At provincial levels, the highest PAFs for IHD were in Markazi and Zanjan (0.77), for stroke, Zanjan (0.74), for HTN in Markazi (0.79), and for DM Ardebil (0.90) provinces.

DISCUSSION

Using PAF, widely regarded as an estimate of the proportion of disease/risk factor(s) burden,[19] we estimate the mortality attributable to excess BMI in Iranian population. We followed the methodology which was used in previous researches.[10,20] In 2011, in adults of 25–65 years old, at national level, excess BMI was responsible for 39.5% (10,210 deaths) of total 25,860 deaths that were attributed to 9 BMI paired outcomes, of them 5619 (55.0%) were males. Considering BMI outcomes, the highest mortality was attributed to IHD (55.7%) which was followed by stroke (19.3%), and DM (12.0%).

Based on the PAFs estimations in 2011, except for colon cancer, the remaining 6 common outcomes of IHD, stroke, HTN, DM, kidney cancer, and pancreatic cancer, were higher for women than men.
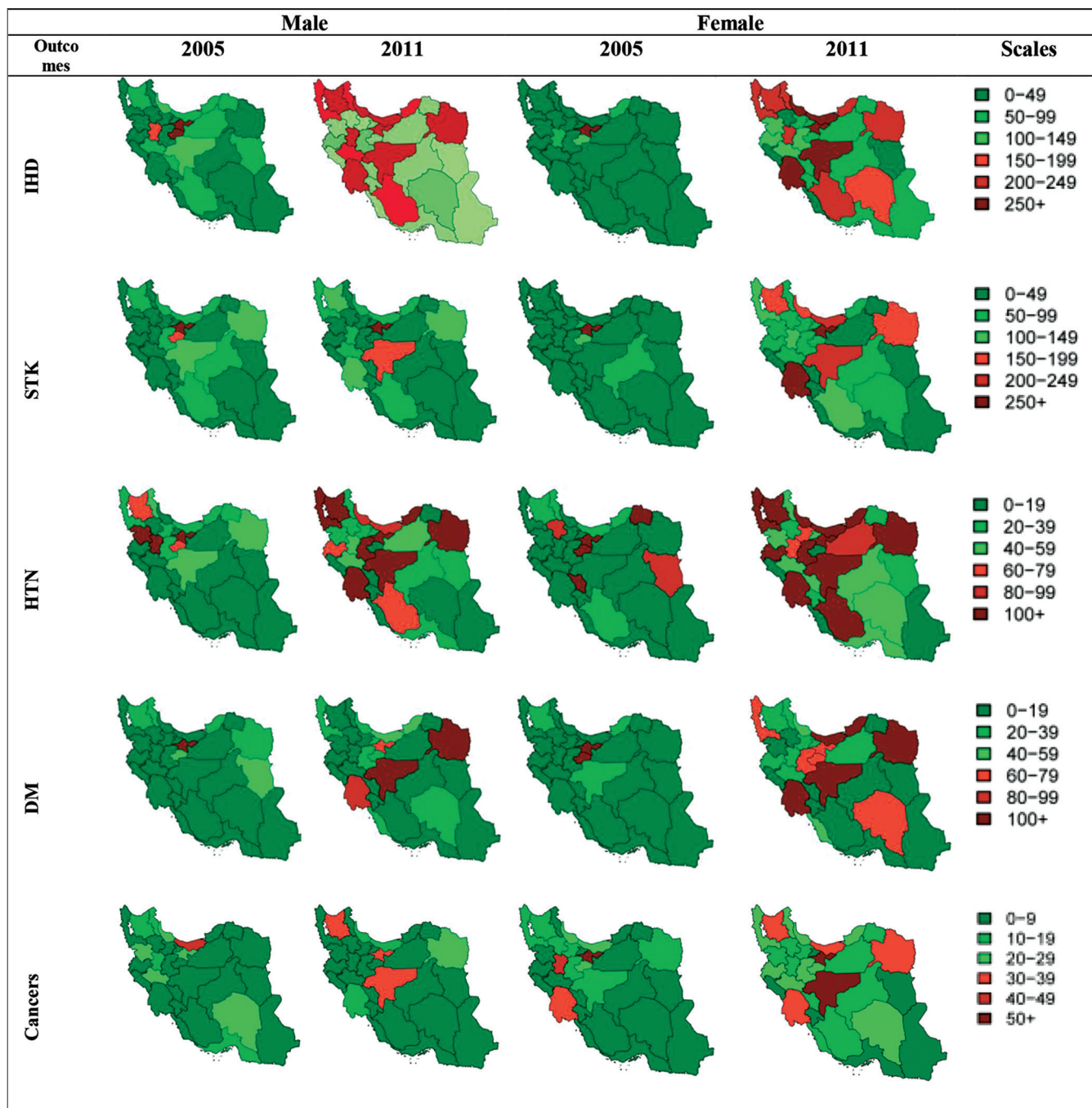
Figure 2: The provincial patterns of excess body mass index attributed deaths by outcomes and sex, in 2005 and 2011

There is a considerable variety among studies regarding the methods and results for PAF calculation and the selection of appropriate counterfactuals.[18] In Iran, studies are limited, and there is no previous study on provincial estimation of PAFs or excess BMI mortality (10, 20, 28). Based on the results of previous study, in 2010, excess BMI was the third cause of cardiovascular disease (CVD) deaths in women, which was responsible for about 17,000 (14,000–20,000) national deaths.[10] For men, excess BMI as the fourth cause of CVD death led to 13,000 (11,000–15,000) deaths. Comparing four socioeconomic-geographical regions of the country, the lowest BMI attributed death was estimated for both males and females in South-East region 700 (600–800). The highest estimations were in the Western region, 5400 (4600–6200) and 7100 (5900–8300), respectively, for men and women. Considering the differences, the highest attributable mortality rate was 1.2–2.2 times that of the lowest.[10]
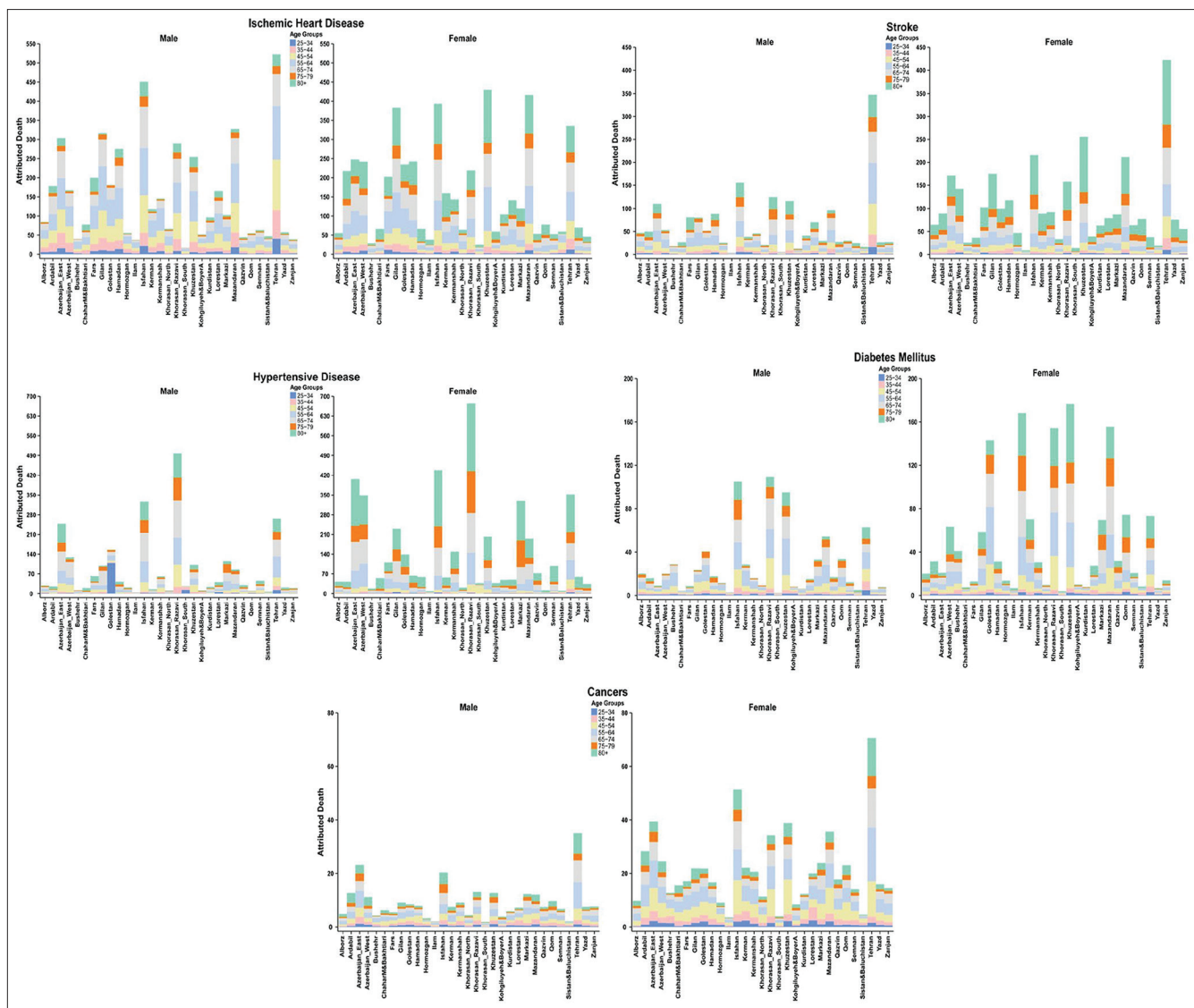
Figure 3: The provincial excess body mass index attributed deaths by outcomes, sex, and age groups, in 2011

Our analysis extends the relevant evidence on national and sub-national CRA analyses.[10] Considering the previous studies in Iran, the present study has several achievements. This study is the first analysis of national and sub-national estimation of mortality attributable to excess BMI in Iranian population. Benefited from GBD studies approaches, using NCDSS data, we estimate the trends of attributed deaths and their correspond uncertainties, at the national and provincial levels from 2005 to 2011, by sex and age. It is northworthy that for the first time, we had access to most comprehensive data of mortality, at the national and sub-national levels. Considering the geographical changes in provincial divisions, dealing with misalignments problems, for a better comparison, our results estimate for 31 provinces.

We also faced with many limitations. First of all, there is a potential source of bias in methods when estimations used with RRs adjusted for confounding. Obesity is correlated with other exposures or unobserved factors in the population resulting in under- (when there is a positive correlation) or over- (negative correlation) estimation of the true PAF when used with adjusted RRs. We did not have data on dietary factors, physical activity, alcohol and drug use, or other metabolic risk factors. Moreover, causes other than those considered in our study may be positively associated with excess adiposity, which biases our estimates of attributable deaths downward. As another important limitations, our exposure data did not include people 65 years of age and older, which limited the scope of our analysis. It is mentionable that to estimate the number of deaths, we used recorded death data that did not consider incompleteness. In our future plan, our death estimations would be presented dealing with these limitations.[24,27]
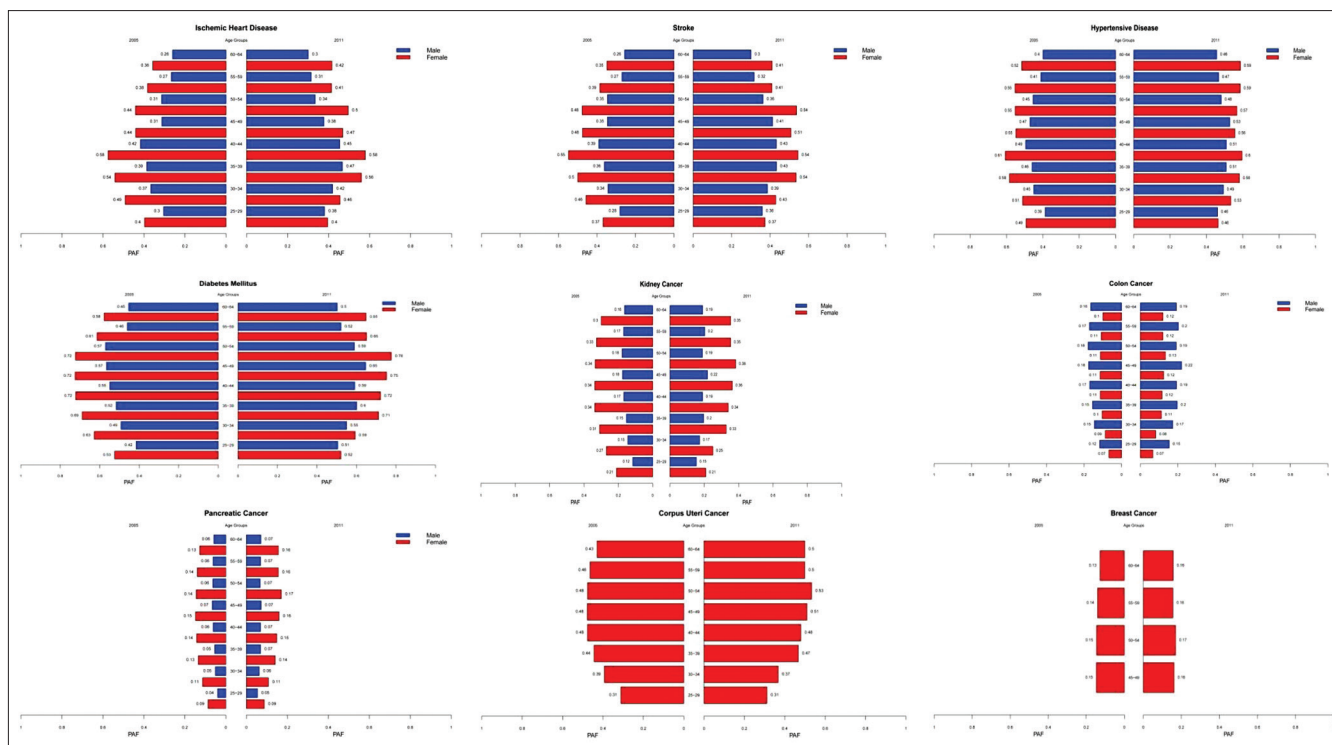
Figure 4: The national PAFs of excess body mass index attributed outcomes, by sex, by age groups, in 2005 and 2011

Considering all of strengths and limitations, under the National Plan of Comprehensive NASBOD project,[28] using most updated modern methodologies and regarding more wide age ranges from 25 up to more than 80 years old,[27,29,30] we are going to estimate trends and burden of BMI, obesity, and overweight, at the national and sub-national levels, for adult Iranian population from 1990 to 2014.[31]

The present results show a growing need to comprehensive implications for the national and sub-national health policies and interventional programs in Iran. Despite the priority of the problem, there is currently no comprehensive program to prevention or control obesity in Iran. These considerations should be followed at the shortest possible time through the primary health care system or community-based lifestyle and dietary interventions.[4,32,33]

Suggested strategies including family-oriented interventions on healthy eating and physical activity by a dietitian, integrating obesity prevention and control programs in the primary health care system, and identifying, implementing, and evaluating of applied interventions are particularly solutions emphasized for dealing with ascending trends of overweight and obesity in Iran and worldwide.[13,14,33-35]

In these regards, evidence-based documents emphasize specifically on "solutions and strategies that could be implemented at the level of the individual." These plans should be designed and followed through a comprehensive by collective societal actions to change the food and activity environments.[35-37] We must also help to bridge the division between individual and collective responsibility for successful long-term weight loss maintenance.[13,36,38]

CONCLUSIONS

According to our knowledge, this is the first analysis of the national and sub-national estimation of mortality attributable to excess BMI in Iranian population. Excess BMI was responsible for 39.5% (10,210 deaths) of total attributed deaths to 9 BMI paired outcomes. Considering the priority of the problem, presented estimations provide practical information for health policies and programs. Results also could be used for future complementary analyses.

ACKNOWLEDGEMENTS

Table 1: The national and provincial population attributable fractions of excess BMI on IHD, stroke, HTN, and DM in Iranian males by age groups in 2011

The population attributable fractions of excess BMI

Province	IHD								Stroke								HTN								DM							
	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
National	0.38	0.42	0.47	0.45	0.38	0.34	0.31	0.30	0.36	0.39	0.43	0.43	0.41	0.36	0.32	0.32	0.46	0.49	0.51	0.51	0.53	0.48	0.47	0.46	0.51	0.55	0.60	0.59	0.65	0.59	0.52	0.50
Alborz	0.43	0.53	0.47	0.67			0.40	0.40	0.40	0.49	0.44	0.64			0.39	0.40	0.49	0.55	0.52	0.63	0.47		0.57	0.57	0.56	0.67	0.61	0.80			0.63	0.63
Ardabil	0.39	0.73		0.31	0.35		0.27		0.37	0.69		0.29	0.38		0.27		0.46	0.65		0.36	0.47		0.41		0.52	0.86				0.40	0.61	0.46
Azerbaijan-East	0.35	0.39	0.46	0.57	0.43	0.35	0.32	0.29	0.33	0.36	0.43	0.53	0.46	0.39	0.32	0.29	0.47	0.46	0.50	0.56	0.53	0.46	0.46	0.44	0.48	0.51	0.60	0.71	0.71	0.61	0.52	0.49
Azerbaijan-West	0.24	0.33	0.47	0.62	0.36		0.38	0.32	0.22	0.32	0.45	0.58	0.39		0.37	0.32	0.34	0.43	0.53	0.61	0.47		0.54	0.48	0.33	0.45	0.61	0.76	0.61		0.60	0.54
Bushehr	0.50	0.44	0.49	0.43	0.51	0.22	0.31		0.47	0.41	0.46	0.39	0.55	0.24	0.31		0.53	0.48	0.52	0.48	0.57	0.34	0.45		0.64	0.57	0.62	0.55	0.79	0.41	0.51	
ChaharMahal and Bakhtiari	0.35	0.09	0.55				0.40	0.36	0.32	0.09	0.52				0.40	0.36	0.43	0.14	0.57				0.57	0.52	0.47	0.13	0.69				0.64	0.58
Fars	0.19	0.43	0.29	0.49	0.14	0.29	0.25	0.29	0.17	0.40	0.26	0.45	0.16	0.32	0.25	0.29	0.28	0.50	0.37	0.53	0.25	0.43	0.38	0.44	0.26	0.56	0.39	0.62	0.28	0.54	0.43	0.49
Gilan	0.40	0.45	0.47	0.32	0.30	0.49	0.34	0.30	0.37	0.42	0.45	0.30	0.34		0.34	0.30	0.50	0.49	0.54	0.37	0.45	0.51	0.51	0.45	0.53	0.58	0.61	0.42	0.55		0.57	0.50
Golestan	0.51	0.41	0.60	0.38	0.46		0.44	0.40	0.48	0.38	0.57	0.36	0.50	0.52	0.44	0.40	0.54	0.47	0.59	0.46	0.56	0.56	0.62	0.58	0.64	0.54	0.74	0.51	0.73	0.77	0.68	0.64
Hamadan		0.40	0.40			0.25	0.19	0.32			0.36			0.28		0.33	0.53		0.43			0.40	0.29	0.48	0.63		0.50			0.47	0.34	0.54
Hormozgan	0.43	0.21	0.45	0.17		0.38	0.26	0.25	0.40	0.19	0.41			0.41	0.26	0.25	0.50	0.29	0.51			0.50	0.41	0.38	0.56	0.28	0.58			0.65	0.45	0.44
Ilam	0.28	0.46		0.40			0.29	0.18	0.25	0.43					0.29	0.18	0.36	0.52		0.47	0.44		0.42	0.28	0.37	0.59				0.54	0.47	0.32
Isfahan	0.23	0.43	0.58	0.53	0.31	0.35	0.36	0.33	0.21	0.41	0.54	0.50	0.34	0.38	0.35	0.33	0.32	0.52	0.59			0.48	0.52	0.49	0.31	0.57	0.72	0.52	0.54	0.61	0.58	0.55
Kerman	0.30	0.27		0.17		0.08	0.28	0.21	0.28	0.24	0.55	0.16		0.10	0.28	0.21	0.40	0.36		0.25		0.17	0.43	0.32	0.41	0.36		0.23		0.18	0.47	0.36
Kermanshah	0.46	0.47	0.31	0.40		0.40	0.29	0.25	0.43	0.42	0.29	0.36		0.44	0.29	0.25	0.52	0.50	0.40	0.47		0.53	0.44	0.39	0.59	0.59	0.42	0.52		0.68	0.50	0.44
Khorasan_North	0.18	0.47	0.29			0.28	0.34		0.17	0.44	0.27			0.31	0.33		0.26	0.54	0.37			0.38	0.50		0.25	0.61	0.39			0.49	0.55	
Khorasan_Razavi	0.31	0.43	0.28	0.53	0.38	0.39	0.31	0.33	0.29	0.40	0.25	0.50	0.41	0.42	0.31	0.33	0.41	0.49	0.38	0.55	0.51	0.53	0.46	0.49	0.42	0.56	0.37	0.67	0.65	0.66	0.52	0.55
Khorasan_South	0.39	0.35	0.59					0.14	0.36	0.33	0.55					0.14	0.45	0.43	0.60					0.24	0.51	0.47	0.73					0.27
Khuzestan	0.38	0.31	0.49	0.32	0.29	0.34	0.30	0.34	0.35		0.46	0.30	0.32	0.37		0.34	0.46	0.40	0.54	0.42	0.43	0.50	0.46	0.51	0.50	0.42	0.63	0.44	0.53	0.60	0.53	0.57
Kohgiluyeh and Boyer-Ahmad	0.36	0.34		0.74	0.50	0.30	0.30		0.33	0.31	0.27	0.69	0.53	0.33			0.43	0.44		0.65	0.58	0.44	0.46		0.48	0.45		0.86	0.78	0.54	0.51	
Kurdistan	0.44		0.49					0.28	0.41		0.47	0.46				0.27	0.50							0.41	0.57							0.47
Lorestan					0.52	0.26	0.17						0.56	0.29	0.17						0.59	0.47	0.26	0.27			0.63		0.81	0.49	0.31	
Markazi	0.49	0.53	0.46	0.47	0.33	0.42	0.29	0.34	0.45	0.51	0.44	0.44	0.37	0.46		0.34	0.45	0.55	0.51	0.48	0.47	0.55	0.45	0.49	0.63	0.66	0.60	0.60	0.59	0.70	0.50	0.55
Mazandaran	0.61	0.56	0.74	0.48	0.36	0.32	0.27	0.34	0.58	0.52	0.70	0.44	0.40	0.35	0.27	0.33	0.61	0.58	0.63	0.53	0.51	0.47	0.41	0.48	0.76	0.70	0.87	0.61	0.63	0.57	0.46	0.54
Qazvin	0.18	0.47	0.29	0.28		0.34	0.44	0.51	0.17	0.44	0.27	0.31		0.33	0.25	0.47	0.26	0.54	0.37	0.38		0.50	0.35	0.53	0.25	0.61	0.39	0.49	0.55	0.37	0.64	
Qom	0.38		0.60		0.36	0.41			0.36		0.57		0.40	0.44	0.44		0.46		0.58		0.48	0.52	0.61		0.51	0.65	0.75	0.63	0.63	0.69	0.68	
Semnan	0.55	0.52	0.31	0.49		0.42	0.40	0.34	0.53	0.48	0.28	0.46		0.46	0.39	0.35	0.55	0.56	0.38	0.54		0.55	0.56	0.51	0.68	0.37	0.40	0.63		0.70	0.63	0.57
Sistan and Baluchistan	0.32	0.27	0.23	0.07			0.10	0.20	0.30	0.25	0.22	0.07			0.10	0.20	0.40	0.35	0.29	0.12			0.16	0.32	0.43	0.31	0.31	0.10			0.18	0.36
Tehran	0.45	0.47	0.53	0.49	0.35	0.40	0.37	0.35	0.42	0.44	0.49	0.45	0.38	0.44	0.36	0.35	0.52	0.51	0.55	0.53	0.47	0.52	0.53	0.51	0.58	0.61	0.67	0.63	0.61	0.68	0.60	0.58
Yazd	0.38	0.30	0.48	0.48	0.38	0.22	0.32	0.31	0.35	0.28	0.46	0.45	0.42	0.24	0.32	0.31	0.44	0.38	0.53	0.52	0.51	0.35	0.48	0.47	0.50	0.40	0.62	0.61	0.65	0.42	0.53	0.52
Zanjan	0.17	0.22		0.46			0.33	0.20	0.16	0.21		0.43			0.33	0.19	0.23	0.32		0.51			0.49	0.31	0.23	0.30		0.60			0.54	0.35

BMI=Body mass index, IHD=Ischemic heart disease, HTN=Hypertension, DM=Diabetes mellitus

Table 2: The national and provincial population attributable fractions of excess BMI on IHD, stroke, HTN, and DM in Iranian females by age groups in 2011

The population attributable fractions of excess BMI

Provinces	IHD								Stroke								HTN								DM							
	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
National	0.40	0.46	0.56	0.58	0.47	0.50	0.41	0.42	0.37	0.43	0.54	0.54	0.51	0.54	0.41	0.42	0.46	0.53	0.58	0.60	0.56	0.57	0.59	0.59	0.52	0.56	0.71	0.72	0.75	0.78	0.65	0.65
Alborz	0.25	0.43	0.60	0.45	0.48	0.48	0.44	0.48	0.22	0.41		0.41	0.52	0.52	0.43	0.48	0.34	0.49		0.51	0.56	0.57	0.60	0.65	0.34	0.57		0.58	0.77	0.75	0.67	0.72
Ardabil	0.47	0.43	0.62	0.73	0.44	0.64	0.39	0.35	0.44	0.41	0.58	0.68	0.48	0.68	0.39	0.35	0.52	0.49	0.63	0.66	0.57	0.63	0.56	0.51	0.60	0.56	0.76	0.85	0.73	0.90	0.62	0.57
Azerbaijan-East	0.34	0.60	0.61	0.63	0.56	0.51	0.43	0.44	0.32	0.57	0.57	0.60	0.60	0.55	0.43	0.43	0.42	0.60	0.61	0.62	0.61	0.60	0.61	0.62	0.46	0.74	0.75	0.77	0.84	0.80	0.68	0.68
Azerbaijan-West	0.36	0.54	0.54	0.70	0.42	0.48	0.47	0.46	0.33	0.50	0.50	0.66	0.45	0.52	0.46	0.46	0.44	0.57	0.55	0.64	0.52	0.59	0.63	0.63	0.48	0.68	0.67	0.84	0.69	0.77	0.71	0.70
Bushehr	0.38	0.48	0.64	0.34	0.50	0.49	0.37	0.42	0.36	0.45	0.60	0.32	0.54	0.53	0.36	0.42	0.44	0.54	0.64	0.42	0.59	0.58	0.53	0.58	0.51	0.62	0.78	0.46	0.78	0.78	0.59	0.65
ChaharMahal and Bakhtiari	0.54	0.49		0.62	0.42	0.63	0.50	0.32	0.51	0.45		0.59	0.46	0.67	0.50	0.32	0.56	0.57		0.61	0.54	0.62	0.67	0.48	0.68	0.63		0.76	0.69	0.88	0.74	0.54
Fars	0.40	0.37	0.35	0.37	0.36	0.48	0.35	0.35	0.38	0.34	0.32	0.34	0.39	0.52	0.34	0.35	0.50	0.45	0.43	0.45	0.48	0.59	0.51	0.52	0.53	0.49	0.47	0.49	0.63	0.77	0.57	0.58
Gilan	0.15	0.37	0.60	0.65	0.46	0.49	0.41	0.33	0.14	0.35	0.57	0.62	0.50	0.53	0.41	0.33	0.23	0.45	0.60	0.63	0.53	0.60	0.57	0.48	0.21	0.49	0.75	0.80	0.74	0.77	0.64	0.53
Golestan	0.49	0.56	0.72	0.52	0.50	0.61	0.47	0.44	0.46	0.52	0.67	0.49	0.54	0.65	0.47	0.43	0.54	0.60	0.65	0.57	0.60	0.62	0.64	0.60	0.62	0.70	0.84	0.66	0.79	0.86	0.71	0.68
Hamadan	0.46	0.27	0.64	0.57	0.30	0.49	0.43	0.52	0.43	0.25	0.60	0.53	0.34	0.53	0.43	0.51	0.53	0.37	0.59	0.58	0.42	0.57	0.60	0.70	0.59	0.37	0.78	0.71	0.54	0.77	0.67	0.77
Hormozgan	0.35	0.50	0.41	0.49	0.44	0.41	0.40	0.28	0.32	0.47	0.39	0.46	0.48	0.43	0.39	0.28	0.43	0.54	0.48	0.54	0.55	0.50	0.57	0.42	0.45	0.64	0.54	0.62	0.73	0.66	0.63	0.47
Ilam	0.21	0.37	0.42	0.46	0.42	0.32	0.30	0.35	0.20	0.34	0.39	0.43	0.45	0.35	0.30	0.35	0.30	0.46	0.50	0.52	0.54	0.46	0.45	0.51	0.29	0.49	0.55	0.59	0.57	0.50		0.58
Isfahan	0.28	0.37	0.52	0.48	0.48	0.48	0.45	0.46	0.27	0.34	0.49	0.45	0.53	0.52	0.44	0.46	0.39	0.45	0.55	0.52	0.56	0.57	0.62	0.64	0.39	0.49	0.67	0.61	0.77	0.77	0.69	0.70
Kerman	0.50	0.57	0.46	0.44	0.36	0.35	0.27	0.38	0.47	0.54	0.43	0.41	0.39	0.39	0.26	0.37	0.53	0.58	0.53	0.51	0.50	0.49	0.41	0.54	0.64	0.71	0.59	0.58	0.62	0.62	0.46	0.60
Kermanshah	0.40	0.37	0.60	0.61	0.33	0.50	0.37	0.46	0.37	0.35	0.57	0.58	0.36	0.53	0.38	0.46	0.48	0.45	0.59	0.60	0.46	0.56	0.55	0.64	0.54	0.49	0.75	0.75	0.59	0.78	0.61	0.70
Khorasan-North	0.27	0.51		0.46		0.50	0.30		0.25	0.47		0.42		0.54	0.30		0.35	0.53		0.53		0.59	0.45		0.37	0.64		0.59		0.79	0.51	
Khorasan-Razavi	0.27	0.51	0.47	0.56	0.42	0.44	0.45	0.40	0.25	0.48	0.45	0.53	0.46	0.48	0.44	0.40	0.36	0.53	0.53	0.60	0.56	0.54	0.63	0.57	0.37	0.65	0.62	0.71	0.70	0.72	0.68	0.63
Khorasan-South	0.44	0.40	0.45	0.50	0.49	0.28	0.32	0.29	0.40	0.38	0.41			0.30	0.32	0.29	0.51	0.45	0.50			0.42	0.48	0.44	0.56	0.52	0.58			0.51	0.54	0.49
Khuzestan	0.41	0.42	0.63	0.50	0.49	0.44	0.43	0.46	0.38	0.39	0.60	0.46	0.53	0.48	0.42	0.46	0.48	0.48	0.61	0.53	0.59	0.54	0.61	0.63	0.54	0.56	0.78	0.64	0.78	0.73	0.67	0.70
Kohgiluyeh and Boyer-Ahmad	0.39	0.49		0.67			0.41	0.46	0.36	0.46		0.62			0.40	0.46	0.48	0.54		0.64			0.58	0.63	0.52	0.63		0.81			0.64	0.70
Kurdistan	0.40	0.33	0.50	0.59	0.55	0.55	0.44	0.32	0.37	0.31	0.47	0.55	0.59	0.59	0.44	0.31	0.37	0.31	0.47	0.55	0.59	0.59	0.44	0.31	0.53	0.44	0.64	0.73	0.83	0.83	0.68	0.53
Lorestan	0.25	0.62	0.59	0.61	0.53	0.50	0.48	0.40	0.23	0.57	0.56	0.58	0.57	0.54	0.48	0.40	0.33	0.59	0.62	0.60	0.61	0.58	0.65	0.56	0.34	0.76	0.73	0.76	0.81	0.79	0.72	0.63
Markazi	0.41	0.29	0.77	0.72	0.59	0.62	0.50	0.64	0.39	0.27	0.73	0.68	0.64	0.66	0.50	0.64	0.48	0.35	0.68	0.63	0.63	0.64	0.67	0.79	0.54	0.38	0.89	0.85	0.86	0.88	0.74	0.87
Mazandaran	0.42	0.58	0.58	0.67	0.54	0.47	0.50	0.50	0.39	0.54	0.54	0.63	0.58	0.51	0.50	0.50	0.48	0.57	0.57	0.62	0.60	0.55	0.68	0.67	0.55	0.72	0.72	0.81	0.82	0.76	0.75	0.75
Qazvin	0.46		0.30						0.42	0.54	0.30						0.53	0.59	0.45						0.59	0.79	0.51					
Qom		0.38	0.69	0.62	0.53	0.56	0.55	0.46		0.35	0.65	0.58	0.57	0.60	0.55	0.46		0.46	0.66	0.59	0.60	0.62	0.72	0.65		0.50	0.83	0.75	0.81	0.84	0.80	0.71
Semnan	0.50	0.56	0.54	0.44	0.49	0.52	0.52	0.36	0.47	0.52	0.51	0.41	0.53	0.56	0.51	0.36	0.53	0.57	0.57	0.51	0.57	0.60	0.69	0.53	0.63	0.70	0.68	0.57	0.77	0.79	0.76	0.59
Sistan and Baluchistan	0.37	0.26	0.46	0.36	0.29	0.33	0.19	0.21	0.34	0.23	0.43	0.34	0.31	0.36	0.19	0.21	0.46	0.34	0.51	0.45	0.40	0.46	0.30	0.32	0.49	0.35	0.58	0.48	0.51	0.58	0.34	0.36
Tehran	0.42	0.52	0.61	0.64	0.52	0.48	0.47	0.48	0.48	0.48	0.58	0.60	0.56	0.53	0.47	0.48	0.50	0.55	0.62	0.64	0.59	0.58	0.64	0.66	0.56	0.66	0.76	0.78	0.80	0.77	0.72	0.72
Yazd	0.52	0.46	0.48	0.62	0.61	0.53	0.36	0.38	0.49	0.43	0.45	0.58	0.64	0.57	0.36	0.38	0.55	0.50	0.52	0.64	0.62	0.58	0.52	0.54	0.66	0.60	0.61	0.76	0.86	0.81	0.59	0.61
Zanjan	0.46	0.28	0.69	0.77		0.51	0.48	0.38	0.43	0.26	0.65	0.74		0.54	0.48	0.38	0.52	0.39	0.64	0.66		0.58	0.65	0.54	0.60	0.38	0.82	0.89		0.77	0.72	0.61

BMI=Body mass index, IHD=Ischemic heart disease, HTN=Hypertension, DM=Diabetes mellitus

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