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Original Research

Trend of fatal poisoning at national and provincial levels in Iran from 1990 to 2015

Z. Ghodsi [a], S.S. Moghaddam [b], S. Saadat [a], M. Yoosefi [b], N. Rezaei [b], H. Ostadrahimi [a,c], P. Mehdipour [b], B. Khalafi [d], S. Sobhani [c], R. Haghshenas [b], M. Alaedini [a], S.B. Jazayeri [a], F. Sadeghian [a,e], M. Sharif-Alhoseini [a], H. Bazireh [f], K. Naghdi [a], P. Derakhshan [a,g], P. Salamati [a], M. Moradi-Lakeh [h], A.H. Mokdad [i], G. O'Reilly [j], V. Rahimi-Movaghar [a,*]

[a] Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran
[b] Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran
[c] Students' Scientific Research Center, Tehran University of Medical Sciences, Tehran, Iran
[d] Lung Diseases and Allergy Research Center, Kurdistan University of Medical Science, Sanandaj, Iran
[e] Center for Health Related Social and Behavioral Sciences Research, Shahroud University of Medical Sciences, Shahroud, Iran
[f] Department of Industrial and Environmental Biotechnology, National Institute of Genetic Engineering and Biotechnology (NIGEB), Tehran, Iran
[g] Student Research Committee, School of Medicine, Iran University of Medical Sciences, Tehran, Iran
[h] Preventive Medicine and Public Health Research Center, Iran University of Medical Sciences, Tehran, Iran
[i] Institute for Health Metrics and Evaluation, University of Washington, Washington, USA
[j] Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia

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ABSTRACT

Objectives: Comprehensive and up-to-date data on fatal injury trends are critical to identify challenges and plan priority setting. This study provides a comprehensive assessment of poisoning mortality trends across Iran.

Study design: The data were gathered from various resources, including death registration systems, cemetery databases of Tehran and Esfahan, the Demographic and Health Survey of 2000, and three rounds of national population and housing censuses.

Methods: After addressing incompleteness for child and adult death data separately and using a spatio-temporal model and Gaussian process regression, the level and trend of child and adult mortality were estimated. For estimating cause-specific mortality, the cause fraction was calculated and applied to the level and trend of death.

Results: From 1990 to 2015, 40,586 deaths due to poisoning were estimated across the country. The poisoning-related age-standardized death rate per 100,000 was estimated to

* *Corresponding author*. Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Sina Hospital, Hassan Abad Square, Imam Khomeini Avenue, Tehran, Iran. Tel.: (+98)9153422682; fax: (+98)2166757009.
E-mail addresses: v_rahimi@sina.tums.ac.ir, v_rahimi@yahoo.com (V. Rahimi-Movaghar).
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have changed from 3.08 (95% uncertainty interval [UI]: 2.32–4.11) in 1990 to 0.96 (95% UI: 0.73–1.25) in 2015, and the male/female ratio was 1.35 during 25 years of study with an annual percentage change of −5.4% and −4.0% for women and men, respectively. The annual mortality rate was higher among children younger than 5 years and the elderly population (≥70 years) in the study period.

Conclusions: This study showed that mortality from poisoning declined in Iran over the period from 1990 to 2015 and varied by province. Understanding the reasons for the differences of poisoning mortality by province will help in developing and implementing measures to reduce this burden in Iran.

Introduction

Fatal injuries, as a challenging issue in health systems, account for about 8.43% of cut-short lives worldwide.[1,2] Poisonings, common causes of injury-related mortality, consist a significant part of hospital admissions and consequently their related mortality.[3] Poisons including medications, recreational drugs, gaseous fumes, fertilizers, and pesticides[2,4] were found to be increased overtime in variety and types worldwide.[5,6] In the United States, the poisoning mortality rate associated with drug overdose has increased roughly by 300% over the past three decades and now is the leading cause of injury-related death.[7] Other data evaluating fatal poisoning in England revealed an increased rate for drug overdose over the past years.[8] Poisoning as an external cause of mortality is the most common form of self-harm in Asian countries. Poisonings are the most common self-harm cause in Asian countries, and among them, drug poisoning mortality is four times higher in underdeveloped countries.[9] Similar to the global patterns, poisoning is one of the most common causes of injury-related mortality and morbidity in Iran.[2]

Since the 1990s, increasing understanding of global public health structure has clarified the importance of healthcare data collection.[2] Comparable registered data sets of mortality indicators categorized by age, sex, etiology, time, and geography are the first pieces of the puzzle in healthcare policy-making.[1] A comprehensive and continuously adopting approach at national and subnational levels helps to set priorities, enable benchmarking, and identify emerging public health challenges before disasters happen.[1] Regular analysis of mortality rates and understanding changes at specific time periods can help in rescuing more lives and reach sustainable development goals.[10] Moreover, ongoing data analyses help to assess the progress of ongoing programs and recognize emerging public health challenges, with the help of predictive models. Implementation of data-driven policies reduces costs and saves money in the healthcare system.

Iran is a vast country with a diverse climate that has resulted in a variety of economic, social, and cultural influences of mortality rates from poisonings. The border provinces of the country are ethnically diverse (Turks, Kurds, Arabs, and others) and the economic situation and their politics have a large cultural diversity. The country has 31 provinces which are also diverse in terms of social development and are classified as being from desirable to very unfavorable with regard to social development.[11] Therefore, there are many differences in the factors affecting the poisoning-related mortality, such as paraquat in agricultural regions. This study was designed to present a precise and updated epidemiologic picture of poison-related mortality using national and provincial level data from 1990 to 2015.

Methods

The aims of this study were only related to death due to poisoning. The methods used in this study, including comprehensive details of data collection and analysis, have been described previously and will be only summarized here again.

Death registration system (DRS) and cemeteries data were available from 1995 to 2010; so, to obtain the necessary estimates, we have performed interpolation and extrapolation. Incomplete data, a challenge of all registry systems, were addressed for children and adults separately.[15] The level and trend of mortality rates were estimated by a parallel study, leading to death rates due to all causes by sex, age groups, and year at national and subnational levels from 1990 to 2015.[12] For estimating the cause-specific mortality rates, the cause of death codes was converted from the International Classification of Diseases version 10 to Global Burden of Disease (GBD) 2013 codes, allowing comparison of the results with the GBD project.[17] Cause-specific mortality fractions were calculated using mixed-effects and spatio-temporal models. The mixed-effects model was constructed by considering the wealth index, average successful years of schooling, and urbanization as covariates.[13–16] Using a weight matrix which contained the effects of time, age groups, and space led to adjusted residuals from the aforementioned mixed effect model. Finally, these adjusted residuals and predictions were added to each other, and this process was simulated 1000 times, and the 2.5th and 97.5th percentiles of this process were considered as 95% uncertainty intervals (UIs).[18]

This is a retrospective observational study using prospectively collected data. In this study, all forms of poisons including solids, liquids, gases, compound substances, unspecified poisons, drugs, medications, therapeutics, along

with accidental poisoning by, and exposure to, carbon monoxide, pesticides, plant foods, and fertilizers were included, and all types of poisoning subcategories were combined.[15]

We used a direct age-standardized approach, using the 2015 Iran population as the reference population. The results presented in this article are part of the National and Subnational Burden of Diseases (NASBOD) study. Estimation of the mortality rate was a complex, multistage process, and comprehensive details of the methods used to derive estimation of causes of death can be found in NASBOD's previously published protocols articles.[18–20]

In the NASBOD study, all-deaths records which were not related to Iranian nationality or Iranian residents who are not living in Iran were excluded. Also, registered records relating to cases of mutilation or buried limbs, stillbirth, or abortion were also excluded. STATA 11 and R 3.0.2 were used for analysis and data visualizations.

Results

From 1990 to 2015, 40,586 deaths due to poisoning were estimated across the country. The overall mortality rate due to poisoning during the study period was 62.08 per 100,000. The age-standardized rate per 100,000 declined from 3.08 (95% UI: 2.32–4.11) in 1990 to 0.96 (95% UI: 0.73–1.25) in 2015, a 68.8% decrease in 26 years. The male to female ratio was 1.29:1 in 1990 and 1.49:1 in 2015. The highest number of fatal poisoning was in 1995. In 1995, 974 women and 1259 men died due to poisoning. The records of poisoning-related deaths were reduced from 1995 to 2015 (Fig. 1). The majority of causalities were in children aged <5 years from 1990 to 1997. In total, 6971 females of all ages (<5 years, 40.2%; 5–14, 9.3%; 15–49, 20.0%; 50–69, 17.1%; >70, 13.4%) and 8917 males all ages (<5 years, 43.8%; 5–14, 8.9%; 15–49, 25.4%; 50–69, 13.3%; >70, 8.6%) died due to poisoning during 1990–1997. From 1998 to 2015, the majority of death cases belonged to the 15–49 age group. There were 10,313 females of all ages (<5 years, 24.6%; 5–14, 7.9%; 15–49, 31.6%; 50–69, 19.3%; >70, 16.6%) and 14,385 males of all ages (<5 years, 21.1%; 5–14, 6.6%; 15–49, 47.9%; 50–69, 13.9%; >70, 10.5%) died due to poisoning during 1998–2015 (Fig. 1).

The age-standardized mortality rate of poisoning was 3.06 (95% UI: 2.24–4.19) and 3.16 (95% UI: 2.43–4.10) per 100,000 among women and men, respectively, in 1990. This rate dropped to 0.77 (95% UI: 0.57–1.04) in women and 1.14 (95% UI: 0.89–1.45) in men in 2015 (Fig. 2).

Children aged <5 years, as well as the elderly population older than 70 years, experienced higher mortality rates due to poisoning during the study period (Fig. 3). Boys and girls younger than 1 year had the greatest number of deaths and were the main victims of poisoning during time interval. The annual mortality rate of fatal poisoning was higher in men compared with women, up to the age of 50 years in 1990 and 70 years in 2015 (Fig. 3).

The annual percentage change of age-standardized mortality rate was −5.4% and −4.0% for women and men, respectively, between 1990 and 2015. However, the rate of decline was not similar in all parts of the country (Fig. 4, Table 1).

The highest and the lowest age-standardized mortality rate per 100,000 in women was observed in 1990 in North Khorasan (7.27 [95% UI: 5.27–10.01]) and Alborz (1.26 [95% UI: 0.88–1.81]) provinces, respectively, and in 2015 in South Khorasan (2.00 [95% UI: 1.47–2.70]) and Tehran (0.30 [95% UI: 0.20–0.45]) provinces, respectively. The highest and the lowest age-standardized mortality rate per 100,000 in men was observed in 1990 in North Khorasan (5.74 [95% UI: 4.41–7.47]) and Alborz (1.31 [95% UI: 0.98–1.74]) provinces, respectively, and in 2015 in Tehran (0.54 [95% UI: 0.39–0.76]) and North Khorasan (2.06 [95%

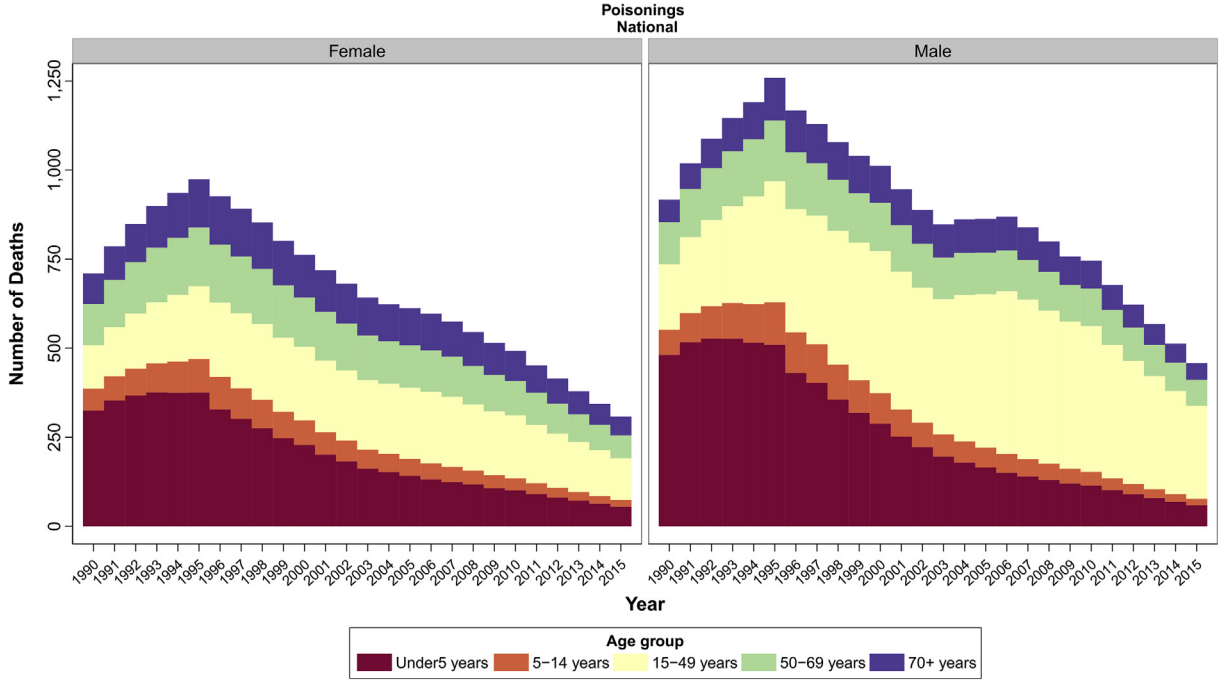

Fig. 1 – Trend of the poisoning mortality number in the national level based on sex groups from 1990 to 2015.

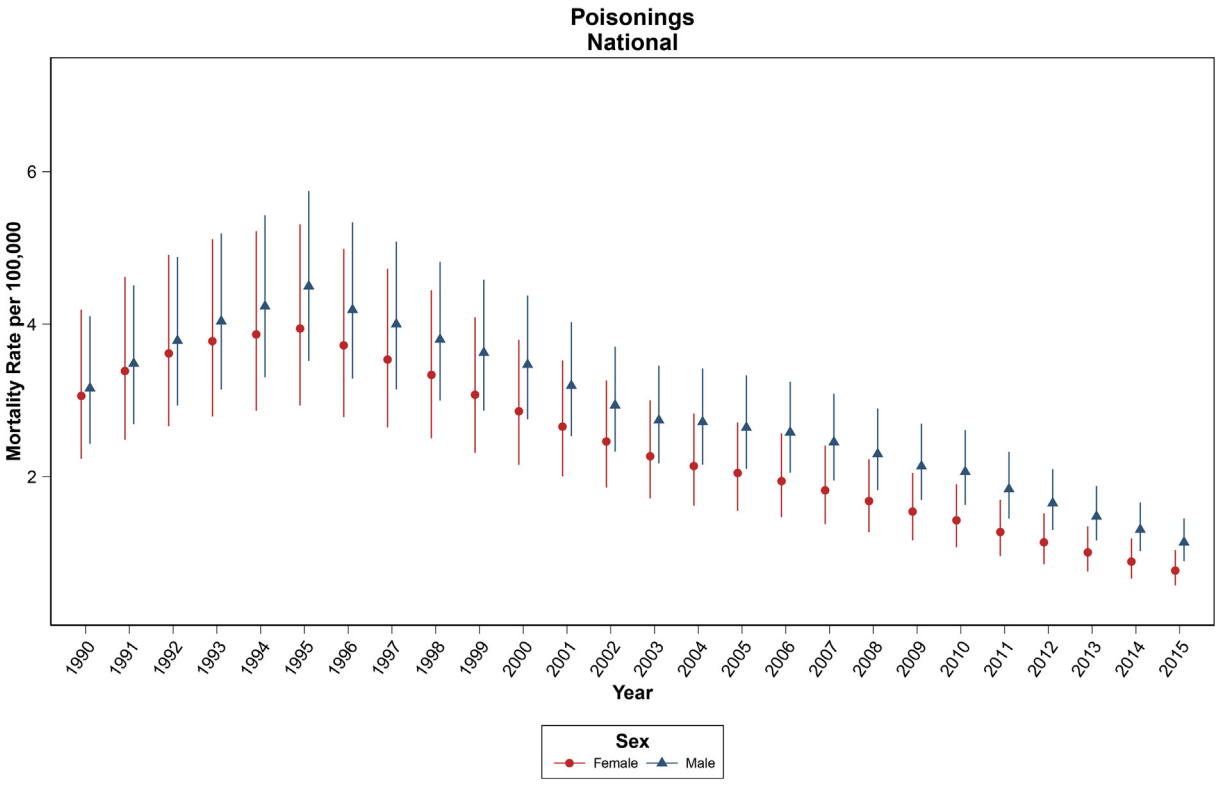

Fig. 2 – Trend of the poisoning age-standardized mortality rate per 100,000 in the national level by sex from 1990 to 2015.

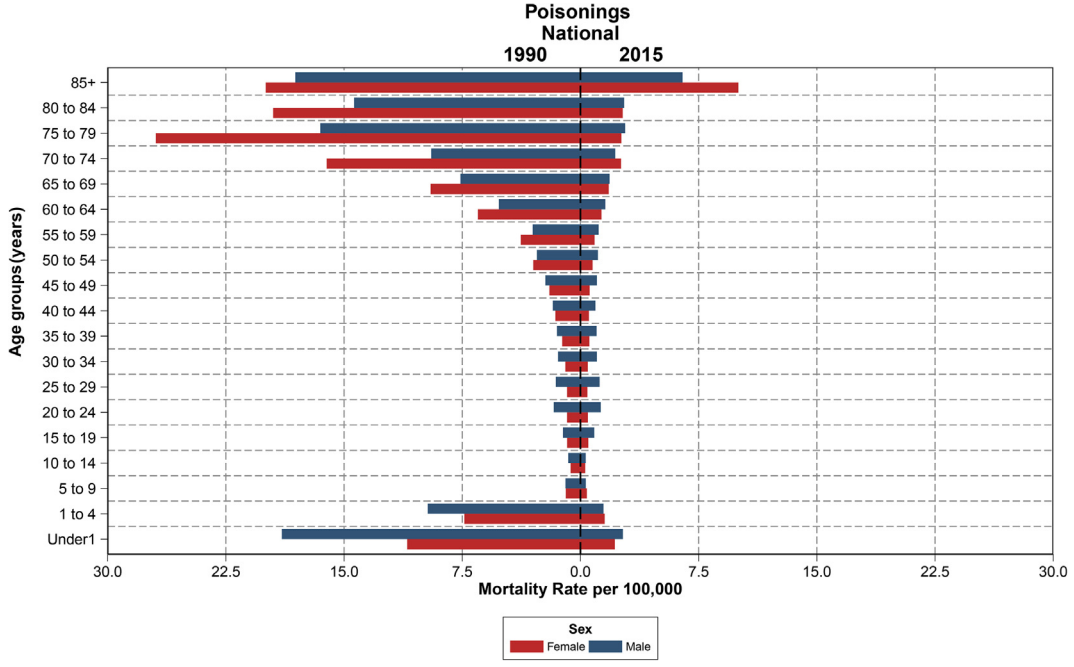

Fig. 3 – Comparison of the mortality rate per 100,000 from poisoning by age groups and sex, in 1990 and 2015.

UI: 1.62–2.64]) provinces, respectively. The highest and the lowest decrease in provincial levels was seen in women in Zanjan (−7.4%) and Hormozgan (−2.5%), respectively. Among men, Tehran and Esfahan had the highest (−6.0%) and lowest decline (−1.7%), respectively (Table 1).

Discussion

This is the first national and provincial level report of the poisoning-related mortality rate and number of deaths in Iran.

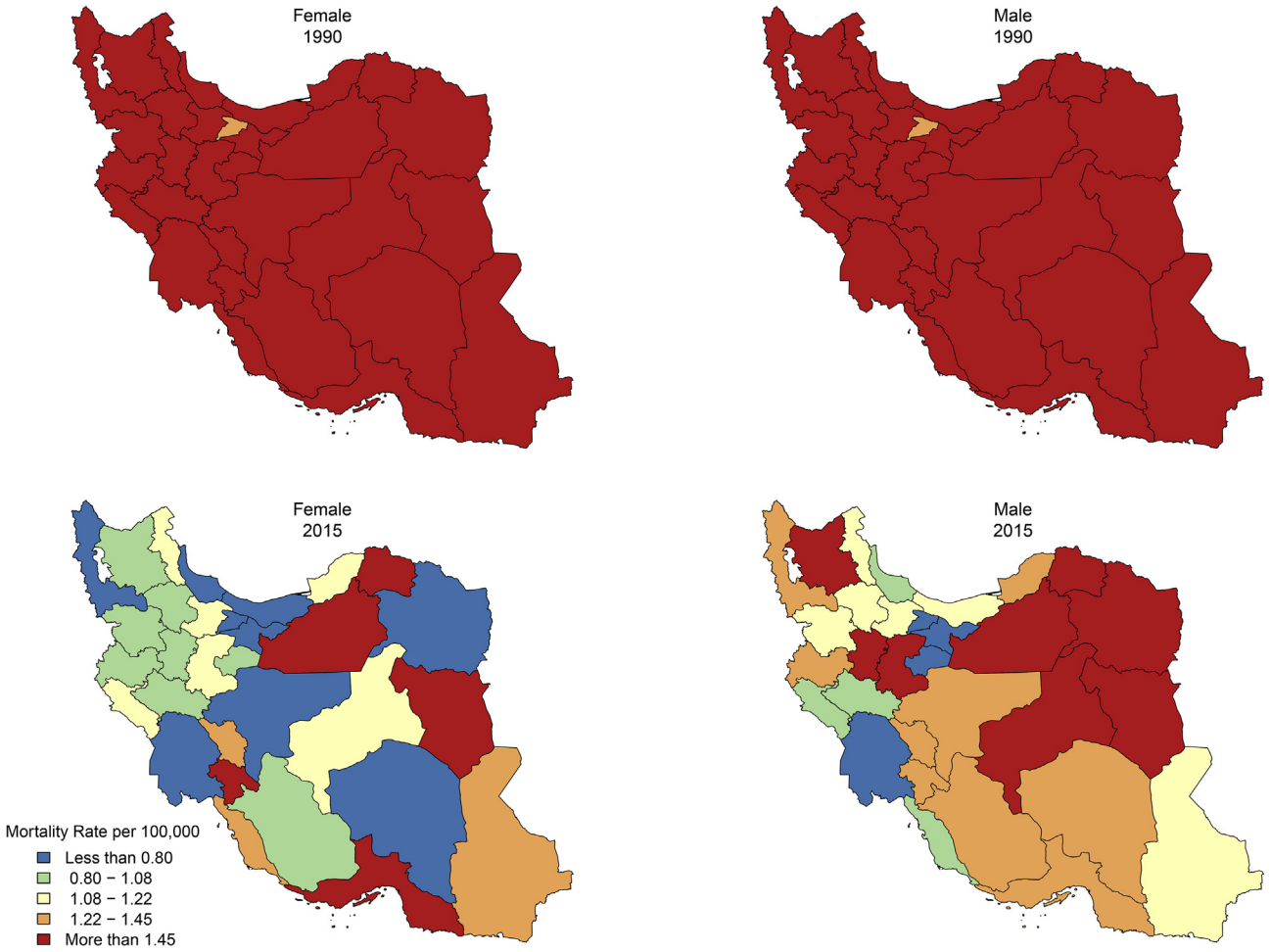

Fig. 4 – The poisoning age-standardized mortality rate per 100,000 at the subnational level in 1990 and 2015, by sex.

Our study showed a reduction of poisoning-related mortality with a similar pattern among most provinces across the country. Our findings call for examining the drivers of poisoning-related mortality at the province level in order to better develop and implement programs to reduce the burden of poisoning-related mortality in Iran. Indeed, if the lowest rates were observed in a province could be copied elsewhere, there would be a tremendous impact on the burden of poisoning-related mortality in Iran.

The decrease in poisoning-related mortality in Iran mirrors the changes in global deaths due to poisoning such that worldwide, the percentage change of poisoning-related mortality was −14.3 during 2005–2015 years.[1] A similar decrease occurred during these years in other countries.[21,22] A Chinese study showed substantial decreases in fatal pesticide self-poisoning from 2006–2016.[23]

Many factors and strategies might have a role in poisoning-related mortality reduction: changes in economic growth, population shifts to urban areas optimizing early care, treatment of poisoned patients in emergency departments and novel treatment methods, new antidotes, improved training, better understanding of poisoning mechanisms, and improved regulation to reduce access to pesticides.[24–28]

Different studies in Iran have shown that pharmaceutical compounds and poisons are among the most important agents of poisoning in most parts of the country.[29–31] Currently, advances in the treatment of poisoned patients have occurred in many centers, and poisoned patients are monitored under supervision by trained clinical health providers. Also, the 29 active Drug and Poison Information Centers are under the supervision of the Ministry of Health.[31] Some studies in Iran showed recent advances in the clinical management of lead poisoning, clinical findings on the therapeutic effects of garlic tablets, and treatment of organ phosphorous poisonings[32–34] with the potential for a reduction of poisoning-related mortality.

However, the longitudinal trend showed an increased poisoning-related mortality rate from 1990 to 1995 in Iran. Because self-poisoning consists two-thirds of suicide attempts in Iran,[35–37] poisoning mortality increasing during the 5 years could be due to a period of the economic crisis after the Iraq–Iran War. A study in Korea showed that poisoning mortality and suicidal poisoning were increased in a longitudinal trend from 1991 to 1998, which it could be due to economic crisis at that years.[38] A study in Finland showed that after the 1990 economic crisis, the risk of suicide increased in boys aged 15 to 19 years by 7.4 times that in girls. Since then, the risk of suicide has dropped dramatically, 1.6 times higher than the risk in girls in 2013.[39]

The comparison of comprehensive and clean updated data revealed a significant improvement in sex- and age-specific

Table 1 – The national and subnational age-standardized mortality rate (per 100,000)* due to poisoning in 1990, 1995, 2000, 2005, 2010, and 2015 with annual percentage change (APC) of the age-standardized mortality rate (%) between 1990 and 2015 by sex.

Location	Female							Male						
	Year						APC 1990–2015 (%)	Year						APC 1990–2015 (%)
	1990	1995	2000	2005	2010	2015		1990	1995	2000	2005	2010	2015	
Alborz	1.26 (0.88–1.81)	1.65 (1.15–2.33)	1.14 (0.82–1.60)	0.75 (0.55–1.04)	0.68 (0.49–0.94)	0.40 (0.29–0.55)	−4.5	1.31 (0.98–1.74)	1.96 (1.48–2.59)	1.47 (1.12–1.92)	1.12 (0.86–1.45)	0.99 (0.76–1.28)	0.57 (0.44–0.74)	−3.3
Ardabil	4.67 (3.49–6.25)	6.23 (4.75–8.18)	4.39 (3.42–5.65)	3.17 (2.47–4.04)	2.32 (1.80–2.97)	1.20 (0.92–1.56)	−5.3	3.78 (2.98–4.78)	5.82 (4.67–7.23)	4.05 (3.30–4.96)	3.27 (2.68–3.98)	2.14 (1.74–2.62)	1.16 (0.93–1.44)	−4.6
Bushehr	4.07 (2.99–5.53)	5.72 (4.30–7.56)	4.22 (3.23–5.49)	3.14 (2.40–4.08)	2.26 (1.72–2.98)	1.30 (0.97–1.74)	−4.5	3.08 (2.40–3.93)	4.45 (3.52–5.62)	3.67 (2.94–4.55)	2.50 (2.01–3.09)	1.71 (1.36–2.14)	0.81 (0.64–1.05)	−5.2
Chaharmahal and Bakhtiari	4.67 (3.51–6.21)	6.01 (4.57–7.87)	3.83 (2.93–4.99)	3.21 (2.47–4.16)	2.23 (1.70–2.91)	1.28 (0.97–1.69)	−5.1	3.38 (2.68–4.28)	4.54 (3.63–5.69)	3.61 (2.90–4.48)	3.11 (2.50–3.84)	2.48 (1.99–3.10)	1.43 (1.14–1.80)	−3.4
East Azerbaijan	3.43 (2.59–4.55)	4.60 (3.52–6.02)	3.51 (2.72–4.52)	2.52 (1.96–3.23)	1.77 (1.37–2.27)	1.01 (0.78–1.31)	−4.8	3.16 (2.50–3.99)	5.00 (4.00–6.23)	4.14 (3.35–5.11)	3.55 (2.89–4.37)	2.72 (2.21–3.35)	1.57 (1.26–1.95)	−2.8
Esfahan	1.87 (1.34–2.59)	2.41 (1.74–3.31)	1.76 (1.29–2.41)	1.54 (1.13–2.09)	1.13 (0.83–1.54)	0.64 (0.46–0.88)	−4.2	1.89 (1.43–2.50)	2.92 (2.23–3.80)	2.32 (1.80–2.98)	2.23 (1.73–2.86)	2.10 (1.62–2.69)	1.23 (0.95–1.59)	−1.7
Fars	2.07 (1.54–2.76)	2.97 (2.26–3.90)	2.15 (1.66–2.80)	1.73 (1.34–2.24)	1.50 (1.15–1.95)	0.89 (0.68–1.18)	−3.3	2.49 (1.95–3.16)	3.84 (3.06–4.82)	3.02 (2.44–3.75)	2.45 (1.97–3.03)	2.33 (1.87–2.91)	1.29 (1.03–1.63)	−2.6
Gilan	2.71 (2.03–3.62)	3.16 (2.40–4.14)	2.10 (1.62–2.73)	1.50 (1.15–1.94)	0.97 (0.74–1.27)	0.57 (0.44–0.76)	−6.0	2.67 (2.11–3.38)	3.44 (2.76–4.29)	2.48 (2.02–3.06)	2.28 (1.85–2.80)	1.75 (1.41–2.16)	1.03 (0.83–1.28)	−3.7
Golestan	3.99 (3.00–5.30)	5.29 (4.01–6.93)	4.30 (3.30–5.58)	3.14 (2.41–4.08)	2.02 (1.54–2.65)	1.19 (0.90–1.58)	−4.7	3.27 (2.58–4.15)	5.25 (4.19–6.56)	4.04 (3.27–5.01)	3.66 (2.96–4.51)	2.86 (2.29–3.58)	1.45 (1.15–1.83)	−3.2
Hamadan	2.68 (2.05–3.50)	3.72 (2.89–4.79)	2.91 (2.29–3.69)	2.37 (1.87–3.00)	1.77 (1.39–2.25)	1.01 (0.79–1.30)	−3.8	3.23 (2.60–4.02)	4.97 (4.04–6.10)	4.38 (3.61–5.31)	3.75 (3.10–4.54)	3.18 (2.60–3.87)	1.95 (1.58–2.41)	−2.0
Hormozgan	2.75 (1.98–3.82)	3.91 (2.88–5.31)	3.46 (2.59–4.58)	3.06 (2.30–4.06)	2.47 (1.84–3.31)	1.46 (1.07–1.99)	−2.5	2.74 (2.12–3.54)	4.52 (3.55–5.73)	5.09 (4.08–6.35)	3.48 (2.78–4.34)	2.10 (1.65–2.66)	1.36 (1.05–1.76)	−2.8
Ilam	6.07 (4.51–8.18)	7.90 (5.92–10.56)	6.03 (4.55–7.98)	3.60 (2.72–4.76)	2.22 (1.67–2.95)	1.21 (0.90–1.63)	−6.2	3.80 (2.98–4.83)	5.47 (4.32–6.88)	4.38 (3.47–5.50)	2.65 (2.10–3.34)	1.70 (1.34–2.17)	0.96 (0.74–1.23)	−5.4
Kerman	3.45 (2.65–4.48)	4.65 (3.63–5.96)	3.46 (2.73–4.39)	2.11 (1.66–2.69)	1.48 (1.15–1.91)	0.77 (0.58–1.00)	−5.8	4.47 (3.61–5.52)	6.23 (5.09–7.59)	5.44 (4.49–6.58)	3.17 (2.61–3.85)	2.45 (1.99–3.00)	1.34 (1.07–1.67)	−4.7
Kermanshah	3.35 (2.57–4.37)	4.81 (3.73–6.19)	3.27 (2.56–4.16)	2.26 (1.77–2.87)	1.66 (1.30–2.13)	0.96 (0.75–1.24)	−4.9	4.22 (3.41–5.23)	6.19 (5.04–7.56)	3.90 (3.20–4.74)	2.96 (2.43–3.58)	2.30 (1.88–2.80)	1.41 (1.14–1.74)	−4.3
Khuzestan	1.64 (1.23–2.18)	2.32 (1.75–3.06)	1.72 (1.31–2.25)	1.37 (1.05–1.80)	1.02 (0.78–1.33)	0.61 (0.47–0.81)	−3.9	2.11 (1.66–2.69)	3.54 (2.81–4.45)	3.19 (2.55–3.98)	1.98 (1.58–2.47)	1.37 (1.10–1.71)	0.80 (0.63–1.00)	−3.8
Kohgiluyeh and Buyer Ahmad	5.80 (4.13–8.15)	7.21 (5.18–9.98)	5.32 (3.88–7.26)	4.27 (3.15–5.76)	2.95 (2.18–3.96)	1.48 (1.10–2.00)	−5.3	3.93 (2.94–5.24)	5.44 (4.13–7.15)	4.24 (3.27–5.48)	3.47 (2.70–4.47)	2.57 (1.99–3.31)	1.37 (1.06–1.79)	−4.1
Kordestan	4.26 (3.12–5.82)	5.59 (4.19–7.43)	4.00 (3.10–5.16)	2.72 (2.14–3.46)	1.73 (1.36–2.21)	0.89 (0.69–1.14)	−6.1	3.68 (2.86–4.76)	5.38 (4.26–6.79)	3.81 (3.09–4.70)	3.12 (2.57–3.80)	2.22 (1.83–2.70)	1.22 (0.99–1.50)	−4.3

(continued on next page)

Table 1 – (*continued*)

Location	Female							Male						
	Year						APC 1990–2015 (%)	Year						APC 1990–2015 (%)
	1990	1995	2000	2005	2010	2015		1990	1995	2000	2005	2010	2015	
Lorestan	3.73 (2.79–4.98)	4.77 (3.64–6.24)	3.56 (2.77–4.57)	2.56 (2.02–3.25)	1.72 (1.35–2.19)	0.84 (0.65–1.08)	−5.8	4.92 (3.87–6.22)	6.72 (5.41–8.33)	5.18 (4.24–6.33)	3.19 (2.62–3.88)	2.00 (1.63–2.44)	1.07 (0.86–1.33)	−5.9
Markazi	2.96 (2.21–3.97)	4.01 (3.04–5.28)	3.16 (2.42–4.11)	2.73 (2.11–3.53)	1.97 (1.52–2.57)	1.10 (0.84–1.46)	−3.9	3.19 (2.53–4.01)	4.67 (3.76–5.80)	3.64 (2.96–4.46)	3.18 (2.59–3.89)	2.53 (2.05–3.12)	1.46 (1.17–1.81)	−3.1
Mazandaran	2.72 (2.00–3.69)	3.21 (2.39–4.31)	2.21 (1.65–2.97)	1.58 (1.17–2.13)	1.01 (0.74–1.37)	0.54 (0.39–0.74)	−6.3	2.68 (2.10–3.43)	3.62 (2.85–4.57)	2.54 (2.01–3.22)	2.37 (1.87–3.01)	1.92 (1.50–2.45)	1.15 (0.89–1.49)	−3.3
North Khorasan	7.27 (5.27–10.01)	9.30 (6.88–12.54)	6.90 (5.17–9.15)	4.81 (3.62–6.37)	2.94 (2.21–3.91)	1.52 (1.13–2.05)	−6.1	5.74 (4.41–7.47)	7.93 (6.18–10.19)	6.35 (5.02–8.05)	5.06 (4.02–6.35)	3.90 (3.08–4.92)	2.06 (1.62–2.64)	−4.0
Qazvin	4.78 (3.65–6.25)	5.83 (4.49–7.56)	4.10 (3.19–5.26)	3.07 (2.39–3.92)	2.05 (1.59–2.64)	1.11 (0.85–1.44)	−5.7	4.91 (3.92–6.08)	6.35 (5.15–7.84)	4.26 (3.48–5.22)	3.25 (2.66–3.97)	2.23 (1.81–2.74)	1.17 (0.94–1.45)	−5.6
Qom	2.63 (1.78–3.86)	3.23 (2.21–4.73)	2.56 (1.77–3.70)	2.10 (1.47–2.99)	1.48 (1.04–2.09)	0.87 (0.62–1.24)	−4.3	2.59 (1.89–3.56)	3.37 (2.48–4.57)	2.49 (1.86–3.33)	1.94 (1.46–2.57)	1.42 (1.07–1.88)	0.74 (0.56–0.99)	−4.9
Razavi Khorasan	3.99 (2.97–5.37)	5.34 (4.02–7.10)	3.81 (2.89–5.02)	2.50 (1.90–3.30)	1.60 (1.20–2.12)	0.73 (0.54–0.97)	−6.6	4.07 (3.14–5.23)	6.20 (4.88–7.87)	5.14 (4.08–6.46)	4.00 (3.17–5.04)	3.17 (2.50–4.02)	1.57 (1.23–2.00)	−3.7
Semnan	5.67 (4.07–7.88)	6.59 (4.77–9.06)	4.82 (3.54–6.55)	3.59 (2.65–4.87)	2.72 (2.00–3.68)	1.54 (1.13–2.11)	−5.1	3.47 (2.63–4.58)	4.81 (3.68–6.25)	3.86 (2.98–4.99)	3.32 (2.58–4.26)	2.73 (2.11–3.51)	1.59 (1.22–2.06)	−3.1
Sistan and Baluchestan	5.61 (3.93–7.97)	6.66 (4.73–9.30)	5.30 (3.83–7.33)	3.75 (2.71–5.15)	2.48 (1.81–3.40)	1.29 (0.93–1.77)	−5.7	4.66 (3.49–6.20)	5.75 (4.35–7.59)	4.48 (3.44–5.83)	2.55 (1.96–3.29)	1.79 (1.38–2.31)	1.12 (0.86–1.45)	−5.6
South Khorasan	5.67 (4.13–7.78)	7.45 (5.50–10.05)	6.25 (4.68–8.34)	4.50 (3.37–6.02)	3.53 (2.62–4.74)	2.00 (1.47–2.70)	−4.1	5.53 (4.24–7.19)	7.15 (5.55–9.21)	5.96 (4.70–7.55)	4.32 (3.40–5.50)	2.96 (2.32–3.79)	1.66 (1.28–2.15)	−4.7
Tehran	1.84 (1.16–2.91)	2.13 (1.37–3.31)	1.27 (0.84–1.93)	0.77 (0.51–1.16)	0.57 (0.38–0.85)	0.30 (0.20–0.45)	−7.0	2.56 (1.75–3.75)	3.14 (2.18–4.50)	2.00 (1.41–2.81)	1.36 (0.97–1.91)	1.05 (0.76–1.46)	0.54 (0.39–0.76)	−6.0
West Azerbaijan	3.16 (2.36–4.23)	3.94 (3.00–5.16)	2.73 (2.12–3.52)	1.88 (1.48–2.41)	1.19 (0.92–1.53)	0.62 (0.47–0.80)	−6.3	2.74 (2.14–3.48)	3.98 (3.18–4.98)	2.87 (2.34–3.54)	2.63 (2.15–3.22)	2.34 (1.91–2.87)	1.30 (1.05–1.61)	−2.9
Yazd	3.63 (2.70–4.88)	4.50 (3.36–6.01)	3.57 (2.69–4.73)	2.87 (2.16–3.80)	2.20 (1.65–2.92)	1.19 (0.89–1.60)	−4.4	3.38 (2.65–4.32)	4.60 (3.62–5.84)	3.53 (2.79–4.45)	2.89 (2.30–3.64)	2.54 (2.01–3.20)	1.45 (1.14–1.85)	−3.3
Zanjan	5.77 (4.17–7.95)	7.41 (5.59–9.81)	5.04 (3.91–6.50)	3.17 (2.44–4.13)	1.87 (1.37–2.55)	0.85 (0.6–1.21)	−7.4	4.57 (3.50–5.96)	6.51 (5.18–8.19)	4.76 (3.87–5.84)	3.39 (2.72–4.22)	2.44 (1.89–3.14)	1.22 (0.91–1.64)	−5.2
National	**3.06 (2.24–4.19)**	**3.94 (2.93–5.31)**	**2.86 (2.16–3.79)**	**2.05 (1.55–2.71)**	**1.43 (1.08–1.90)**	**0.77 (0.57–1.04)**	**−5.4**	**3.16 (2.43–4.10)**	**4.50 (3.52–5.75)**	**3.47 (2.75–4.38)**	**2.64 (2.10–3.33)**	**2.06 (1.63–2.61)**	**1.14 (0.89–1.45)**	**−4.0**

*Data in parenthesis are 95% UI.

poisoning-related mortality. The mortality rate was found to decrease considerably from 1990 to 2015; by 75% and 65% for women and men, respectively. Detailed analysis showed higher mortality rates in males during all years of the study. This difference scaled up from 1990 to 2015 and might reflect increased exposure to occupational chemicals and heavy metals and substance abuse in men.[40,41] However, there is also evidence that suggests men are more likely to use poisoning as a suicidal method.[42,43] Forensic toxicology analysis in Tehran reported a male-to-female ratio of 2 to 1 in the self-poisoning suicide death rate.[30] The differences in male and female trends could be explained partly by social changes in Iran, including an improvement in women's literacy and an increased life expectancy in women.[42,44] Studies in China and Poland showed a higher mortality rate in males as well.[5,45] In a study, alcohol was the primary mortality cause in males and medications were the most common cause in females.[5] Shin et al.[38] reported a higher proportion of fatal poisoning in females from 1991 to 2001 in Korea. In the US, similar to other regions of the world, poisoning is one of the three most common forms of suicidal attempts, and among females, whites and 15- to 24-year individuals have the highest risk of poisoning-related mortality.[46,47]

The most vulnerable age groups in the present study were elderly (>70 years) and children <5 years. The majority of causalities were in children <5 years from 1990 to 1997. From 1998 to 2015, the majority of death cases belonged to 15–49 years age group. One of the most common causes of accidental poisoning and mortality in children is unsafe storage of medications in a suitable place or container.[6,48] Studies showed that at being elderly, the socio-economic level and dependency affect the poisoning rate.[40,49]

Aggregated data sets of sex- and age-specific poisoning mortality rates at national and provincial levels presented a similar pattern in most provinces. However, the analyses demonstrated discrepancies in poisoning-related mortality based on different demographic, socio-economic, and psychological structures across the country. A rising pattern in the sociodemographic index depicts a starting point to assay the country's mortality pattern at age-standardized levels. On the other hand, inequalities in health programs and medical care accessibility affect mortality patterns.[1] Stringhini et al. showed that mortality was greater in lower socio-economic status communities than those with a higher socio-economic status.[50] In our study, the provinces of Zanjan, Tehran, and Mazandaran had a significant decrease in the poisoning mortality rate, and Hormozgan had the least decrease in fatal poisoning in women from 1990 to 2015. In a study, the provinces of Tehran and Mazandaran are to be more developed compared with other provinces of the country, whereas Hormozgan is less developed compared with the other provinces.[11] In addition, the highest population growth rates in the country were observed in Hormozgan from 2011 to 2016, where there was the second highest rate of population growth in the country between 2005 and 2010.[51] Increase in the prevalence of mental health conditions, low price, and easy access to psychological prescription drugs has made psychologic drug abuse, a common phenomena in urban areas.[52–54] However, the decrease in the rate of poisoning could be the result of more rigorous supervision on the drug supply chain and strengthening or the development of comprehensive plans in major cities such as Tehran and Mazandaran.

Access to emergency services is an important factor in the intoxication mortality rate. An undeveloped emergency service led to a higher mortality rate in treatable cases in developing countries (10–20% in comparison to 0.5–1% in developed countries).[55] Two studies in Iran were based on important health indicators, showing that the provinces of Tehran and Mazandaran were ranked as the most desirable provinces in terms of indicators of access to health care, whereas Hormozgan was among the most undesirable and undeveloped provinces.[56,57]

In our study, two provinces of Ilam and Kermanshah followed almost the same pattern in reducing mortality due to poisoning. In two previous studies conducted in Ilam and Kermanshah of Iran, the high poisoning mortality rate was due to the high prevalence of poisoning as a method of suicide, with the highest prevalence in the age group of 15–24 years. These two provinces share much cultural and behavioral similarity.[58,59]

A smaller decrease in the mortality rate was also observed in Fars and Khuzestan, with a relatively hot climate and similarity in agricultural structure. In these regions, there are agricultural activities in most seasons of the year, and paraquat, the most important herbicide, is widely used as weed killer. In addition, in the present study, the mortality due to poisoning in women was similar in southern provinces including Fars, Khuzestan, and Hormozgan and showed a lesser decrease in the mortality trend. In a study in the southwest of Iran, the poisoning rate due to suicide was reported to be 96.6% in Khuzestan and paraquat was known to be one of the deadliest poisons and frequently used for suicide.[60] In the study by Shin et al.,[38] suicidal poisoning occurred with a higher frequency in summer. Considering that pesticides are estimated to be a substantial cause of fatal poisoning, more availability to toxic agents by the victims, inadequate supervision of pesticide poisoning in clinical centers, and even the community, insufficient attention to the development of training programs to minimize these types of deaths at different levels, poor medical management services at different levels of health services, and inappropriate storage of pesticides all could be considered as possible reasons for this pattern of poisoning-related mortality in these provinces.[60] This article, by addressing the factors affecting the further reduction of death in some provinces over the course of 25 years, can have a positive impact on the improvement of other provinces in this country. It may provide a better understanding of the issue for people who are unfamiliar with the burden of disease in Iran because the main focus of the discussion in these articles is provincial differences. The reasons for the reduction of poisoning-related mortality across Iran may be multifaceted, including an increase in preventive interventions; more supervision over access to pesticides and drugs; improvement in the infrastructure of the registry system; improvements in the healthcare system, including the clinical management and treatment of poisoned patients; regulations for access to poison; and the end of the Iraq–Iran War.[2,61–63]

Limitations

Although the present study used various methods to assess the mortality rate, there were still some limitations. It is possible that these results might be biased due to extreme mortality changes and computational constraints. The mean ages of the population were excluded in this study as it is directly affected by mortality rates. Moreover, using other data sources except for Demographic health survey (DHS)—in which data collection methods may be different—is another limitation. Also, we were unable to adjust the results to different social factors. Further studies are needed to analyze these related factors.

Conclusion

Reducing preventable deaths and promoting healthy lives are important goals in a health system. However, it requires detailed, comprehensive, up-to-date, and valid data on comparative mortality at national and subnational levels. During the 25 years of the present study, a decline was achieved in fatal poisoning in Iran at the national and subnational level.

The possible recommendations to continue such achievement could be gains through more political action on preventable deaths, improvement of preventive programs and health services, and continuing injury control. The findings on national and province trends in poisoning mortality should act as a baseline for discussions about health targets in future.

Author statements

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Ethical approval

The Ethics Committee of Tehran University of Medical Sciences approved the study, and the reference number is IR.TUMS.EMRI.REC.1396.00175.

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Competing interests

None declared.

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